THE No1 MONTHLY FOR THE ELECTRONICS & MUSIC HOBBYIST

ELECTRONICS & MUSIC MAKER

PROJECTS, FEATURES, NEWS & REVIEWS
IN ELECTRONICS & ELECTRO~MUSIC

AUGUST 1981
65p

PA SIGNAL PROCESSOR
HIGH QUALITY AUDIO CONTROL WITH LIMITER, PPM & ACTIVE CROSSOVER

HEXADRUM
A NEW STYLE TOUCH-SENSITIVE ELECTRONIC MUSIC MAKER

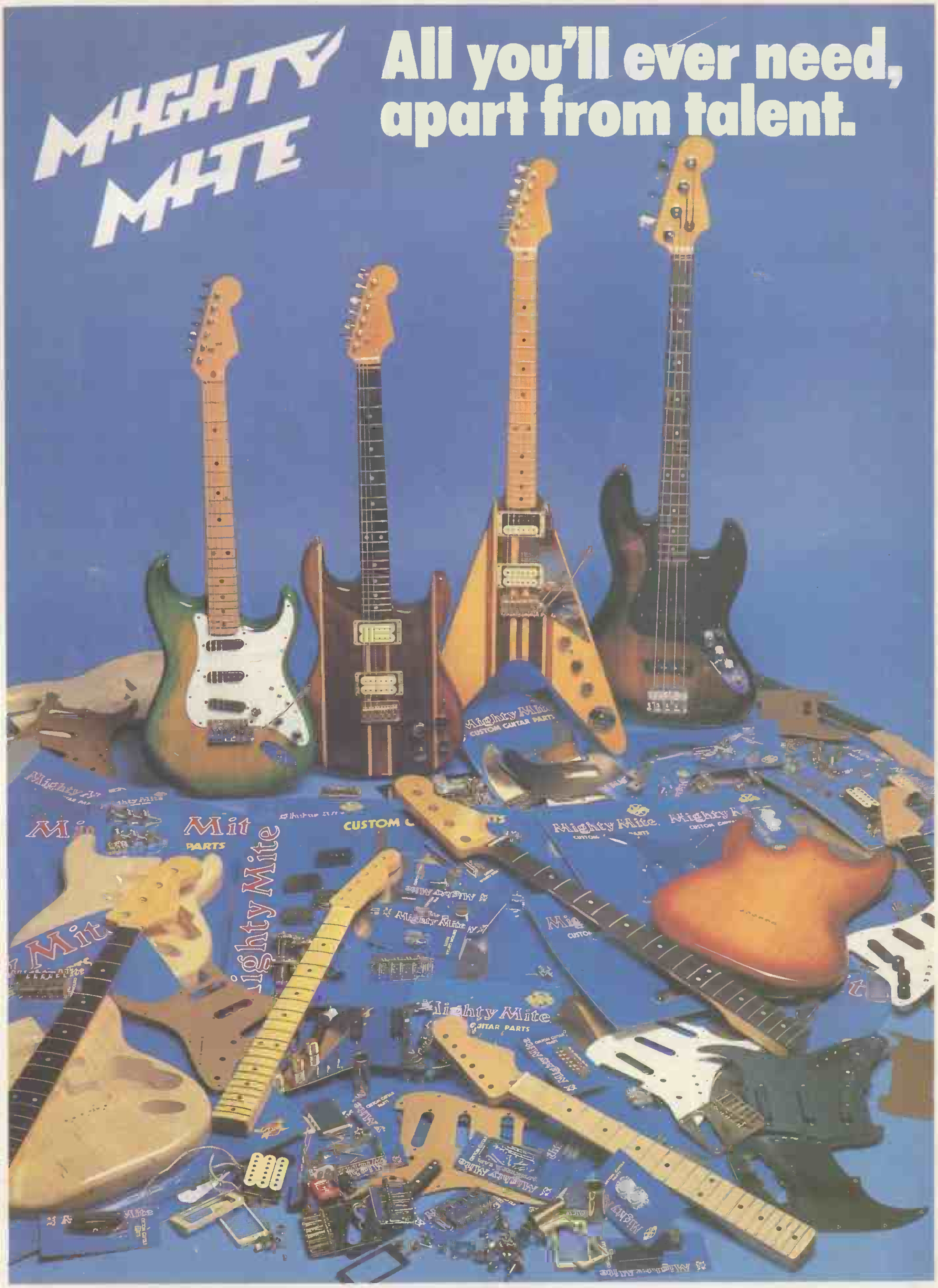
CAR AERIAL BOOSTER
BOOST YOUR CAR RADIO AM/FM RECEPTION

POWERCOMP
MICRO-PERIPHERALS POWER SUPPLY UNIT

PLUS
- MODEL CAR RACE STARTER
- CASIO VL~TONE REVIEW
- INSTRUMENT SYNTHESIS FOR MICROCOMPUTERS
- IRMIN SCHMIDT COMPOSING ON HIS PLANET

THREE SPECIAL OFFERS!!

HOME * WORKSHOP * VEHICLE * EDUCATION * COMPUTING * ELECTRO~MUSIC


MIGHTY MITE
All you'll ever need, apart from talent.

ELECTRONICS & MUSIC MAKER

August 1981

100 Pages for the Electronics and Music Hobbyist!

Editor
Mike Beecher
Art Editor
Peter Blackmore
Production Manager
Brian Searle
Editorial Secretary
Sue Forster
Technical Illustrators
John Dudley
David Stacey
Roy Smith
Photography
Ian James

Consultants
Projects
Robert Penfold
Circuit Design
Chris Lare
Electro-Music
Vince S. Hill
David Ellis
Microprocessors
Peter Kershaw
Music Synthesis
Tim Souster
Studio Recording
Mark Andrews
Education
Steve Leverett
Hi-Fi
Jeff Macaulay
TV & Video
Andy Emmerson
Stage Equipment
Ben Duncan
Organ Electronics
Ken Lenton-Smith
Guitar Electronics
Adrian Legg
Percussion Electronics
Warren Cann
Electronics News
Mark Space
Book Reviews
Nigel Fawcett
Microcomputers
Graham Knight
Software
Graham Daubney
Course Writers
Norman Butler
Graham Hall
Technical Lab
Bob Kirsch
Dave Goodman
Studio Technician
Glenn Rogers

Editorial Offices
282 London Road
Westcliff-on-Sea
Essex SS0 7JG
Tel: (0702) 338878

Advertisement Manager
Alan Gibbs. Tel. 01-527 3376

Advertisement Sales
Terry Day
Dennis Hill

Advertisement Offices
Electronics & Music Maker
Hillcroft House
16 The Avenue
Highams Park
London E4 9LD
Tel: 01-527 3376

Published by
Maplin Publications
282 London Road
Westcliff-on-Sea
Essex SS0 7JG
Tel: (0702) 338878

Distributed by
Cemas Limited
24 Bridge Street
St Ives
Huntingdon
Cambridgeshire PE17 4EG
Tel: (0480) 63942

Printed by
Eden Fisher (Southend) Limited

Typeset by
Quillset Typesetting

Subscriptions
Rates for 12 issues:
UK & Overseas Surface: £9.90
Europe: £11.64
Airmail: £25.20

Special Offers (Overseas)
LP — extra 56p on price
Cassette — extra 19p on price

CONTENTS

ETI VOCODER

COMPLETE KIT ONLY £195 + VAT!

Features as a construction article in Electronics Today International this design enables a vocoder of great versatility and high intelligibility to be built for an amazingly low price. 14 channels are used to achieve its high intelligibility, each channel having its own level control. There are two input amplifiers, one for speech either from microphone or a high level source e.g. mixer or cassette deck and one for external excitation (the substitution signal) from either high or low level sources. Each amplifier has its own level control and a rather special type of tone control giving varying degrees of bass boost with treble cut or treble boost with bass cut. The level of the speech and excitation signals are monitored by LED PPM meters with 10 lights – 7 green and 3 red which indicate the level at 3dB steps. There are three internal sources of excitation – a noise generator and two pulse generators of variable frequency and pulse width. Any of the internal sources and the external source can be mixed together. There is a voiced/unvoiced detector which substitutes noise for the excitation signal at the points in speech where the vocal chord derived sounds of the speaker are substituted for by the unvoiced sounds of sibilants, etc. There is a slew rate control which smooths out the changes in spectral balance and amplitude enabling a change of the speech into singing or chanting and other special effects. A foot switch is provided to permit a complete freeze in spectral balance and amplitude whenever required. An LED on this indicates when the freeze is in operation.

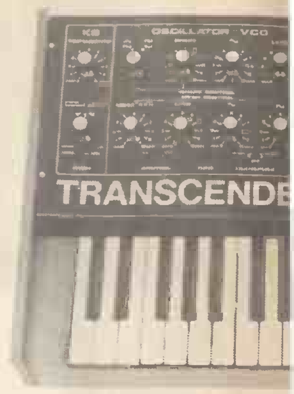
An output mixer allows mixing of the speech, external excitation and vocoder output. The majority of the components fit into the large analysis/synthesis board with the rest on 8 much smaller boards with the controls and sockets mounted on them for ease of construction. Connectors are used for the small amount of wiring between the boards.

The kit includes fully finished metalwork, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc – even a 13A plug!

TRANSCENDENT 2000 SINGLE BOARD

Designed by consultant Tim Orr (formerly synthesiser designer for EMS Ltd.) and featured as a constructional article in ETI, this live performance synthesiser is a 3 octave instrument transposable 2 octaves up or down giving sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.
The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film), and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesiser comparable in performance and quality with ready-built units selling for many times the price.
Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesiser with nothing more elaborate than a multi-meter and a pair of ears!

COMPLETE KIT ONLY £168.50 + VAT!



Cabinet size 24.6" x

CHROMATHEQUE 5000 5 CHANNEL LIGHTING

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward. Kit includes fully finished metalwork, fibreglass PCB controls, wire etc. – Complete right down to the last nut and bolt!

MANY MORE KITS AND ORDERING INFORMATION ON PAGE 33

All projects on this page can be purchased as separate packs, e.g. PCBs, components sets, hardware sets, etc. See our free catalogue for full details and prices.

POWERTRAN ELECTRONICS
PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3WW
ANDOVER
(STD 0264) 64455

POWI

DJ90 STEREOMIXER as being featured in Electronics Today International – July issue!

COMPLETE KIT ONLY £97.50 + VAT!

This versatile new mixer, shown fitted to our console, has 2 stereo inputs for magnetic cartridges, a stereo auxilliary (e.g. cassette or jingle machine) input and a microphone input. The decks can be automatically panned either fast or slow and all 3 music inputs can be mixed with slider controls. There is a 5-section graphics equaliser and a beat-lift control. Also there is a voice-over unit (ducking) and an override button for interrupt announcements. The microphone input can be modulated at a variable rate to produce 'growl' effects and there is monitoring of any music input (pre-fade listen) via the stereo headphone socket and a pair of LED PPMs. The kit includes fully finished metalwork fibreglass, PCBs, controls, wire etc. – complete down to the last nut and bolt! The console is shown fitted with two 19" panel units – a Chromatheque 5000 lighting controller and an SP2-200 stereo 100W/channel power amplifier. For a 200W/channel system two SP2-200s could be fitted.
Power supply for mixer with screening metal box **£9.90+VAT**. Console complete with switch panel, lid feet and carrying handles **£69.50+VAT**.
BSR P256 – their latest belt-drive disco turntable **£29.90+VAT**.

POWERTRAN

TRANSC

MULTI VO

COMPLETE

Cabinet size 36.3" x

SP2-200 2-CHANNEL 100 WATT AMPLIFIER

COMPLETE KIT ONLY £64.90 + VAT!

The power amplifier section of the MPA 200 has proved not only very economical but very rugged and reliable too. This new design uses 2 of these amplifier sections powered by separate power supplies fed from a common toroidal transformer. Input sensitivity is 775mV. Power output is 100 rms into 8 ohm from both channels simultaneously.
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. – complete down to the last nut and bolt!

ELECTRONICS & MUSIC MAKER

For the electronic hobbyist, from beginner to skilled enthusiast, E&MM provides building projects for the home, workshop and vehicle as well as its specialist area of electro-music.

Even prior to the start of E&MM in February this year, the magazine's launch publicity resulted in our projects research team being inundated with offers from established and prospective writers.

The general reader with good experience of electronics design and construction may not realise that we are pleased to consider and even develop, whenever possible, projects that will be of value to hobbyists.

Our contributors come from all walks of life and have included teenagers who have plenty of ideas but not always the knowledge to utilise latest devices, specialist engineers who present their projects immaculately, musicians with a host of interfacing, effects and instrument designs to be solved, and senior citizens having years of involvement in dabbling with electronics.

Projects in the Making!

by Mike Beecher, Editor
Electronics & Music Maker.

A major consideration for a project submitted is that they are tried and tested designs. Our contributors have to follow a publication plan that guarantees the project definitely works and ensures that the circuit diagrams, printed circuit boards and parts allocated for it are correct.

First, the design, description and circuit diagrams are checked by myself and the projects team for preliminary approval as to its suitability for publication. Computer filing of many published electronics projects allows us to check the originality of the proposed project.

The next stage is for the author to submit his prototype and this is thoroughly tested in our technical lab against the specification and for faults.

An important extra stage in the development of a project follows - the building of a second 'production' model using our own specially designed printed circuit boards or Veroboard etc, plus components that have been checked for availability.

We always provide a supply source to enable readers to buy all the necessary electronic components and ready-made printed circuit boards. Everything down to the last nut and bolt is specified as far as possible by the contributor.

Finally, the text for the article to be published is checked by the projects editor and along with sufficient photographs is prepared for printing by our editorial staff.

Having a technical lab, as well as an electro-music studio as part of our overall publication resources, ensures that the latest circuit components are used and serves to update not only the reader, but our contributors as well with the most suitable devices.

Projects always aim to be of good quality and low cost, providing a direct benefit for the hobbyist in making with electronics.

Readers Letters

Send to: Reader's Letters, Electronics & Music Maker
282 London Road, Westcliff-on-Sea, Essex SS0 7JG.

Dear Editor,
The balanced-line system described by Chris Lare should be very useful, but I think the battery-switching arrangements could cause problems. In the line driver a partially-inserted (or half-pulled-out) jack-plug will put the right-channel microphone in series with the battery supply, when the tip of the plug touches the 'ring' contact of the jack. Some microphones can stand this, but others most definitely can't. Likewise in the line receiver a partially-inserted plug puts 9V on to the input of the following mixer or amplifier — and that could do somebody's speakers a power of no-good. Further, in both units the whole supply current always has to flow through a plug-and-socket connection that is directly in series with the signal circuit, and so the slightest movement of the plug will cause noise.
Fortunately these defects can all be eliminated very simply by transferring the switching action to the 5-way DIN connectors. In each unit, battery negative is removed from the 'sleeve' contact of the stereo jack socket and transferred to pin 2 of the DIN socket, from which the existing earth connection is removed. (The earth connection is *not* removed from the shell of the socket.) Then in each DIN plug pin 2 and the shell are connected together as well as to the screen of the cable. The stereo jack sockets may be left as they are, or replaced with mono ones (cheaper!).

E. Jones
Shropshire

All the high impedance microphones used with the prototype boxes utilised an output transformer, and thus any problems due to partially inserted jack plugs were not relevant since no DC path to the 'works' existed. However, many microphones, most notably low impedance types without a transformer may be damaged if plugged in by mistake. In addition, although the ring of the plug will be at 9 volts, it is fed through a high impedance. Having said this it is wise to accept that accidents and abuses do occur, and the idea of using the DIN connector is interesting. This will avoid any problems with the microphones, but will not really help at the receiver end since a large DC surge will appear on the output as the capacitors charge up anyway. To add a slow switch on circuit would add as many components as the basic circuit and was not considered reasonable. Like all audio, connections must be made with the volume down.
If a DIN style switch is used, very high quality connectors must be used, the cheaper plastic style tarnish very quickly resulting in poor chassis connections while the pin 2 connection is still good resulting in far more noise than would ever occur through using the jack switch.
The ideal solution, and one which avoids all these problems is a simple switch added to the circuit at the relevant point; or is so ideal after all — having left it on overnight a couple of times and found the batteries flat . . .
Chris Lare

Dear Sir,
I have been a 'fan' of electronic music for many years now. As a matter of fact it was Kraftwerk that sparked my interest off in 1974 with the famous "Autobahn". One item of interest is that on this LP Kraftwerk used an electronic drum system of their own design. In this system there is an electrical contact between the drum stick and a 'conductive' drum pad. The drum stick itself was connected to the system by an ordinary guitar type lead. All this long before the electronic drum machines we know so well today.
Kraftwerk are now touring Britain, so how about a feature on this remarkable group?
I have just purchased a Moog Prodigy synthesiser but I find that I am the only person I know who likes this area of music. Therefore, I feel it would be useful to people like myself if you ran a section where budding musicians could write in, to make contact with fellow electro-musicians, perhaps indicating their level of skill, thus encouraging the formation of new groups or people to play together just for the fun of it.

D. Jones
Bangor-on-Dee, Clwyd

An interview with Kraftwerk is planned and we've taken you up on your second suggestion as you'll see in our new Classified section this month.

Dear Sir,
I have recently made two of your car battery monitors (E&MM March 1981) and I require help on two points.
First, I notice that LED 1 tends to glow faintly permanently, although the operation of the remainder of the LEDs appears normal. Is this correct? Or, what should I do to correct it. (Incidentally, I have added 2.2uF tant. to the supply leads to absorb supply spikes and this appears to have made no difference.)
Second, I notice that the LEDs are sometimes a little too faint to see in sunlight conditions. R2 is the brightness control. What are the permissible limits to brighten the LEDs without over-running either the chip or the LEDs? (I am operating the chip in the dot-mode.) If I can brighten the LEDs I intend to use a CMOS switch with a control from the lights to vary the LED brightness.

Richard Grant
Newcastle-on-Tyne

Assuming that there are no wiring errors in your unit the most likely cause of the problem is a faulty LM3914. The maximum LED current the LM3914N can supply is 30mA and this would require R2 to have a value of 400 ohms (390 ohms is the nearest preferred value). This current is only available if the device is used in the 'dot' mode, since its maximum dissipation would probably be exceeded if it were to be used at maximum current in the 'bar' mode.

Dear Sir,
Please could you answer the following: Would the MOSFET amp featured in your June issue be suitable for a Bass Guitar? Secondly can you recommend a suitable Pre-Amp with Volume-Bass-Treble?

K. Ritch
Deerness, Orkney Isles

The Mosfet Amp has been tried with Gibson and Fender guitars along with various speaker cabinets and produces a 'Punchy' sound at low frequencies and high sensitivity to the upper harmonics. Ideal for use with bass-lead guitars and all keyboard instruments.
A pre-amp with volume, bass, treble and many extras specifically for use with guitars – keyboards will soon be published in E&MM, so keep watching!

Dear Editor
Congratulations on a superb magazine. It's just what I have been looking for — something constructional as well as good write-ups on electronic music. It would be great if you could publish a rhythm box or just a circuit similar to the one used in the Matinée Organ. Good luck in the future and keep up the good work.
P.S. Great sweatshirts!

C. J. Nash
Cardiff

P.A. SIGNAL PROCESSOR

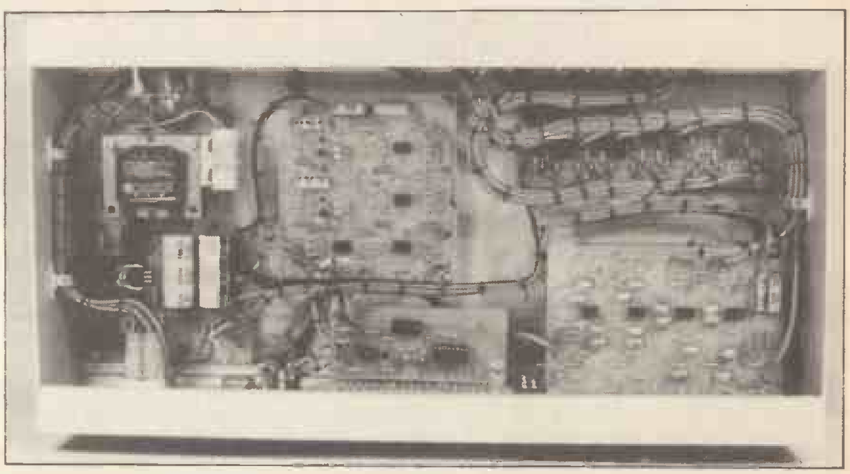
PARTS COST GUIDE
£90
less case

Part 1

by Chris Lare

A professional quality stereo audio control system for group and theatre PA use featuring:

- ★ Audio Limiter
- ★ LED Peak Program Meters
- ★ 3-way Active Crossover
- ★ Balanced Line Output



Nowadays it is usual for a rock group to perform on stage with a high power sound system termed the 'PA'. This two part article describes designs for an audio limiter, a peak program meter and a three band active crossover to help exploit the full capabilities of small and medium sized PA rigs. Although the prototypes were built as stand alone pieces of equipment containing all these functions, there is no reason why the individual designs cannot be installed in existing equipment thereby providing a cheaper form of upgrade.

Many smaller PA rigs used for Pub and Club work expand as and when money is available and as a result are often not as efficiently organised as they would have been had the entire sum of money been available at one time. Often, the quest for higher powers will have resulted in several amplifiers and speakers being purchased and run directly in parallel. The next step to change this form of system into a more orderly arrangement is often avoided because of an assumption of great cost (probably true) and a lack of suitable parts or designs. The E&MM Signal Pro-

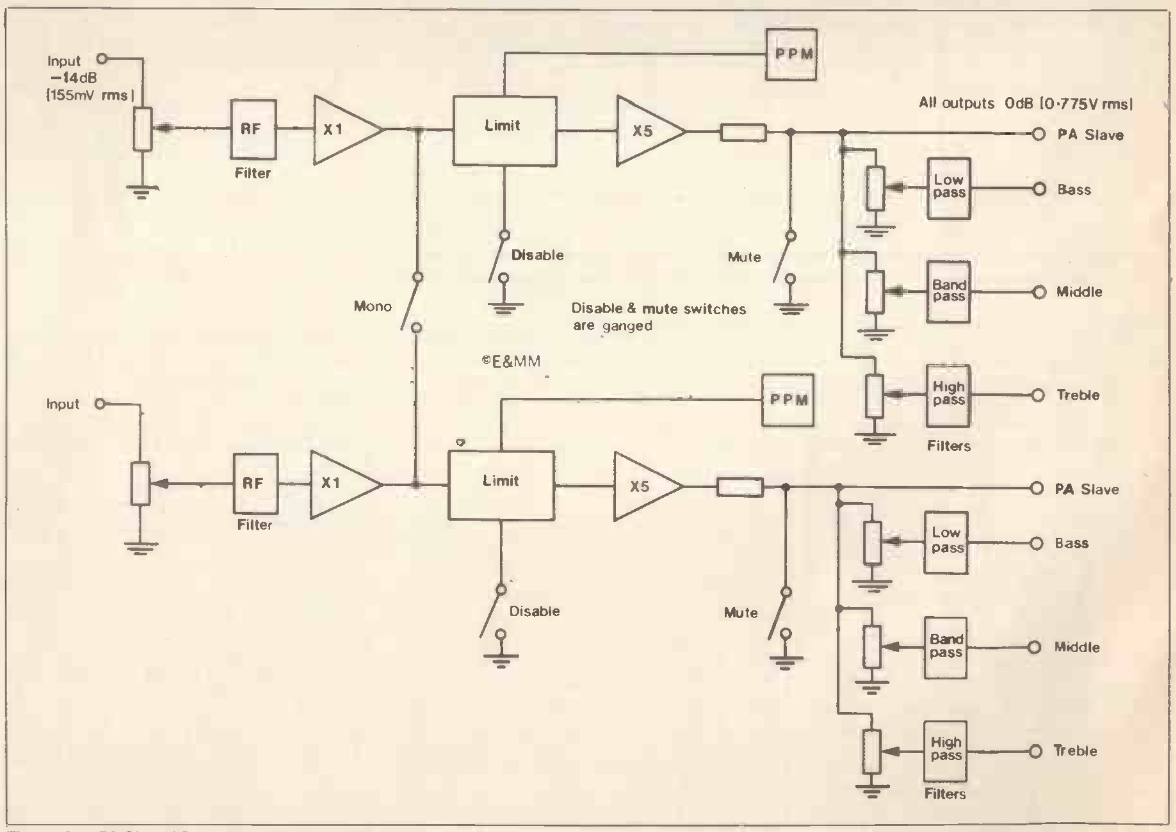


Figure 1. PA Signal Processor block diagram.

cessor is intended to be added to such a system and will generally give a considerable improvement in sound quality, and possibly surprisingly, an increase in apparent volume level. The processor consists of three functional blocks: limiter, peak program meter and active crossover together with a power supply. The function of each block will be covered in some detail before the actual design and construction are described.

Figure 1 shows the block diagram of the stereo prototypes which were built into a 19" rack case. It is intended that this case should be used next to the mixer (or even disco deck), although there is no reason why it should not be used stage side, or why the various functions should not be split up, since each function is self contained. The high impedance input of -14dB sensitivity is connected directly to a level control and thence to a ×1 buffer to drive the limiter. The limiter can be disabled as required. The output from the limiter is available directly (PA Slave Output) to drive additional PA systems or tape recorders, or via a three band crossover with individual level controls on each band. A peak program meter (PPM) uses a convenient output from the limiter (although it also may be used on its own) and displays the audio level as a moving dot on a line of light emitting diodes. Two extra switches are included, a mono switch which is very necessary if the signal source should fail in one channel, and a mute switch which simply switches off all the sound outputs without affecting the meter — useful for setting up levels.

The limiter and PPM will be covered in this part, the active crossover, a suitable power supply and an optional balanced line driver in the second and final part next month.

In the circuit diagrams which follow only the right hand channel is drawn. The components for this channel all have a fixed offset numbering starting at 100, whereas those in the left channel start at 200. Some components do not have an offset, these are common to neither channel and are all to do with the power supply or decoupling.

During construction, particularly if the complete unit is to be built, it is suggested that each board (or set for the PPM) is tested before final installation because it is much easier to debug on a bench. Testing procedures for each board are given after the constructional description, although final calibration is

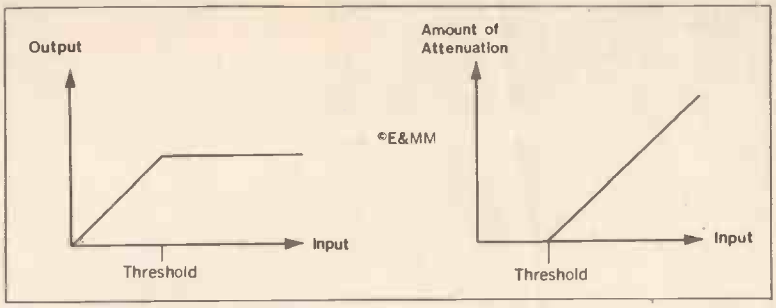


Figure 2. Ideal limiter characteristics.

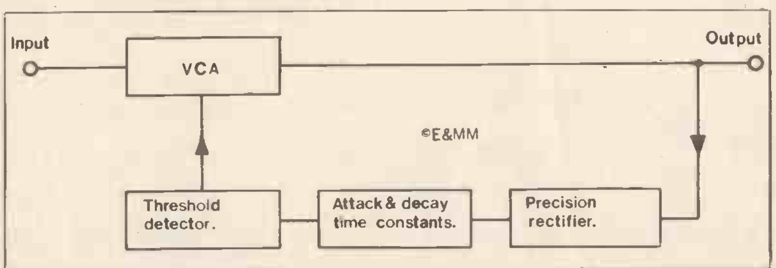


Figure 3. Limiter block diagram.

left until the end of the second article.

It is strongly suggested that only new and branded components are used in the construction of this equipment since it must be reliable even after a few years on the road.

The Limiter

A Limiter is inserted into the audio path to prevent overload of the PA system caused by sudden peaks in level (e.g. shouting down a microphone). In this way a limiter performs no action upon the audio signal, until the level of that signal reaches a pre-determined threshold. Once the threshold is exceeded the limiter progressively attenuates the signal keeping the output constant at the threshold level. The response of an ideal limiter is shown in Figure 2.

A limiter should not be confused with a compressor, although the action is very similar. A compressor reduces the dynamic range of the signal over the entire range and does not have a defined threshold like the limiter. As a result the effect of a compressor is much less obvious, but generally compressed music is much less exciting to listen to because of the lack of dynamic range. Compression is nearly always used when a record is cut, since the dynamic range of a record is low. As stated, in the PA facility the limiter is used more for protection and does not act on the music if the system is properly set up. Thus a limiter is more suited to the requirements here.

A limiter must be capable of reducing the level of music quickly, so as to prevent the overload; 10ms is usually considered a suitable time. The decay time (time to return the level to its original level) must be reasonably long to help avoid sudden shifts in music level. It is important to note that the attack time should not be less than 10ms because the bass response will be affected.

The effect of a limiter is audible since the music level will dip (the effect known as 'breathing'), but the overall effect is far less objectionable than the distortion generated by overload.

A block diagram for a limiter is shown in Figure 3. The output from the voltage controlled attenuator is fed to a precision rectifier, and thence to an attack/decay time constant. The voltage output of the time constant reduces the signal level if the threshold is exceeded by increasing the attenuation. This system is a feedback control path, essential because the VCA chosen does not have a linear voltage/attenuation characteristic.

Stereo Limiters

In the PA signal processor a stereo limiter is required and the best way to do this is open to some debate. A compound limiter with a common rectifier/time constant is apparently the best way since any gain reduction will occur on both channels, thus preserving the stereo image. However, such a system will not detect overload in one channel if the other is lightly driven because of the combined nature of the control path. The logical development is to provide a peak detector for each channel and develop a common control voltage from this. When additional circuits are added to allow differences in the VCA module to be cancelled out, the circuit becomes very cumbersome. Accordingly a pair of identical but separate limiters were used. This proved to perform as well as the complex limiter in actual use. Obviously, the image problem still exists, but this was not very noticeable; again it should be remembered that the limiter will not operate during normal performance.

The Circuit

Figure 4 shows the circuit of the right hand channel of the limiter. The VCA employs a common and cheap 2N3819 FET. Experiments were done with a new generation VCA integrated circuit (the B&B audio 1537) but this was found to generate immense distortion under severe overload, most probably due to cross-modulation in the input stage. Admittedly, this limiter will distort at the same level, but the distortion is much less objectionable and may be regarded as 'soft'.

The source of the 2N3819 FET is held about 4 volts off ground by the resistor capacitor combination. Now, as the FET control voltage (on the gate) starts to rise above the pinch off level the FET resistance starts to fall, thus attenuating the signal by virtue of R103. Since the FET resistance is determined by the gate/source voltage, it is obvious that by increasing the source voltage the

PA Limiter board.

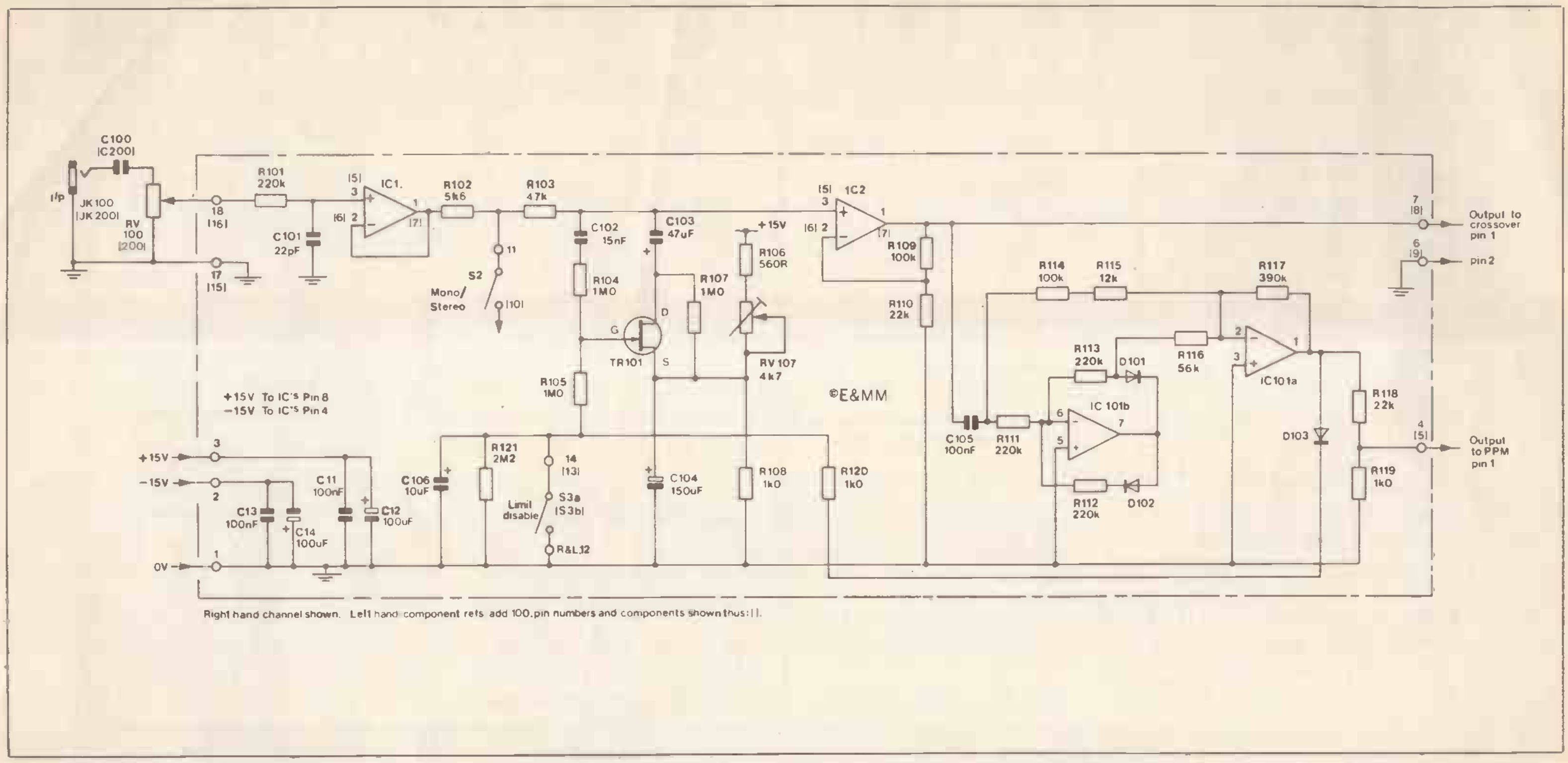


Figure 4. Limiter circuit.

effect of a given gate voltage is reduced. The source voltage is determined by the preset position, and hence the preset serves to set the limiting threshold. It is well known that the distortion produced by an FET can be much reduced by superimposing half the drain voltage on the gate voltage — C102, R104.

The output from the VCA is fed to the ×5 buffer to increase the signal level to 0dB, which in turn feeds the following stages and the precision rectifier, built around IC101. The operation of such a rectifier is slightly tricky and it will be more fully understood if it is realised that the positive and negative signal paths are completely different. If the input is negative, then D102 and R112 conduct creating a virtual earth at pin 6 of IC101. This effectively 'earths' the end of R116. The negative signal is also fed to pin 2 of IC101 and thus emerges as a positive signal, of the same amplitude. A positive signal, however, causes D101 and R113 to conduct, hence the input end of R116 goes negative. The positive signal is also routed by R114 and R115 and the resultant summation gives one 'unit' of negative signal since R116 is half R115 plus R114. This negative 'unit' is inverted by IC101a to again give a positive output. Thus both negative and positive inputs give positive outputs with the gain determined by R117). The output from this rectifier is smoothed by the time constant (D103, R120, C106 and R121) and fed to the gate of the FET. The limiter is disabled by shorting the time constant to ground, hence turning the FET hard off.

A bonus is available in that the precision rectifier output is always present and exactly follows the output signal level. As such, the output from the rectifier can be very conveniently used to drive the PPM, thus avoiding the need to provide another rectifier. The output level from the rectifier is reduced by R118 and R119 to a level suitable for the PPM.

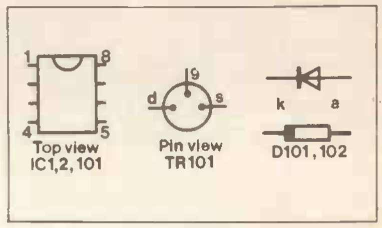
The circuit diagram also shows the input buffer and the low pass filter. R102 is included to prevent damage to the IC when the mono switch is used. Note that the level input to the limiter should not exceed 200mV RMS and an attenuator must be used if higher levels are required.

Construction

All the components for the stereo limiter and the buffers are mounted on one circuit board (Figure 5). The board is designed so that all the switch functions are available at the front of the board, thus minimising wiring. Note that alternative packages for 2N3819s exist and not all have the same pin layout.

Testing

Testing will be more easily accomplished if a scope and signal generator are available, but a meter can be used with less accuracy. Connect the board to a current limited supply and switch on. Check that the power rails are correct on each IC and then connect an audio input. Disable the limiters by linking the appropriate pins on the PCB. Check that the output is present and five times larger than the input. Enable the limiter. Adjust the input level to be larger than 200mV and then alter the presets. At some point it should be noticed that the output starts to be attenuated. Repeat for both limiters. If nothing happens check the output of the rectifiers



Limiter pin connections.

PARTS LIST FOR LIMITER BOARD AND BUFFER

Notes:
1. Component numbering for left and right channels runs 101, 102, etc and 201, 202, etc respectively. Components numbered 1,2,3, etc are common to both channels).
2. All totals are for stereo.

Resistors - all 5% ⅓W carbon unless specified

R101,111,112,113	220k	8 off	(M220K)
R102	5k6	2 off	(M5K6)
R103	47k	2 off	(M47K)
R104,105,107	1M0	6 off	(M1M0)
R106	560R	2 off	(M560R)
R108,119,120	1k0	6 off	(M1K0)
R109,114	100k	4 off	(M100K)
R110,118	22k	4 off	(M22K)
R115	12k	2 off	(M12K)
R116	56k	2 off	(M56K)
R117	390k	2 off	(M390K)
R121	2M2	2 off	(M2M2)
RV107	4k7 min. hor. preset	2 off	(WR57M)

Capacitors

C101	22p polystyrene	2 off	(BX24B)
C102	15n polyester	2 off	(BX71N)
C103	47u 10V tantalum	2 off	(WW75S)
C104	150u 16V axial electrolytic	2 off	(FB55K)
C105,11,13	100n polyester	4 off	(BX76H)
C106	10u 16V tantalum	2 off	(WW68Y)
C12,14	100u 16V axial electrolytic	2 off	(FB49D)

Semiconductors

D101,102	1N4148	4 off	(QL80B)
D103	OA91	2 off	(QH71N)
TR101	2N3819	2 off	(QR36P)
IC101,1,2	LF353	4 off	(WQ31J)

Miscellaneous

S2	SPST miniature toggle		(FH00A)
S3	DPDT miniature toggle		(FH04E)
	Printed circuit board		(GA07H)

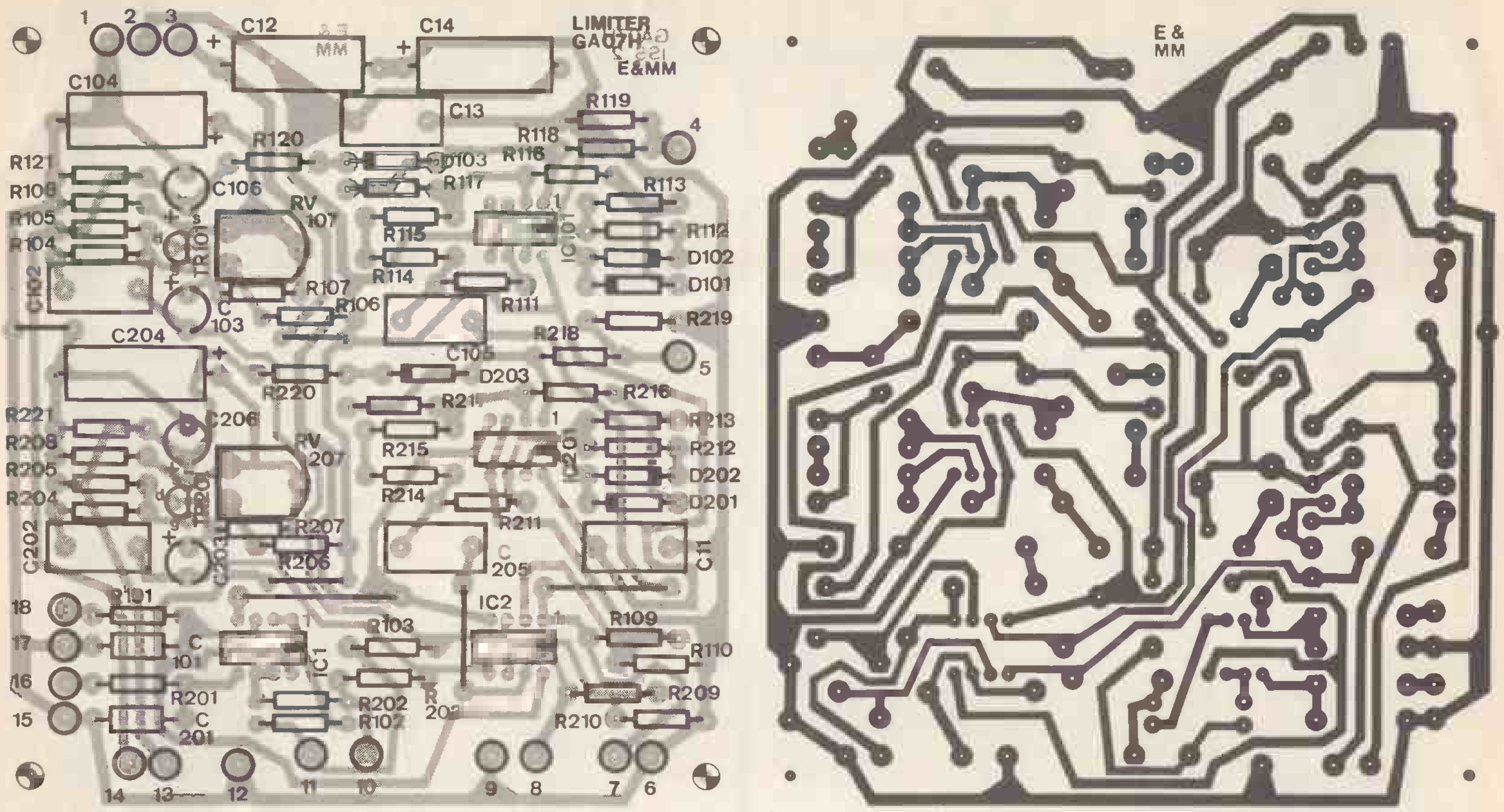


Figure 5. Limiter component overlay and PCB.

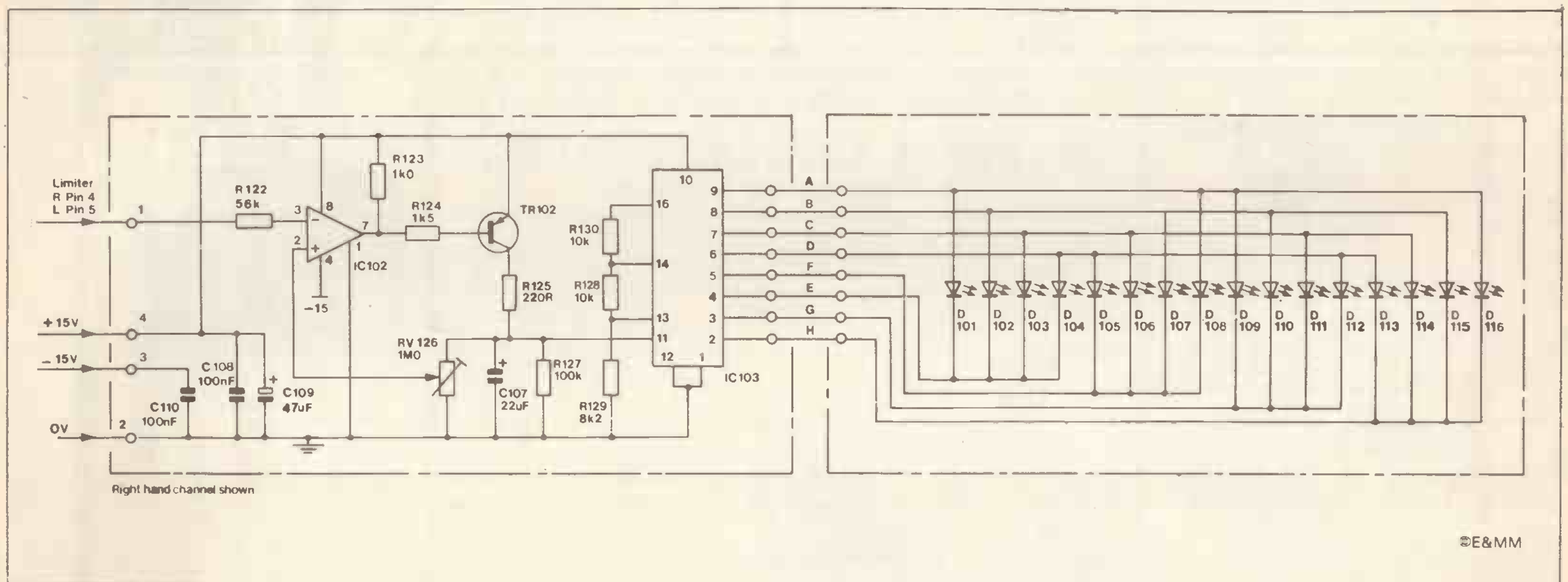


Figure 6. PPM circuit.

and the time constant, remembering that a standard meter will alter the time constant. The final setting up of this module will be covered in the last stages, once it is installed.

The Peak Program Meter

The peak program meter uses a string of 16 LEDs, of which the bottom 12 are green, followed by one orange and three red. The orange will be set to indicate an output of 0dB, and thus the reds will indicate degrees of overload. In this PPM only one led is lit at a time rather than the usual bar graph display, where all the leds up to the level point are lit. This means that the colour change that occurs indicating an overload is much more obvious — particularly out of the corner of the eye when attention is focused on the stage. This type of display is termed a 'moving point' for obvious reasons. The PPM uses the output of the precision rectifier in the limiter section, but it is worth noting that the circuit will work with any audio signal, not necessarily rectified; in this case only the positive peaks in the audio will register.

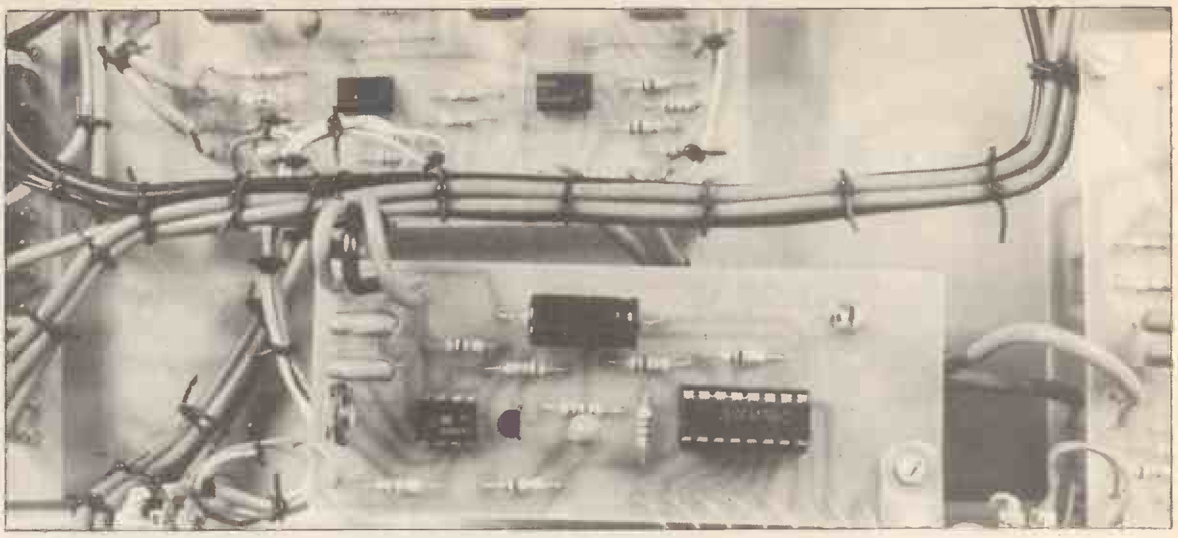
The Circuit

The LED string is driven by a Siemens UAA170L bargraph driver (Figure 6). This was chosen in preference to the LM3914 series because it offered a 16 LED resolution rather than just 10 from the National chip. The integrated circuit is connected according to the application notes, where V_{ref} min and V_{ref} max refer to the minimum display voltage and maximum voltage respectively. R130 determines the LED current, which should not exceed 50mA.

A PPM should have a fast attack time and a slow decay time, and since both are different from those used in the limiter, a different and slightly more complex peak detector is used to achieve an attack time of 5ms and a decay time of 2 seconds. The detector employs a 311 comparator. When the voltage on pin 2 is lower than that on pin 3 the output of the comparator goes low, charging the capacitor by means of TR102 and the attack defining resistor R125. Obviously, when the converse is true the open collector output of the comparator is held high by R123 and nothing further happens. The preset RV126, reduces the proportion of the capacitor voltage to allow calibration of the complete unit.

Construction

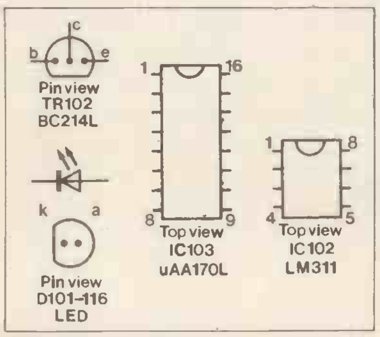
Three printed circuit boards are used, of which two are identical driver circuits. It is suggested that a socket be used for the driver ICs. The third board houses both sets of LEDs (Figure 7). Assemble the driver boards noting that the top board uses double-sided PCB pins for supply connections and insert the wire links into the display board, but do not insert the LEDs until the front panel is complete and final assembly is under way. Then, the LEDs should be fitted into the holes on the display board, but not soldered in. The board is then offered up to the front panel and bolted to the pillars. The LEDs are then guided into the relevant holes with a screwdriver, pressed into place and their wires soldered to the board and trimmed. Note that no LED holders were used in the prototype. The bottom driver board should now be bolted to a bracket, thence to the display board, and linked in with 8 pieces of bare wire. Test this board. The upper board may now be mounted in the same way and a ½" 6BA pillar mounted between the two boards to keep them steady. Three pieces of bare wire were used to connect the power to the bottom driver board, the wires being soldered to three double-sided PCB pins inserted into the top board.



PA Display component board.

Testing

Connect to a power supply and switch on. The bottom LED should light. Apply an audio signal and confirm that the display point moves. If nothing happens check the peak detector and if the display performs erratically a short between two drive lines or a broken drive line is nearly always the cause.



PPM pin connections.

PARTS LIST FOR PEAK PROGRAM METER

Resistors - all 5% ⅓W carbon unless specified

R122	56k	2 off	(M56K)
R123	1k0	2 off	(M1K0)
R124	1k5	2 off	(M1K5)
R125	220R	2 off	(M220R)
R127	100k	2 off	(M100K)
R128,130	10k	4 off	(M10K)
R129	8k2	2 off	(M8K2)
RV126	1M0 min. vert. preset	2 off	(WR77J)
Capacitors			
C107	22u 16V tantalum	2 off	(WW72P)
C108,110	100n polyester	4 off	(BX76H)
C109	47u 25V axial electrolytic	2 off	(FB39N)
Semiconductors			
TR102	BC214L	2 off	(QB62S)
IC102	LM311	2 off	(QY09K)
IC103	UAA170L	2 off	(QY14Q)
LED 101-112	LED green 2.9mm	24 off	(WL33L)
LED 113	LED orange 2.9mm	2 off	(WL34M)
LED 114-116	LED red 2.9mm	6 off	(WL32K)
Miscellaneous			
	16 pin DIL socket	2 off	(BL19V)
	Display PCB		(GA15R)
	Display component PCB	2 off	(GA14Q)
	Double-sided Veropins		(FL23A)
	Brackets		
	Bolt 6BA ¼in.		(BF05F)

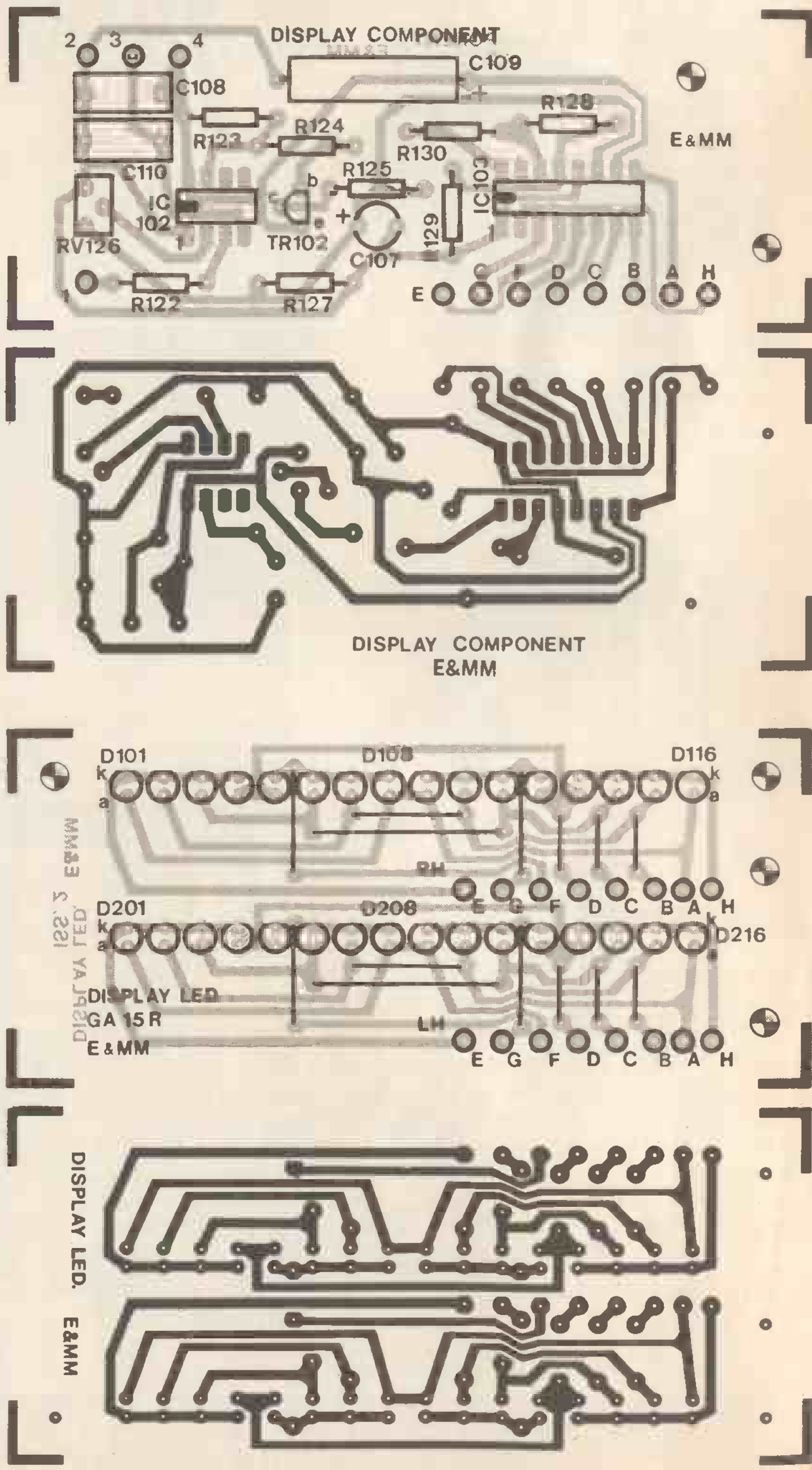


Figure 7. PPM PCBs and component overlays.

OF A NEW ERA

ILP

Which modules?

In launching eighteen different units all within amazingly compact cases to help make complete audio systems using I.L.P. power amplifiers, we bring the most exciting, the most versatile modular assembly scheme ever for constructors of all ages and experience. Study the list – see how these modules will combine to almost any audio project you fancy – and remember *all I.L.P. modules are compatible with each other*, they connect easily. Modules HY6 to HY13 measure 45 x 20 x 40mm. HY66 to HY77 measure 90 x 20 x 40mm. They are so reliable that all I.L.P. modules carry a 5 year no quibble guarantee.

MODEL NO.	MODULE	DESCRIPTION/FACILITIES	CURRENT REQUIRED	PRICE	VAT
HY6	MONO PRE AMP	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Volume/Bass/Treble	10mA	£6.44	£0.97
HY7	MONO MIXER	To mix eight signals into one	10mA	£5.15	£0.77
HY8	STEREO MIXER	Two channels, each mixing five signals into one	10mA	£6.25	£0.94
HY9	STEREO PRE AMP	Two channels mag. Cartridge/ Mic + Volume	10mA	£6.70	£1.01
HY11	MONO MIXER	To mix five signals into one + Bass/Treble controls	10mA	£7.05	£1.06
*HY12	MONO PRE AMP	To mix two signals into one + Bass/Mid-range/Treble	10mA	£6.70	£1.01
*HY13	MONO VU METER	Programmable gain/LED overload driver	10mA	£5.95	£0.89
HY66	STEREO PRE AMP	Mic/Mag. Cartridge/Tape/Tuner/Aux + Volume/Bass/Treble/Balance	20mA	£12.19	£1.83
HY67	STEREO HEADPHONE	Will drive headphones in the range of 4Ω – 2KΩ	80mA	£12.35	£1.85
HY68	STEREO MIXER	Two channels, each mixing ten signals into one	20mA	£7.95	£1.19
HY69	MONO PRE AMP	Two input channels of mag. Cartridge/ Mic + Mixing/Volume/Treble/Bass	20mA	£10.45	£1.57
HY71	DUAL STEREO PRE AMP	Four channels of mag. Cartridge/Mic + Volume	20mA	£10.75	£1.61
*HY72	VOICE OPERATED STEREO FADER	Depth/Delay	20mA	*To be announced*	
*HY73	GUITAR PRE AMP	Two Guitar (Bass/Lead) and Mic + separate Volume/Bass/Treble + Mix	20mA	£12.25	£1.84
†HY74	STEREO MIXER	Two channels, each mixing five signals into one + Treble/Bass	20mA	£11.45	£1.72
†HY75	STEREO PRE AMP	Two channels, each mixing two signals into one + Bass/Mid-range/Treble	20mA	£10.75	£1.61
†HY76	STEREO SWITCH MATRIX	Two channels, each switching one of four signals into one	20mA	*To be announced*	
†HY77	STEREO VU METER DRIVER	Programmable gain/LED overload driver	20mA	£9.25	£1.39

* Ready August – may be ordered now
† Ready September – may be ordered now

All the above modules operate from ±15V minimum to ±30V maximum – higher voltages being accommodated by use of dropper resistors. HY67 can only be used with the PSU 30 power supply unit.

The modules are encapsulated and include latest design high quality clip-on edge connectors.

For easy mounting we recommend
B6 Mounting board for modules HY6 – HY13
78p + 12p. V.A.T.
B66 Mounting board for HY66 – HY77
99p + 13p. V.A.T.

All I.L.P. modules include full connection data.

I.L.P. Products are of British Design and Manufacture.

TO ORDER USING OUR FREEPOST FACILITY

Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to I.L.P. Electronics Ltd. If sending cash, it must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order. *When ordering, U.K. customers must include the appropriate V.A.T. as shown.*
PAYMENT MAY BE MADE BY ACCESS OR BARCLAYCARD IF REQUIRED.

OF RECEIVING YOUR ORDER

ALL WITH ILP'S 5 YEAR NO QUIBBLE GUARANTEE

To: I.L.P. ELECTRONICS LTD, FREEPOST 8, ROPER CLOSE, CANTERBURY CT2 7EP

Please supply ....

.... Total purchase price £ ....

I enclose Cheque ☐ Postal Orders ☐ International Money Order ☐

Please debit my Access/Barclaycard Account No. ....

....

NAME ....

ADDRESS ....

....

Signature ....

E&MM/8

ALL U.K. ORDERS DESPATCHED POST FREE

POWERCOMP

- ★ **Multi-purpose**
- ★ **Overload indication on ±5V rails**
- ★ **Current limiting**
- ★ **Fully floating**

by Trev Miller

PARTS COST GUIDE £39 less case

Many constructors with micros are probably now considering adding peripherals to their systems, such as the Wordmaker, published in the June issue of E&MM. The power supply for the central processor of such systems will rarely be capable of supplying the additional voltage and current requirements of peripherals. To overcome this problem a general purpose peripheral power supply (Powercomp) has been designed which should satisfy most micro users' additional requirements.

The power supply unit has four regulated voltage rails, whose outputs are fixed at +12V, +5V, -5V and -12V. The +12V, -5V and -12V rails are current limited at 1A, with fold back protection to 240mA, 750mA and 350mA respectively. The +5V line will supply up to 2A continuous with a short-circuit current limit of 4A. The supplies are fully floating, with provision on the front panel for tying to mains earth. An indication that each line is up to its specified nominal voltage is provided by an LED above each output terminal. The LEDs on the two 5V lines remain lit until the supplies are loaded down to about 4.5V. No-load ripple on the lines is less 10mV RMS, and at full load on every line, less than 50mV RMS.

Circuit

The circuit diagram of the power supply unit is shown in Figure 1. A 60VA transformer (T1) provides outputs of 10V and 15V symmetrically about a centre 0V tap. The 15V and 10V outputs are rectified separately by BR1 and BR2 respectively, providing ±21V, smoothed by C1 and C4, and ±14V, smoothed by C7, C8 and C11, under no-load conditions. When loaded, more than one volt may be dropped across each bridge diode and several volts of ripple will remain on each

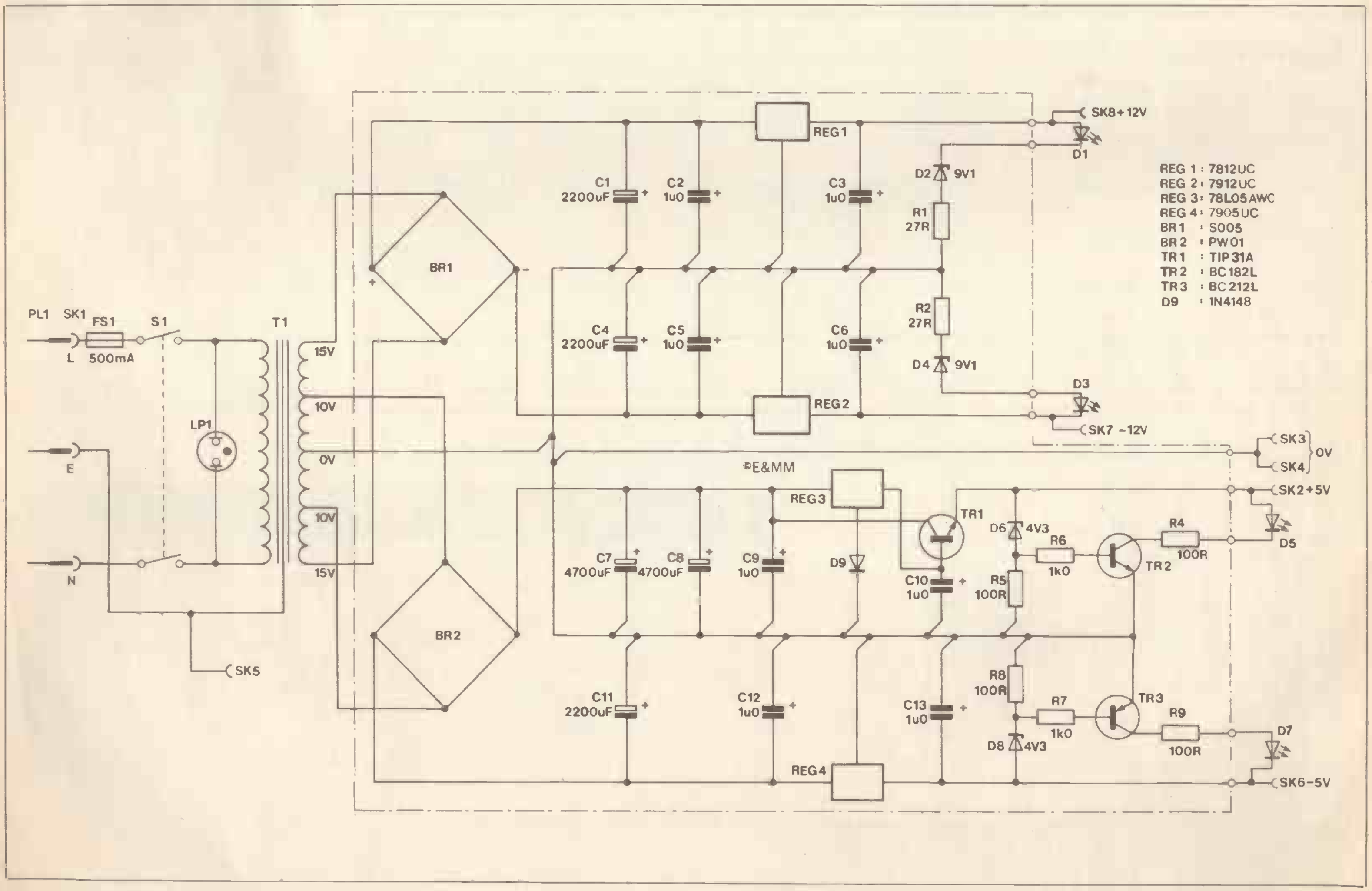
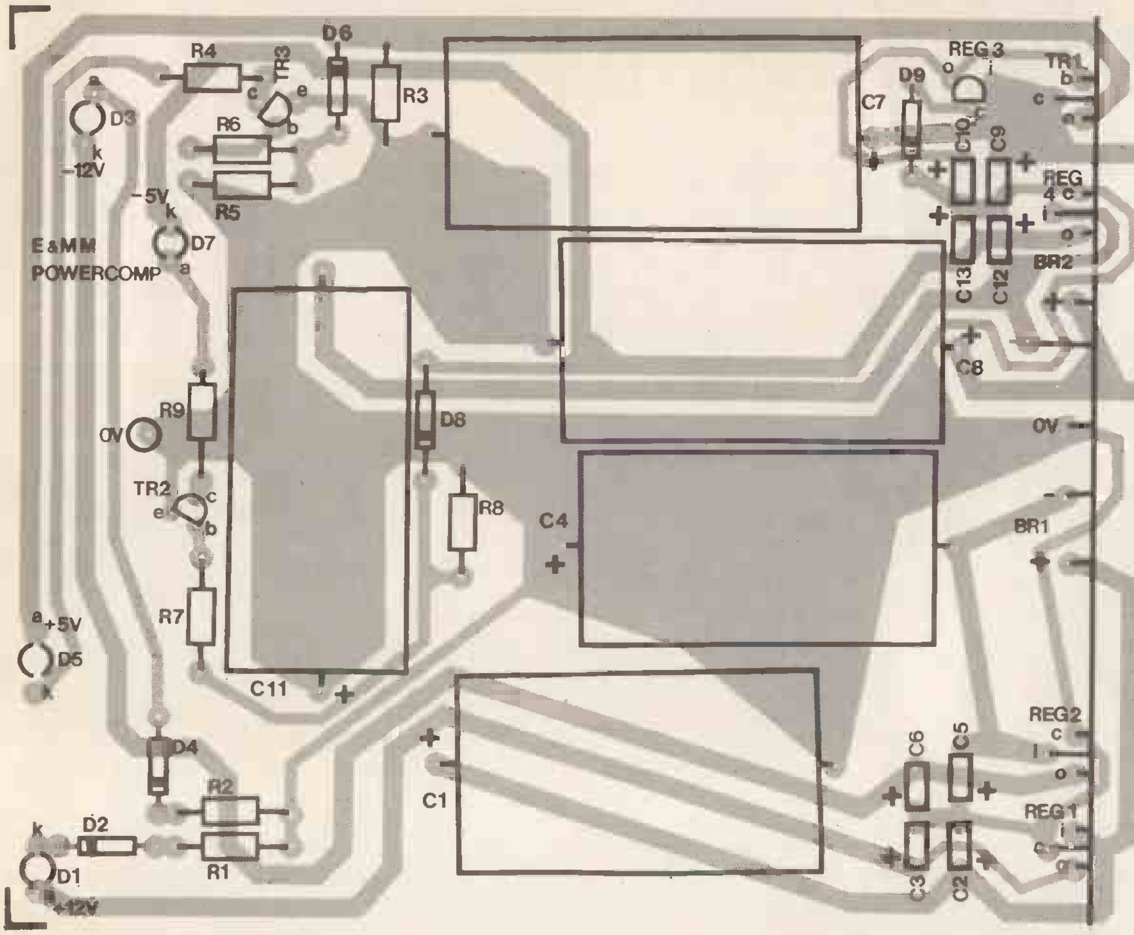
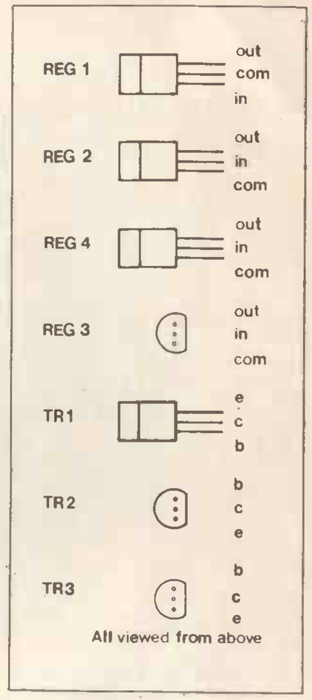
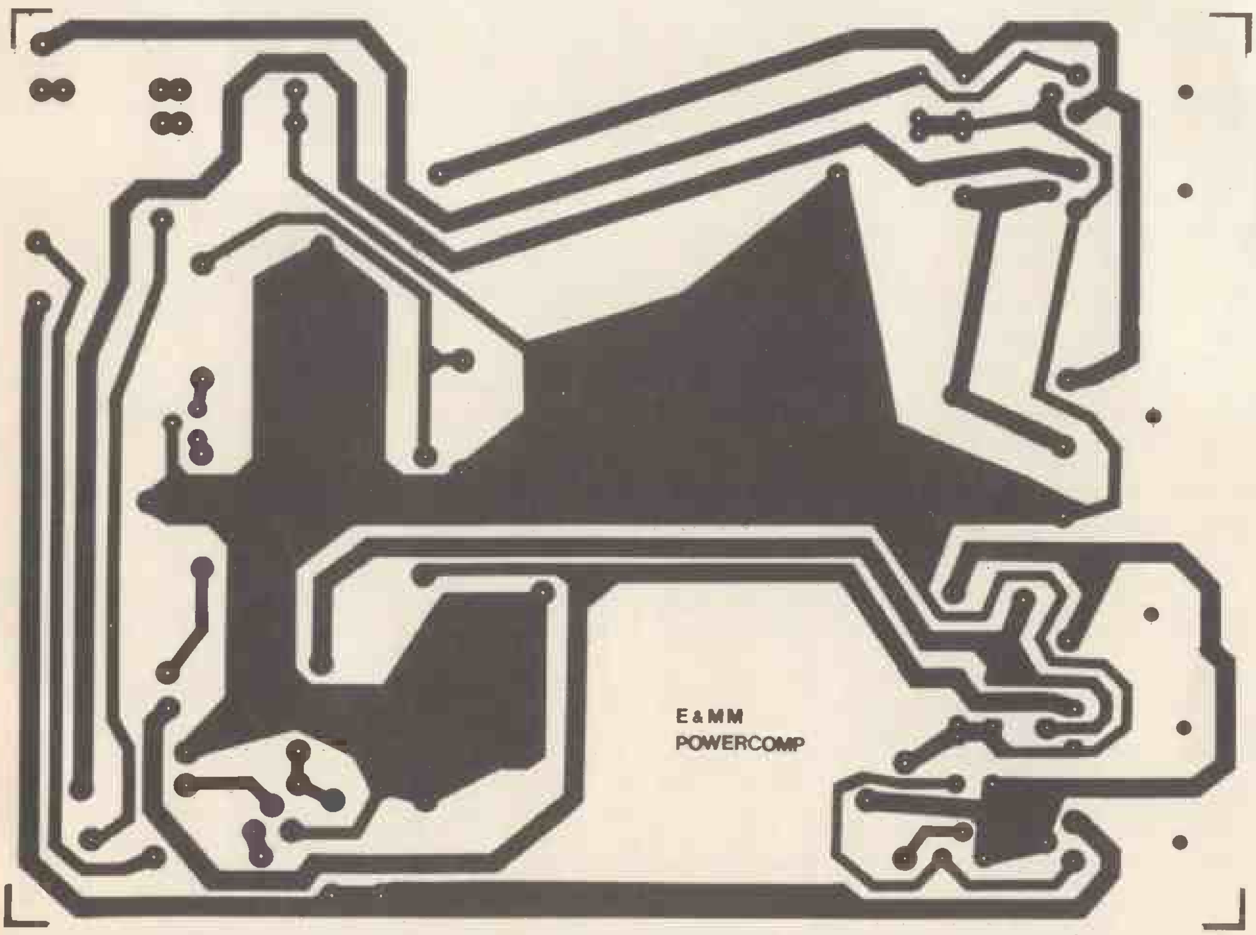


Figure 1. The power supply circuit.





Regulator and transistor pin connections.



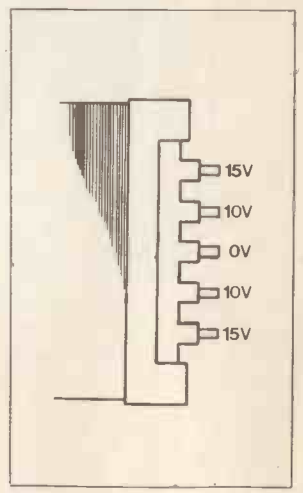
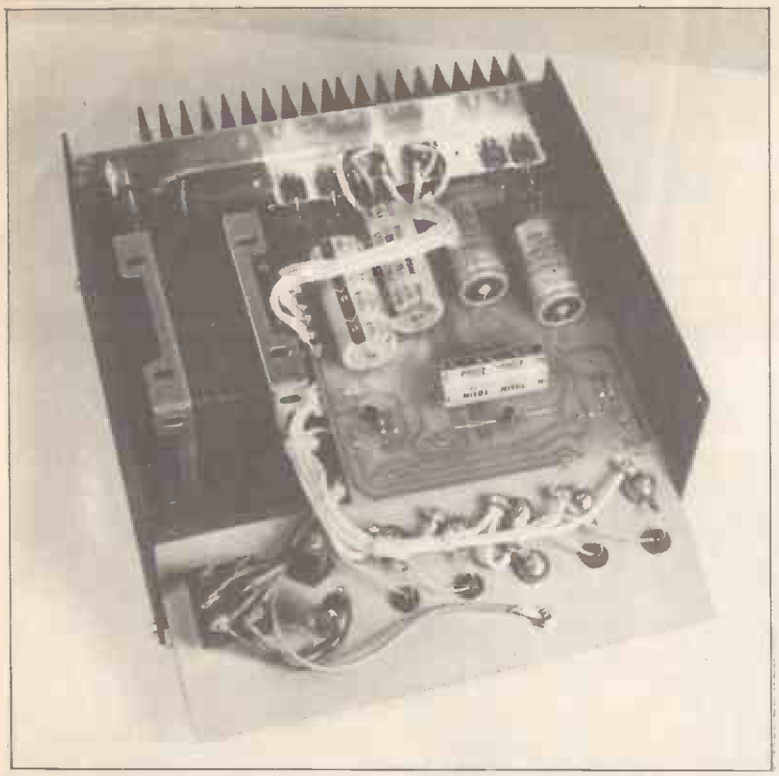


Figure 4. Transformer terminations.

Figure 2. PCB Track and component layouts.



Completed power supply showing internal layout.

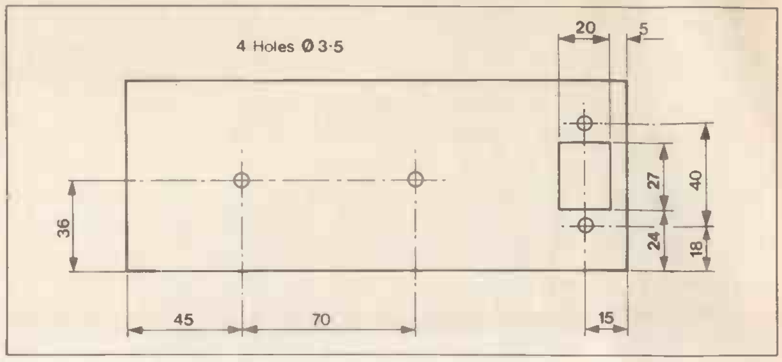


Figure 3(a). Drilling and cutting of back panel.

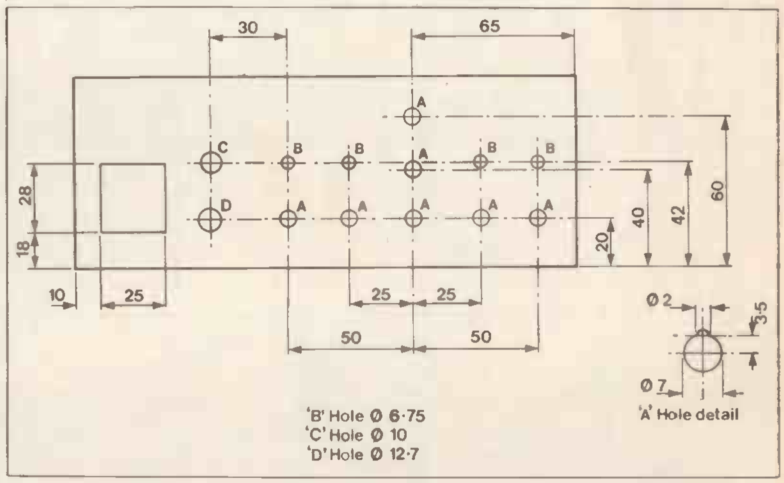


Figure 3(b). Drilling and cutting of front panel.

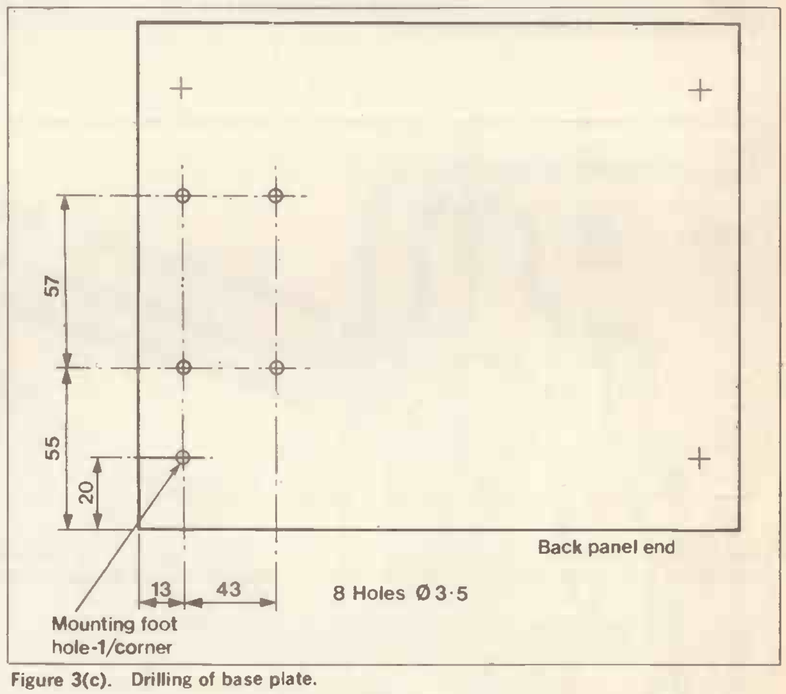


Figure 3(c). Drilling of base plate.

raw supply line. This ripple is normally rejected by the regulators, provided it remains above their minimum input voltage threshold. On each of the one amp lines, current fold back occurs at loads sufficient to cause ripple to appear on the outputs. The 1uF capacitors on the input and output of each regulator reduce the possibility of high frequency oscillation occurring.

Since no cheap, plastic case, two amp, five volt regulator is readily available, the five volt positive rail is regulated by a small 100mA device boosted by a power transistor. The diode in the sense line of the regulator raises the voltage at its output by 0.7V to compensate for the power transistor's V_{BE} drop. The specified power transistor has sufficient gain to provide a current in excess of the rated output before the regulator is loaded to its limit. Ripple breakthrough on the +5V line does not occur until the current drawn exceeds two amps, at which point indicator D5 will extinguish, giving a visual warning of overload.

Indication on the 12V lines is provided by simple, series LED, Zener resistor networks. The knee in low-voltage Zener characteristics is not sufficiently defined to give good switching of the 5V indicator LEDs, and since only 2.6V of a 5V supply remains after dropping 2.4V across a green LED, a 2.7V Zener is hardly adequate. The step in the current to forward voltage relationship of simple diodes is similarly too ill-defined to provide a sharp switch-off. The network used in the circuit provides a better cut-off to supply-undervoltage relationship. Considering the +5V supply, as the voltage at the junction of R5 and R6 approaches the base voltage of TR2, the transistor switches off, reducing the current through D5 to almost zero. R5 provides the required load for D6 and R4 limits the 'on' current through D5.

Construction

The prototype was housed in a sturdy metal cabinet. Since the unit contains parts that are connected to the mains, *operation without the cabinet securely tied to earth can be dangerous.* One of the mains input plug mounting points, a transformer fixing point and the earth terminal on the front panel should all therefore be used as earth points. A metal washer used in place of the plastic insulator on the back of the earth terminal will effect the required earth when the terminal is wired.

The printed circuit board (Figure 2) carries all parts except the transformer and the other mains components, the LEDs and the output terminals. The board is mounted onto the heatsink bracket, which also has the three one amp regulators, the power transistor and the two bridge rectifiers bolted to it. The heatsink bracket and heatsinks are best mounted on the backplate before assembly to the PCB. The two heatsinks are each held in place by a single No. 8 self-tapping screw, also securing the heatsink bracket to the backplate. The aluminium plate supplied with the case kit was used as the backplate, having better heat conduction than the plastic coated steel panel which was used as the front panel instead. The back panel must be drilled as shown in Figure 3(a) and the holes transferred to the heatsinks, located clear of the mains plug and the edges of the panel. A thermally conductive compound (e.g. Thermpath) should be used between all heatsink parts and the backplate as well as between the devices and the heatsink bracket. Mica insulators and plastic bushes (for nylon screws) must be used to mount the regulators and power transistor to the bracket. Where tracks on the board pass close to the mounting holes. Insulating washers should also be used.

Front panel, bottom plate, back plate and a side plate all need to be drilled. Details are given in Figure 3 for all but the side plate, in which the holes provide ventilation for the transformer. A row of holes should be drilled near the top and bottom of this particular plate.

The only wiring for the unit is mains to fuse, switch, neon and

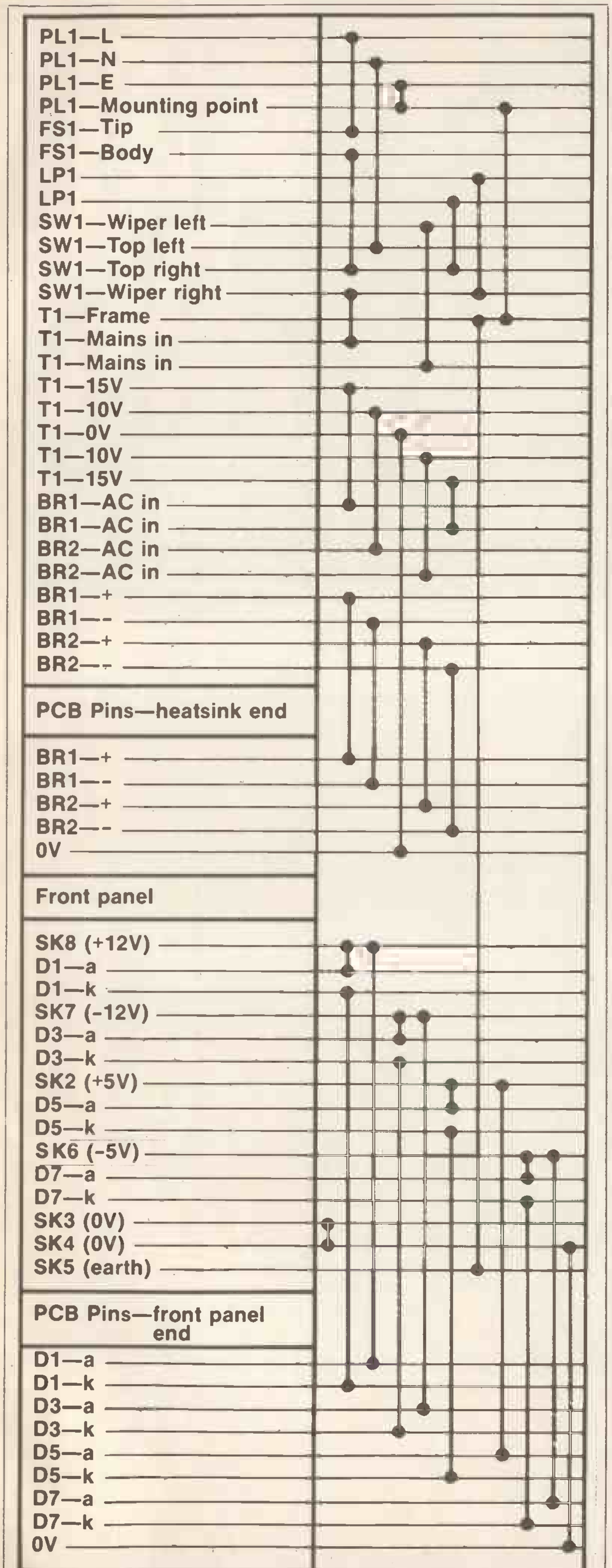


Figure 5. Pianola wiring diagram.

transformer, and output terminals and LEDs to PCB. Figure 5 is a pianola wiring diagram, as used in commercial wiring. The points that are wired together are given but routing of cables is left to the discretion of the constructor. The internal photograph of the unit will give an indication of how this could be accomplished. The transformer connections are shown in Figure 4. Heavy gauge wire, e.g. 32/0.2, 1mm² (6A rating), should be used for all connections except to the LEDs, for which 7/0.2, 0.22mm² wiring is ample.

Testing

After assembly, switch the unit on with no load and check that all indicator LEDs are brightly lit. The output lines should be well within 0.5V of their nominal voltage. The heatsinks and transformer should remain quite cool without load.

Check all lines for ripple with a 'scope if available. A full load may be placed on each 12V line using 15Ω, 10W resistors to 0V. The -5V line may be simultaneously loaded with a 4.7Ω, 7W resistor and the +5V line with a 2.2Ω, 10W resistor.

Under short circuit conditions, some regulators may oscillate at high frequencies. To reduce coupling of this oscillation to the other supply lines, a 10nF polyester capacitor can be added between the back of each output terminal and 0V terminal. **E&MM**

PARTS LIST

Resistors - all 5% ½W carbon film			
R1,2	27R	2 off	(S27R)
R3	4k7		(S4K7)
R4,5,8,9	100R	4 off	(S100R)
R6,7	1k0	2 off	(S1K0)
Capacitors			
C1,4	2200u 40V axial electrolytic	2 off	(FB91Y)
C7,8	4700u 25V axial electrolytic	2 off	(FB96E)
C11	2200u 25V axial electrolytic		(FB90X)
C2,3,5,6,9, 10,12,13	1u 35V tantalum bead	8 off	(WW60Q)
Semiconductors			
BR1	S005 2A 50V Bridge rectifier		(QL09K)
BR2	PW01 6A 100V Bridge rectifier		(WQ57M)
REG1	uA7812UC 1A + 12V regulator		(QL32K)
REG2	uA7912UC 1A -12V regulator		(WQ93B)
REG3	uA78L05AWC 100mA +5V regulator		(QL26D)
REG4	uA7905UC 1A -5V regulator		(WQ92A)
TR1	T1P31A NPN power transistor		(QL15R)
TR2	BC182L PNP transistor		(QB55K)
TR3	BC212L PNP transistor		(QB60R)
D1,3,5,7	LED, Green, standard size	4 off	(WL28F)
D2,4	BZY88C9V1 Zener	2 off	(QH13P)
D6,8	BZY88C4V3 Zener	2 off	(QH05F)
D9	1N4148 diode		(QL80B)
Miscellaneous			
S1	DPDT rocker switch		(FH34M)
LP1	Neon square		(RX81C)
FS1	Fuse 500mA		(WR02C)
	Fuse holder		(RX96E)
SK1	Eurostyle mains socket		(HL16S)
PL1	Eurostyle mains plug		(HL15R)
SK2	Terminal post, red		(HF07H)
SK3	Terminal post, yellow		(HF09K)
SK4-6	Terminal post, green	3 off	(HF05F)
SK7	Terminal post, blue		(HF03D)
SK8	Terminal post, black		(HF02C)
	PCB		(GA34M)
	LED clip	4 off	(YY40T)
	Insulating set	4 off	(WR23A)
	Case WX3 (Centurion)		(XY64U)
	Heatsink type 2E	2 off	(HQ70M)
	Heatsink bracket		(HQ69A)
	Self-tapping screws No. 8, ½in.	2 off	(BF69A)
	Bolt, 4BA ½in.	8 off	(BF03D,
	Nut 4BA	8 off	BF17T)
	Washer 4BA, shakeproof	8 off	(BF25C)
	Cabinet feet	4 off	(FW19V)
	Bolt 6BA 1in.	2 off	(BF07H)
	Bolt 6BA ½in.	6 off	(BF06G)
	Nut 6BA	8 off	(BF18U)
	Washer 6BA, shakeproof	8 off	(BF26D)
T1	60 VA, 15,10,0,10,15V (Type 60 FE75)		

Transformer available from Fladar Electric, PO Box 19, Brookside Engineering Industrial Units, Springfield Drive, Westcliff-on-Sea, Essex. Price £6.10 including VAT, postage and packing.

CAR AERIAL BOOSTER

- ★ **Basic but functional design**
- ★ **AM and FM reception**
- ★ **Ideal for areas with poor signal reception**
- ★ **Low cost**
- ★ **Easy to install**

PARTS COST GUIDE £6

by Robert Penfold

Although a normal car aerial has the useful feature of being omnidirectional, it is less than ideal in terms of signal pick-up. This often results in weak and noisy reception on both the AM and FM bands, especially in areas of relatively low signal strength.

This aerial booster is simply inserted between the aerial lead and the car radio aerial socket, the only other connection that is required is one to the positive side of the car battery. The booster is only suitable for 12 volt negative earth systems but this system is used in most vehicles today. The unit is effective over medium, long, low frequency short wave, and VHF broadcast bands. The degree of improvement obtained depends on a number of factors but in general there would be a substantial improvement in results if the booster was employed with an insensitive receiver in a poor reception area, and little or no improvement if it was used with a receiver having "state of the art" design in a strong reception area.

Basic Arrangement

The booster uses separate amplifiers for the AM and FM bands with a form of crossover arrangement to ensure that the two amplifiers hinder each other as little as possible. The block diagram in Figure 1 outlines the system used.

A high-pass filter blocks AM band signals from the VHF amplifier while a low-pass filter blocks VHF band signals from the AM amplifier. This ensures that no significant amounts of aerial signal are wasted by being fed to the

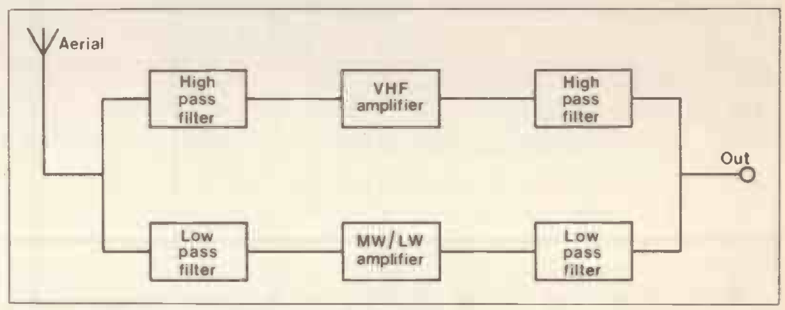


Figure 1. Block diagram of the car aerial booster.

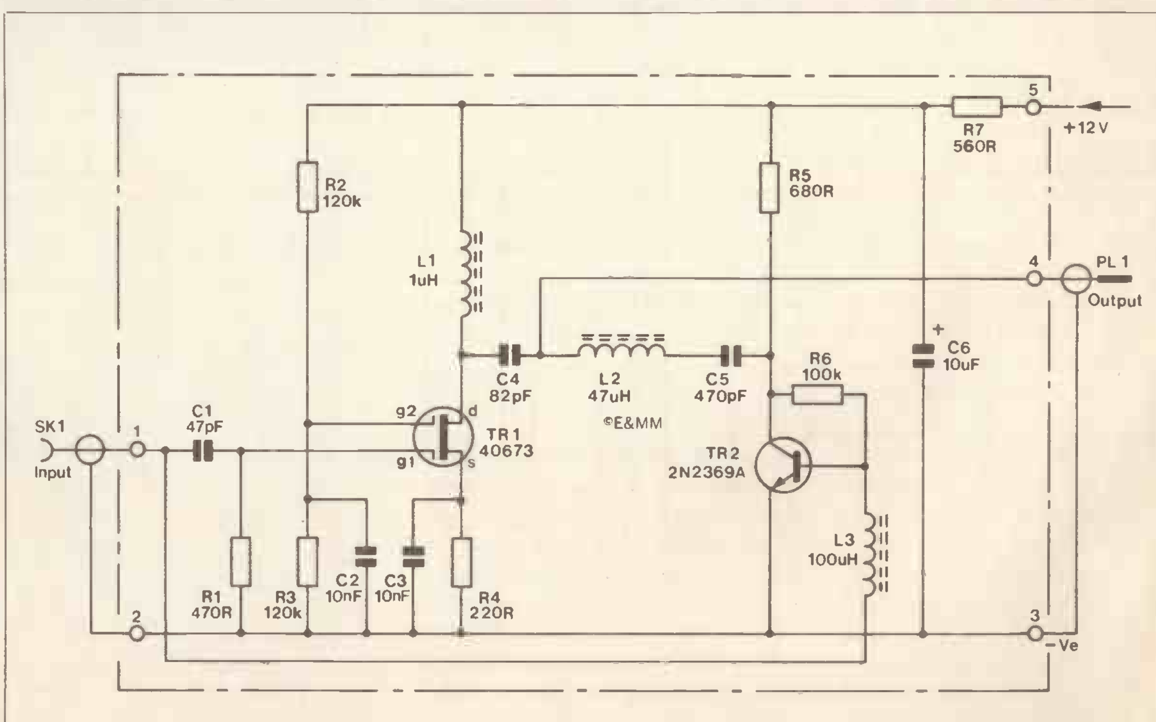


Figure 2. Car aerial booster: circuit diagram.

wrong amplifier stage. Both amplifiers are simple broadband, untuned types. The high-pass and low-pass filters at the outputs prevent either amplifier from feeding any significant amount of its output signal into the other amplifier stage, which would obviously give reduced gain. It also prevents VHF noise from the AM amplifier reaching the output and effectively reducing the noise performance of the FM amplifier stage. Noise from VHF over the AM bands is not really a problem, but the high-pass filter at the output will tend to block any noise of this type that is produced.

Circuit

Figure 2 shows the complete circuit diagram of the booster.

TR1 is used in the VHF amplifier and is a dual gate MOSFET used in the common source mode of operation. A dual gate MOSFET is used as it gives good gain and low noise at VHF. A choke load (L1) is used for TR1 but in other respects it is quite conventional.

The high-pass filter action at the input and output is provided by using low value capacitors (C1 and C4 respectively) at these points. C4 also provides DC blocking at the output. This very simple method of filtering seems to be more than adequate in practice.

TR2 is used in the common emitter mode and is the AM amplifier. It is run at a fairly high collector current (about 8mA) and has a fairly low collector load resistor value so that it maintains good voltage gain up to frequencies of several megahertz. This enables the unit to be used on the low frequency, short-wave broadcast bands (25, 31, 39 and 49 metre bands) if desired.

L2 and L3 have high impedances at VHF, and therefore give the low-pass filtering at the input and output of the AM amplifier. C5 merely provides DC blocking at the output of TR2 and is not a filter component.

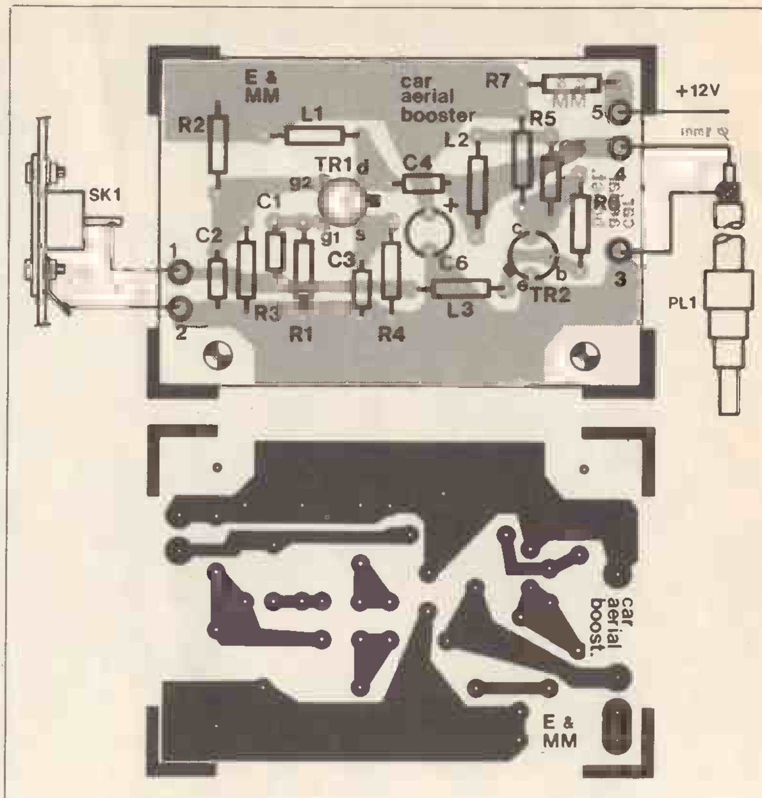
R7 and C6 form a supply decoupling network and these prevent the inevitable noise spikes on the vehicle's supply from degrading the noise performance of the booster. No on/off switch is needed since the current consumption of the circuit is only around 10mA and this is negligible to a car battery which has a very high capacity (in the order of 38Ah or more).

Construction

The aerial booster is built on a printed circuit board, the track and component layouts for which are shown in Figure 3. TR1 is a MOSFET device but as it has internal protection diodes, does not require any special handling precautions.

A small aluminium box makes an inexpensive and practical case for the project, but a non-metallic case could be used if preferred. SK1 is mounted at one end of the box and a solder tag is fitted onto one of its mounting bolts. The opposite end of the case is drilled to produce an exit hole for the output lead which is a coaxial type. This hole should be fitted with a grommet to protect the lead. It should be possible to use this hole as an exit point for the positive supply lead also, without any difficulty.

If Veropins are used on the printed circuit board to carry the off-board connections, the board can be mounted in the case prior to making the connections to SK1, the output lead, and the positive supply lead. If a metal case is used, fit spacers over the mounting bolts so that the connections on the underside of the board do not short-circuit to the case. It is then only necessary to fit a car aerial plug to the output lead and the booster is ready for installation and use. E&MM



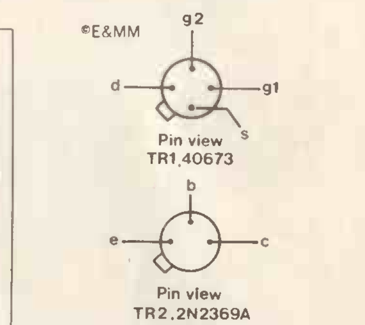
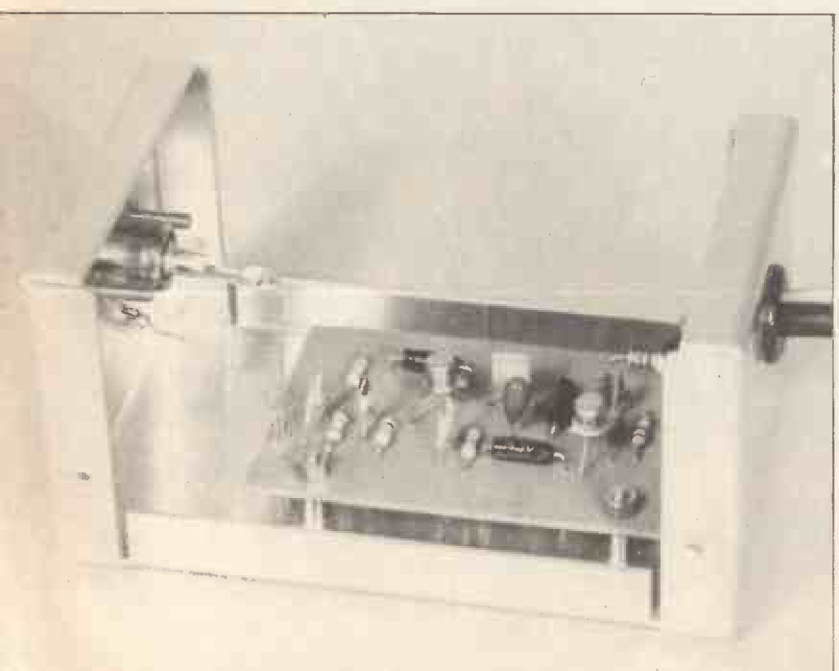


Figure 3. PCB track and component layout and SK1 fixing details.



Internal view of car aerial booster.

PARTS LIST

Resistors - all ⅓ watt 5%

R1	470R		(M470R)
R2,3	120k	2 off	(M120k)
R4	220R		(M220R)
R5	680R		(M680R)
R6	100k		(M100k)
R7	560R		(M560R)

Capacitors

C1	47p ceramic plate		(WX52G)
C2,3	10n ceramic plate	2 off	(WX77J)
C4	82p ceramic plate		(WX55K)
C5	470p ceramic plate		(WX64U)
C6	10u 16V tantalum bead		(WW68Y)

Semiconductors

Tr1	40673		(QX34M)
Tr2	2N2369A		(QR12N)

Inductors

L1	1uH		(WH29G)
L2	47uH		(WH39N)
L3	100uH		(WH41U)

Miscellaneous

	Case type AB9		(LF10L)
SK1	Chassis Car Aerial Socket		(HH14Q)
PL1	Skeleton Car Plug		(HH13P)
	Coax cable 1 metre		(XR30H)
	Bolt 6BA ½in	2 off	(BF06G)
	Nut 6BA	4 off	(BF18U)
	Spacer 6BA ¼in	2 off	(FW34M)
	Grommet		(FW59P)
	Printed circuit board		(GA40T)
	Washer, shakeproof 6BA	2 off	(BF26D)


SPACE-AGE TECHNOLOGY AT YOUR FINGERTIPS
ATARI
MANCHESTER'S BEST ATARI DEALER
PUT YOURSELF ONTO OUR NEW ATARI CARTRIDGE INFORMATION MAILING LIST
ATARI
VIDEO COMPUTER SYSTEM £99
SPACE INVADERS £24.95
FULL RANGE OF CARTRIDGES IN STOCK AT LOWEST PRICES!
ATARI 400 COMPUTER NOW AVAILABLE
INVADER 1000
£19.95
CALL IN TO SEE OUR SUPERB RANGE OF HAND-HELD COMPUTER GAMES
ANSAMAC
ANSWERING MACHINE
£64.95
Post Office CERTIFIED
MORPHY ENCORE CHESS COMPUTER
£149
STRONGEST CHESS PROGRAMME AVAILABLE!
TOSHIBA
KT-S2
Stereo Cassette and FM Radio
£99.95
SENSORY CHESS CHALLENGER
CHESS CHALLENGER
THE FIRST THINKING CHESS GAME THAT 'SEES' EVERY MOVE YOU MAKE!
£119.00
NEW! RADOFIN
ADD-ON TELETEXT DECODER II
Dial-a-page news and information on your T.V.
£199
SPECIAL MAIL ORDER SERVICE WRITE OR PHONE FOR FULL DETAILS
BARCLAYCARD
VISA
CALL IN TO SEE OUR COMPLETE RANGE OF ADVANCED ELECTRONIC PRODUCTS. ALL ON FULL DEMONSTRATION. BEST RANGE IN MANCHESTER AND AT THE LOWEST PRICES! ALL OUR PRODUCTS CARRY A FULL 12 MONTHS GUARANTEE.
WE ARE OPEN:
TUESDAY-FRIDAY: 10am-1pm & 2pm-5pm
SATURDAY: 10-3pm
PLEASE NOTE – CLOSED MONDAYS
GEMINI ELECTRONICS
Dept. E&MM/8, 50 Newton St. (off Piccadilly), Manchester. Tel: 061-236 3083.
WE ARE AT THE CORNER NEWTON ST./ HILTON ST.

HEXADRUM

Sounds of the future are as simple to make as drumming your fingers on this novel instrument!

- ★ Six electronic bongo tones
- ★ Touch sensitive
- ★ Battery powered
- ★ Ideal for home, education and studio

RECORDED ON CASSETTE NO. 3

PARTS COST GUIDE
£13
less case

Until recently, many electronic percussion instruments have been little more than impact-triggered synthesisers of varying complexity, all subject to the disadvantage that the nature of the shock causing their sound in no way affects the character of the sound produced. To vary the loudness or timbre of the sound, some control must be adjusted, an action not exactly compatible with the fluent playing of percussion.

Hexadrum is a different kind of electronic percussion instrument: it is touch sensitive. The six sensors are arranged to be beneath the fingertips of a comfortably placed hand and are played by simply tapping with the fingertips. A harder tap produces a louder sound; a tap with an object harder than a fingertip produces a sharper sound. Any number of sensors may be struck at any time to produce a composite sound. The only electronic control is to set the overall signal level output, in other words, a volume control.

When played through an amplifier and speaker system designed to give faithful reproduction of audio, the sounds of Hexadrum are best described as similar to bongoes, though the lower range drums are of a lower range than normally encountered in bongoes and more like a bass drum. Like all other electronic instruments, Hexadrum may be played through any special effects unit, such as reverberation, echo, phaser, flanger or synthesiser external input, to obtain a different sound.

Its use is not restricted to trained percussionists, for the 'hand' layout virtually gives all 'finger-tappers' opportunity to experiment with rhythms. The potential of this low cost instrument makes it ideal for the music room - be it in school, home or studio. The touch sensitive pads give the Hexadrum some of that creative dynamic feel of the skin drum. Being battery powered, the unit can be connected via guitar coiled cable to group amplifier for on-stage performance. In the home or classroom, the output plugs direct into tape, mic or line inputs of your stereo (or mono) unit.

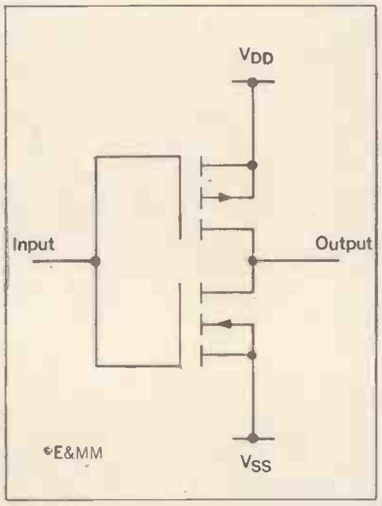


Figure 1. Output stage of 4069 inverter.

Piezo-ceramic Pick-ups

The touch sensors employed in Hexadrum are piezo-ceramic wafers deposited on thin brass plates about the size of twopenny pieces. Striking such a brass plate causes it to vibrate, distorting the ceramic layer attached to it and creating a small piezo-electric potential across the ceramic. This voltage, of the order of millivolts, is picked off from the brass backplate and another very thin electrode deposited on top of the ceramic.

As the voltage across the ceramic is proportional to its distortion, the signal produced by striking the brass plate contains all the frequencies of vibration of the plate. Amplified and reproduced in its raw form, this signal sounds (not surprisingly) like the sound actually made by the brass plate when struck: a short burst of almost white noise with a sharp attack and relatively rather longer decay. Though the plates do resonate, this is at several kilohertz, as they are far too small and rigid to mimic exactly the vibrations of the skin of a drum. However, the envelope of the sound is similar to that of a drum, and contained within the noise are the frequencies required to simulate the timbral qualities of a drum.

Filters, logically!

The way the sound of Hexadrum is extracted from the noise signal produced by the piezo transducers is, of course, by filtering. To implement six large-gain filter preamplifiers as cheaply as possible, a single CMOS hex-inverter pack is used. Placing DC feedback around each inverter converts the digital gates to simple large-gain, analogue, inverting amplifiers. Since the output from the amplifiers is not intended to be a faithful, amplified reproduction of their input signal, the limitations of the gates as amplifiers are acceptable in this application.

A problem associated with the novel use of CMOS logic to perform analogue functions occurs as a result of the transfer characteristics and the biasing, or rather the lack of biasing, of the FETs making up the device used. The output section of each inverter is shown in Figure 1. The gates of the two FETs are also DC coupled to the input of the inverter. When an input voltage within the noise margin of the inverter, a band between the two supplies, is applied to the gate both FETs will be partially on together. Such a condition exists when the inverter is included in a feedback loop. The result is that a quiescent current that is substantially larger than quoted for the pack flows through the FETs. This mode of operation is analagous to amplifier class A operation.

To minimise the FET bias current, the inverter pack is run from a 5.6V supply provided by a Zener. This reduces its quiescent current from about 20mA at 9V to 5mA compared to a manufacturers quoted value of 10nA!

The circuit diagrams of the Hexadrum and the component values for each drum are shown in Figure 2.

The frequency response of the filters is bandpass, with a 12dB per octave cutoff except in the case of the lowest range drum in which the roll-off is not so steep. RV11-61 provide some control of

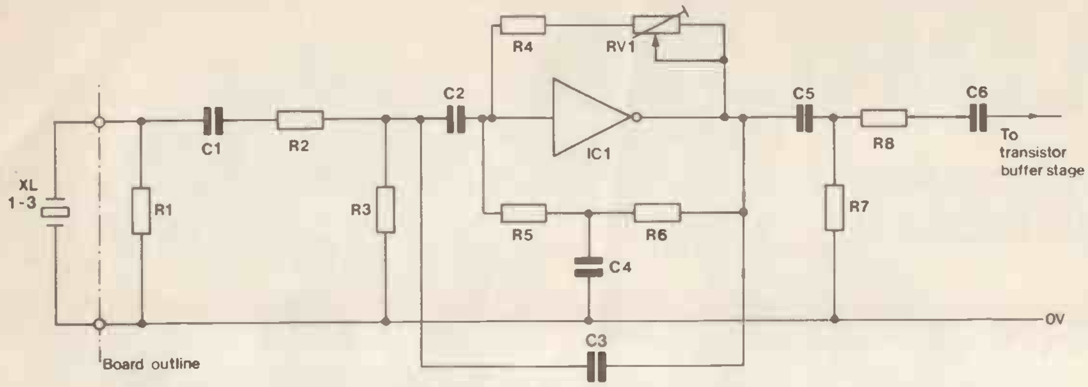


Figure 2(a). Circuit of upper range drums.

Compon-ent ref.	R1	R2	R3	R4	R5	R6	R7	R8	C1	C2	C3	C4	C5	C6
Drum 1	180k	68k	10k	180k	68k	68k	180k	150k	15nF	4n7	4n7	12nF	12nF	1n5
Drum 2	Values as for drum 1								27nF	10nF	10nF	27nF	27nF	1n5
Drum 3	Values as for drum 1							470k	39nF	15nF	15nF	39nF	39nF	4n7

Figure 2(b). Resistor and capacitor values for Figure 2(a).

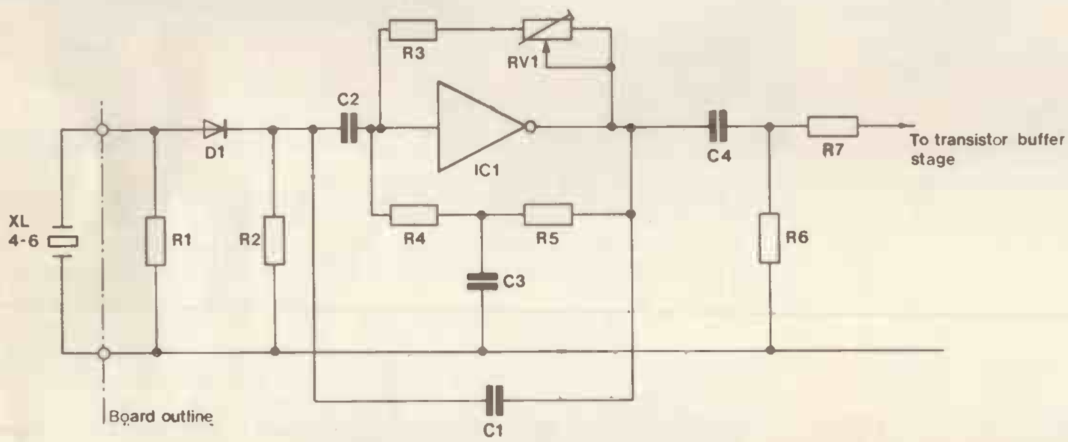


Figure 2(c). Circuit for lower-range drums.

Compon-ent ref	R1	R2	R3	R4	R5	R6	R7	C1	C2	C3	C4
Drum 4	180k	10k	180k	68k	68k	180k	680k	22nF	68nF	68nF	68nF
Drum 5	Values as for drum 4						470k	33nF	100nF	100nF	150nF
Drum 6				Not used			470k	47nF	150nF	Not used	150nF

Figure 2(d). Resistor and capacitor values for Figure 2(c).

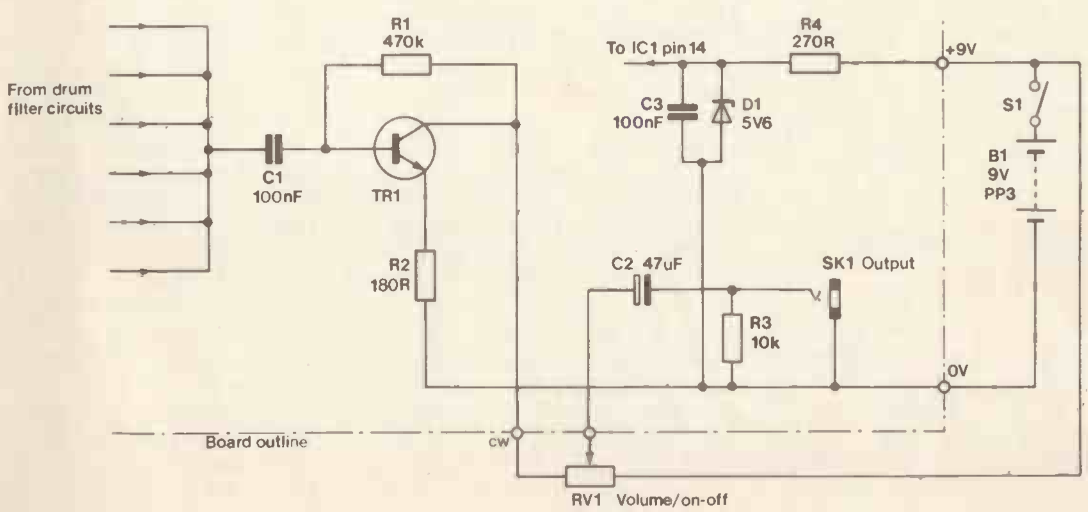


Figure 2(e). Circuit of transistor buffer stage and supply wiring.

the resonance of each filter. At their resonant frequencies, the filters have a gain of about 40dB. The frequencies covered by the drums encompass several octaves, from 40Hz up to 5kHz.

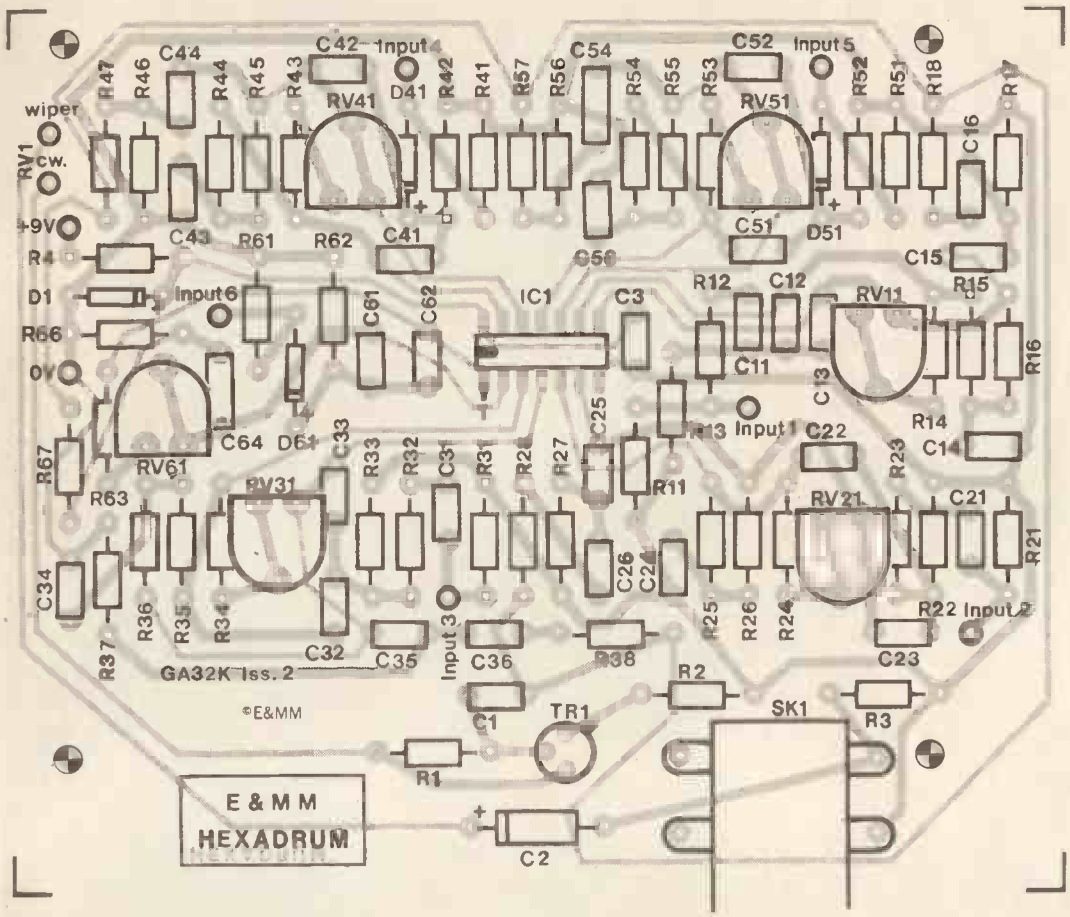
Although the filters may look a little unorthodox, they can be regarded as modified versions of the well known multiple feedback/bandpass type with adjustable resonance.

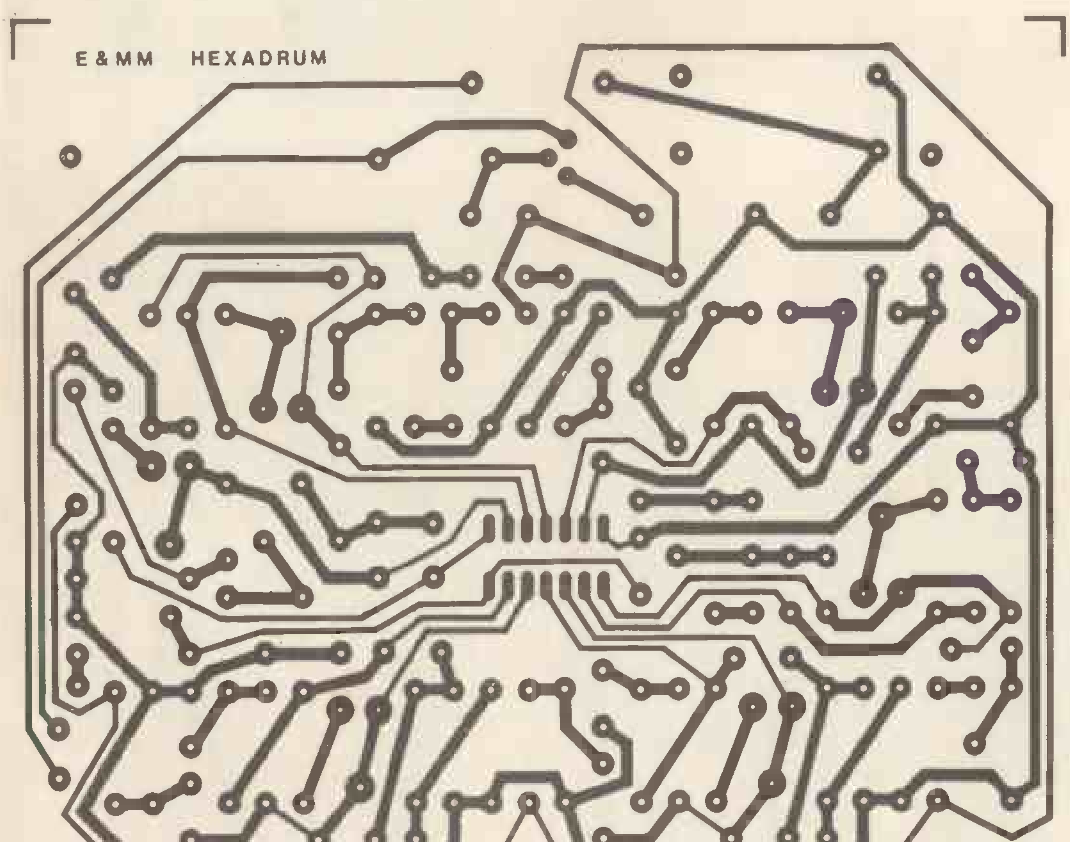
Construction

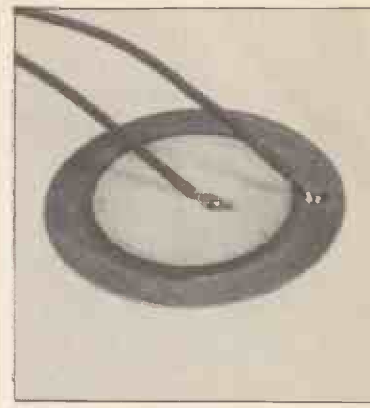
Assembly of the printed circuit board is straightforward, following the normal practice of installing pins, passive components and finally the integrated circuit which should be mounted in a socket. The output jack socket is best fitted first to the side panel, the tags then bent to lay flat against the circuit board and only soldered in place when the board is screwed down.

Before undertaking any work on the case, double check the layout of all parts to be mounted on it. The reasons for this are that the circuit board and its mounting points are assymetrical, in addition to which the two case halves only fit together one way round. For the orientation of the board and non-board mounted components, check the photographs and diagrams given. Note that some of the unused board mounting pillars on the base and lid sections of the suggested case must be cropped off to allow room for the volume control potentiometer and switch.

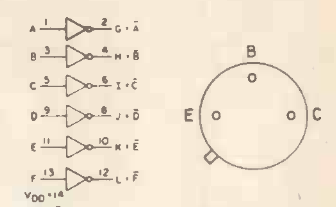
No layout for the pick-ups is given as the constructor is the best person to ascertain this from the most comfortable position of the hand of the player. However, ensure that no pick-up is to be located over one of the circuit board mounting pillars before beginning cutting. If the lid of the case is covered with masking tape or self adhesive plastic film to prevent damage to it during construction, the outline of the player's hand may be marked out directly onto this. An effective method of cutting the holes for the pick-ups is to use a sheet metal punch of diameter 20-23mm. In order to attach the earth wire to the brass plate, a small notch must also be made in the edge of the hole, either by drilling a small hole of diameter less than 3mm adjacent to the edge of the punched hole or simply filing. The earth leads themselves must be soldered very cleanly to the brass rims of the pick-ups before they are installed. This is shown in the photograph. The brass area is a large heat sink and so therefore requires quite a lot of heat but the minimum of solder. The pick-ups







Soldering to the piezo transducers.



IC1 pinout

TR1 pinout (viewed from below)

can then be fixed in place using a cyanoacrylate adhesive, such as Loctite Super Glue 3. Soldering to the silvered electrode must be done with the minimum of heat for a fraction of a second, or destruction of the silvering begins to occur. Connections from inputs to pick-ups are neatly made with ribbon cable. The inputs are numbered from the highest pitch to the lowest. Since hum was a slight problem in the prototype (cured by sticking earthed aluminium foil inside the case and earthing the metal panels), the constructor may find screened leads to the pick-ups reduce the problem.

Assuming completion of all other mechanical work on the case, the circuit board may now be screwed down and hardwired to the pick-ups, potentiometer, battery and switch.

The artwork on the case of one prototype was made by cutting the shape of the hand out of coloured, self-adhesive plastic. Another case was sprayed using a matt black cellulose aerosol, then a mask in the shape of the player's hand was cut with a scalpel from an outline drawn on self-adhesive film initially applied to the case. Finally, fix the sponge rubber 'Trimseal' pads over the pick-ups and screw the case together to complete construction. The presets may need to be adjusted to damp the resonance of some of the drums (anticlockwise) and peak the resonance of others.

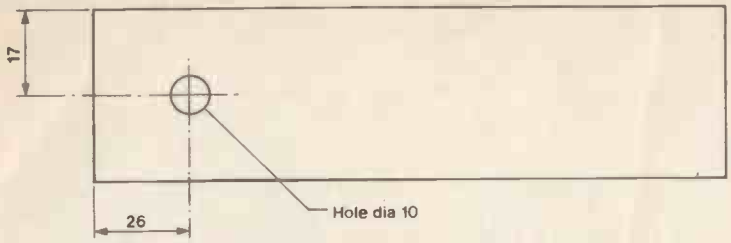


Figure 3(a). Drilling of case side panel for volume control.

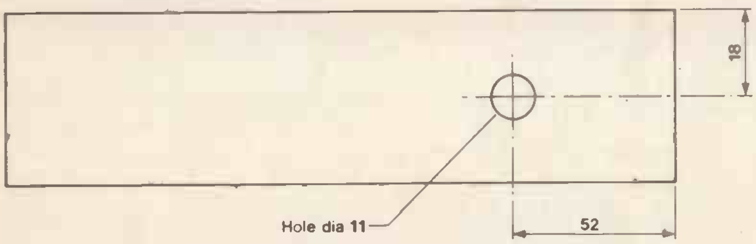


Figure 3(b). Drilling of case side panel for jack socket.

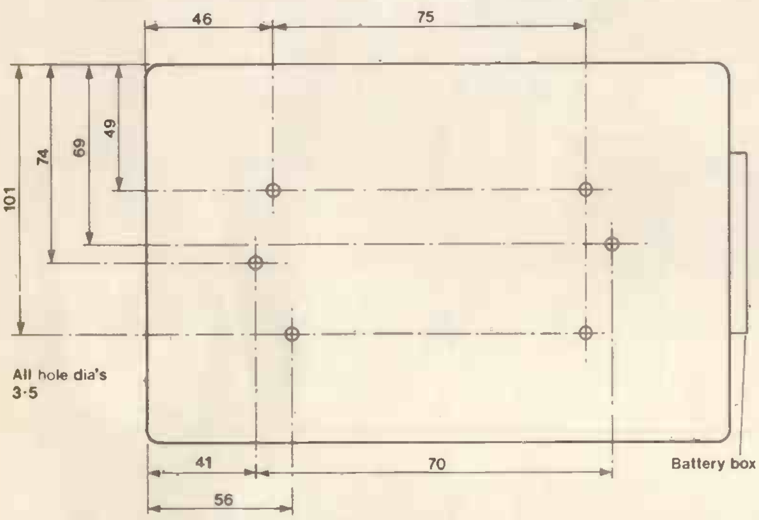


Figure 3(c). Drilling of case bottom moulding for adjustment of presets.

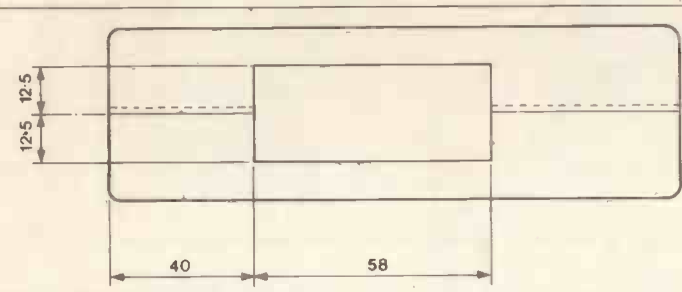
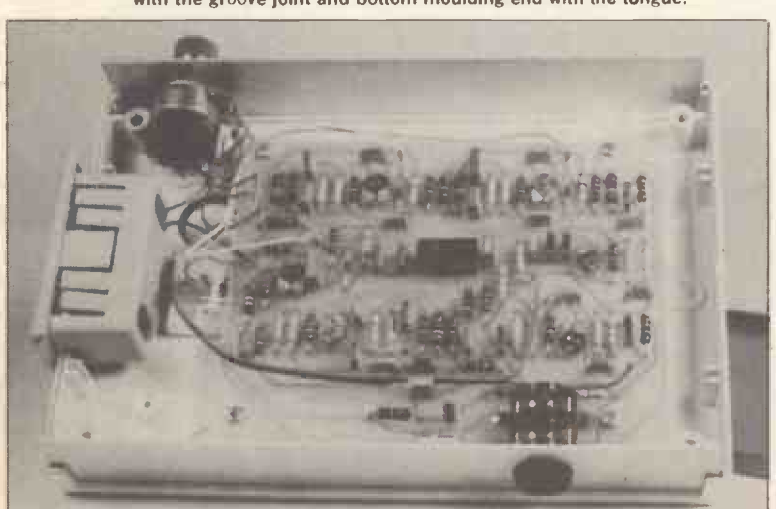
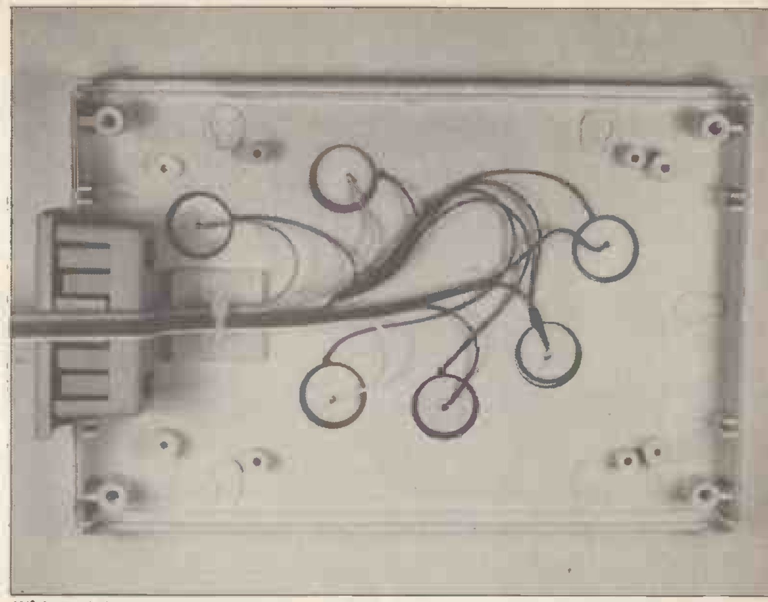


Figure 4. Battery box aperture. The cut-outs must be made in the top moulding end with the groove joint and bottom moulding end with the tongue.



Internal layout of completed unit.



Wiring of the piezo transducers.

PARTS LIST

Resistors - all ½ or ⅓ Watt, 5% carbon			
R1,38,57,67	470k	4 off	(S470K)
R2	180R		(S180R)
R3,13,23,33 42,52,62	10k	7 off	(S10K)
R4	270R		(S270R)
R11,14,17,21 24,27,31,34 37,41,43,46 51,53,56,61 63,66	180k	18 off	(S180K)
R12,15,16,22 25,26,32,35 36,44,45,54 55	68k	13 off	(S68K)
R18,28	150k	2 off	(S150K)
R47	680k		(S680K)
RV1	Switched pot. 4k7, linear		(FW41U)
RV11,21,31 41,51,61	470k Hor. S-min preset	6 off	(WR63T)
Capacitors			
Electrolytic			
C2	47u, 10V axial		(3B38R)
Polycarbonate			
C1,3,52,53	100n	4 off	(WW41U)
C11,32,33	15n	3 off	(WW31J)
C12,13,36	4n7	3 off	(WW26D)
C14,15	12n	2 off	(WW30H)
C16,26	1n5	2 off	(WW23A)
C21,24,25	27n	3 off	(WW34M)
C22,23	10n	2 off	(WW29G)
C31,34,35	39n	3 off	(WW36P)
C41,42	22n	2 off	(WW33L)
C43,44	68n	2 off	(WW39N)
C51,52	33n	2 off	(WW35Q)
C54,64	150n	2 off	(WW43W)
C61,62	47n	2 off	(WW36S)
Semiconductors			
IC1	CD4069UBE		(QX25C)
TR1	BC108C		(QB32K)
D1	BZY88C5V6		(QH08J)
D41,51,61	1N4148	3 off	(QL80B)
Miscellaneous			
XL11,21,31,41, 51,61	Piezo transducer 27mm	6 off	(QY13P)
SK1	Jack socket		(HF90X)
	14 pin DIL Socket		(BL18U)
	Knob K15		(HB36P)
	Verobox type 201		(LL05F)
	PP3 Battery holder		(XX33L)
B1	PP3 Battery		
	Hexadrum PCB		(GA32K)
	Rubber disc 27mm	6 off	(QY16S)
	⅜" nut for RV1 stem		
	Veropins type 214S	14 off	(FL24B)
	10-way ribbon cable 1m		(XR06G)

Note: The parts list and ready-made circuit board have the component reference number prefixed by the number of the drum circuit in which it is used, e.g. drum 1, R3 becomes R13.

E&MM

ELECTRONICS MUSIC & EFFECTS KITS

AUTOWAH UNIT
Automatically gives wah or swell sounds with each guitar note played.
Kit order code = M-SET-58 £16.04

GUITAR EFFECTS UNIT
Modulates the attack, decay and filter characteristics of a signal from most audio sources producing 8 different switchable sounds that can be further modified by manual controls.
Kit order code = M-SET-42 £14.11

GUITAR FREQUENCY DOUBLER
Produces an output one octave higher than the input. Inputs and outputs may be mixed to give greater depth.
Kit order code = M-SET-98 £10.55

GUITAR MULTIPROCESSOR
An extremely versatile sound processing unit capable of producing, for example, flanging, vibrato, reverb, fuzz and tremolo as well as other fascinating sounds. May be used with most electronic instruments. Some SW's not incl. in kit – see list for selection.
Kit order code = M-SET-85 £72.90

GUITAR OVERDRIVE
Sophisticated versatile fuzz unit incl. variable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering.
Kit order code = M-SET-56 £19.60

GUITAR PRACTICE AMPLIFIER
A 8 watt mains powered amplifier suitable for instrument practise or as a test gear monitor. Drives 8 or 15 ohm speakers (not incl. in kit).
Kit order code = M-SET-106 £18.72

GUITAR SUSTAIN
Maintains the natural attack whilst extending note duration.
Kit order code = M-SET-75 £11.77

PHASER
An automatically controlled 6 stage phasing unit with internal oscillator. Depth can be increased with extension.
Main kit code = M-SET-88 £18.34
Extension kit = M-ADN-88 £7.31

PHASING & VIBRATO
Includes manual and automatic control over the rate of phasing and vibrato. Capable of superb full sounds. A separate power supply is included.
Kit order code = M-SET-70 £42.85

SMOOTH FUZZ
As the name implies!
Order code = M-SET-91 £11.68

SPLIT-PHASE TREMOLO
The output of the internal generator is phase-split and modulated by an input signal. Output amplitudes, depth and rate are panel controlled. The effect is similar to a rotary cabinet.
Kit order code = M-SET-102 £27.55

SWITCHED TONE TREBLE BOOST
Provides switched selection of 4 preset tonal responses.
Kit order code = M-SET-89 £10.51

AUDIO EFFECTS UNIT
A variable siren generator that can produce British and American police sirens, Star Trek Red Alert, heart beat monitor sounds, etc.
Kit order code = M-SET-105 £12.91

FUNNY TALKER
Incorporates a ring modulator, chopper and frequency modulator to produce fascinating sounds when used with speech and music.
Kit order code = M-SET-99 £15.43

WIND & RAIN EFFECTS
As the name says!
Order code = M-SET-28 £9.94

DISCOSTROBE
A 4-channel 200-watt light controller giving a choice of sequential, random or full strobe mode of operation.
Kit order code = M-SET-57 £36.52

LIST
Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components. Overseas enquiries for list – Europe send 50p, other countries send £1.00

All kits include custom designed printed circuit boards

KIMBER-ALLEN KEYBOARDS
Claimed by the manufacturers to be the finest moulded plastic keyboards available. All octaves are c-c, the keys are plastic, slope fronted, spring loaded, fitted with actuators and mounted on a robust aluminium frame. 3-octave £25.50, 4-oct £32.25, 5-oct £39.50. Gold-clad contacts (1 needed for each note) type GJ (SPCO) 33p each. Type GB (2-PR N/O) 38p each.

CHOROSYNTH
A standard keyboard version of the published Elektor 30-note chorus synthesiser with an amazing variety of sounds ranging from violin to cello and flute to clarinet amongst many others.
Kit plus keyboard & contacts = M-SET-100 £114.12

FORMANT SYNTHESISER
For the more advanced constructor who puts performance first. This is a very sophisticated 3-octave synthesiser with a wealth of facilities including 6 oscillators, 3 waveform converters, voltage controlled filter, 2 envelope shapers and voltage controlled amplifier. Case and hardware not included – see our lists for further details.
Kit plus keyboard & contacts = M-SET-66 £323.35

P.E. MINISONIC SYNTHESISER
A very versatile 3-octave portable mains operated synthesiser with 2 oscillators, voltage controlled filter, 2 envelope shapers, ring modulator, noise generator, mixer, power supply and sub-min toggle switches to select the functions. A case is excluded, but the text gives comprehensive constructional details.
Kit plus keyboard & contacts = M-SET-38 £169.69

Prices include 15% VAT & U.K. P&P

128-NOTE SEQUENCER
Enables a voltage controlled synthesiser, such as the P.E. Minisonic, to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are initiated from the 4-octave keyboard and note length and rhythmic pattern are externally variable.
Kit plus keyboard & contacts = M-SET-76 £114.09

16-NOTE SEQUENCER
Sequences of up to 16 notes long may be pre-programmed by the panel controls and fed into most voltage-controlled synthesisers. The notes and rhythms may be changed whilst playing making it more versatile than the name would suggest.
Kit order code = M-SET-86 £60.13

DIGITAL REVERB UNIT
A very advanced unit using sophisticated I.Q. techniques instead of noise-prone mechanical spring lines. The basic delay range of 24 to 90ms can be extended up to 450ms using the extension unit. Further delays can be obtained using more extensions.
Main kit order code = M-SET-78 £67.22
Extension kit = M-ADN-78 £45.94

BASIC COMPONENT SETS
Include specially designed drilled & tinned fibreglass printed circuit boards, all necessary resistors, capacitors, semiconductors, potentiometers and transformers. They also include basic hardware such as knobs, sockets, switches, a nominal amount of wire and solder, a photocopy of the original published text, and unless otherwise stated, a robust aluminium box. Most parts may be bought separately. For fuller kit and component details see our current lists.

Kits originate from projects published in PE, EE and Elektor.

Terms: C.W.O., MAIL ORDER OR COLLECTION BY APPOINTMENT
TEL.: 01-302 6184
(MONDAY-FRIDAY)

RING MODULATOR
Compatible with the formant and most other synthesisers.
Kit order code = M-SET-87 £11.69

WAVEFORM CONVERTER
Converts saw-tooth waveform into sinewave, mark-space sawtooth, regular triangle, or squarewave with variable mark-space. Ideally one should be used with each synthesiser oscillator.
Kit order code = M-SET-67 £20.13

RHYTHM GENERATORS
Two different kits – the control units are designed around the M252 and M253 rhythm-gen chips which produce pre-programmed switch-selectable rhythms driving 10 effects instrument generators feeding into a mixer.
12-rhythm unit = M-SET-103-258 £64.10
15-rhythm unit = M-SET-103-252 £57.26

6-CHANNEL MIXER
A high specification stereo mixer with variable input impedances. Specs given in our lists. The kit excludes some SW's – see lists for selection. The extension gives two extra channels.
Main kit code = M-SET-90 £88.99
Extension kit = M-ADN-90 £11.74

3-CHANNEL STEREO MIXER
Full level control on left and right of each channel, and with master output control and headphone monitor.
Kit order code = M-SET-107 £18.68

3-MICROPHONE STEREO MIXER
Enables stereo live recordings to be made without the hole in the middle effect. Independent control of each microphone.
Kit order code = M-SET-108 £12.31

HEADPHONE AMPLIFIER
For use with magnetic, ceramic or crystal pick-ups, tapedeck or tuner, and for most headphones. Designed with RIAA equalisation.
Kit order code = M-SET-104 £18.10

VOICE OPERATED FADER
For automatically reducing music volume during disco talk-over.
Kit order code = M-SET-30 £7.80

DYNAMIC NOISE LIMITER
Very effective stereo circuit for reducing noise found in most tape recordings.
Kit order code = M-SET-97 £12.67

DYNAMIC RANGE LIMITER
Automatically controls sound output levels.
Kit order code = M-SET-62 £9.51

TUNING FORK
Produces 84 switch-selectable frequency-accurate tones with LED monitor displaying beat-note adjustments.
Kit order code = M-SET-46 £34.56

TUNING INDICATOR
A simple octave frequency comparitor for use with synthesisers where the full versatility of Kit 46 is not needed.
Kit order code = M-SET-69 £14.41

PULSE GENERATOR
Produces controllable pulse widths from 100NS to 2 sec. variable frequency range of 0.1HZ to 100HZ.
Kit order code = M-SET-115 £21.45

SIGNAL TRACER & GENERATOR
Allows audio signals to be injected into circuits under test, and for tracing their continuity. Includes frequency & level controls.
Kit order code = M-SET-109 £15.31

WAVEFORM GENERATOR
Provides sine, square and triangular wave outputs variable between 1HZ & 100KHZ up to 10V P-P.
Kit order code = M-SET-112 £21.58

SPEECH PROCESSOR
Improves the intelligibility of noisy or fluctuating speech signals, and ideal for inserting into P.A. or C.B. radio systems.
Kit order code = M-SET-110 £9.21

FREQUENCY COUNTER
A 4-digit counter for 1HZ to 99HZ with 1HZ sampling rate.
Kit order code = M-SET-79 £43.30

EXPOSURE TIMER
Controls up to 750 watts in 0.5 sec. steps up to 10 minutes, with built-in audio alarm.
Kit order code = M-SET-98 £36.44

More kits and Components are in our Lists

PHONOSONICS : Dept E&MM8 : 22 HIGH ST. : SIDCUP : KENT : DA14 6EH
More kits and components are in our lists. Prices correct at time of press. E&OE subject to availability

THE MATINÉE ORGAN

A complete electronic organ to build at low cost

PART 6:
Rhythm voicing
Final effects and output circuits
Explanation of controls

Rhythm Voicing Circuit

The outputs of the rhythm unit from ICs 21 and 22 as shown in Figure 40 are fed to the rhythm voicing circuits shown in Figure 42. These outputs go high to trigger the relevant instrument. The characteristic sound of the bass drum, low bongo, conga drum, claves and high bongo are all produced by versions of the same type of circuit.

For example, when the input to the low bongo is low, the circuit is just prevented from oscillating as set by RV21. When the input pulses high, TR22 is triggered into oscillation. The incoming pulse is given the required duration by C80 and R295 and then fed to the complex network that determines the characteristic frequency and envelope of the sound required. In this circuit (and the conga drum) a second preset, in this case RV20, is provided to adjust the length of the resonating period and thus the overall tonal quality of the instrument. The output is then mixed with the other four circuits and fed via C121 to the rhythm volume drawbar RV18.

The white noise required for the cymbal and snare sounds is produced from the reverse biased junction of TR29 whose collector is not connected. This noise is fed via C104 to the base of the amplifying transistor TR27. This transistor is turned on when any one of the three inputs to snare and cymbals is triggered by the rhythm unit. In the case of short cymbals, for example, the pulse from the rhythm unit is level-shifted by TR30 and lengthened by TR31 and C112. The pulse also controls the two filter circuits around TR28 and TR34 which give the characteristic tonal quality of the instrument with a rapid attack and a decay time set by C103, C113 and C115.

RV27 controls the overall level of the white noise and RV26 controls the level of the snare white noise only. Note that when the snare drum is triggered, not only is the white noise triggered, but the high bongo is also triggered. The outputs of the two filters are coupled via C111 and C120 to the rhythm volume drawbar RV18.

Master Mixer Circuit

The outputs of all the circuits so far described are connected to the inputs of the master mixer shown in Figure 43. There are two signal paths through the mixer; the main path carrying flutes and/or strings which can be switched through the wah, reverb and rotor circuits and a "strings direct" path which allows the strings to bypass the wah, reverb and rotor circuits.

Figure 43 shows S19, "strings direct", operated and in this condition the collector of TR55 is high and IC17 a and d are on (and therefore b and c are off). The strings from the upper and lower manual are therefore connected to the strings balance control RV47 and mixed together by R569 and R570 and then go to the final output pre-amp via R581.

The flute voices from the upper and lower manuals are connected to the main path and if S19 is not operated (i.e. IC17 b and c are on), the strings will be mixed with them and the composite signal connected to the main path via the balance control, RV46.

The lower manual main path is connected via R576 to the pre-mixer IC46a. The upper manual main path, however, is connected via S34a, the wah on/off switch and R575 to IC46a. Thus the manual and auto wah only operate on the upper manual. The output of IC46a now goes to the reverb circuit.

If S34, wah on/off, is operated and S35 released (auto), the upper manual main path is connected to the wah bandpass filter TR52 and associated components. The signal is amplified at mixer TR53 and reconnected to R575 via S34c. The auto wah envelope is triggered from the upper manual envelope shaper TR45 via S34d and S35c to TR51 which shapes the pulse. This signal controls the feedback of the bandpass filter.

If S35 is operated (manual), the foot pedal becomes a manual wah control and the volume function of the pedal is replaced by preset RV48. The upper manual envelope trigger is now disconnected from the wah envelope shaper and replaced by the foot pedal via S34b and S35a to the bandpass filter.

Reverb Circuit

The reverb circuit is shown in Figure 44. The input from the pre-mixer, IC46a (Figure 43), bypasses the reverb driver amp IC38 via R396 and R402 if the reverb drawbar RV34 is fully in. If the reverb drawbar is fully out the bypass line is connected to ground via the wiper of RV34, allowing the signal to go to the spring line driver power amp IC38. The output from the spring line is amplified by mixer IC39. In addition, C140 and R401 provide a high frequency bypass to give a more natural sound at full reverb. The output of IC39 is connected to the rotor on/off switch S17a.

Rotor Circuit

With reference to Figure 45, S17 is shown in the off position, in which case the rotor is bypassed by R412 and returned to the final mixer C230 in Figure 43. With the rotor switched in, a percentage of

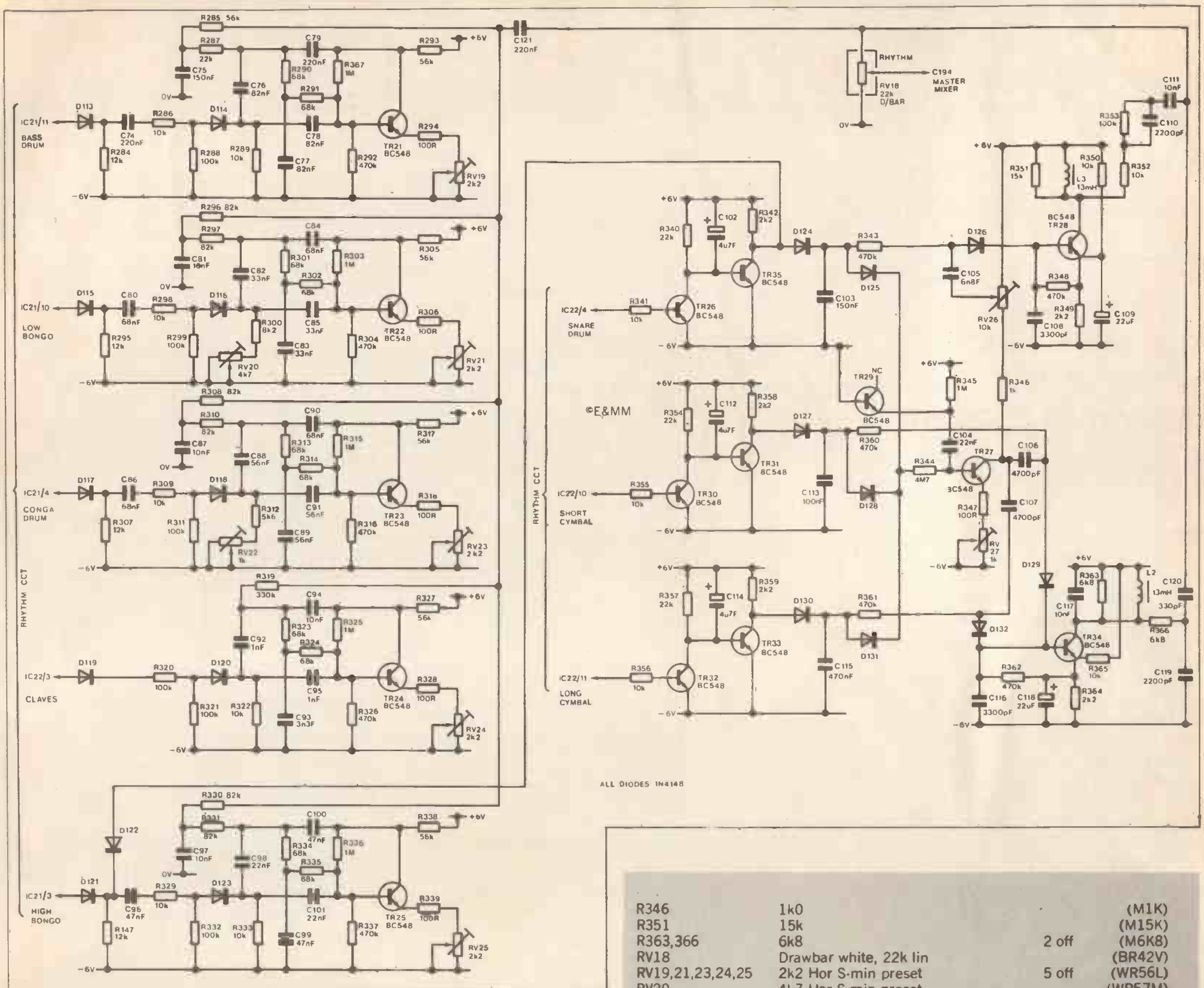


Figure 42. Circuit diagram of the rhythm voicing.

PARTS LIST FOR RHYTHM VOICING CIRCUIT

Resistors - all 5% ⅓W carbon unless specified

R147,284,295,307	12k	4 off	(M12K)
R285,293,305,317, 327,338	56k	6 off	(M56K)
R286,289,298,309, 322,329,333,341, 350,352,355,356, 365	10k	13 off	(M10K)
R287,340,354,357	22k	4 off	(M22K)
R288,299,311,320, 321,332,353	100k	7 off	(M100K)
R290,291,301,302, 313,314,323,324, 334,335	68k	10 off	(M68K)
R292,304,316,326, 337,343,348,360, 361,362	470k	10 off	(M470K)
R294,306,318,328, 339,347	100R	6 off	(M100R)
R296,297,308,310, 330,331	82k	6 off	(M82K)
R300	8k2		(M8K2)
R303,315,325,336, 345,367	1M	6 off	(M1M)
R312	5k6		(M5K6)
R319	330k		(M330K)
R342,349,358,359, 364	2k2	5 off	(M2K2)
R344	4m7 (10%)		(M4M7)
R346	1k0		(M1K)
R351	15k		(M15K)
R363,366	6k8	2 off	(M6K8)
RV18	Drawbar white, 22k lin		(BR42V)
RV19,21,23,24,25	2k2 Hor S-min preset	5 off	(WR56L)
RV20	4k7 Hor S-min preset		(WR57M)
RV22,27	1k0 Hor S-min preset	2 off	(WR55K)
RV26	10k Hor S-min preset		(WR58N)

Capacitors

C74,79,121	220nF polycarbonate	3 off	(WW45Y)
C75,103	150nF polycarbonate	2 off	(WW43W)
C76,77,78	82nF polycarbonate	3 off	(WW40T)
C80,86,90	68nF polyester	3 off	(BX75S)
C81,87,94,97	10nF polyester	4 off	(BX70M)
C82,85	33nF polyester	2 off	(BX73Q)
C83	33nF polycarbonate		(WW35Q)
C84	68nF polycarbonate		(WW39N)
C88,89,91	56nF polycarbonate	3 off	(WW38R)
C92,95	1nF polycarbonate	2 off	(WW22Y)
C93	3n3F polycarbonate		(WW25C)
C96	47nF polycarbonate		(WW37S)
C98,101,104	22nF polyester	3 off	(BX72P)
C99,100	47nF polyester	2 off	(BX74R)
C102,112,114	4u7F 63V axial	3 off	(FB18U)
C105	6n8F polycarbonate		(WW27E)
C106,107	4700pF ceramic	2 off	(WX76H)
C108,116	3300pF ceramic	2 off	(WX74R)
C109,118	22uF 10V axial	2 off	(FB29G)
C110,119	2200pF ceramic	2 off	(WX72P)
C111,117	10nF ceramic	2 off	(WX77J)
C113	100nF polycarbonate		(WW41U)
C115	470nF polycarbonate		(WW49D)
C120	330pF ceramic		(WX62S)

Semiconductors

D113-132 inc.	1N4148	20 off	(QL80B)
TR21-35 inc.	BC548	15 off	(QB73Q)

Miscellaneous

L2,3	13mH choke	2 off	(HX58N)

the signal is connected to IC30 which is a series of phase-shift filters and another part of the signal passes to the rotor output via C64 and R251. The remainder of the input signal passes to IC32a and b which are phase-shift filters running 180° out of phase with IC30. The outputs of IC30d and IC32b are re-mixed with the direct signal and are then connected through S17b to the final mixer C230 in Figure 43.

IC31 contains six elements that are used as voltage-controlled resistors which, when changing value, alter the phase relationship between the inputs and outputs of each of the six op-amps in the signal path to give the characteristic swirling sound of a mechanical "Leslie"-type rotor.

IC43a and b and TR20 form a voltage-controlled oscillator that runs at one of two selectable rates: 1Hz and 7Hz. The rate is selected by S18, rotor fast/slow. When changing between fast and slow and vice versa, R265,6,7 and C70 give a slow transition to simulate more accurately a mechanical rotor.

R275 feeds the ramp oscillator output to IC31 by DC blocking capacitor C72. R275 also feeds the signal to an inverter formed by IC33, whose output is fed to IC31 via DC blocking capacitor C73. RV52 applies a bias voltage to IC31 but when adjusting you will note that the change takes place after a delay, due to the charge or discharge time of C72 and C73. This ramping input to IC31 controls the resistance change in the elements and thus the rate of phase change in the signal.

Final Mixer and Power Amp Circuits

Figure 43 shows IC46b which is the final mixer. All the signals previously described are mixed together here and applied to pin 6 of IC46b. The output is connected via the potential divider R583 and R597 to the swell pedal (unless manual wah is selected) and then to the master volume control RV50.

Figure 46 shows the main power amp. IC16 is an IC power amp type TDA2030, giving around 15W output into 4 ohms. Pins are provided on the main PCB that may be connected (using screened leads) to an external power amp or the line input of a hi-fi amplifier should additional power be required. The output of IC16 is connected via C201 to a headphone jack for connection to a pair of stereo headphones and then to the main loudspeaker. This completes the description of all the circuits in the Matinée organ.

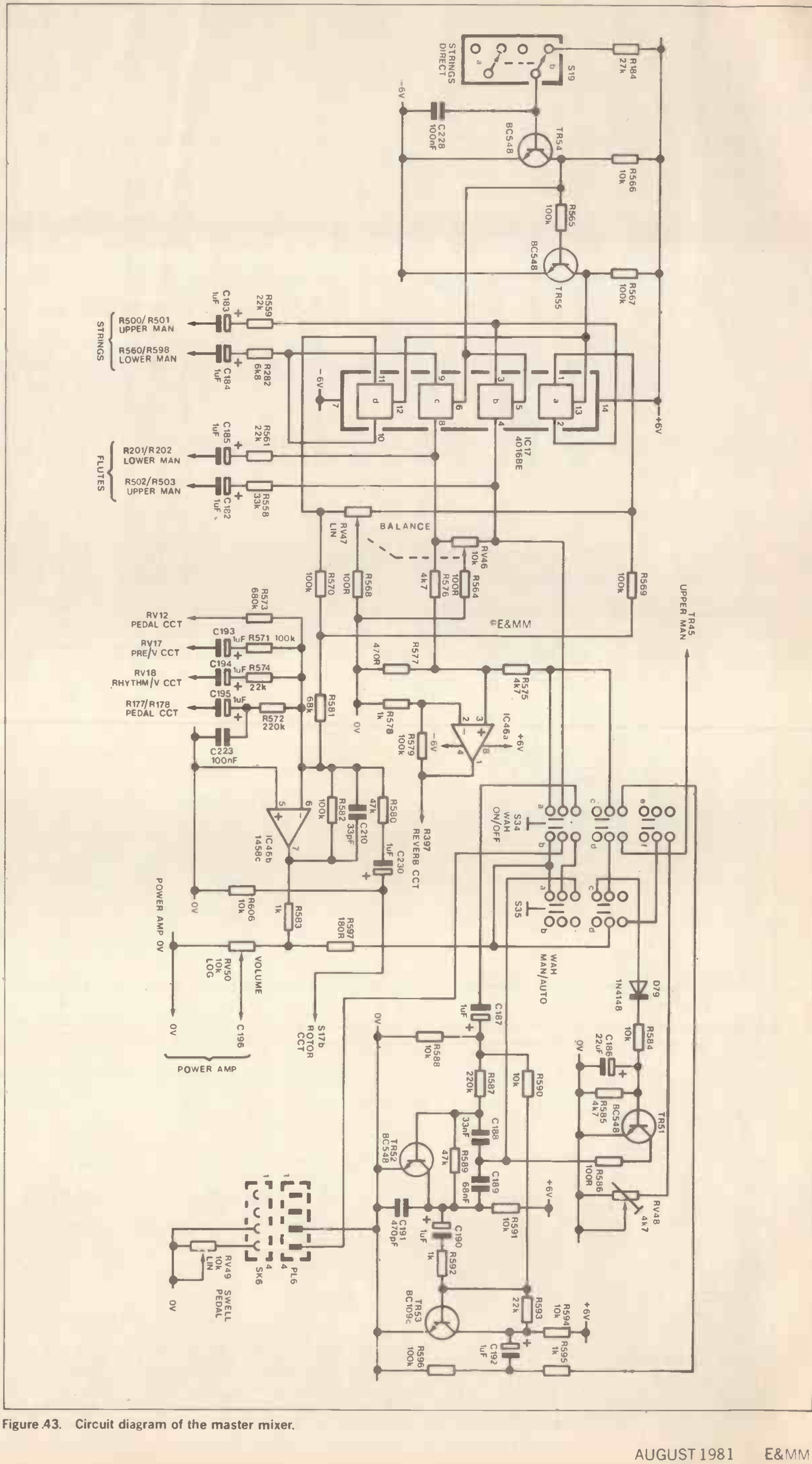


Figure 43. Circuit diagram of the master mixer.

TTLs by TEXAS					
		74367	60p	4025	20p
7400	11p	74368	60p	4026	130p
7401	12p	74390	100p	4027	40p
7402	12p	74393	120p	4028	60p
7403	14p	74490	150p	4029	75p
7404	14p			4030	40p
7405	18p	**74LS SERIES**		4031	170p
7406	30p	74LS00	14p	4034	200p
7407	30p	74LS02	14p	4035	110p
7408	18p	74LS03	18p	4036	295p
7409	18p	74LS04	18p	4039	295p
7410	15p	74LS05	20p	4040	60p
7411	20p	74LS08	20p	4041	80p
7412	20p	74LS09	20p	4042	65p
7413	25p	74LS10	20p	4043	75p
7414	35p	74LS11	30p	4044	70p
74C14	90p	74LS13	30p	4046	80p
7416	27p	74LS14	50p	4047	75p
7417	27p	74LS20	20p	4048	55p
7420	17p	74LS21	30p	4049	30p
7421	30p	74LS27	30p	4050	30p
7422	22p	74LS30	20p	4051	65p
7423	25p	74LS32	27p	4052	80p
7425	30p	74LS37	30p	4053	65p
7426	30p	74LS38	30p	4054	130p
7427	25p	74LS42	60p	4055	125p
7428	30p	74LS47	60p	4056	120p
7430	17p	74LS51	24p	4059	500p
7432	30p	74LS55	30p	4060	90p
7433	30p	74LS73	30p	4063	100p
7437	30p	74LS74	27p	4066	35p
7438	30p	74LS75	36p	4067	400p
7440	17p	74LS76	36p	4068	18p
7441	70p	74LS83	70p	4069	20p
7442A	50p	74LS85	80p	4070	30p
7443	112p	74LS86	36p	4071	25p
7444	112p	74LS90	40p	4072	25p
7445	80p	74LS92	70p	4073	25p
7446A	93p	74LS93	50p	4075	25p
7447A	60p	74LS96	110p	4076	60p
7448	70p	74LS107	45p	4081	22p
7450	17p	74LS109	60p	4082	27p
7451	17p	74LS112	40p	4086	72p
7453	17p	74LS113	45p	4089	150p
7454	17p	74LS114	45p	4093	45p
7460	17p	74LS122	70p	4094	200p
7470	36p	74LS123	60p	4095	95p
7472	30p	74LS124	180p	4096	95p
7473	32p	74LS125	50p	4097	340p
7474	30p	74LS126	50p	4098	90p
7475	38p	74LS132	80p	4039	120p
7476	32p	74LS133	30p	40100	220p
7480	50p	74LS136	45p	40101	132p
7481	100p	74LS138	55p	40102	180p
7482	84p	74LS139	55p	40103	180p
7483A	80p	74LS145	120p	40104	99p
7484	100p	74LS147	160p	40105	120p
7485	110p	74LS148	140p	40106	50p
7486	30p	74LS151	70p	40107	60p
7489	210p	74LS153	80p	40108	470p
7490A	30p	74LS154	200p	40109	100p
7491	80p	74LS155	50p	40110	300p
7492A	40p	74LS156	50p	40114	250p
7493A	30p	74LS157	50p	4502	90p
7494	75p	74LS158	60p	4503	50p
7495A	60p	74LS160	90p	4507	45p
7496	50p	74LS161	75p	4508	200p
7497	180p	74LS162	90p	4510	70p
74100	100p	74LS163	80p	4511	80p
74107	34p	74LS164	70p	4512	80p
74109	40p	74LS165	100p	4514	200p
74116	100p	74LS166	120p	4515	200p
74118	100p	74LS170	120p	4516	75p
74119	100p	74LS173	110p	4518	70p
74120	110p	74LS174	80p	4520	80p
74121	34p	74LS175	70p	4521	220p
74122	48p	74LS181	200p	4526	90p
74123	60p	74LS190	75p	4527	150
74125	60p	74LS191	75p	4528	80p
74126	60p	74LS192	75p	4532	110p
74128	60p	74LS193	75p	4534	500p
74132	60p	74LS195	75p	4536	300p
74136	60p	74LS196	75p	4538	120p
74141	75p	74LS197	90p	4543	140p
74142	200p	74LS221	90p	4553	320p
74145	90p	74LS240	120p	4556	60p
74147	120p	74LS241	120p	4560	180p
74148	100p	74LS242	90p	4569	180p
74150	120p	74LS243	90p	4572	30p
74151A	50p	74LS244	100p	4583	100p
74153	50p	74LS245	120p	4584	50p
74154	90p	74LS247	140p	4585	100p
74155	60p	74LS251	75p	4724	150p
74156	60p	74LS253	75p	40097	90p
74157	60p	74LS257	75p	14411	700p
74159	120p	74LS258	75p	14412	900p
74160	70p	74LS259	100p	14433	1100p
74161	70p	74LS266	100p	14500	700p
74162	70p	74LS273	120p	14599	290p
74163	70p	74LS279	55p		
74164	90p	74LS283	75p		
74165	90p	74LS298	160p		
74166	90p	74LS323	250p		
74167	200p	74LS324	150p		
74170	200p	74LS348	200p		
74172	300p	74LS365	48p		
74173	90p	74LS367	50p	**INTERFACE ICs**	
74174	75p	74LS368	50p	AD536A	£13
74175	75p	74LS373	120p	AD561J	1400p
74176	70p	74LS374	120p	AD7524	600p
74177	90p	74LS375	120p	DM8131	375p
74178	100p	74LS377	120p	DP8304	450p
74180	80p	74LS378	100p	DS8835	250p
74181	160p	74LS390	90p	DS8836	150p
74182	90p	74LS393	90p	DS8838	225p
74184A	120p	74LS399	200p	MC1488	65p
74185	120p	74LS445	140p	MC1489	65p
74186	500p	74LS670	225p	MC3446	300p
74188	325p			MC3480	850p
74190	90p	**4000 SERIES**		25S10	350p
74191	90p	4000	15p	58174	£12
74192	90p	4001	18p	75107	160p
74193	90p	4002	20p	75110	160p
74194	90p	4006	70p	75114	160p
74195	95p	4007	20p	75150	175p
74196	70p	4008	70p	75154	175p
74197	80p	4009	40p	75182	230p
74198	120p	4010	40p	75324	375p
74199	120p	4011	18p	75361	150p
74221	90p	4012	25p	75363	150p
74251	100p	4013	35p	75365	150p
74259	120p	4014	75p	75451/2	72p
74278	200p	4015	70p	75491/2	70p
74279	110p	4016	35p	8T26	160p
74283	140p	4017	50p	8T28	160p
74284	250p	4018	70p	8T95	180p
74285	250p	4019	45p	8T97	160p
74290	100p	4020	66p	81LS95	120p
74293	100p	4021	75p	81LS96	140p
74298	100p	4022	700p	81LS97	120p
74365	60p	4023	20p	81LS98	140p
74368	60p	4024	40p	9602	220p

93 SERIES		74S SERIES			
				74S114	120p
9301	160p	74S00	60p	74S124	300p
9302	175p	74S04	60p	74S132	160p
9308	316p	74S05	75p	74S133	75p
9310	275p	74S08	75p	74S138	225p
9311	275p	74S10	60p	74S139	225p
9312	160p	74S20	60p	74S157	250p
9314	165p	74S30	60p	74S163	300p
9316	225p	74S32	90p	74S174	250p
9321	225p	74S37	90p	74S175	320p
9322	150p	74S64	60p	74S194	350p
9334	380p	74S74	90p	74S241	450p
9368	250p	74S85	300p	74S260	70p
9370	300p	74S86	180p	74S373	500p
9374	200p	74S112	120p	74S374	500p

LINEAR ICs			
AY1-0212	600p	MC1310P	150p
AY1-1313	668p	MC1458	48p
AY1-1320	320p	MC1495L	350p
AY1-5050	140p	MC1496	70p
AY3-1270	840p	MC3340P	120p
AY3 8910	750p	MC3403	90p
AY3-8912	650p	MM57160	620p
AY5-4007D	520p	NE531	150p
CA3046	70p	NE555	20p
CA3048	225p	NE556	70p
CA3080E	72p	NE564	420p
CA3086	48p	NE565	130p
CA3089E	225p	NE566	155p
CA3090AQ	375p	NE567	140p
CA3130E	90p	NE571	425p
CA3140E	50p	NE5534A	250p
CA3160E	100p	PLL02A	500p
CA3161E	140p	S566B	270p
CA3162E	450p	SAD1024A	1250p
CA3189E	300p	SFF96364	800p
CA3280	180p	SL490	400p
DAC1408-8	200p	SN76477	175p
HA1388	260p	SP8515	750p
ICL7106	850p	TA 7120	200p
ICL8038	300p	TA7204	250p
ICM7555	80p	TA7205	250p
LF1331	30p	TA7222	200p
LF351	48p	TA7310	200p
LF356P	95p	TAA621	275p
LM10C	425p	TBA641B11	300p
LM301A	27p	TBA651	200p
LM311	70p	TBA800	90p
LM318	200p	TBA810	100p
LM319	225p	TBA820	90p
LM324	45p	TBA950	300p
LM339	75p	TCA220	350p
LM348	95p	TCA940	175p
LM358P	50p	TDA1004	300p
LM377	175p	TDA1008	320p
LM380	75p	TDA1010	225p
LM381AN	180p	TDA1022	570p
LM386	95p	TDA1024	120p
LM393	100p	TDA1034B	250p
LM709	36p	TDA1170	300p
LM710	50p	TDA2002V	325p
LM725	350p	TDA2020	320p
LM733	100p	TL071/81	45p
LM741	18p	TL072/82	75p
LM747	70p	TL074	130p
LM748	35p	TL084	110p
LM2917	250p	TL170	50p
LM3302	100p	UAA170	175p
LM3900	70p	ULN2003	100p
LM3909	70p	UPC1156H	300p
LM3911	130p	XR2206	300p
LM3914	225p	ZN414	90p
LM3915	225p	ZN419C	225p
LM3916	225p	ZN424E	135p
LM13600	125p	ZN425E	350p
MB3712	150p	ZN427E	650p
		ZN1034	200p

VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	-ve		-ve	
5V	7805	55p	7905	60p
12V	7812	55p	7912	60p
15V	7815	55p	7915	60p
18V	7818	55p	7918	70p
24V	7824	55p	7924	70p
100mA	TO-92		79L05	70p
5V	78L05	30p	79L12	70p
12V	78L12	30p	79L15	70p
15V	78L15	30p		

OTHER REGULATORS

LM309K	135p	78HGKC	600p
LM317T	200p	78HO5KC	550p
LM323K	500p	78MGT2C	135p
LM723	37p	79HGKC	600p
		TL497	300p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	180p	ORP61	120p
ORP12	120p	TIL78	55p

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL116	90p

LEDS

0.125''		0.2''	
TIL32	55p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18p	NSB5881	570p
		TIL311	600p
DISPLAYS		TIL312/3	110p
3015F	200p	TIL321/2	130p
DL704	140p	TIL330	140p
DL707 Red	140p	7750/60	200p
FND357	120p	**DRIVERS**	
FND500	110p	9368	250p
FND507	110p	9370	300p
MAN3640	175p	UDN6118	320p
MAN4640	200p	UDN6184	320p

TRANSISTORS									
AC126	25p	BFR40	25p	TIP30A	48p	2N3055	48p	3N140	120p
AC127/8	20p	BFR41	25p	TIP30C	60p	2N3442	140p	3N141	110p
AC176	25p	BFR79	25p	TIP31A	58p	2N3553	240p	3N201	110p
AC187/8	25p	BFR80	25p	TIP31C	62p	2N3565	30p	3N204	120p
AF116	50p	BFR81	25p	TIP32A	68p	2N3584	250p	40290	250p
AD149	70p	BFX29	40p	TIP32C	82p	2N3643/4	48p	40361/2	75p
AD161/2	45p	BFX30	34p	TIP33A	90p	2N3702/3	12p	40408	90p
AU107	200p	BFX84/5	40p	TIP33C	114p	2N3704/5	12p	40409	100p
BC107/8	11p	BFX86/7	30p	TIP34A	115p	2N3706/7	14p	40410	100p
BC109	11p	BFX88	30p	TIP34C	160p	2N3708/9	12p	40411	300p
BC117	20p	BFW10	90p	TIP35A	225p	2N3773	300p	40594	120p
BC147/8	9p	BFY50	30p	TIP35C	290p	2N3819	25p	40595	120p
BC149	10p	BFY51/2	30p	TIP36A	270p	2N3820	50p	40673	75p
BC157/8	10p	BFY56	33p	TIP36C	340p	2N3823	70p	40871/2	100p
BC159	11p	BFY90	90p	TIP41A	65p	2N3866	90p		
BC169C	12p	BRY39	45p	TIP41C	78p	2N3902	700p		
BC172	12p	BSX19/20	24p	TIP42A	70p	2N3903/4	18p		
BC177/8	17p	BU104	225p	TIP42C	82p	2N3905/6	20p		
BC179	18p	BU105	190p	TIP54	160p	2N4037	65p		
BC182/3	10p	BU108	250p	TIP120	120p	2N4058/9	12p		
BC184	11p	BU109	225p	TIP122	130p	2N4061/2	18p		
BC187	30p	BU126	150p	TIP142	130p	2N4123/4	27p		
BC212/3	11p	BU180A	120p	TIP147	130p	2N4125/6	27p		
BC214	12p	BU205	200p	TIP2955	78p	2N4401/3	27p		
BC237	15p	BU208	200p	TIP4055	70p	2N4427	90p		
BC327	16p	BU406	145p	TIS43	48p	2N4871	60p		
BC337	16p	E300	50p	TIS93	30p	2N5087	27p		
BC338	16p	E308	50p	ZTX108	12p	2N5089	27p		
BC461	36p	E310	50p	ZTX300	13p	2N5172	27p		
BC477/8	30p	MJ2501	225p	ZTX500	15p	2N5179	90p		
BC516/7	40p	MJ2955	90p	ZTX502	18p	2N5191	90p		
BC547B	16p	MJ3001	225p	ZTX504	30p	2N5194	90p		
BC548C	9p	MJE340	60p	2N457A	250p	2N5245	40p		
BC549C	16p	MJE2955	100p	2N696	35p	2N5296	55p		
BC557B	16p	MJE3055	70p	2N697	25p	2N5401	50p		
BC559C	18p	MPF102	45p	2N698	45p	2N5457/8	40p		
BCY70	18p	MPF103/4	40p	2N706A	30p	2N5459	40p		
BCY71/2	22p	MPF105/6	40p	2N708	30p	2N5460	60p		
BD131/2	50p	MPS6531	50p	2N918	45p	2N5485	44p		
BD135/6	54p	MPS6534	50p	2N930	18p	2N5875	250p		
BD139	56p	MPSA06	30p	2N1131/2	36p	2N6027	48p		
BD140	60p	MPSA12	50p	2N1613	25p	2N6041	160p		
BD189	60p	MPSA13	50p	2N1711	25p	2N6044	160p		
BD232	95p	MPSA20	50p	2N2102	70p	2N6052	300p		
BD233	75p	MPSA42	50p	2N2160	350p	2N6059	325p		
BD235	85p	MPSA43	50p	2N2219A	30p	2N6107	65p		
BD241	70p	MPSA56	32p	2N2222A	30p	2N6247	190p		
BD242	70p	MPSA70	50p	2N2369A	25p	2N6254	130p		
BDY56	200p	MPSU06	63p	2N2484	30p	2N6290	65p		
BF200	32p	MPSU07	60p	2N2646	45p	2N6292	65p		
BF244B	35p	MPSU45	90p	2N2904/5	30p	2SC1172	150p		
BF256B	70p	MPSU65	78p	2N2906A	30p	2SC1306	150p		
BF257/8	32p	OC28	130p	2N2907A	30p	2SC2028	120p		
BF259	36p	OC35	130p	2N2926	9p	2SC2029	250p		
BFR39	25p	TIP29A	40p	2N3053	30p	2SC2078	200p		
		TIP29C	55p	2N3054	85p	3N128	120p		

DIODES

BY127	12p
BYX36-300	20p
OA47	9p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

HEAT SINKS
For TO220 Voltage Regs and transistors 22p
For TO5 12p

BRIDGE RECTIFIERS

1A	50V	19p
1A	100V	20p
1A	400V	25p
1A	600V	30p
2A	50V	30p
2A	100V	35p
2A	400V	45p
3A	200V	60p
3A	600V	72p
4A	100V	95p
4A	400V	100p
6A	50V	80p
6A	100V	100p
6A	400V	120p
10A	400V	200p
25A	400V	400p

ZENERS
2.7V-33V
400mW 9p
1W 15p

TRIACS PLASTIC

3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	96p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

1A 50V	70p
1A 400V	90p
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
BT106	110p
C106D	45p
MCR101	36p
TIC44	27p
2N3525	130p
2N4444	140p
2N5060	34p
2N5064	40p

LOUD-SPEAKERS

Size		
2½	64R	80p
2½	8R	80p
2	8R	90p
1½	8R	100p

MODULATORS
6MHz UHF 375p
8MHz UHF 450p

MEMORIES			
2101-4L	400p	8279	950p
2102-2L	120p	TMS9918	POA
2107B	500p	Z80P10	500p
2111-4	250p	Z80AP10	600p
2112-4	300p	Z80CTC	500p
2114	200p	Z80ACTC	600p
2114-2L	300p	Z80ADART	£15
4027-3	300p	Z80ADMA	£12
4044	700p	Z80S10-1	£24
4116	200p	**UART**	
4118-4	700p	AY-3-1015P	400p
5101	300p	AY-5-1013P	350p
6514-45	£5	IM6402	450p
6810	200p	**CHARACTER GENERATORS**	
74S201	300p	RO-3-2513 U.C.	600p
ROM/PROMs		RO-3-2513 L.C.	700p
71301	700p	SN74S262AN	£10
74S188	225p	**KEYBOARD ENCODER**	
74S287	350p	AY-5-2376	700p
74S471	650p	74C922	500p
74S571	650p	**CRYSTALS**	
CPUs		32.768KHz	250p
1600	1200p	100KHz	300p
1802CE	750p	200KHz	370p
2650A	£16	1.0MHz	320p
6502	550p	1.008MHz	350p
6800	370p	1.8432MHz	325p
6802	650p	2.00MHz	325p
6809	£16	2.45760MHz	325p
8080A	450p	3.276MHz	300p
8085A	650p	3.5795MHz	175p
1NS8060	1000p	4.00MHz	290p
TMS9980A	£20	4.194MHz	POA
Z80	550p	4.43MHz	125p
Z80A	650p	5.0MHz	325p
EPROMs		6.0MHz	300p
1702A	500p	6.144MHz	300p
2708	350p	7.0MHz	300p
2716 (-5V)	500p	7.168MHz	300p
2532	£9	8.00MHz	300p
2732	£8	8.867MHz	300p
SUPPORT DEVICES		10.00MHz	310p
3242	800p	10.7MHz	300p
3245	450p	1p.0MHz	350p
6522	600p	16.00MHz	350p
6532	825p	18.00MHz	300p
6820	375p	18 432	350p
6821	180p	19.968MHz	390p
6845	£16	26.690MHz	350p
6850	180p	27.145MHz	325p
6852	370p	38.6667MHz	350p
6875	600p	48.0MHz	300p
8154	950p	55.5MHz	400p
8155	800p	116MHz	350p
8205	320p		
8212	200p		
8216	200p		
8224	250p		
8226	250p		
8228	250p		
8251	400p		
8253	800p		
8255	400p		
8257	800p		
8259	800p		

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	20p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

ZERO INSERTION FORCE SKT
24 pin £7

WIRE WRAP SOCKETS BY TEXAS

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

HEADER PLUGS

14 pin	80p
16 pin	80p
24 pin	100p
40 pin	275p

SOFTY Ideal Software/Hardware Development Tool. Using SOFTY you can develop your Programmes. Debug/Verify and then commit them to EPROM.
KIT £100. BUILT AND TESTED £125
Also available Expansion Board for Programming single rail (+5v) EPROMS. **Ready built £40.**

MINI FLOPPY DISC DRIVE MECHANISM: Teac. Type FD-50A 40 track 5¼'' Double/Single Density drives £140

FLOPPY DISC CONTROLLER

FD1771	£24
FD1791	£36
FD1691	£15
2143	£6.50

EPROM ERASERS Type UV140. Will erase up to 14 EPROMS in approx. 20 mins. Has slide-in tray for safe use. MAINS and ERASE indicators £61.50

ACORN ATOM. Supplied with full size OWERTY Keyboard, 8K ROM, 2K RAM and can be expanded to 12K ROM, 12K RAM. Included are UHF Modulator for connection to domestic TV and Free Manual on Programming in BASIC or Machine Code.
Kit £120. Built £150. P&P £2.50.

VEROBOARDS 0.1 (copper clad)

2.5x3.75''	75p
2.5x5''	85p
3.75x3.75''	85p
3.75x5''	95p
3.75x17''	340p
4.75x17.9''	420p
Pkt of 100 pins	50p
Spot face cutter	86p
Pin insertion tool	118p
Vero Wiring Pen	140p

ANTEX IRONS

C-15W	415p
CX-17W	425p
CCN-15W	425p
X25	440p

SPARE BITS

C/CX/CCN	50p
X25	50p

SPARE ELEMENTS

C/CX/X25	180p
CCN	200p

DIL SWITCHES

6-way SPST	90p
8-way SPST	100p
4-way SPST	80p

DIGITAST

Any colour	60p
With LED	90p

COUNTERS		TTL & ECL	
74C925	550p	MC4024	325p
74C928	600p	MC4044	325p
ICM7216B	2000p	10116	70p
ICM7217A	850p	10231	350p
ZN1040E	700p		

★SPECIAL OFFERS★

	1-24	25-99	100
2114L (450ns)	1.30	1.20	1.10
2716 (+5V)	3.00	2.75	2.50
4116 (200ns)	1.30	1.20	1.10

★ SPEECH SYNTHESISER ★

(A Project by TEXAS INSTRUMENTS LTD)

- ★ Superb major solid state speech project for under £100
- ★ Promises to have a dramatic impact on State-of-Art Electronics – now, and for generations to come
- ★ Complete talking library of over 200 words with further expansion space
- ★ Easy interfacing to a microcomputer through a few lines of BASIC
- ★ Pitch control has exciting electronic music applications
- ★ A reprint of original constructional article by E&MM (June '81) and available at 65p plus large SAE.

Complete Kit of parts (inc. PCB) £87
(NB: We are fully authorised TEXAS INSTRUMENT supplier for above project)

NEW RETAIL SHOP
305 Edgware Road, W2
Open: 9.30-5.30

Please add 30p P&P & VAT 15%
Government, Colleges, etc. Orders accepted
CALLERS WELCOME
Mon-Fri 9.30-5.30
Saturday 10.30-4.30

TECHNOMATIC LTD.
Dept E&MM, 17 BURNLEY ROAD, LONDON NW10
(2 minutes Dollis Hill tube station — ample street parking)
Tel: 01-452 1500/01-450 6597 Telex: 922800

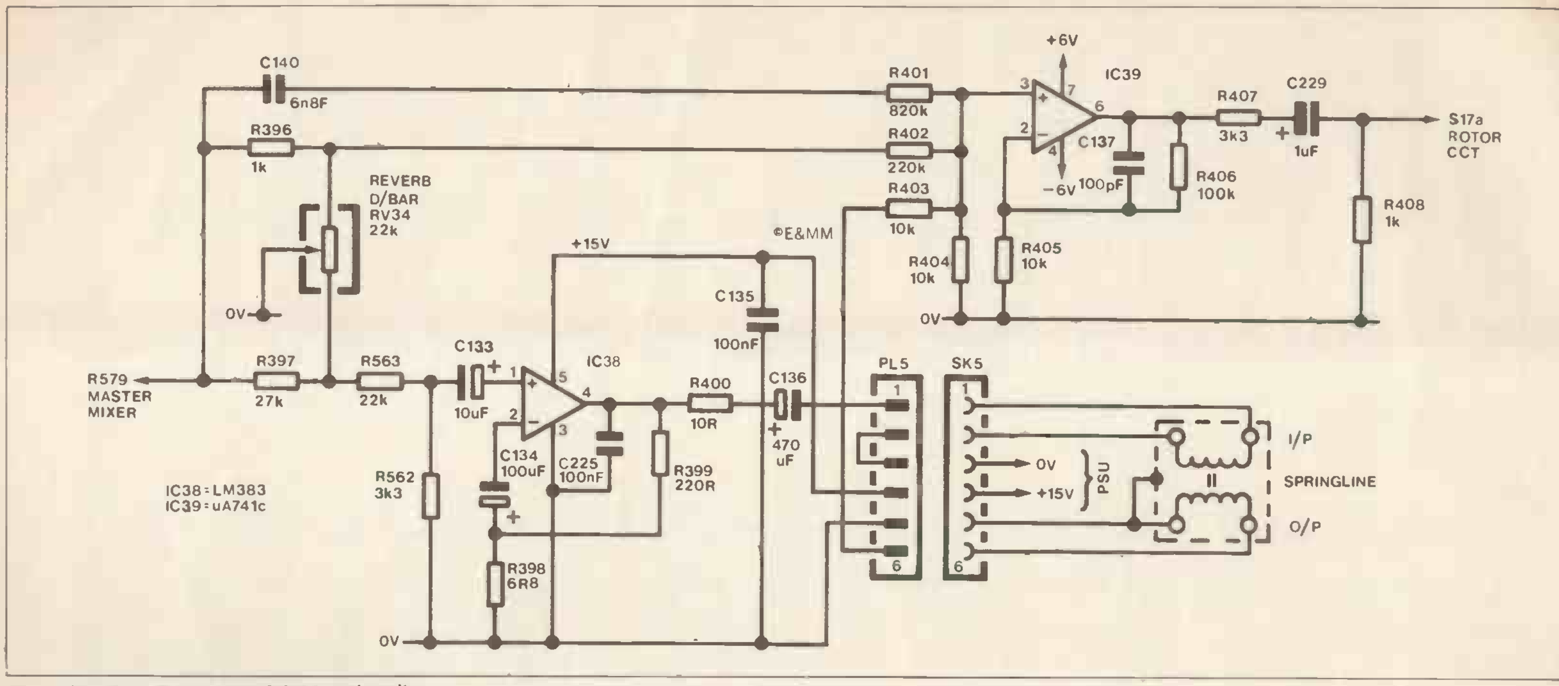


Figure 44. Circuit diagram of the reverb unit.

PARTS LIST FOR MASTER MIXER CIRCUIT

Resistors - all 5% ¼W carbon unless specified

R184	27k		(M27K)
R282	6k8		(M6K8)
R558	33k		(M33K)
R559,561,574,593	22k	4 off	(M22K)
R564,568,586	100R	3 off	(M100R)
R565,567,569-71, 579,582,596	100k	8 off	(M100K)
R566,584,588,590, 591,594,606	10k	7 off	(M10K)
R572,587	220k	2 off	(M220K)
R573	680k		(M680K)
R575,576,585	4k7	3 off	(M4K7)
R577	470R		(M470R)
R578,583,592,595	1k0	4 off	(M1K)
R580,589	47k	2 off	(M47K)
R581	68k		(M68K)
R597	180R		(M180R)
RV46/47	10k lin dual pot		(FW85G)
RV48	4k7 Hor S-min preset		(WR57M)
RV49	Swell pedal (part of)		(XY89W)
RV50	10k log pot		(FW22Y)

Capacitors

C182-185,187,190, 192-195, 230	1uF 63V axial elect.	11 off	(FB12N)
C186	22uF 10V axial elect.		(FB29G)
C188	33nF polyester		(BX73Q)
C189	68nF polycarbonate		(WW39N)
C191	470pF ceramic		(WX64U)
C210	33pF ceramic		(WX50E)
C223,228	100nF disc ceramic	2 off	(BX03D)

Semiconductors

D79	1N4148		(QL80B)
TR51,52,54,55	BC548	4 off	(QB73Q)
TR53	BC109c		(QB33L)
IC17	4016BE		(QX08J)
IC46	1458c		(QH46A)

Miscellaneous

S19	Tablet rocker orange		(BH50E)
S34	Latchswitch 6-pole		(FH69A)
S35	Latchswitch 4-pole		(FH68Y)
PL6	Minicon latch plug, rt angle (4-way)		(FY91Y)
SK6	Minicon latch housing (4-way)		(HB58N)
	Minicon terminal	4 off	(YW25C)

PARTS LIST FOR REVERB CIRCUIT

Resistors - all 5% ⅓W carbon unless specified

R396,408	1k0	2 off	(M1K)
R397	27k		(M27K)
R398	6R8		(M6R8)
R399	220R		(M220R)
R400	10R		(M10R)
R401	820k		(M820K)
R402	220k		(M220K)
R403-405	10k	3 off	(M10K)
R406	100k		(M100K)
R407,562	3k3	2 off	(M3K3)
R563	22k		(M22K)
RV34	Drawbar blue, 22k lin		(BR98G)

Capacitors

C133	10uF 25V axial elect.		(FB22Y)
C134	100uF 10V axial elect.		(FB48C)
C135,225	100nF disc ceramic	2 off	(BX03D)
C136	470uF 16V axial elect.		(FB72P)
C137	100pF ceramic		(WX56L)
C140	6n8F polycarbonate		(WW27E)
C229	1uF 35V tantalum		(WW60Q)

Semiconductors

IC38	LM383		(WQ33L)
IC39	uA741c		(QL22Y)

Miscellaneous

PL5	Minicon rt.angle latch plug (6-way)		(FB99H)
	Short spring line		(XL08J)

PARTS LIST FOR ROTOR CIRCUIT

Resistors - all 5% ⅓W carbon unless specified

R158,268-272, 274	47k	7 off	(M47K)
R241,412	18k	2 off	(M18K)
R242	82k		(M82K)
R243,253,264	10k	3 off	(M10K)
R244-250, 252, 254-263,273,277	100k	21 off	(M100K)
R251,278	1k0	2 off	(M1K)
R265	4k7		(M4K7)
R266,276	33k	2 off	(M33K)
R267	6k2 ½W		(S6K2)
R275	1M		(M1M)
R279	220k		(M220K)
R280,281	330k	2 off	(M330K)
RV52	100k Hor S-min preset		(WR61R)

Capacitors

C59,64,66	100nF polyester	3 off	(BX76H)
C60-63,65,67,68	10nF polyester	7 off	(BX70M)
C69	220nF polycarbonate		(WW45Y)
C70	470uF 16V axial elect.		(FB72P)
C71	390nF polycarbonate		(WW48C)
C72,73	4u7F 63V axial elect.	2 off	(FB18U)
C214	150pF ceramic		(WX58N)

Semiconductors

TR20	BC548		(QB73Q)
IC30	3403		(QH51F)
IC31	4049UBE		(QX21X)
IC32,34	1458c	2 off	(QH46A)
IC33	uA741c		(QL22Y)

Miscellaneous

S17,18	Tablet rocker grey	2 off	(BH49D)

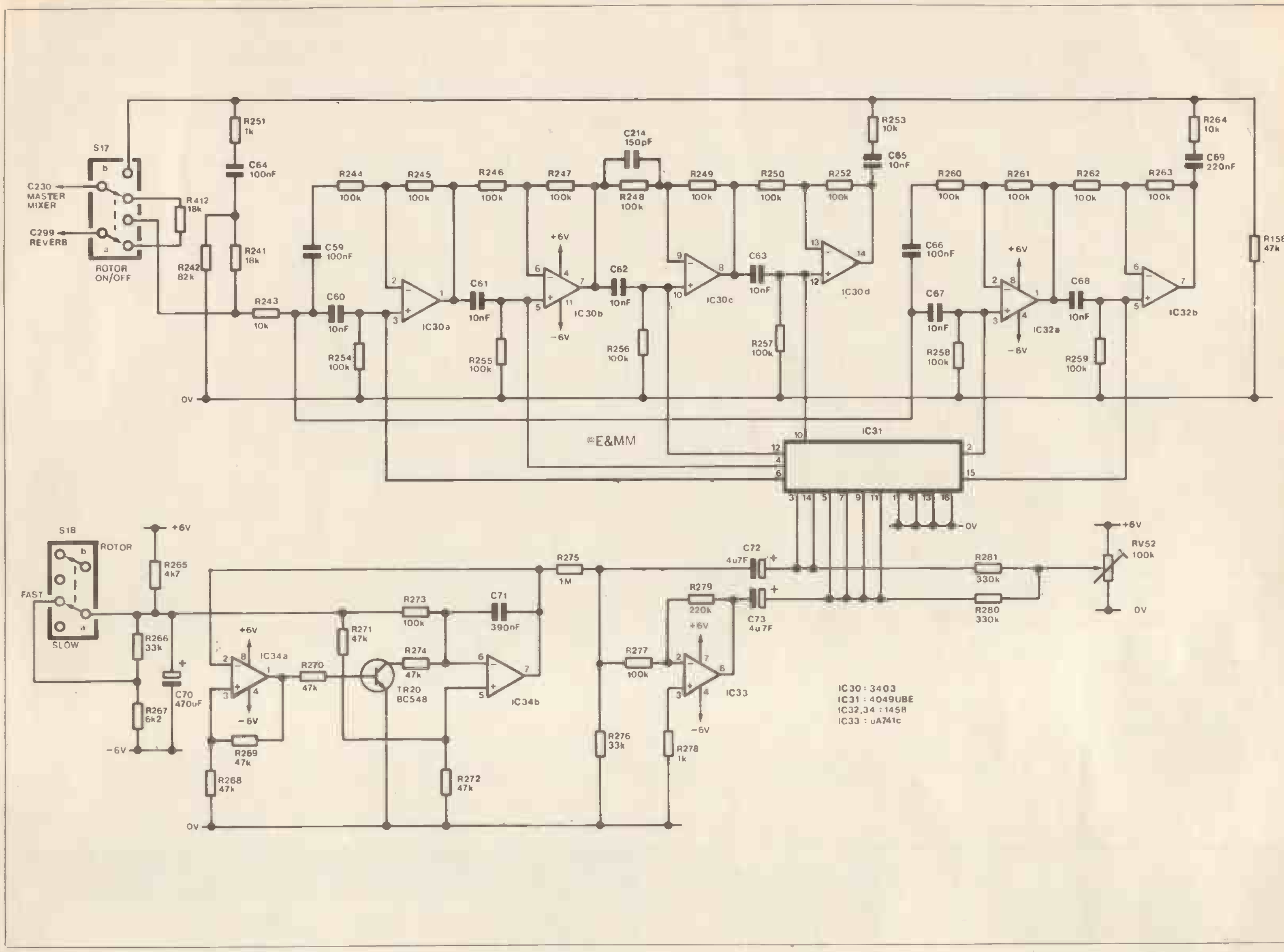


Figure 45. Circuit diagram of the rotor unit.

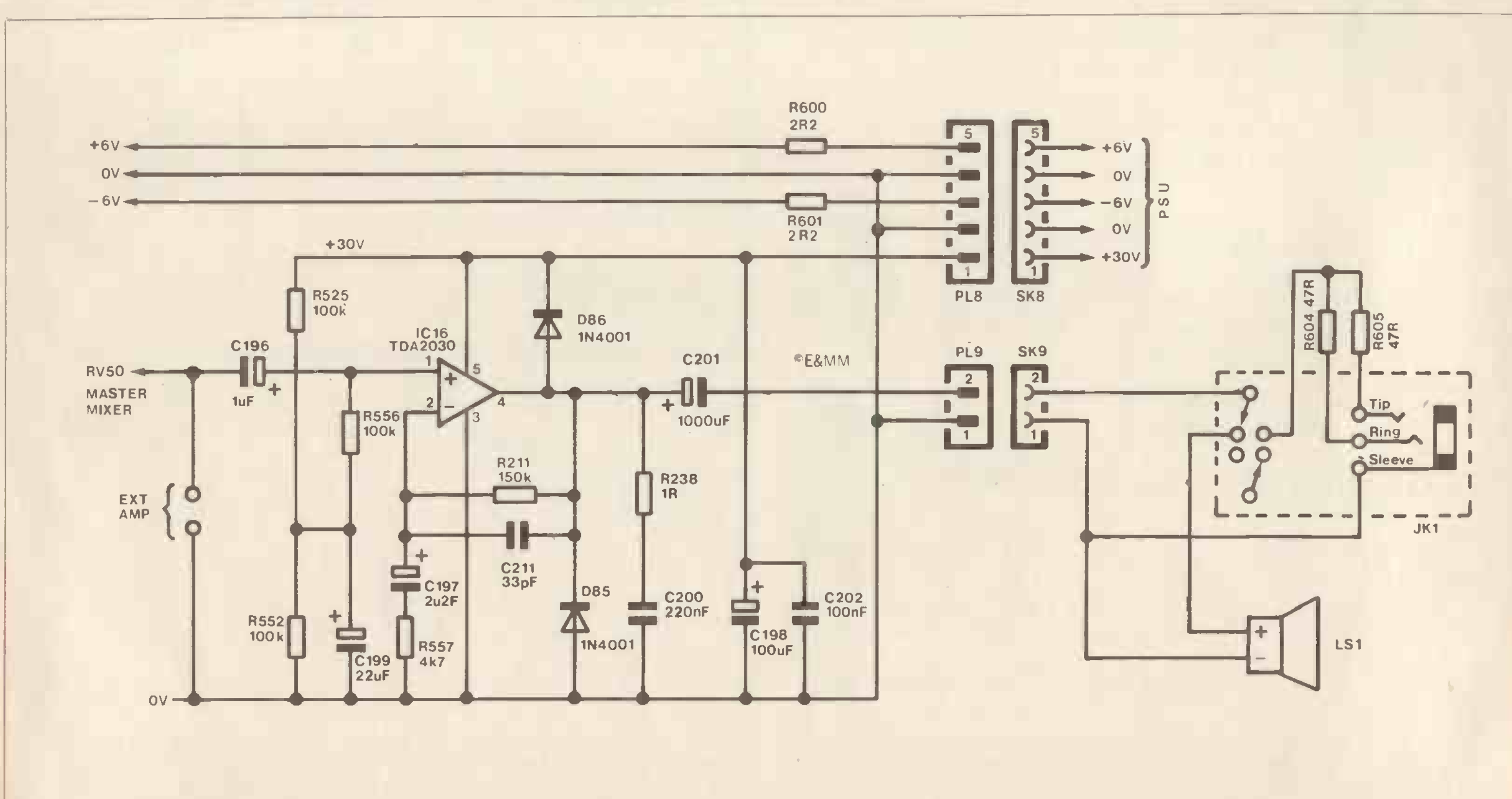


Figure 46. Circuit diagram of the power amp.

PARTS LIST FOR POWER AMP CIRCUIT

Resistors - all 5% ⅓W carbon unless specified			
R211	150k		(M150k)
R238	1R ½W		(S1R)
R525,552,556	100k	3 off	(M100K)
R557	4k7		(M4K7)
R600,601	2R2 3W	2 off	(W2R2)
R604,605	47R ½W	2 off	(S47R)
Capacitors			
C196	1uF 63V axial elect.		(FB12M)
C197	2u2F 63V axial elect.		(FB15R)
C198	100uF 40V axial elect.		(FB50E)
C199	22uF 63V axial elect.		(FB31J)
C200	220nF polyester		(BX78K)
C201	1000uF 25V axial elect.		(FB83E)
C202	100nF polyester		(BX76H)
C211	33pF ceramic		(WX50E)
Semiconductors			
D85,86	1N4001	2 off	(QL73Q)
IC16	TDA2030		(WQ67X)
Miscellaneous			
JK1	DPDT jack socket		(BW80B)
LS1	Loudspeaker TC30		(XG02C)
PL8	Minicon latch plug 5-way		(FY93B)
PL9	Minicon rt,angle latch plug (2-way)		(FY92A)
SK9	Minicon latch housing (2-way)		(HB59P)
	Minicon terminal	2 off	(YW25C)
	Bolt 6BA ¼in.		(BF05F)
	Washer 6BA, shakeproof		(BF26D)*
	Nut 6BA		(BF18U)
	Veropin 2141	2 off	(FL21X)

*For fixing IC16

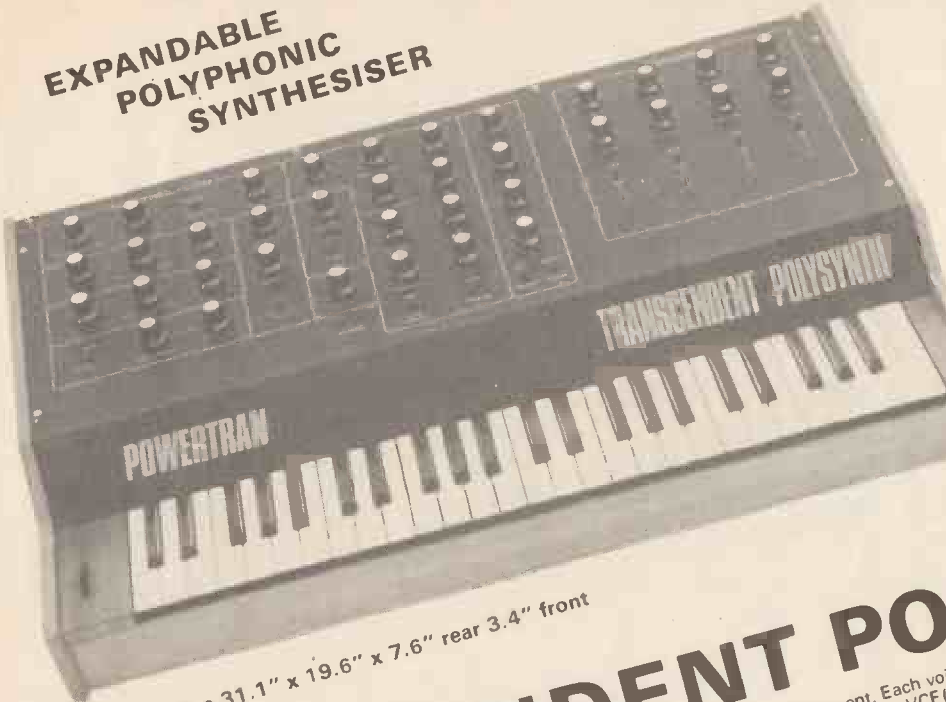
PARTS LIST OF MISCELLANEOUS ITEMS

SK7/SKA	Jumper cable (17-way)		(BX98G)
	Screened cable black	3m	(XR12N)
	Hook-up wire orange	2m	(BL05F)
	Hook-up wire violet	5m	(BL08J)
	Hook-up wire yellow	4m	(BL10L)
	Strapping wire 22swg		(BL14Q)
	Tie-wrap 92	2 off	(BF91Y)
	Knob M2	3 off	(RW89W)
	Rct.latchbutton black	21 off	(FH61R)
	Rct.latchbutton red	3 off	(FH63T)
	Rct.latchbutton white	2 off	(FH64U)
	Rct.latchbutton grey	4 off	(FH62S)
	Latchbracket (16-way)		(HY26D)
	Reset bar (15-way)		(HY27E)
	Latchbracket (9-way)		(HY28F)
	Reset bar (6-way)		(HY29G)
	Latchbracket (5-way)		(HB60Q)
	Reset spring	2 off	(FH86T)
	Push-on receptacle	4 off	(HF10L)
	Push-on cover	4 off	(HF12N)
	Matinee main PCB		(XY86T)
	Pot mounting bracket		(YK05F)
	6BA bolt ¼in.	2 off	(BF05F)
	6BA bolt ¼in.	2 off	(BF05F)*
	6BA nut	2 off	(BF18U)*
	6BA washer, shakeproof	2 off	(BF26D)*
	Veropin 2141	20 off	(FL21X)
Miscellaneous			
	Track pins	11 pks	(FL82D)
	Iso bolt M3 × 9mm	5 pks	(HY30H)**
	Steel washer 4BA	22 pks	(HY31J)**
	Component schedule	1	(XH53H)

*For fixing pot bracket
**For fixing d/bars

Continued next page ▶

EXPANDABLE POLYPHONIC SYNTHESISER



Cabinet size 31.1" x 19.6" x 7.6" rear 3.4" front

COMPLETE KIT ONLY

£320.00 + VAT!
(single voice)

Plug in extra Voices — Kit price £52 + VAT
(£48 — + VAT if ordered with kit)

TRANSCENDENT POLYSYNTH

By brilliant design work and the use of high technology components the Polysynth brings to the reach of the home constructor a machine whose versatility and range of sounds is matched only by ready built equipment costing thousands of pounds. Designed by synthesiser expert Tim Orr and being featured in Electronics Today International, this latest addition to the famous Transcendent family is a 4 octave (transposable over 7½ octaves) polyphonic synthesiser with internally up to 4 voices making it possible to play simultaneously up to 4 notes. Whereas conventional synthesisers handle only one at a time.

The basic instrument is supplied with 1 voice and up to 3 more may be plugged in. A further 4 voices may be added by connecting to an expander unit, the metalwork and woodwork of which is designed for side by side matching with the main instrument. Each voice is a complete synthesiser in itself with 2 VCOs, 2 ADSRS, a VCA and a VCF (requiring only control voltages and a power supply, the voice boards are also suitable for modular systems). One of these voices is automatically allocated to a key as it is operated. There are separate tuning controls for each VCO of each voice. All other controls are common to all the voices for ease of control and to ensure consistency between the voices.

Although using very advanced electronics the kit is mechanically very simple with minimal wiring, most of which is with ribbon cable connectors. All controls are PCB mounted and the voice boards fit with PCB mounted plugs and sockets. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (resistors 2%, metal oxide or metal film of 0.5% and 0.1%), nuts, bolts, etc.

Kit also available as separate packs

Pack		Price
POLY 1	Pair of PCB's for multiplex cct. K.B. contacts	£9.50
POLY 2	IC's IC sockets, Rs, Cs, for multiplex cct.	£8.20
POLY 3	Superior quality keyboard	£32.25
POLY 4	Contacts and bus bars	£12.00
POLY 5	Double sided plated through PCB for digital control and pitch/gate generator cct.	£17.25
POLY 6	Rs, Cs, heat sink for fitting to Pack 5	£10.50
POLY 7	IC's IC sockets, diodes for fitting to Pack 5	£31.30
POLY 8	Double sided mother board (for plug-in voices)	£18.90
POLY 9	Rs, Cs, connectors for mother board	£14.10
POLY 10	IC's IC sockets, Trs, heat sinks for mother board	£13.10
POLY 11	PCB for master controls (left of section marked VOICES)	£18.80
POLY 12	IC's IC sockets, diodes, Trs, Rs, Cs for master control PCB	£9.30
POLY 13	Pots, Switches for master control board	£11.80
POLY 13	Pots, Switches for master control board	£11.80
POLY 14	PCB for VOICE controls	£6.80
POLY 15	Pots, switches, diodes, Cs for VOICE PCB	£4.80
POLY 16	PCB for plug in voice	£8.20
POLY 17	Rs, Cs, presets, connectors for one voice	£16.30
POLY 18	IC's, IC skts, diodes for one voice	£27.50
POLY 19	Transformer 0-120-240, 17-0-17, 0-7.7	£6.30
POLY 20	Pitch bend control	£3.90
POLY 21	Misc parts e.g. jack sockets, knobs, mains switch etc.	£13.00
POLY 22	Ribbon cable, ribbon cable connectors, mains cable	£8.45
POLY 23	Fully finished metalwork and fixing parts	£25.60
POLY 24	Solid teak cabinet	£25.80
POLY 25	Construction manual	£1.50
	Total cost for individually purchased packs for single voice instrument	£355.15
	Special kit for 4 voice expander kit including connectors	£295.00

	Price
ADSR IC CEM 3310	£4.00
VCO IC CEM 3340	£6.00

ICs and details of all packs in our FREE CATALOGUE

ALL PRICES VAT EXCLUSIVE

Quote E&MM on all enquiries

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

SALES COUNTER: If you prefer to collect your kit from the factory call at Sales Counter Open 9 a.m. — 12 noon, 1—4.30 p.m. Monday-Thursday.

PRICE STABILITY: Order with confidence. Irrespective of any price changes we will honour all prices in this advertisement until September 30th 1981 if this months's advertisement in Electronics & Music Maker is quoted with your order. Errors and VAT rate changes excluded.

EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1.00 handling and postal documentation.

U.K. ORDERS: Subject to 15%* surcharge for VAT. No charge is made for carriage. *or at current rate if changed.

MANY MORE KITS ON PAGES 2 & 3

POWERTRAN

ANDOVER (0264) 64455

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

POWERTRAN ELECTRONICS, Portway Industrial Estate, Andover, Hants SP10 3WW

Please send me the following kits...

I enclose cheque/postal orders for ....

Name.................................... Address...

E&MM/8

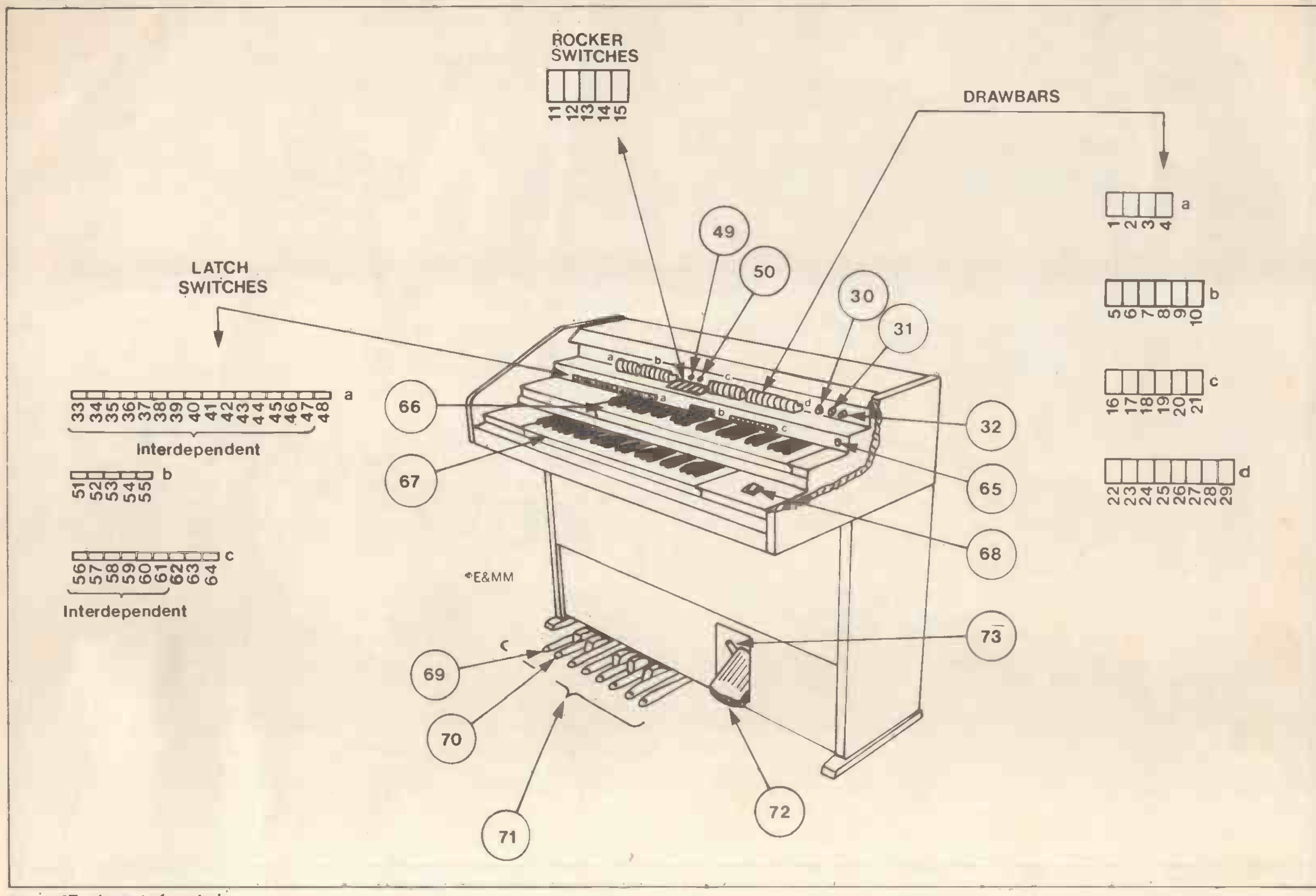


Figure 47. Layout of controls.

Get to know your Matinée Organ

The following text in conjunction with Figure 47 describes and identifies the switches and controls fitted to the Matinée Organ.

1. **16' Organ Bass drawbar.** The deepest sounding pedal voice. In auto mode this stop is inoperative.
2. **8' Organ Bass/Auto Bass drawbar.** A similar pedal voice to 16', but one octave higher. In auto mode this drawbar sets the volume of the auto bass line still using the 8' Organ Bass voice.
3. **Sustain drawbar.** Gives a fully variable delay on both Organ Bass voices. In auto mode sustains the auto bass line.
4. **8' Bass Guitar drawbar.** A pedal voice designed to simulate the characteristic sound of a bass guitar. In auto mode this stop is inoperative. Any of the pedal voices can be used together, for instance to simulate a string bass use the 16' Organ Bass with Sustain and a small amount of 8' Bass Guitar.
5. **16' Flute accompaniment drawbar.** The lowest harmonics in this voice have been removed to make it more useful as an accompaniment voice. In auto mode this stop is inoperative.
6. **8' Flute/Piano Vamp accompaniment drawbar.** When the Vamp button is pressed, this drawbar sets the volume of a vamping piano sound.
7. **8' String/Guitar Vamp accompaniment drawbar.** When the Vamp button is pressed, this drawbar sets the volume of a vamping guitar sound.
8. **4' Flute accompaniment drawbar.** This stop is inoperative in auto mode.
9. **4' String/Countermelody accompaniment drawbar.** In auto mode this drawbar sets the volume of the countermelody. Note that in auto mode all accompaniment voices are 8' only.
10. **Sustain accompaniment drawbar.** In auto mode this stop is inoperative.
11. **Rotor on/off switch.** Controls an electronic rotor effect, but has no effect on pedal or preset voices.
12. **Rotor fast/slow switch.** Changes the speed of the rotor effect with the advantage of slow transition as with a mechanical type.
13. **Strings Direct switch.** When operated, any string voice bypasses the reverb, wah and rotor effect. When playing with a combination of string and flute voices and rotor on, a pleasing effect can be obtained with this switch. For the best effect set the string drawbars to about half the setting of the flute drawbars. In auto mode this switch has the effect of enhancing the vamping guitar voice.
14. **Vibrato on/off switch.**
15. **Vibrato Delay switch.** When vibrato is on, this switch has the effect of delaying the onset of vibrato after a first key is pressed on the upper manual only. This effect is best used with a single solo voice when it helps to achieve a sound closely resembling an acoustic instrument being played.
16. **Vibrato Rate drawbar.** When vibrato is on, this drawbar varies the speed of the effect.
17. **Vibrato Depth drawbar.** With vibrato on, sets the depth of the vibrato effect in the overall sound.
18. **Rhythm Volume drawbar.** Sets the level of the drum accompaniment.
19. **Presets Volume drawbar.** Sets the volume of the banjo, accordion, harpsichord, piano and percussion stops.
20. **Banjo Repeat drawbar.** Controls the rate of repeat of the banjo and percussion voices. There is no repeat when drawbar fully in.
21. **Reverb Depth drawbar.** Sets the depth of the reverb effect in the overall sound. Has no effect on pedal or preset voices.
22. **16' Flute solo drawbar.**
23. **16' Cello solo drawbar.**
24. **8' Flute solo drawbar.**
25. **8' String solo drawbar.**
26. **8' Clarinet solo drawbar.**
27. **4' Flute solo drawbar.**
28. **4' String solo drawbar.**
29. **Sustain solo drawbar.**
30. **Tempo control.** Adjusts the speed of the accompaniment rhythm.
31. **Balance control.** Sets the relative levels of the upper and lower manuals.
32. **Master Volume control.** Sets the final output level of the whole organ.
33. **Waltz switch.**
34. **Jazz Waltz switch.**
35. **Slow Rock switch.**
36. **Country switch.**
37. **Swing switch.**
38. **Rumba switch.**
39. **March switch.**
40. **Tango switch.**
41. **Disco switch.**
42. **Funk switch.**
43. **Reggae switch.**
44. **Cha-cha switch.**
45. **Bossa Nova switch.**
46. **Samba switch.**
47. **5/4 switch.**

48. **Group Select switch.** Selects the second variation of each rhythm. An interesting effect can be created by switching between rhythms whilst playing a tune.

49. **Downbeat Indicator.** On 5/4 time only, flashes on the last and first beat of each bar.

50. **Beat Indicator.** When auto-start selected, rhythm speed can be gauged whilst organ is silent prior to playing. Note that when rhythm stop/start and auto stop/start are both released, this lamp may remain on depending on the point at which the rhythm was stopped.

51. **Rhythm Stop/Start switch.** With this switch selected and auto stop/start not selected, the rhythm starts immediately on the downbeat and remains running. See also 52.

52. **Auto-Stop/Start switch.** Note that this switch has nothing to do with the automatic mode, but simply provides automatic stopping and starting of the rhythm unit. With this switch selected and rhythm stop/start not selected, the downbeat and beat lamps function but sound is only heard when keys on the lower manual are pressed. Also the rhythm always starts on the downbeat. When all keys are released on the lower manual the rhythm stops at once. However, when the rhythm stop/start switch is also selected the rhythm will continue to the end of the bar after the last key is released on the lower manual. Also in this condition, beginners may find it an advantage that the rhythm unit continues running whilst changing chord. Should you wish the rhythm unit to start playing when you press a lower manual key and continue to run, then it is necessary to start playing with rhythm stop/start and auto-stop/start selected and then release auto-stop/start shortly after beginning. Then the rhythm can be stopped in the usual way by switching the rhythm stop/start switch off.

53. **Auto Accompaniment on/off switch.** When this switch is selected the function of the lower manual changes. If any single key in the lowest octave is pressed, an 8' chord with that key as the root note is generated (or the most left key if more than one key is pressed). The second octave repeats this function and the chord is the same, not an octave higher. Note that whilst not normally used in auto mode, the right-hand two octaves do repeat the sound of the last key, played in the lower octaves. The volume and tonal quality of the chord is set by the 8' Flute and 8' String accompaniment drawbars. Also when this switch is selected the normal pedal function is cut off (but see 69 and 70). When rhythm stop/start and/or auto-stop/start is also selected, the countermelody is available (see 9) and auto bass is available (see 2).

54. **Vamp on/off switch.** This switch only functions if rhythm stop/start and/or auto-stop/start is also selected. If auto accompaniment is off, then any manual chord played will be vamped and if auto accompaniment is on then the automatic chord will be vamped.

55. **Memory on/off switch.** If auto accompaniment is off, then all last notes played on the lower manual will continue to sound after key(s) released. If auto accompaniment on and rhythm stop/start and/or auto-stop/start are selected, the countermelody is memorised and if vamp is on, the vamping chord is also memorised.

Important note: when memory has been used with auto accompaniment it is important to switch memory off before auto accompaniment is switched off, otherwise a discord may be generated.

56. **Preset Voices Cancel switch.** This switch releases any previously pressed preset voice switch and must be selected if no preset voice is selected otherwise the upper manual may not sound at all.

57. **Banjo Preset Voice solo switch.** (See 19 and 20.) Note that this stop must be played by lifting all fingers from the solo manual before playing the next note or chord.

58. **Accordion Preset Voice solo switch.** (See 19.) Note that this stop must be played by lifting all fingers from the solo manual before playing the next note or chord.

59. **Harpsichord Preset Voice solo switch.** (See 19.) A longer sustain can be achieved by holding down the note. Remember that this stop must be played by lifting all fingers from the solo manual before playing the next note or chord.

60. **Piano Preset Voice solo switch.** (See 19 and 73). A longer sustain can be achieved by holding down the note. This stop must be played by lifting all fingers from the solo manual before playing the next note or chord.

61. **Percussion (4') solo switch.** (See 19.) The repeat drawbar also operates with this stop although it would not normally be used with it. The stop produces a very fast initial attack and is best used to complement the solo manual drawbar voices i.e. with drawbars add switch also selected.

62. **Drawbars Add solo switch.** When selected, the upper manual voices on drawbars sound in addition to any preset voice selected.

63. **Wah on/off switch.** This only operates on the upper manual drawbar voices.

64. **Wah Auto/Manual switch.** When wah is on and this switch is not selected, wah occurs whenever a new key is pressed on the upper manual after all keys have been released. When wah is on and this switch is selected, the swell pedal becomes a wah pedal and the organ's output volume is now under control of the master volume only.

65. **Headphone Socket.** For use with any stereo headphone with a standard stereo ¼in. jack plug. When a headphone is connected, the main loudspeaker is switched off.

66. **Solo or upper manual.**

67. **Accompaniment or lower manual.**

68. **Mains on/off switch.**

69. **Minor Chord.** Changes any automatic chord to minor. (See 70.)

70. **Seventh Chord.** Changes any automatic chord to seventh. Note that if minor and seventh are pressed together, a minor seventh chord is produced.

71. **Pedalboard.** Only one note plays at a time and if more than one note pressed only the lowest one sounds.

72. **Swell Pedal/Wah Pedal.** Normally a volume control used whilst playing, but if wah is on and manual wah is selected, the pedal generates a wah effect when moved.

73. **Glide/Piano Sustain switch.** Except when piano switch selected, the pitch of the whole organ is shifted down by one semitone. Normally used to create a Hawaiian Guitar effect e.g. with harpsichord and selected drawbar voices. When piano is selected, the switch sustains notes after the keys have been released similar to the loud pedal on a piano.

Amendments and Corrections

Since the original circuits and parts lists were prepared for publication, we have made many improvements. These, plus any errors and omissions, are given in the following lists.

Part 1 (March issue)

Page 7. Parts list for master oscillator.
- R370 should be 330k (was 68k).
- R373 should be 470R (was 1k0).
- R374 should be 47k (was 10k).
- R375,6 should be 47k (were 4k7).
- R607 should be 100k (added).
- RV29 should be 10k (was 220k).
- RV31 should be 10k (was 1k0).
- C123 should be 3.3uF at 63V (was 10uF at 25V).
- C126 should be 100uF at 6.3V (was 22uF at 10V).
- C127 should be 33pF (was 100pF).
- C128 should be 330nF (was 100nF).

Page 10. Figure 2.
- Make all changes as for page 7.
- R607 is in parallel with C126.
- The two wires to S36 should be shown via PL6.
- S20 and S21 should be S20b and S21b. Add note: S20a and S21a unused.
- S31d should be shown as a latchswitch.

Part 2 (April issue)

Page 37. Text.
- Just prior to heading "Organ Voice Circuits", the pulse is provided by C208 and R379 (not C212).

Page 37. Fig. 7.
- Circuit around 1C44 redrawn, see Figure 48.
- C212 is in parallel with R485.
- C213 is in parallel with R493.
- C217 is connected between IC42 pin 8 and 0V, positive end to IC.
- TP1 added at IC43 pin 9.
- TP2 added at IC43 pin 8.
- TR45 emitter goes to R603 in preset voice circuit.
- TR45 collector, R507, D148 and D149 junction connected to S34d in master mixer circuit.
- Make all changes as for page 38 parts list.

Page 38. Parts list for upper manual.
- R413-R417 should be 5k6 (added).
- R418-R423 should be 1k0 (added).
- R437 should be 22k (was 27k).
- R473 should be 8k2 (was 47k).
- R484 should be 10k (was 100k).
- R485 should be 220k (was 470k).
- R487 should be 470R (was 150R).
- R490 should be 100k (was 10k).
- R492 should be 1k0 (was 100k).
- R493 should be 150k (was 470k).
- R494 should be 10k (was 27k).
- R500,502 should be 100R (were 2k2).
- R501 should be 1k0 (was 8k2).
- R503 should be 10k (was 8k2).
- R505 should be 150R (was 100R).
- RV35 should be 100k (was 10k).
- C141 should be 10nF (was 3n3).
- C142 should be 100nF (was 22nF).
- C143 should be 100nF (was 68nF).
- C144 should be 39nF (was 15nF).
- C145 should be 470pF (was 330pF).
- C147,8 should be 100nF (were 10nF).
- C149 should be 120nF (was 68nF).
- C150 should be 47nF (was 22nF).
- C153,154 should be 100nF (were 10nF).
- C156 should be 82nF (was 47nF).
- C161 should be 820pF (was 1n5).
- C164 should be 12nF (was 100nF).
- C165 should be 12nF (was 22nF).
- C212 should be 100pF ceramic (added).
- C213 should be 120pF ceramic (added).
- C217 should be 1000uF 6.3V axial (added).
- C221,2 should be 3n9 ceramic (added).
- C237-C241 should be 220pF ceramic (added).

Page 38. Figure 8.
- D76 and D77 are removed and replaced by R603. The junction of R603 and C167 is also connected to the emitter of TR45 in the upper manual circuit Figure 7.
- On 1C45, pins 9 and 10 are linked, pins 13 and 14 are linked and pin 6 is connected to -6V.
- Lower end of RV17 should be connected to 0V (not -6V).
- The wipers of S27a and S33b should be shown connected to -6V (not 0V).
- R509 shown connected between KPS rail and -6V should be shown connected between TR46 emitter and KPS rail.
- C227 should be between 1C45 pin 6 and 0V.
- C215 should be between 1C45 pin 8 and top end of RV17, positive to 1C.
- C224 should be between 1C40 pin 14, R510 junction and top of S32b (was shown linked).
- C226 should be between TR44 emitter and -6V.
- TP3 added at 1C45 pin 8.
- Make all changes as for parts list page 39.

Page 39. Parts list for preset voices circuit.
- R411 should be 390R (was 47R).
- R509 should be 270R (was 1k0).
- R521 should be 22k (was 39k).
- R526 should be 680R (was 1k0).
- R537 should be 270R (was 560R).

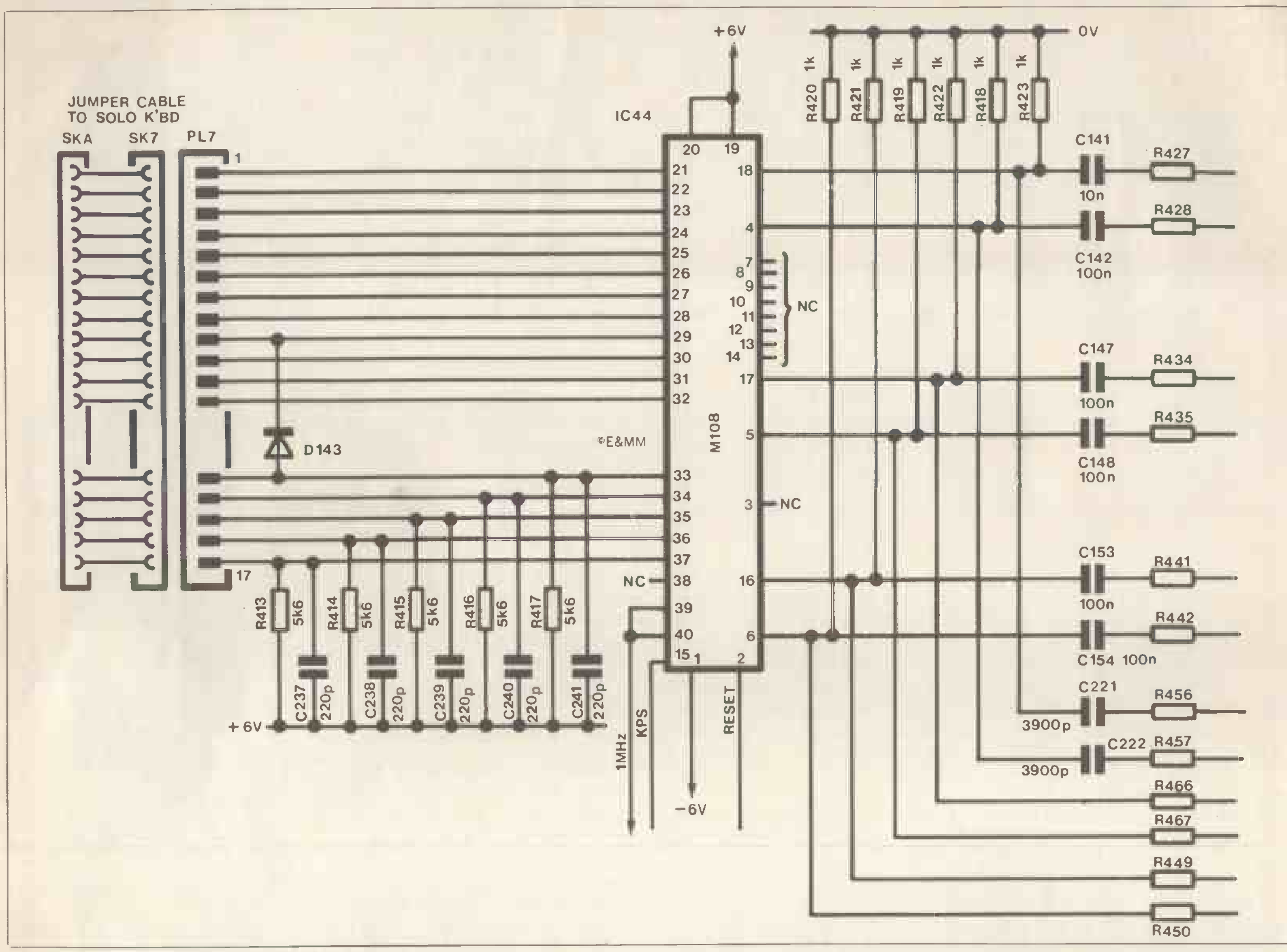


Figure 48. Amended upper manual M108 circuit.

R540 should be 47k (was 100k).
R541 should be 5k6 (was 12k).
R553 should be 10k (was 22k).
R554 should be 10k (was 4k7).
R603 should be 47R (added).
C171,174,180 should be 22uF 10V axial (was 470uF 16V).
C177 should be 47nF carbonate (was 100nF).
C215 should be 2.2uF 35V tantalum (added).
C224 should be 15nF polyester (added).
C226,227 should be 100nF disc (added).
D76,77 deleted.
TR50 should be BC548 (was BC108C).
S31 should be latchswitch 4-pole (added).

Page 39. Text.
In last paragraph before heading "preset voice circuits", C166 charges via D149 and R505 (not D19).

Part 3 (May issue)

Page 25. Fig. 16.
R2 should be 4k7.
R3 should be 2k7.
R4 should be 5k6.

Page 26. The 4-pole latchswitch mentioned in the text should read '2-pole latchswitch'.

Page 28. Fig. 23.
In connections to PL1, pins 1 and 2 are transposed.

Page 28. Parts list banjo repeat circuit.
R390 should be 68k (was 33k).
C130 should be 1uF carbonate (was axial).

Page 29. Fig. 24.
Make all changes as parts list page 28.

Part 4 (June issue).

Page 34. Figure 34.
PL1 and SK1 connections to pins 1 and 2 transposed.
TP7 added to IC3 pin 9.

Page 35. Parts list for pedalboard circuit.
RV124 should read RV12.

Part 5 (July issue).

Page 33. Figure 39.
There should be no vertical line connecting the 0V line under C22,C23 etc. and the junction of R109,R110 and the junction of R111,R112.
There should be no vertical line connecting the 0V line under C28,C27 etc. and the junction of R122, R123 etc.
C220 should be connected between IC14 pin 11 and -6V and not between pin 9 and -6V. On IC15, pins 9 and 10 are linked and pins 13 and 14 are linked.
TP4 added at IC15 pin 8.
TP5 added at IC14 pin 8.
TP6 added at IC14 pin 9.

Page 36. Figure 40.
On IC24, pins 1 and 2 are transposed and pins 22 and 23 are transposed. Pins 18 and 20 should be shown connected to -6V and pin 21 should be connected to -1V.
IC29, pin 3 should be connected to -1V and pins 4 and 12 should be connected to -6V.

Page 38. Parts list for lower manual.
R120,213 should be 4k7 (were 390k).
R126,132 should be 390k (added).
R202 should be 1k (was 10k).

And Finally

One final item that we have omitted to mention previously is the strapping required as shown in Figure 49. The EPROM is pre-programmed with 30 rhythm patterns and this strap is required in order that the downbeat light

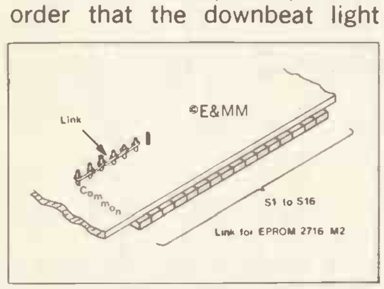


Figure 49. Strapping for EPROM.

functions correctly. The strap required might be different if the chip contained different rhythms. Maplin can provide charts for you to fill in if you wish, to write your own rhythms for use with the Matinee and they will program a chip for you at a small charge.

Maplin have set up a technical enquiry desk for Matinée constructors, so if you have any technical problems with your Matinée organ, please telephone (0702) 554155 and ask for Matinée technical enquiries. A very reasonably priced organ stool is available from Maplin to go with the Matinée. The order code is XB95D and the current price is £29.50.

Now that the organ is built, we are sure many of you will be interested in our special offer set of books that will help you learn to play the Matinée. An excellent set of books that will guide you to greater enjoyment of this superb instrument. Finally, may we wish you many happy hours at the keyboard. **E&MM**

FREE OUR CURRENT BARGAIN LIST WILL BE ENCLOSED WITH ALL ORDERS.

TRANSMITTER SURVEILLANCE *
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox – all electronic parts and circuit. £2.30.

RADIO MIKE *
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £6.90 comp. kit.

SAFE BLOCK
Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit. £1.95.

6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy if you have an amplifier to connect it to or a pair of high resistance headphones. Price £11.95.

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price £2.30. Crystal earpiece 65p. High resistance headphones (gives best results) £3.75. Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy to fault find – start at the arial and work towards the speaker – when signal stops you have found the fault. Complete kit £4.95.

INTERRUPTED BEAM
This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components – relay, photo transistor, resistors and caps etc. Circuit diagram but no case. Price £2.30

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £11.50 + £2.50 post.

GPO HIGH GAIN AMP/SIGNAL TRACER. In case measuring only 5¼in x 3¼in x 1¼in is an extremely high gain (70dB) solid state amplifier designed for use as a signal tracer on GPO cables, etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An absolute bargain at only £1.85. Suitable 80ohm earpiece 69p.

> NEW KIT THIS MONTH!
> CB RADIO – Listen in with our 40-channel monitor. Unique design ensures that you do not miss sender or caller.
> Complete kit with case and instructions only £5.99.

8 POWERFUL BATTERY MOTORS
For models, Meccanos, drills, remote control planes, boats etc. £2.50.

WATERPROOF HEATING WIRE
60 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses – around water pipes, under grow boxes in gloves and socks. 23p per metre.

COMPONENT BOARD Ref. W0998
This is a modern fibreglass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including 4 3amp 400v types (made up in a bridge) 8 transistors type BC107 and 2 type BFY-51 electrolytic condensers. SCR ref 2N 5062, 250uf 100v DC and 100uf 25v DC and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at £1.15.

FRUIT MACHINE HEART. 4 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot". £9.95. + £4 carriage.

4-CORE FLEX CABLE
White pvc for telephone extensions, disco lights, etc. 10 metres £2, 100 metres £15. Other multicore cable in stock.

MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

EXTRACTOR FANS – Mains Voltage

Ex-computer, made by Woods of Colchester, ideal as blower; central heating systems, fume extraction etc. Easy fixing through panel, very powerful 2,500 rpm but quiet running. Choice of 2 sizes, 5" £5.50. 6" £6.50. post £1 per fan.

POCKET AUDIO COMPONENT TESTER

With it you can quickly test diodes, rectifiers, transistors, capacitors, check wiring and p.c. boards for open circuits, find the anode and cathode of a diode or rectifier and whether a transistor is PNP or NPN, which are the base collector and emitter connections. Condensers, if bad give a continuous signal but if good, give intermittent signals of varying length depending on their value. The test current is very low (2uA) and the voltage only 1.4v, so it is also possible to check MOS devices, as well as sensitive transistors with out fear of damaging them. The unit is supplied complete with internal battery, which should last many months. Price £3.45p.

*(Not licenceable in the U.K.)

SUPER HI-FI SPEAKER CABINETS

Made for an expensive Hi-Fi outfit – will suit any decor. Resonance free cut-outs for 8" woofer and 4" tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black. Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.50 the pair.

LOUDSPEAKERS

8" woofer and 4" tweeter, 4 ohms 35 watts power rating £6.90 per pair. Ditto but 8 ohms, £11.50 per pair. Post £2.00.

Vu METER SNIP.

Approximately 1 5/8" square, suitable for use as a recording level meter power output indicator or many similar applications. Full vision front, cover easily removable if you wish to alter the scale. Special snip price £1.00, or 10 for £9.00.

MOTORISED DISCO SWITCH

With 10 amp changeover switches. Multi-adjustable switches all rated at 10 amps, this would provide a magnificent display. For mains operated 8 switch model £6.25, 10 switch model £6.75, 12 switch model £7.25.

3 CHANNEL SOUND TO LIGHT KIT

Complete kit of parts for a three-channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is £14.95 in kit form or £19.95 assembled and tested.

THIS MONTH'S SNIP

REED SWITCHES
Wire ended, glass encapsulated. Contacts make when magnet brought near. Very many uses, i.e. combination locks, anti-intruder window & door switches, wind direction indicator, computer keyboard, secret switches, etc. etc. SNIP OFFER: 10 SWITCHES FOR £1.00, inc. post and VAT.
Purchasers receive circuits and details of some suggested uses.

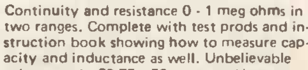
FLUORESCENT TUBE INVERTER

For camping – car repairing – emergency lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer an inverter for 12" 8 watt miniature tube for only £5.25. (With tube and tube holders as well).

12v MOTOR BY SMITHS

Made for use in cars, these are series wound and they become more powerful as load increases - they will in fact burn themselves out if overloaded to stopping point. Size 3½" long by 3" dia. These have a good length of ¼" spindle – price £3.45. Ditto, but double ended £4.25.

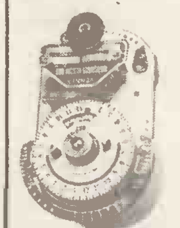
MINI-MULTI TESTER Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.v. mirrored scale. 11 instant range measures: DC volts 10, 50, 250, 1000. AC volts 10, 50, 250, 1000. DC amps 0 – 100 mA.


Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only £6.75 + 50p post and insurance.

FREE Amps range kit to enble you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but of you already own a Mini-Tester and would like one, send £2.50.

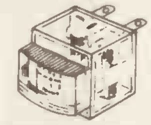
MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy to assemble modular form this should sell at about £30 – but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £16.75 including VAT and post.
FREE GIFT – buy this month and you will receive a pair of Goodman's eliptical 8"x 5" speakers to match this amplifier.

VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. These are new but without case, but we can supply plastic cases (base and cover) £1.75 or metal case with window £2.95. Also available is adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/offs per 24hrs. This makes an ideal controller for the Immersion heater. Price of adaptor kit is £2.30.

DELAY SWITCH

Mains operated – delay can be accurately set with pointers knob for periods of up to 2½hrs. 2 contacts suitable to switch 10 amps – second contact opens a few minutes after 1st contact. £1.95.

LEVEL METER

Size approximately ¾" square, scaled signal and power but cover easily removable for rescaling. Sensitivity 200 uA. 75p.

STEREO HEADPHONES

Japanese made so very good quality. 8 ohm impedance. padded, terminating with standard ¼" jack-plug. £2.99 Post 60p.

BRIDGE RECIFIER
1 amp 400v 30p each.
10 for £2.50. 100 for £20.00

TIME SWITCH BARGAIN
Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with the dials. Comes complete with knobs. £2.50.

12V SUBMERSIBLE PUMP
Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming, etc. and you get a very good head. Suitable for water, paraffin and any non-explosive non-corrosive liquid. One use if you are a camper, make yourself a shower. Price: £8.50.

POPULAR SNIP – STILL AVAILABLE
And it still carries a free gift of a desoldering pump, which we are currently selling at £6.35p. The snip is perhaps the most useful breakdown parcel we have ever offered. It is a parcel of 50 nearly all different computer panels containing parts which must have cost at least £500. On these boards you will find over 300 IC's. Over 300 diodes, over 200 transistors and several thousand other parts, resistors, condensors, multi-turn pots, recifiers, SCR, etc. etc. If you act promptly, you can have this parcel for only £8.50, which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel. Surely this is a bargain you should not miss! When ordering please add £2.50 post and £1.27 VAT.

SOLENOID WITH PLUNGER

Mains operated £1.99
10 – 12 volts DC operated £1.50.

YOUR LAST CHANCE FOR THIS BARGAIN
100 twist drills, regular tool shop price over £50, yours for only £11.50. With these you will be able to drill metal, wood, plastic, etc. from the tiniest holes in P.C.B. right up to about ¼". Don't miss this snip – send your order today.

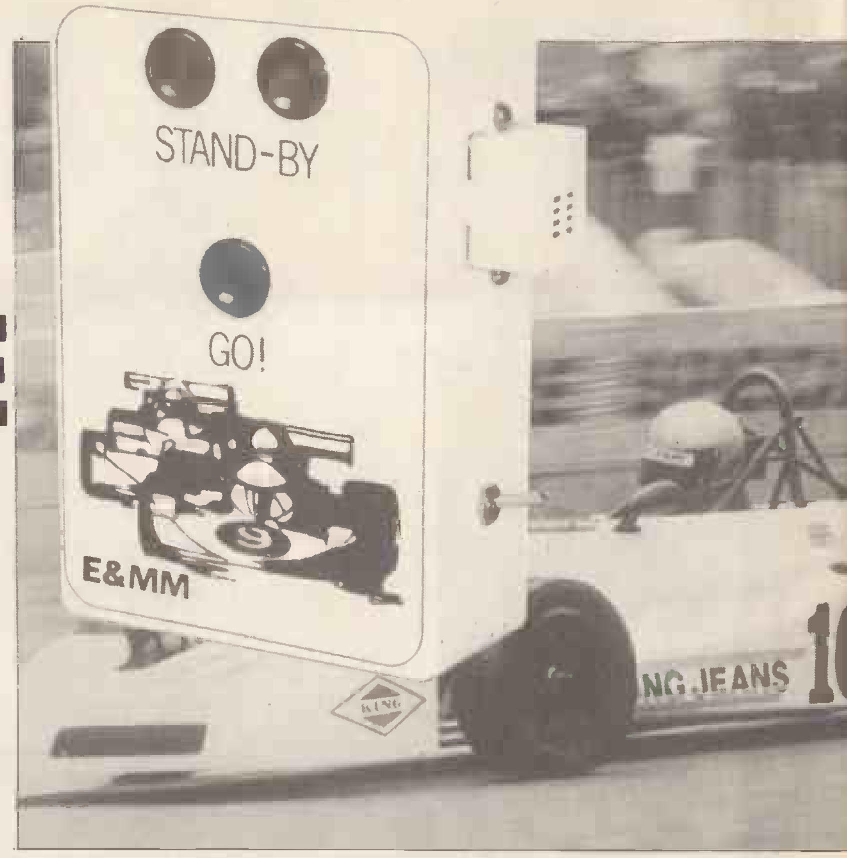
MINI MONO AMP on p.c.b., size 4"x 2" approx. Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 1 W rms. More technical data will be included with the amplifier. Brand new, perfect condition, offered at the very low price of £1.15 each, or 10 for £10.00.


J. BULL (Electrical) Ltd.
(Dept. EM), 34 - 36 AMERICA LANE,
HAYWARDS HEATH, SUSSEX RH16 3QU.

J. BULL (Electrical) Ltd – Established 25 years. MAIL ORDER TERMS: Cash with order -- please add 60p to all orders under £10, to offset packing, etc. ACCESS & BARCLAYCARD WELCOMED. Our shop is open to callers. BULK ENQUIRIES INVITED. Telephone: Haywards Heath (0444) 54563.

Young Ideas

This series will present a variety of projects designed to appeal to the younger reader but not necessarily suitable for the complete beginner. We shall be pleased to receive articles or project ideas for possible use in this feature.



CAR RACE STARTER

"STAND-BY . . ." Engines roar as race-drivers rev up in anticipation of the start of 'Grand Prix 1981'. All eyes are on the red flashing lights and the track siren blares out - suddenly lights are green and the crowd cheers for the "GO"!

This simple timer unit is designed to provide a start indication for slot-car races and a display of three LEDs provides the main indication. When the unit is first switched on, two red LEDs flash on alternately at a rate of a little more than one Hertz, and this continues for about ten seconds. The red LEDs are then cut off from the power supply, and a green LED is switched on to mark the beginning of the race. A buzzer is pulsed in sympathy with one of the red LED indicators and gives an audible warning that the race is about to start.

The unit is powered by an internal 9 volt (PP3 size) battery and is therefore completely self contained.

The Circuit

Two 555 timer integrated circuits are used in the circuit; one to flash the two red LEDs, and the other to give the ten second delay before the start indication is produced. The full circuit diagram of the unit is shown in Figure 1.

IC1 is used as an astable (oscillator) and its operating frequency is set at a little over 1 Hertz by the values of timing components R3, R4, and C1. The value of R4 has been made high in relation to that of R3 so that the charge and discharge times of C1 are virtually identical and a rough squarewave output is produced at pin 3 of IC1.

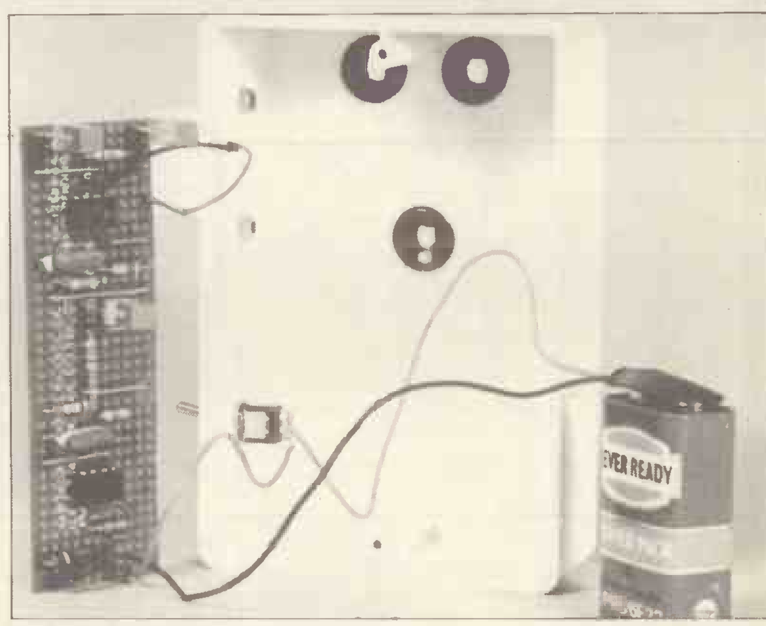
D1 and D2 are driven from the output of IC1 and these have R1 and R2 as their respective current limiting resistors. These two resistors are not of equal value because IC1 can sink a much higher current than it can source. R2 has therefore been made slightly lower in value than R1 in order to balance the LED operating currents and brightness. The ICM7555 CMOS version of the 555 device is used in the IC1 position as this has a current consumption of only about 80uA, as opposed to a current consumption of approximately 8mA for the standard device and this helps to keep the current consumption of the unit down to a reasonable level (about 12 to 15mA). D1 will be switched on when IC1's output goes low and D2 will be switched on when its output goes high, thus giving the required alternate flashing action.

IC2 is used in the monostable mode and gives a single output pulse when its trigger input (pin 2) is taken below one third of the supply voltage. C2 will be totally uncharged at switch-on and this gives a suitable trigger pulse as soon as S1 is switched to the on position. The output at pin 3 of IC2 then goes high for a period which is determined by the values of R8 and C3. The specified values give an output pulse of around ten seconds in duration and this positive pulse is used to power the astable circuitry. At the end of the pulse the astable circuitry is switched off and power is applied to the start LED which is D3.

R7 rapidly discharges C2 when the unit is switched off and ensures that the circuit is triggered again when S1 is returned to the on position.

The audible alarm signal is produced by WD1 which is an electronic buzzer. This is connected so that it is switched on at the same time as D1.

Note that IC2 should not be an ICM7555 device, as the latter cannot provide sufficient output current to drive the astable circuitry.



Veroboard and other parts wired up.

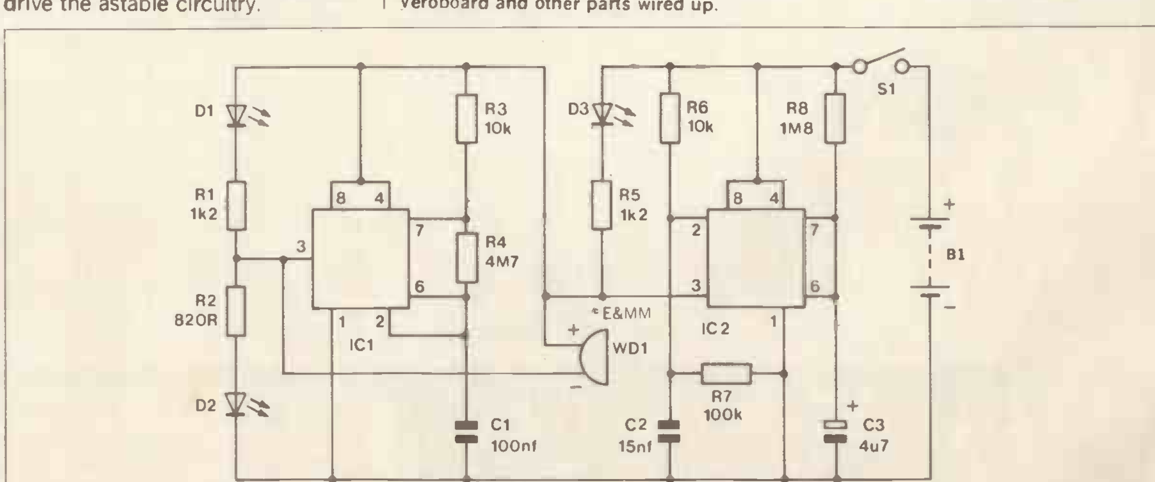
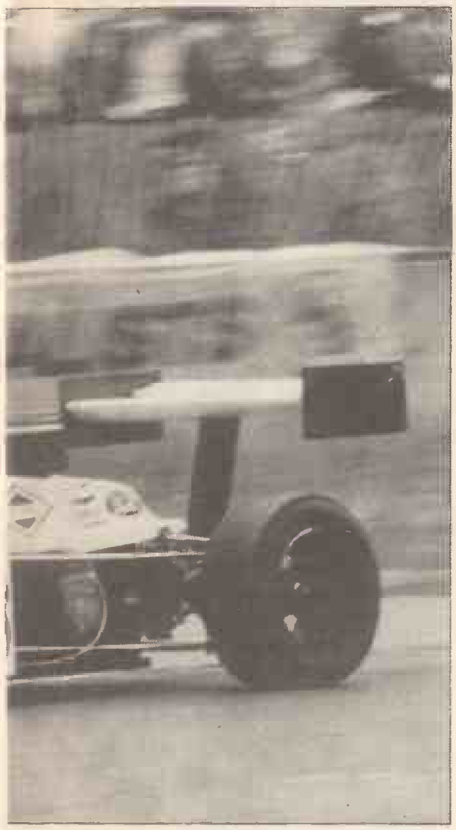
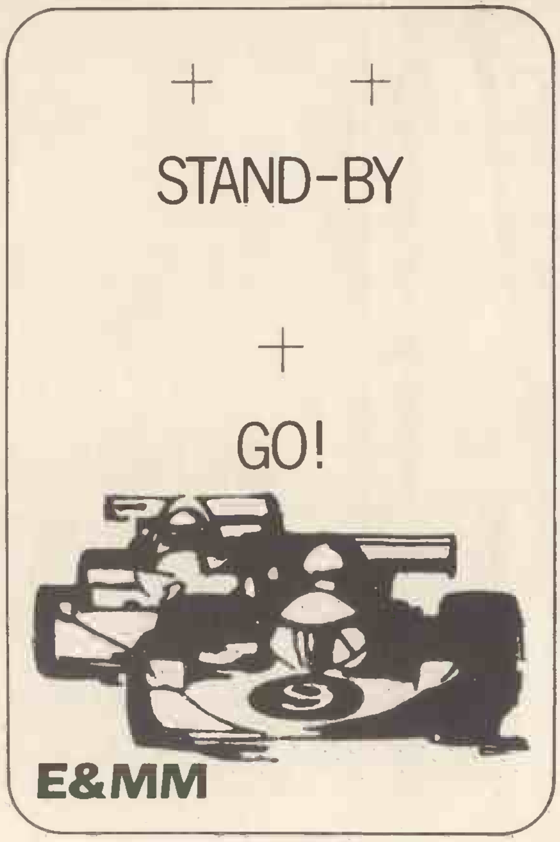


Figure 1. Car Race Starter circuit diagram.





PARTS COST GUIDE £6

PARTS LIST

Resistors - all 5% ⅓W carbon

R1,5	1k2	2 off	(M1K2)
R2	820R		(M820R)
R3,6	10k	2 off	(M10K)
R4	4M7		(M4M7)
R7	100k		(M100K)
R8	1M8		(M1M8)

Capacitors

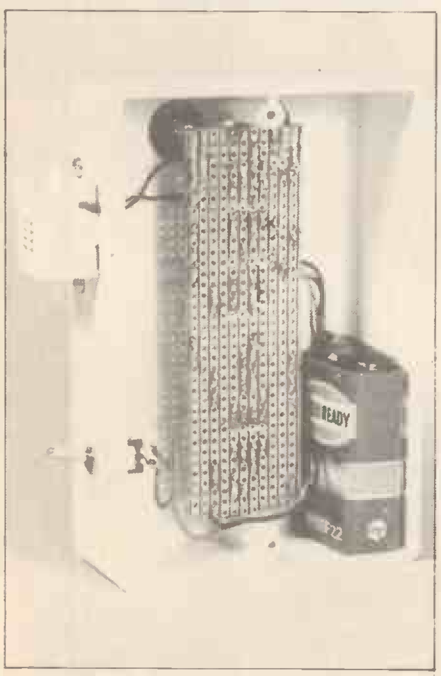
C1	100n polyester		(BX76H)
C2	15n polyester		(BX71N)
C3	4u7, 63V axial electrolytic		(FB18U)

Semiconductors

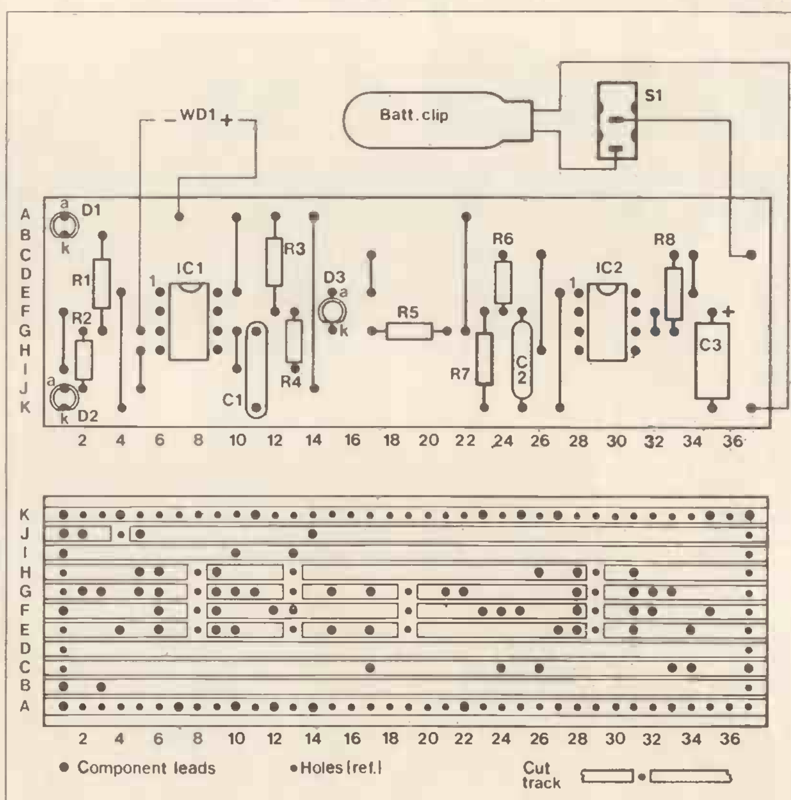
IC1	ICM7555		(YH63T)
IC2	NE555		(QH66W)
D1,2	LED, red square type L3	2 off	(YY51F)
D3	LED, green square type L3		(YY52G)

Miscellaneous

WD1	Solid state buzzer		(FL40T)
B1	PP3 battery		
	PP3 connector		(HF28F)
S1	SPST Ultra-min toggle		(FH97F)
	Small grommet	3 off	(FW59P)
	Case PB1 white		(LF01B)
	Veroboard 10346		(FL08J)



Rear view of unit showing Veroboard, buzzer, etc. in position.



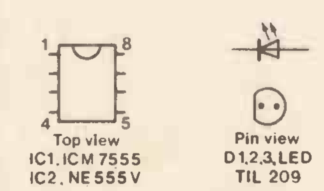
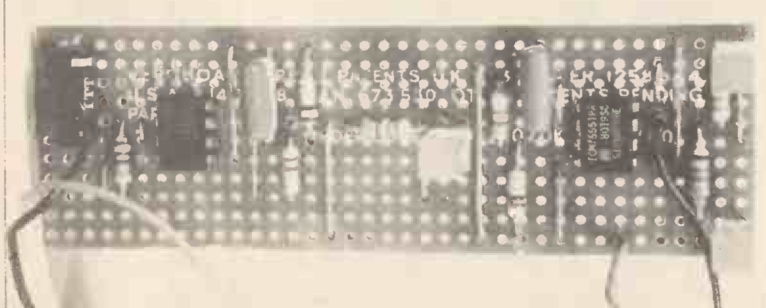


Figure 2. Car Race Starter: Veroboard, component layout and wiring details.



Veroboard components and links.

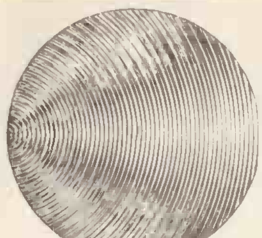
Construction

The unit will fit neatly into an inexpensive plastic box type PB1, but any case of a similar size should be usable. The case is used vertically and S1 plus WD1 are fitted on the right hand side of the unit. WD1 requires 8BA fixings, and a small hole must be drilled in the case at the rear of WD1 to enable its leadout wires to pass through to the interior of the case. The three LEDs are mounted on the front panel and the holders for these must be mounted in positions that match the spacing of the LEDs, which are mounted on the component panel. The component panel is mounted only by means of the three LEDs. Square LEDs fitted in grommets of a suitable size are used on the prototype, but the LEDs can be any types of the appropriate colours.

Figure 2 gives details of the component panel and wiring of the unit. The component panel is a Veroboard having 11 copper strips by 37 holes, and this can conveniently be a strip cut from a 95 x 63mm or 95 x 95mm piece of board. There are fifteen breaks in the copper strips to be made before the components and link wires are soldered into place. Be careful to connect the semiconductors and C3 the right way round. Note that although IC1 is a CMOS device, the special handling precautions that are normally associated with CMOS devices are not necessary due to the internal protection circuitry of the ICM7555. Leave the leadout wires of D1 to D3 reasonably long or it may be found that some of the other components on the board will get in the way and make it impossible to fit the board into the case.

Once the component panel has been completed, wire in S1, WD1, and the battery clip (making sure that WD1 and the battery clip are connected with the correct polarity), and then thoroughly check all the wiring two or three times before fitting the component panel into place and testing the unit.

We've supplied the front panel legend for you to use or copy to complete the project. You'll soon find that the Race Starter will make an exciting 'lead-in' to your races. **E&MM**

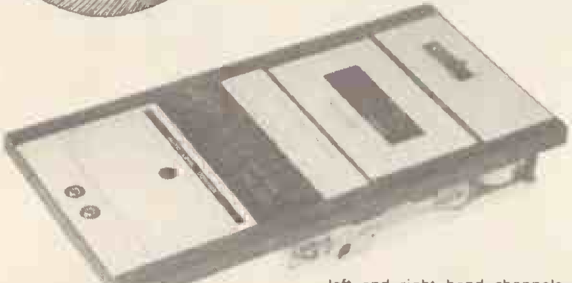


APPROVED thandar STOCKIST

B.K. ELECTRONICS
A SOUND CHOICE

APPROVED thandar STOCKIST

★ PROMPT DELIVERY ★ PRICES INCLUDE V.A.T. ★ AMPLE STOCKS
A PERSONAL SERVICE FROM A SMALL EXPANDING COMPANY



STEREO CASSETTE TAPE DECK MODULE. Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V Input Impedance: 68K. Output level: 400mV to both left and right hand channels. Output Impedance: 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5½in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) £3.

GEC AM/FM STEREO TUNER AMPLIFIER CHASSIS. Originally designed for installation into a music centre. Supplied as two separate built and tested units which are easily wired together. **Note:** Circuit diagram and interconnecting wiring diagrams supplied. **Rotary Controls:** Tuning, on/off volume, balance, treble, bass. **Push-button controls:** Mono, Tape, Disc., AFC, FM (VHF), LW, MW, SW. **Power Output:** 7 watts RMS per channel, at better than 2% THD into 8 ohms. 10 watts speech and music. **Frequency Response:** 60Hz-20kHz within ± 3dB. **Tape Sensitivity:** Output – typically 150 mV. Input – 300 mV for rated output. **Disc Sensitivity:** 100mV (ceramic cartridge). **Radio:** FM (VHF), 87.5MHz – 108MHz. Long wave 145kHz – 108kHz. Medium wave. 520kHz – 1620kHz. Short wave. 5.8MHz – 16MHz. **Size:** Tuner – 2¾in x 15in x 7½ in approx. Power amplifier – 2in x 7½in x 4½in approx. 240V AC operation. Supplied complete with fuses, knobs and pushbuttons, and LED stereo beacon indicator. **Price £23.50** plus £2.50 postage and packing.

NEW RANGE QUALITY POWER LOUDSPEAKERS (15″, 12″ and 8″). These loudspeakers are ideal for both hi-fi and disco applications. Both the 12″ and 15″ units have heavy duty die-cast chassis and aluminium centre domes. All three units have white speaker cones and are fitted with attractive cast aluminium (ground finish) fixing escutcheons.
Specification and Price:–

15″ 100 watt R.M.S. Impedance 8ohm 59 oz. magnet, 2″ aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. **Price £32 each.** £2.50 Packing and Carriage each.

12″ 100 watt R.M.S. Impedance 8 ohm, 50 oz. magnet. 2″ aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz. Sensitivity 95dB. **Price £23.70 each.** £2.50 Packing and Carriage each.

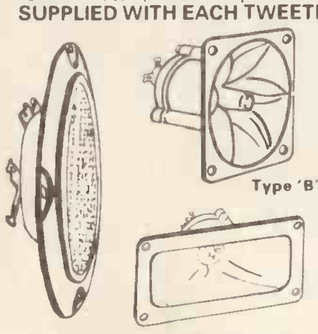
8″ 50 watt R.M.S. Impedance 8 ohm, 20 oz. magnet. 1″ aluminium voice coil. Resonant Frequency 40Hz. Frequency Response to 6KHz. Sensitivity 92dB. Also available with black cone and black protective grill. **Price £8.90 each.** £1.25 Packing and Carriage each.

JVC TURNTABLE. JVC Turntable supplied complete with an Audio Technica AT10 stereo magnetic cartridge.

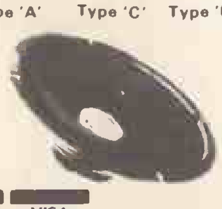
- ★ 'S' shaped tone arm.
- ★ Belt driven.
- ★ Full size 12in platter.
- ★ Precision calibrated counterbalance weight (0-3 grms.)
- ★ Anti-skate (bias) device. Nylon thread weight.
- ★ Damped cueing lever.
- ★ 240V AC operation, (50Hz).
- ★ Cut-out template supplied.

Size – 12¾in x 15¾in (approx).
Price £28.50 plus £2.50 postage and packing.

PIEZO ELECTRIC TWEETERS – MOTOROLA
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is **not** required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



Type 'A' 3in round with removable wire mesh. Ideal for bookshelf hi-fi speakers. **Price (Type 'A') £3.45 each.**
Type 'B' 3½in super horn. For general purpose speakers disco and PA systems, etc. **Price £4.35 each.**
Type 'C' 2in x 5in wide dispersion horn. For hi-fi systems and quality disco etc. **Price £5.45 each.**
Type 'D' 2in x 6in wide dispersion horn. Frequency response extending down to mid-range (2000 c/s) suitable for hi-fi systems and quality disco. **Price £6.90 each.**
Post and Packing, all types, 15p each (or SAE for Piezo leaflets).



LOUDSPEAKER
High quality full range 8in loudspeaker. 10 watts RMS. 8ohm. Rolled surround with aluminium centre dome.
Price £3.75 each plus £1 Postage and Packing.

MATCHING THREE WAY LOUDSPEAKERS AND X-OVER

BUILD A QUALITY 60 watt SYSTEM
10″ 50 watt RMS WOOFER
5″ 20 watt MID RANGE
3″ 15 watt RMS TWEETER
3 way CROSSOVER

A MATCHING SET of three high quality loudspeakers each fitted with cast aluminium fixing escutcheons and domed black mesh protective fronts. All three units have attractive aluminium centre domes. The escutcheons/mesh fronts are removable to enable a unique choice of baffle board construction. For example, the loudspeakers can be mounted directly on to a veneered board or with the escutcheons removed, they can be conventionally mounted and covered with fabric.
The three way crossover is attached to a mounting panel which incorporates two recessed (black and red) spring loaded loudspeaker terminals. **Price £19.95 + £2.50 P&P.**

B.K. ELECTRONICS

VISA

Dept. E&MM/8
37 Whitehouse Meadows, Eastwood, Leigh-on-Sea, Essex SS9 5TY

Access

★ SAE for current lists. ★ Official orders welcome. ★ All prices include VAT. ★ Mail order only. ★ All items packed (where applicable) in special energy absorbing PU foam. Callers welcome by prior appointment, please phone 0702-527572.

CIRCUIT MAKER

One of the nice features about a magazine such as this is the way readers can contribute, thus presenting their ideas to a large number of people. Each contribution may be a full feature or constructional article describing some piece of electronic, electro-musical equipment, or more probably, a short piece containing the circuit diagram and a short piece of explanatory text. It is thus our intention to set aside pages in each issue for 'Circuit Maker', a feature dedicated to short ideas, mostly sent in by readers.

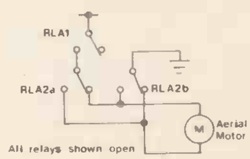
Car - Automatic Aerial Controller

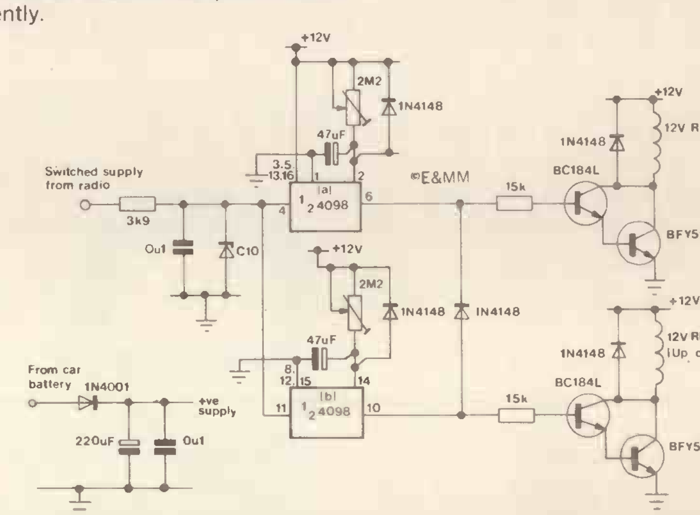
The more expensive car aerials have switches built into them, which together with a relay, enables the aerial to be raised or lowered in response to an on/off signal such as the radio circuit supply. Cheaper aerials use a dashboard mounted changeover switch which is pressed by hand long enough to raise or lower the aerial. This is not only inconvenient but tends to result in the aerial being left up when the car is unattended thereby defeating the object of an electric aerial. Such aerials may be made fully automatic with the addition of couple of relays and a CMOS monostable.

The circuit consumes only 20uA in its' quiescent state and should be left connected to the battery at all times. An additional connection to the radio is needed, and should be made to the radio side of the on/off switch so that it goes high when the radio is switched on (assuming negative earth). This connection is used to trigger two monostables, both contained in a 14528 (4098) integrated circuit; the capacitor and 10 volt Zener are included to help remove any surges or spikes that might damage the CMOS inputs.

One of the relays is used to switch on the aerial motor, the other to determine the direction of travel by simply reversing the motor supply. When the radio is first switched on the 'a' monostable is triggered for a predetermined period and closes the motor drive relay. The aerial will be raised because the up/down relay is still in the up mode (open). The monostable period should be set to allow the aerial to extend fully. When the radio power is removed the second monostable is triggered (off the -ve edge) and closes both relays by virtue of the diode OR gate to the motor relay. The aerial thus retracts, and again the time should be set on the relevant preset. Two diodes are included across the presets to protect the CMOS device if the battery is removed from the car but no reset is included and so the aerial will do funny things for a short time after power is first applied.

It is important to note that certain makes of electric aerial do not like continually being put up and down. This circuit contains no protection for such actions; personally, I am usually too busy driving to play with the aerial at three second intervals. By omitting such protection a tremendous saving in component cost can be obtained - unlike another version published recently.





Syntom Modification

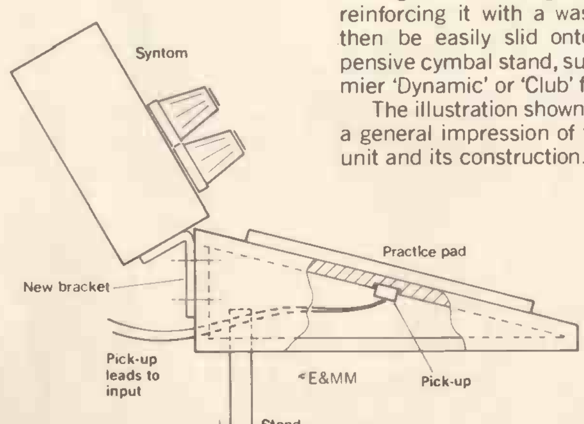
T. D. Liddle, Oxon

This simple modification to the 'Syntom' project (described in the April '81 issue of E&MM) enables a very exciting and effective syndrum to be produced for a fraction of the cost of a commercial syndrum.

A simple bracket constructed from aluminium is used instead of the handwheel bolt and clamp. The pad to be struck is a 'New Era' practice pad which can be obtained for under £10. The underside of this is drilled out at the centre, leaving about 2mm of wood between the rubber and the top of the crystal pick-up which is inserted into this hole, fixed solidly, and finally covered. The syntom has to be screwed to the back of the pad, at a convenient angle, left to the constructor's discretion.

If desired, the unit can be painted black and fixed to a stand simply by drilling a hole through the pad and reinforcing it with a washer. It can then be easily slid onto any inexpensive cymbal stand, such as a Premier 'Dynamic' or 'Club' for example.

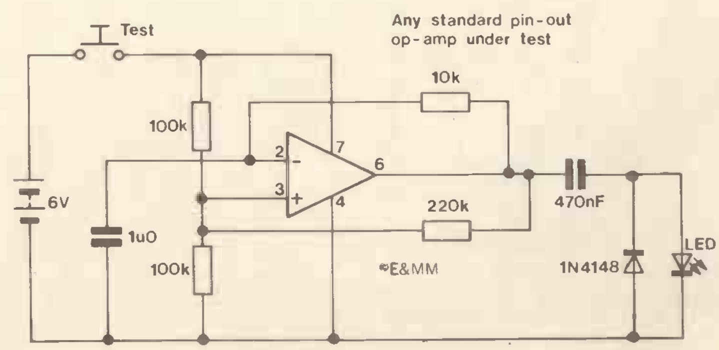
The illustration shown below gives a general impression of the finished unit and its construction.



Workshop - Simple op-Amp tester

Many designs have been published for op-amp testers, often with multi-state outputs to indicate how the device has failed. These are largely meaningless since if the device has failed it is useless. This tester design simply lights an LED if the op-amp is functional, and will suffice for 99% of the occasions a tester is required. A much more sophisticated tester would obviously be required to check for bias currents, offsets and noise.

In this tester the op-amp is connected as an oscillator, with a frequency of 1kHz, determined by the 10K feedback resistor. The non-inverting input is held nominally at half the rail voltage by the 100k resistors allowing the 220K resistor to provide a large amount of hysterisis. A functional op-amp will oscillate and charge and discharge the 0.47uF capacitor via the two diodes, one of which is an LED and will light due to the current flow. Obviously if the op-amp fails to oscillate the LED will not light because no current will flow through the capacitor irrespective of the final DC state of the output.

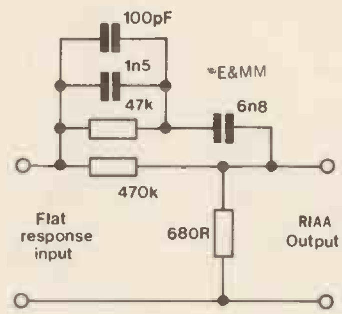


Workshop - Inverse RIAA source

Testing RIAA equalised phono inputs on an amplifier is rather tedius due to the level of bass boost involved, and this means that the test tone level must be continuously altered as the frequency is changed. Furthermore, a suitable level at 2KHz will overload and possibly damage an amplifier if the frequency is accidentally changed to 200 Hz.

An ideal source for this purpose should offer the exact inverse of the defined RIAA equalisation so the overall output of the amplifier will be flat across the audio band. The simple passive circuit described here offers a reasonable approximation to the required response using standard value components. Close tolerance parts will obviously improve the situation. The circuit is connected between the signal source and the phono inputs under test. The fact that the network is passive indicates that the input signal level will be considerably attenuated, a point of little consequence when it is remembered that typical phono inputs require a signal level in the order of 3 mV.

The component values chosen set the response breakpoints at 49.8, 498 & 2116 Hz, whereas the specification states 50, 500 & 2120 Hz so the total error is quite small (less than 0.5 per cent).



Workshop - Capacitor Bridge

A. E. Thompson, Wolvercote, Oxford.

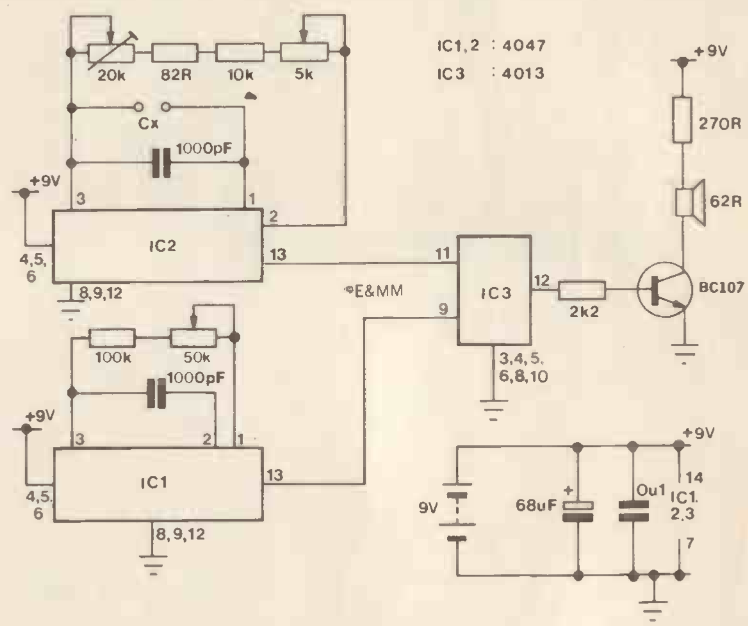
Capacitance bridges and the more recent digital capacitance meters cover a wide range of capacitance, but are generally quite expensive. Fortunately another well established method of such measurements is to use a beat frequency oscillator (BFO); these devices have been available for many years using LC oscillators. The problems of such oscillators is that they tend to lock due to stray coupling, thus great care is needed in their construction. This design is for a very low-cost alternative, using two RC oscillators and digital-integrated circuits. The accuracy of the instrument is limited only by the linearity of two potentiometers and the ability of the constructor to mark the front panel accurately.

The circuit consists of two astable multivibrators running at a frequency determined by potentiometers and the 1000p capacitors. The 50K pot is calibrated 0-500p, and with this to zero resistance a 4kHz oscillation is obtained. The 5K pot is calibrated ± 25p, and with this in its centre position, the preset is adjusted for zero beat in the absence of Cx so that both oscillators run at the same frequency. The presence of a capacitor Cx causes the relevant oscillator to run at a slower frequency, a difference corresponding to 3Hz/p.

The beat frequencies are detected by a D-type flip-flop, acting as a true frequency subtractor (IC3). The output from this flip-flop will be a frequency equal to the difference of the two input frequencies, when the input frequencies are equal the flip-flop output frequency will be zero. To raise the output from the flip-flop to a convenient audio level it is amplified by the BC107 before being fed to a miniature loudspeaker.

The circuit is used by adjusting the 50K pot (0-500p) to give zero beat output, the value of the unknown capacitor being directly read from the calibrated dial. Capacitors of a few Picafarads can be measured with fair resolution by turning the 50K pot to zero and using the calibration of the 5K pot (± 25p).

Obviously high stability components are required for the construction and scrap, junk box bits should not be used; the stability over a long period is good. The circuit will operate with supplies ranging from 4 to 12 volts with no drift at all so a PP3 or PP6 battery may be used. The current consumption is about 1mA at balance and some 14 mA out of balance, due to the speaker consumption, this may be reduced by increasing the value of the series 270R resistor shown fitted.



Studio - Patch Bay

D. Ward Hunt, Sheffield

After a few weeks of continually having to plug and unplug various items of equipment in order to connect them up in different ways, I decided to look for a way of overcoming the problem. Professional studios use a 'jack field' where all the inputs are arranged down one side of a panel and all the outputs down another side, each intersection having a simple jack-socket fitted. Any patch may be quickly set up by plugging shorted jack-plugs in at the required intersection. The cost of this is very high indeed.

In the end a patch bay was designed, using 2.5 mm jack-plugs and sockets. Each input and output is bought to the bay and terminated in a jack-socket, and the patching is achieved by using leads terminated at both ends with a jack-plug. The panel should be designed to suit the particular studio, but a typical example is shown.

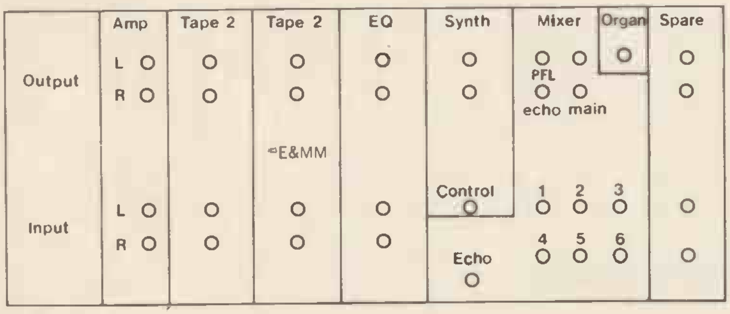
The following points should be borne in mind when designing and building the patch bay:

A metal box should be used to ensure good screening.

Screened patch-cords must be used.

Leave some spare input and output sockets available for future expansion.

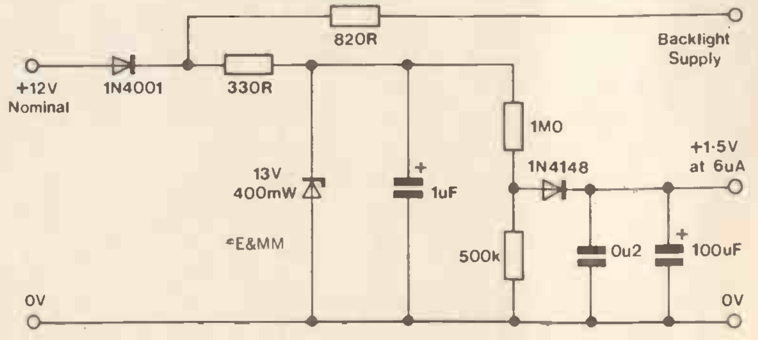
Use different sized sockets, if speakers and power amp levels are to be patched on the same board to prevent accidental patching of incompatible voltages.



Car - LCD clock supply

The Maplin LCD clock module (Maplin reference XL07H) makes a very attractive car clock, and can be run from the car battery. This is not quite as simple as it may be though because any conventional three diode shunt regulator will consume too much standing current, tending to drain the battery. The best solution appears to be a supply dropper calculated for 12 volts with plenty of decoupling and a series diode to hold the output in event of a short period voltage drop (such as starting). A 13 volt Zener should be added to clamp the input voltage if it rises above 13 volts, this will probably occur once the engine is running and the battery is being charged. The losess in a shunt regulator are naturally not important then. The backlight supply for the clock is separate, thus it will not affect the main part of the decoupling.

Using the values shown the clock will run for 13 seconds or so if the supply is removed, and should not be affected by voltage drops that may occur.



BI-PAK The Professional approach

TRANSISTORS

Type	Price
AC107	25
AC125	30
AC126	22
AC127	22
AC128	20
AC128K	37
AC132	26
AC141	26
AC141K	40
AC142	26
AC142K	40
AC176	24
AC176K	40
AC187	25
AC187K	40
AC188	25
AC188K	40
ACY17	50
ACY18	50
ACY19	50
ACY20	50
ACY21	50
ACY22	50
AD130	75
AD140	70
AD142	85
AD143	85
AD149	70
AD161	40
AD162	40
AD161/162 M/P	80
AF114	50
AF115	50
AF116	50
AF117	50
AF118	65
AF124	50
AF125	50
AF126	50
AF127	50
AF139	38
AF239	42
AL102	1.90
AL103	1.80
ASY26	50
ASY28	50
ASY29	50
AU104	1.90
AU110	1.90
AU113	1.90
BC107	10
BC107A	11
BC107B	11
BC107C	12
BC108	10
BC108A	11
BC108B	11
BC108C	12
BC109	10
BC109A	11
BC109B	11
BC109C	12
BC113	16
BC114	17
BC115	18
BC116	19
BC116A	20
BC117	20
BC118	17
BC119	28
BC120	35
BC125	25
BC126	30
BC132	18
BC134	18
BC135	18
BC136	20
BC137	20
BC138	28
BC139	32
BC140	25
BC141	28
BC142	25
BC143	25
BC144	40
BC145	46
BC147	09
BC148	09
BC149	09
BC150	20
BC151	22
BC152	20
BC153	25
BC154	19
BC157	10
BC158	10
BC159	10
BC160	26
BC161	38
BC167	11
BC168	10
BC169	10
BC169C	11
BC170	09
BC171	09
BC172	09
BC173	09
BC174	15
BC175	35
BC177	14
BC178	14
BC179	14
BC180	12
BC181	10
BC182	10
BC182L	10
BC183	10
BC183L	10
BC184	10
BC184L	10
BC186	15
BC187	18
BC207	11
BC208	11
BC209	12
BC212	10
BC212L	10
BC213	10
BC213L	10
BC214	10
BC214L	10
BC225	26
BC226	36
BC237	13
BC238	14
BC239	15
BC251	15
BC251A	16
BC261	18
BC300	30
BC301	28
BC302	29
BC303	28
BC304	28
BC307	13
BC327	12
BC328	13
BC337	13
BC338	13
BC384	14
BC440	30
BC441	30
BC460	32
BC461	32
BC477	20
BC478	20
BC479	20
BC546	10
BC547	10
BC548	10
BC549	11
BC550	14
BC556	14
BC557	13
BC558	13
BC559	14
BCY30	80
BCY31	80
BCY32	85
BCY33	80
BCY34	80
BCY70	14
BCY71	15
BCY72	15
BCZ10	70
BCZ11	70
BCZ12	70
BD106	50
BD115	50
BD116	50
BD121	65
BD123	65
BD124	75
BD131	35
BD132	35
BD131/132 M/P	80
BD133	40
BD135	35
BD136	35
BD137	35
BD138	36
BD139	38
BD140	38
BD139/140 M/P	80
BD155	50
BD175	60
BD176	60
BD177	68
BD178	68
BD179	75
BD180	75
BD185	68
BD186	68
BD187	75
BD188	75
BD189	78
BD190	78
BD195	90
BD196	90
BD197	95
BD198	95
BD199	99
BD200	99
BD201	80
BD202	80
BD201/202 M/P	1.70
BD203	80
BD204	80
BD203/204 M/P	1.70
BD205	80
BD206	80
BD207	80
BD208	80
BD222	47
BD225	47
BD232	85
BD233	65
BD234	55
BD235	55
BD236	58
BD237	65
BD238	65
BD239A	50
BD240A	50
BD239A/240A	1.00
BD240	45
BD241	45
BD506	38
BD508	38
BDX32	2.20
BDY11	1.30
BDY17	1.80
BDY20	80
BDY55	1.40
BDY56	1.60
BF115	25
BF117	50
BF118	75
BF119	75
BF121	50
BF123	60
BF125	50
BF127	60
BF152	25
BF153	25
BF154	22
BF155	35
BF156	28
BF157	28
BF158	28
BF159	28
BF160	28
BF162	24
BF163	30
BF164	50
BF165	50
BF167	24
BF173	24
BF176	36
BF177	24
BF178	25
BF179	30
BF180	30
BF181	30
BF182	30
BF183	30
BF184	22
BF185	22
BF186	26
BF187	26
BF188	32
BF194	10
BF195	10
BF196	12
BF197	12
BF198	15
BF199	16
BF200	30
BF222	90
BF224	20
BF240	17
BF241	18
BF244	28
BF257	30
BF258	30
BF259	35
BF262	60
BF263	60
BF270	36
BF271	31
BF273	36
BF274	38
BF324	35
BF336	34
BF337	34
BF338	38
BF371	26
BF457	37
BF459	38
BF594	30
BF595	28
BF596	28
BFR39	24
BFR40	25
BFR41	25
BFR50	25
BFR52	25
BFR62	24
BFR79	28
BFR80	28
BFW10	55
BFX29	25
BFX30	30
BFX84	24
BFX85	26
BFX86	26
BFX87	26
BFX88	26
BFX90	55
BFY50	20
BFY51	20
BFY52	20
BFY53	20
BFY90	80
BIP19	38
BIP20	38
BIP 19/20 M/P	80
BRY39	39
BSX19	20
BSX20	20
BSX21	21
BSY95	13
BSY95A	13
BU105	1.60
BU105/02	1.95
BU204	1.40
BU205	1.40
BU208	1.90
BU208/02	2.25
GP300	40
MJ480	95
MJ431	1.05
MJ490	95
MJ491	1.15
MJ2955	90
MJE340	50
MJE370	55
MJE371	60
MJE520	45
MJE521	65
MJE2955	90
MJE3055	65
MJE3440	52
MP8113	52
MPF102	60
MPF104	35
MPF105	35
MPSA05	20
MPSA06	20
MPSA55	20
MPSA56	20
ND120	18
OC19	85
OC20	1.85
OC22	1.50
OC23	1.50
OC24	1.35
OC25	1.00
OC26	1.00
OC28	90
OC29	95
OC35	90
OC36	90
OC41	20
OC42	22
OC44	24
OC45	20
OC70	24
OC71	15
OC72	24
OC74	26
OC75	30
OC76	35
OC77	50
OC79	40
OC81	22
OC81D	24
OC82	24
OC82D	30
OC83	26
OC84	38
OC139	80
OC140	80
OC169	80
OC170	80
OC171	80
OC200	46
OC201	95
OC202	1.20
OC203	85
OC204	90
OC205	1.15
R2008B	2.50
R2010B	2.60
TIC44	29
TIC45	35
TIP29	30
TIP29A	55
TIP29B	42
TIP29C	44
TIP30	38
TIP30A	40
TIP30B	42
TIP30C	44
TIP31	38
TIP31A	40
TIP31B	42
TIP31C	44
TIP32	38
TIP32A	40
TIP32B	42
TIP32C	44
TIP41A	44
TIP41B	46
TIP41C	48
TIP42A	44
TIP42B	46
TIP42C	48
TIP2955	60
TIP3055	50
TIS43	22
TIS90	20
TIS91	22
TIS92	22
UT46	20
ZTX107	10
ZTX108	10
ZTX109	10
ZTX300	12
ZTX301	12
ZTX302	16
ZTX303	16
ZTX304	20
ZTX330	15
ZTX500	13
ZTX501	12
ZTX502	16
ZTX503	12
ZTX504	25
ZTX531	25
ZTX550	25
2N388	36
2N388A	56
2N404	20
2N404A	24
2N524	40
2N527	50
2N598	40
2N599	46
2N696	24
2N697	24
2N698	30
2N699	32
2N706	10
2N706A	12
2N707	48
2N708	14
2N711	30
2N717	30
2N718	25
2N718A	50
2N726	29
2N727	29
2N743	20
2N744	20
2N914	20
2N918	30
2N929	20
2N930	18
2N946	40
2N1131	24
2N1132	24
2N1302	25
2N1303	28
2N1304	28
2N1305	28
2N1306	35
2N1307	35
2N1308	40
2N1309	40
2N1599	35
2N1613	28
2N1711	30
2N1889	45
2N1890	45
2N1893	40
2N2147	75
2N2148	70
2N2192	38
2N2193	38
2N2194	38
2N2217	25
2N2218	25
2N2218A	28
2N2219	28
2N2219A	30
2N2220	20
2N2221	20
2N2221A	22
2N2222	20
2N2222A	20
2N2368	18
2N2369	14
2N2369A	14
2N2411	25
2N2412	25
2N2646	47
2N2711	22
2N2712	22
2N2714	22
2N2904	24
2N2904A	26
2N2905	24
2N2905A	26
2N2906	18
2N2906A	20
2N2907	20
2N2907A	22
2N2923	15
2N2924	15
2N2925	15
2N2926G	10
2N2926Y	09
2N2926O	09
2N2926R	09
2N2926B	09
2N3010	20
2N3011	20
2N3053	22
2N3054	45
2N3055	42
2N3402	21
2N3403	21
2N3404	29
2N3405	42
2N3414	16
2N3415	16
2N3416	29
2N3417	29
2N3614	1.00
2N3615	1.05
2N3616	1.05
2N3646	09
2N3702	09
2N3703	09
2N3704	09
2N3705	09
2N3706	10
2N3707	10
2N3708	09
2N3708A	09
2N3709	09
2N3710	10
2N3711	10
2N3771	1.40
2N3772	1.60
2N3773	2.20
2N3819 (FET)	18
2N3820 (FET)	45
2N3821 (FET)	60
2N3823 (FET)	60
2N3903	12
2N3904	12
2N3905	12
2N3906	12
2N4058	12
2N4059	14
2N4060	14
2N4061	12
2N4062	12
2N4220 (FET)	35
2N4284	28
2N4285	28
2N4286	28
2N4287	28
2N4288	28
2N4289	28
2N4290	28
2N4291	28
2N4292	28
2N4293	28
2N4860 (FET)	60
2N4923	65
2N5135	10
2N5138	10
2N5172	14
2N5194	56
2N5245	40
2N5294	50
2N5296	50
2N5448	12
2N5457 (FET)	32
2N5458 (FET)	32
2N5459 (FET)	35
2N5551	36
2N6027 (P.U.T.)	34
2N6121	70
2N6122	70
2N6289	70
2S301	50
2S302	43
2S302A	43
2S303	56
2S304	71
2S305	80
2S306	80
2S307	80

DIODES

Type	Price
AA119	08
AA120	08
AA129	09
AAY30	09
AAZ13	15
AAZ17	15
BA100	10
BA102	20
BA144	09
BA148	15
BA154	12
BA155	14
BA156	14
BA173	15
BA248	16
BB104	30
BAX13	07
BAX16	08
BY100	22
BY101	22
BY105	22
BY114	22
BY124	22
BY126	11
BY127	12
BY128	16
BY130	17
BY133	21
BY156	08
BY164	51
BY176	75
BY206	30
BY210-600	09
BYZ10	45
BYZ11	45
BYZ12	40
BYZ13	40
BYZ16	41
BYZ17	36
BYZ18	36
BYZ19	36
OA5	60
OA10	35
OA47	08
OA70	08
OA79	10
OA81	10
OA85	10
OA90	07
OA91	07
OA95	07
OA182	13
OA200	08
OA202	08
IN34A	07
IN60	06
IN914	04
IN916	05
IN4148	04
IS44	05

74 SERIES TTL

Type	Price
7400	14
7401	12
7402	12
7403	12
7404	13
7405	13
7406	28
7407	28
7408	20
7409	20
7410	13
7411	20
7412	22
7413	30
7414	50
7416	28
7417	28
7420	14
7421	32
7422	24
7423	28
7425	28
7426	30
7427	28
7428	34
7430	14
7432	28
7433	36
7437	30
7438	30
7440	15
7441	60
7442	60
7443	1.00
7444	1.00
7445	90
7446	90
7447	65
7448	65
7450	15
7451	15
7452	15
7453	15
7454	15
7460	15
7470	32
7472	28
7473	32
7474	30
7475	44
7476	35
7480	48
7481	95
7482	70
7483	68
7484	95
7485	95
7486	28
7489	1.95
7490	36
7491	75
7492	50
7493	36
7494	75
7495	65
7496	65
74100	1.10
74104	50
74105	50
74107	32
74110	46
74111	60
74118	95
74119	1.20
74121	36
74122	46
74123	60
74124	60
74136	65
74141	60
74144	2.50
74145	80
74150	1.00
74151	65
74153	65
74154	1.00
74155	70
74156	70
74157	70
74160	90
74161	90
74162	90
74163	90
74164	1.00
74165	1.00
74166	1.00
74167	2.30
74174	90
74175	80
74176	85
74177	85
74180	90
74181	2.30
74182	85
74184	1.35
74190	1.00
74191	1.00
74192	95
74193	1.00
74194	90
74195	90
74196	95

CMOS

Type	Price
CD4000	18
CD4001	19
CD4002	20
CD4006	92
CD4007	22
CD4008	80
CD4009	40
CD4010	48
CD4011	22
CD4012	22
CD4013	45
CD4014	84
CD4015	84
CD4016	42
CD4017	80
CD4018	85
CD4019	45
CD4020	99
CD4021	1.05
CD4022	95
CD4023	23
CD4024	70
CD4025	20
CD4026	1.50
CD4027	48
CD4028	80
CD4029	1.00
CD4030	55
CD4031	2.00
CD4034	1.95
CD4035	1.20
CD4036	3.30
CD4037	95
CD4038	1.15
CD4040	95
CD4041	78
CD4042	78
CD4043	88
CD4044	88
CD4045	1.50
CD4046	1.10
CD4047	95
CD4048	65
CD4049	45
CD4050	45
CD4052	80
CD4054	1.25
CD4055	1.25
CD4056	1.35
CD4068	25
CD4069	25
CD4070	29
CD4071	25
CD4072	25
CD4081	26
CD4082	26
CD4085	90
CD4093	70
CD4501	28
CD4502	1.20
CD4503	70
CD4506	70
CD4507	60
CD4508	2.95
CD4510	99
CD4511	1.15
CD4516	1.10
CD4518	1.00
CD4520	1.00
CD4528	1.10
CD4531	1.50
CD4561	1.00

VOLTAGE REGULATORS

Type	Price
MVR7805 MVR7824	all 59p Ea.
MVR7905 MVR7924	all 63p Ea.
78L05 78L24	all 28p Ea.
79L05-79L24	all 55p Ea.
LM309K	1.25
UA79MGHC	2.50
LM320 15v 12v, 15v 24v	95p Ea

74 LS SERIES TTL

Type	Price
74LS00	13
74LS01	13
74LS02	15
74LS03	15
74LS04	15
74LS05	22
74LS08	21
74LS09	21
74LS10	20
74LS11	22
74LS12	26
74LS13	34
74LS14	50
74LS15	34
74LS20	18
74LS21	26
74LS22	32
74LS26	38
74LS27	35
74LS28	35
74LS30	18
74LS32	22
74LS33	34
74LS37	28
74LS38	28
74LS40	25
74LS42	55
74LS47	72
74LS48	80
74LS49	90
74LS51	24
74LS54	28
74LS55	28
74LS63	1.40
74LS73	30
74LS74	30
74LS75	38
74LS76	42
74LS78	46
74LS83	68
74LS85	75
74LS86	38
74LS90	38
74LS91	1.10
74LS92	68
74LS93	58
74LS95	95
74LS96	1.10
74LS107	40
74LS109	70
74LS112	38
74LS113	68
74LS114	38
74LS122	68
74LS123	60
74LS124	1.60
74LS125	45
74LS126	45
74LS132	60
74LS136	50
74LS138	60
74LS139	68
74LS145	1.15
74LS147	2.00
74LS148	1.60
74LS151	70
74LS153	68
74LS156	65
74LS156	80
74LS157	60
74LS158	60
74LS160	85
74LS161	75
74LS162	1.00
74LS163	90
74LS164	90
74LS165	1.20
74LS166	1.70
74LS168	1.80
74LS169	1.80
74LS170	2.50
74LS173	95
74LS174	95
74LS175	95
74LS181	2.70
74LS183	2.80
74LS190	95
74LS191	95
74LS192	95
74LS193	95
74LS194	95
74LS195	85
74LS196	1.00
74LS197	85
74LS221	1.00
74LS240	1.60
74LS241	1.60
74LS242	1.60
74LS243	1.60
74LS244	1.50
74LS245	2.20
74LS247	1.20
74LS248	1.20
74LS249	1.20
74LS251	1.20
74LS253	90
74LS257	90
74LS258	1.10
74LS260	85
74LS259	1.50
74LS261	4.00
74LS266	72
74LS273	1.65
74LS275	3.50
74LS279	85
74LS280	2.40
74LS283	85
74LS290	90
74LS293	1.00
74LS295	1.90
74LS298	1.50
74LS299	3.50
74LS323	3.50
74LS324	1.90
74LS325	3.00
74LS326	3.20
74LS327	3.10
74LS348	1.80
74LS352	1.50
74LS353	1.50
74LS365	45
74LS366	55
74LS367	62
74LS368	80
74LS373	1.45
74LS374	1.45
74LS375	1.10
74LS378	1.20
74LS386	75
74LS393	1.10
74LS395	2.00
74LS398	2.70
74LS399	2.00
74LS390	1.40
74LS670	2.50

COMPUTER I.C.s

Type	Price
2114L-3	2.40
2708	3.50
2516/2715-5v	4.90
4116	2.25

LINEAR I.C.'s

Type	Price
CA270BE	95
CA280Q	95
CA3011	98
CA3014	1.75
CA3018	65
CA3020	1.75
CA3028	80
CA3035	2.30
CA3036	1.00
CA3042	1.60
CA3043	1.85
CA3046	70
CA3052	1.60
CA3054	1.10
CA3075	1.50
CA3080	65
CA3081	1.50
CA3085	95
CA3089	2.00
CA3090	3.60
CA3123E	1.50
CA3130E	90
CA3140E	48
LF351N	55
LF353N	88
LF356N	90
LM301A	25
LM304	1.60
LM308	75
LM311	65
LM317H	2.50
LM318H	1.95
LM324N	48
LM337T	1.35
LM339N	65
LM348N	90
LM380	85
LM381	1.45
LM382N	1.20
LM384	1.45
LM386	85
LM387	1.10
LM3915	2.20
LM3916	2.45
LM1458	42
LM3900	58
LM3909N	70
LM3914N	2.20
LM3911N	1.20
MC1304	1.90
MC1310P	1.45
MC1312	1.70
MC1350	1.20
MC1352	1.40
MC1469	2.70
MC1496	90
NE555	20
NE556	55
NE565	1.20
NE566	1.50
NE567	1.70
72702	46
UA703C	25
UA709C	25
72709	46
709P	35
UA710C	40
72710	30
UA711C	32
72711	32
UA723C	45
72723	45
UA741C	24
72741	24
741P	17
UA747C	60
72747	60
UA748	35
748P	35
SN76013N	1.60
SN76023N	1.65
SN76110	1.50
SN76115AN	1.90
SN76660N	90
TAA550B	35
TAA621	2.00
TAA661B	1.50
TBA120B	70
TBA540	1.40
TBA641A	2.20
TBA800	85
TBA810S	95
TBA820	70
TBA920Q	2.50
TCA270S	1.40
ZN414	90

SILICON RECTIFIERS

Type	Price
200mA	
IS920 50v	06
IS921 100v	07
IS922 150v	08
IS923 200v	09
IS924 300v	10
1 Amp	
IN4001 50v	04½
IN4002 100v	05
IN4003 200v	06
IN4004 400v	06
IN4005 600v	07
IN4006 800v	07
IN4007 1000	08
1.5 Amp	
IS015 50v	09
IS020 100v	10
IS021 200v	11
IS023 400v	13
IS025 600v	14
IS027 800v	16
IS029 1000v	20
IS031 1200v	25
3 Amp	
IN5400 50v	11
IN5401 100v	12
IN5402 200v	14
IN5403 300v	15
IN5404 400v	16
IN5405 500v	17
IN5406 600v	18
IN5407 800v	22
IN5408 1000v	25
6 Amp	
BYX38-300	45
BYX38-600	60
BYX38-300R	45
BYX38-600R	60
10 Amp	
IS10/50 50v	30
IS10/100 100v	35
IS10/200 200v	40
IS10/400 400v	50
IS10/600 600v	60
IS10/800 800v	70
IS10/100 1000v	85
IS10/1200 1200v	95

THYRISTORS

Type	Price
1 Amp — TO39 CASE	
THY1A/50v	34
THY1A/100v	38
THY1A/200v	42
THY1A/400v	50
THY1A/600v	65
THY1A/800v	78
BT101/500R	80
BT102/500R	80
BT106	1.25
BT107	93
BT108	98
2N3228	70
3 Amp — TO66	
THY3A/50v	35
THY3A/100v	37
THY3A/200v	40
THY3A/400v	50
THY3A/600v	60
THY3A/800v	75
5 Amp — TO64	
THY5A/50v	36
THY5A/100v	45
THY5A/200v	50
THY5A/400v	57
THY5A/600v	60
THY5A/800v	75
5 Amp — TO66	
THY5A/50v	36
THY5A/100v	45
THY5A/200v	50
THY5A/400v	57
THY5A/600v	60
THY5A/800v	75
2N3525	77
BTX30/50L	40
BTX30/400L	70
BT116	1.50
C106D	38
BTY79/400R	95
5 Amp — TO220 PLASTIC	
THY5A/50vP	35
THY5A/100vP	45
THY5A/200vP	47
THY5A/400vP	50
THY5A/600vP	60
THY5A/800vP	70
10 Amp — TO48	
THY10A/50v	45
THY10A/100v	50
THY10A/200v	55
THY10A/400v	60
THY10A/600v	80
THY10A/800v	1.10
16 Amp — TO48	
THY16A/50v	65
THY16A/100v	80
THY16A/200v	90
THY16A/400v	1.20
THY16A/600v	1.50
THY16A/800v	2.00
30 Amp — TO49	
THY30A/50v	1.30
THY30A/100v	1.50
THY30A/200v	2.95
THY30A/400v	4.00
THY30A/600v	4.20

TRIACS & DIACS

Type	Price
2 Amp — TO39	
TR12A/100v	30
TR12A/200v	42
TR12A/400v	50
10 Amp — TO48	
TRI110A/100v	55
TRI10A/200v	80
TRI10A/400v	90
4 Amp — TO202	
TR14A/400v	48
8 Amp — TO220	
TR18A/400v	64
10 Amp — TO220 PLASTIC	
TRI10A/400P	85
6 Amp — TO220	
TR16A/100v	45
TR16A/200v	52
TR16A/400v	60
12 Amp — TO220	
TRI12A/400v	70
DIACS	
BR100	20
D32	20

SPECIAL OFFER
never to be repeated
CPU 8080AN £1.50

ZENER DIODES

Type	Price
400W 1 3V 39V	all at 8p
1 3W 1 3V 100V	all at 15p
10W 1 3V-100V	all at 35p

BRIDGE RECTIFIERS

Type	Price
1 Amp RMS	
BR1/50v	20
BR1/100v	22
BR1/200v	25
BR1/400v	29
2 Amp RMS	
BR2/50v	35
BR2/100v	40
BR2/200v	44
BR2/400v	50
BR2/1000v	65
6 Amp RMS	
BR6/50v	75
BR6/100v	80
BR6/200v	88
BR6/400v	95

– new extended 1981 range

AL30A 10w R.M.S.
AUDIO AMPLIFIER MODULES

£4.16

AL60 25w R.M.S.
AUDIO AMPLIFIER MODULE
25 Watts RMS

£5.15

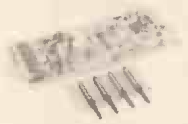
SPM120 STABILISED POWER SUPPLIES
SPM120/45
SMP120/55
SMP120/65

£6.38

AL80 35w R.M.S.
AUDIO AMPLIFIER MODULE

£8.07

S450
STEREO FM TUNER
Fitted with phase lock-loop



£25.56

Stereo 30
COMPLETE AUDIO CHASSIS

7+7w R.M.S.

£21.09

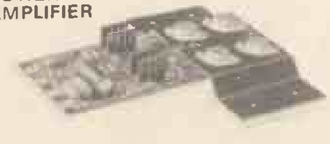
GE100 Mk2.
10 CHANNEL MONOGRAPHIC EQUALISER

£23.00

AL120 50w R.M.S.
AUDIO AMPLIFIER (With integral heat sink and short-circuit protection).

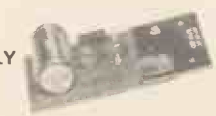
£13.14

AL250 125w R.M.S.
POWER AMPLIFIER



£19.60

SPM80
STABILISED POWER SUPPLY



£4.84

VPS30
REGULATED VARIABLE STABILISED POWER SUPPLY

£7.60

MONO PRE-AMPLIFIERS

MM 100. Supply voltage 40-65v Inputs: Tape, Mag P.U. Microphone Max output 500mv. **£12.43**

MM 100G. Supply voltage 40-65v inputs: 2 Guitars. Microphones Max output 500mv. **£12.43**

PA100
STEREO PRE-AMPLIFIER

£17.65

PA200
STEREO PRE-AMPLIFIER

£18.24

STA5. 5 watts per channel Stereo Amplifier. Kit consisting of: 2xAL20 amplifiers, 1xPA 12 pre-amplifier, 1xPS12 power supply, 1x2036 transformer and necessary wiring diagram **£19.52**

STA10. 10 watts per channel Stereo Amplifier. Kit consisting of: 2xAL30 amplifiers, 1xPA12 pre-amplifier, 1xPS 12 power supply, 1x2036 transformer and necessary wiring diagrams. **£20.63**

STA15. 15 watts per channel Stereo Amplifier. Kit consisting of: 2xAL60 amplifiers, 1xPA100 pre-amplifier, 1xSPM80 power supply, 1x2034 transformer, 2xcoupling capacitors for 8 ohms 470mfd 30v and necessary wiring diagram. **£36.76**

STA25. 25 watts per channel Stereo Amplifier. Kit consisting of: 2xAL60 amplifiers, 1xPA100 pre-amplifier, 1xSPM120/45 power supply, 1x2040 transformer, coupling capacitors for 8 ohms 470 mfd 45v, 1xreservoir capacitor 2200mfd 100v and necessary wiring diagram. **£40.50**

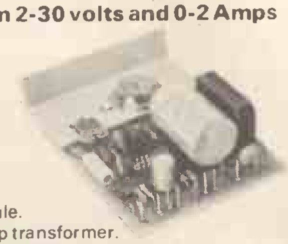
STA35. 35 watts per channel Stereo Amplifier. Kit consisting of: 2xAL80 amplifiers, 1xPA200 pre-amplifier, 1x2035 transformer, 2xcoupling capacitors 470mfd at 50v for 8 ohms, 1xreservoir capacitor 2200mfd 100v and necessary wiring diagram. **£45.76**

STA50. 50 watts per channel Stereo Amplifier. Kit consisting of: 2xAL120 amplifiers. 1xPA200 pre-amplifier, 1x2041 transformer, 2xcoupling capacitors 1000mfd 63v, 1xSPM 120/65, 1xreservoir capacitor 3300mfd 100v and necessary wiring diagram. **£59.89**

STA100. 100 watts per channel Stereo Amplifier. Kit consisting of: 2xAL250 amplifiers, 1xPA200 pre-amplifier. 2xSPM 120/65 power supplies, 2x2041 transformers, 2xcoupling capacitors 1000mfd 100v and necessary wiring diagram. **£84.68**

Stabilised Power Supply Kit
Variable from 2-30 volts and 0-2 Amps

VPS30



Kit includes:
1 – VPS30 Module.
1 – 25 volt 2 Amp transformer.
1 – 0-50v 2" Panel Meter.
1 – 0-2 Amp 2" Panel Meter.
1 – 470 ohm wirewound potentiometer.
1 – 4K7 ohm wirewound potentiometer.
Wiring Diagram Included.

KIT £20 + VAT

HARDWARE IN PACKS OF 25

839	0BA 1" Bolt	0.70
840	0BA ½" Bolt	0.40
842	2BA 1" Bolt	0.35
843	2BA ½" Bolt	0.30
844	2BA ¼" Bolt	0.32
845	4BA 1" Bolt	0.28
846	4BA ½" Bolt	0.20
847	4BA ¼" Bolt	0.18
848	6BA 1" Bolt	0.24
849	6BA ½" Bolt	0.18
850	6BA ¼" Bolt	0.20
851	0BA Solder Tags	0.20
852	2BA Solder Tags	0.16
853	4BA Solder Tags	0.14
854	6BA Solder Tags	0.12
855	0BA Full Nut	0.42
856	2BA Full Nut	0.26
857	4BA Full Nut	0.18
858	6BA Full Nut	0.18
859	0BA Washer	0.12
860	2BA Washer	0.09
861	4BA Washer	0.09
862	6BA Washer	0.09

FUSE HOLDERS

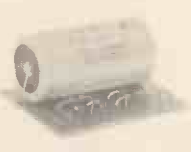
506	20mm Chassis Fuse Holder	0.14
507	1¼" Chassis Fuse Holder	0.14
508	1¼" Car in line Fuse Holder	0.12
509	20mm Panel Fuse Holder	0.26
510	1¼" Panel Fuse Holder	0.32

FUSES:

Quick Blow 20mm:		
611	150mA	0.06
612	250MA	0.06
613	500MA	0.06
614	800MA	0.07
615	1 Amp	0.06
616	1.5 Amp	0.07
617	2.0 Amp	0.06
618	2.5 Amp	0.06
619	3.0 Amp	0.06
620	3.15 Amp	0.07
621	5.0 Amp	0.06
Semi Delay: 20mm		
622	100MA	0.07
623	250MA	0.07
624	500MA	0.07
625	1 Amp	0.07
626	1.6 Amp	0.07
627	2 Amp	0.07
628	2.5 Amp	0.07
629	3.15 Amp	0.07
630	5.0 Amp	0.07
Quick Blow: 1¼"		
631	250MA	0.06
632	500MA	0.06
634	800MA	0.06
635	1 Amp	0.06
636	1.5 Amp	0.06
637	2.0 Amp	0.06
638	2.5 Amp	0.06
639	3 Amp	0.06
641	4 Amp	0.06
642	5 Amp	0.06

PS12 POWER SUPPLY MODULE
Power supply for AL20A-30A, PA12, S450 etc.

Input A.C. Voltage 15-20V.
Output D.C. Voltage 22-30V approx. (Dependent upon input.)
Output Current 800mA maximum.
Dimensions 60x43x26mm.



£1.65

Transformers are not included with power supplies.
SPM 120 Range also require reservoir and output capacitors.

BP124. 5 watt 12v max. – Siren Alarm Module. **£3.85**

GE100MK11. 10 channel mono-graphic equaliser, complete with sliders and knobs. **£23.00**

VPS30. Variable regulated stabilised power supply 2-30v 0-2 amps **£7.60**

PS250. Consists – 1 capacitor & 4 diodes for constructing unstabilised power supply for AL250 to 125 watts **2.90**

TRANSFORMERS

2034. 1.7 amp 35v. Suit SPM80. **£4.90**
2035. 2 amp 55v **£6.65**
2036. 750mA 17v. Suit: PS12. **£2.85**
2040. 1.5 amp 0-45v-55v. Suit: SPM120/45, SPM120/55v. **£6.45**
2041. 2 amp 0-55v-65v. Suit: SPM120/55, SPM120/65v. **3.46**
2039. 1 amp 0-20v. Suit Stereo 30. **£3.50**
2043. 150mA 15-0-15v. Suit: SG30. **£1.60**

ACCESSORIES

139. Teak Cabinet. Suit: Stereo 30, 320x235x81mm. **£7.00**
140. Teak Cabinet. Suit: STA15, 425x290x95mm. **£9.50**
FP100. Front Panel for PA100 & PA200. **£1.80**
BP100. Back Panel for PA100 & PA200. **£1.60**
GE100FP. Front Panel for one GE100MK11. **£1.75**
2240. Kit of parts including Teak Cabinet, Chassis, Sockets and Knobs etc. (To house STA15 Amplifier). **£19.95**

Full data sheets are available FREE on request, please enclose a S.A.E.

PA12
STEREO PRE-AMPLIFIER

£8.55

MPA30
MAGNETIC CARTRIDGE PRE-AMPLIFIER

£3.27

BP124 SIREN ALARM MODULE
American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break-down, and other security purposes.

ONLY £3.85 5 WATTS –

Access and Barclaycards accepted — just telephone our Orderline — Ware (STD 0920) 3182. All prices exclude VAT, add 50p postage per order. Terms: C.W.O., cheques, Postal Orders payable to Bi-Pak at address below.

BI-PAK
SEMICONDUCTORS

Dept. EMM/8 P.O. BOX 6, WARE, HERTS.
Tel: Ware (STD 0920) 3442. Telex: 817861.
Giro No. 3887006.
Visit our shop at: 3, Baldock St, Ware, Herts.

STOP! PRESS!

CB ACCESSORIES

105	Adjustable Aerial Gutter Mount	£3.00
106	CB Mobile Antenna	£9.50
1340	Mobile or CB Mike 600 ohms	£4.98
1341	Mobile or CB Mike 250 ohms	£6.00
1715	PL 259 Plug	£0.40
1716	SO239 Socket 4 hole fixing	£0.38
1717	SO239 Socket single hole fixing	£0.40
1718	PL258 Double Ended Female Coupler	£0.40
1719	NC555 Reducer for PL259 (Small)	£0.16
1720	NC556 Reducer for PL259 (Large)	£0.16
1721	M359 Right Angle Coupler PL259 SO239	£0.75
1722	M358 T Connector Female-Male-Female	£0.85
1723	NC563 Inline Coupler PL259 x 2	£0.60
1724	BNC15 50 ohm standard plug	£0.64
1725	BNC1502 Chassis mounting socket	£0.75
1726	BNC1503 Chassis mounting socket single hole fixing	£0.70
1727	BNC1520 BNC male to SO239 female	£0.85
1728	BNC1521 BNC female to PL259 male	£0.85

Project Wiring

by Christopher Roper

Perhaps the most neglected part of any amateur project, is the project wiring itself. The object of this article is to show that given a little time, practice and patience, it is a fairly simple exercise to produce a neat wiring layout, for any piece of equipment; whilst at the same time adding to the pleasure that can be derived from the hobby.

Planning a layout

One of the first things to be considered when planning a layout is neatness, whilst allowing provision for circuit boards, etc, to be removed at a later date if necessary. In the majority of cases, the positions of the various boards and other components, such as switches and potentiometers, will dictate the wiring layout; but there is usually scope for individual requirements. A few minutes spent in pre-planning can save time and trouble later.

As to the loom itself, try to ensure that the individual wires run parallel to each other, with sufficient slack being left at the ends, to enable any soldered joint to be removed and replaced at least once if necessary. Direct point to point wiring should be avoided and it is best to run any cable form at chassis level so that it can be fixed down at regular intervals. It is often a good idea to run one or more spare leads within the loom, for use in case of failure or modification of the equipment. Sharp bends, in the wires, should be avoided and where a cable crosses a hinged portion of a chassis, it should be flexible enough so as not to be put under any strain. Any loom passing through a chassis should be suitably protected from abrasion by the use of a protective grommet. Another point for consideration, is that of individual wire identification, especially when a loom consists of a large number of wires. One obvious method of identification is the use of different coloured wires; and if this method is adopted it is useful to follow some type of sequence. For myself, I use the standard resistor colour code, working from brown (no. 1) to black (no. 10); so that if, for example, I am wiring a multiway connector, then pins 1, 11, 21, etc will be wired in brown; pins 2, 12, 22, etc will be wired in red, and so on.

An alternative method is to employ the use of plastic cable markers, which are numbered or lettered as to requirements. These markers are made so as to slide onto the ends of individual wires. When a cable form is comprised of many wires, then a combination of these two methods can be time saving. For example, wire no. 35 is green with a no. 3 cable marker fixed on the end, so that both the colour of the wire and the marker, together, identify the wire. As a last resort, a piece of numbered tape attached to the ends of the wires will suffice. If a wiring or circuit diagram is to hand, it is a good idea to mark the various wire colours or numbers onto it, so that it is easy to see where individual wires run from and too. In this way the chances of wiring mistakes are minimised.

As most amateur projects are fairly small and usually 'one-offs', pre-formed looms are unnecessary, so that most wiring is usually formed and laced; or tie wrapped, directly into the chassis. Lacing a loom is fairly simple and straightforward, but the use of this technique will add a professional finish to any project, and with a little practice it is possible to produce a piece of equipment that not only works as intended but does not resemble a mare's nest of wiring when the back panel is removed. A well thought out loom is a compliment to a well designed project.

The basics of lacing

Lacing is just one method of holding a wiring loom together, but it is probably the one which produces the most pleasing results. There are two popular methods of lacing, both of which can be used to good effect. In the first method one end of the lacing cord is tied firmly to the cable form. The cord is then pulled up into a loop (A), and a second loop (B) is passed down behind the loom (Figure 1).

Loop (B) is then pulled up in front of the loom, level with loop (A) (Figure 2).

The free end of the lacing cord is then passed through loop (B) and then loop (A) (Figure 3).

The cord is then pulled tight, pulling the two loops together, around the cable form (Figure 4).

This action is repeated for each subsequent lace, along the length of the cable form, whilst trying to keep the lacing evenly spaced. The cord is pulled tight enough so as to grip the cable, but not so tight as to damage the insulation. At the end of the loom the cord is again 'tied off'. The second method of lacing is as simple as the first. One end of the lacing cord is again tied to the cable form, as in Figure 5.

The free end is passed down behind the loom. A loop (A) is then formed as before. The loop is then twisted one complete turn (i.e. 360°) anticlockwise — as in Figure 6.

The free end of the cord is then passed through the loop and pulled tight — Figure 7.

The finished lace is then as shown in Figure 8.

Although complete in their entirety, both types of lacing can be improved

Figure 1

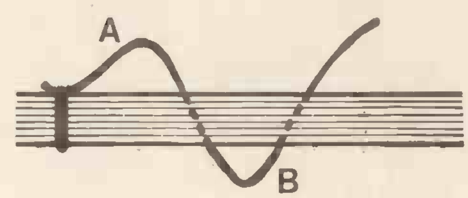


Figure 2

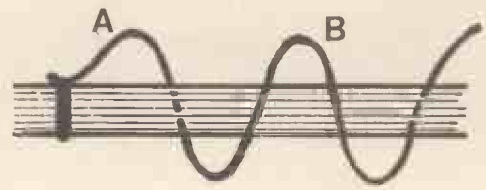


Figure 3

Figure 4

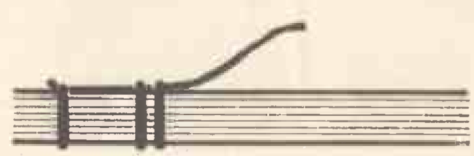


Figure 5

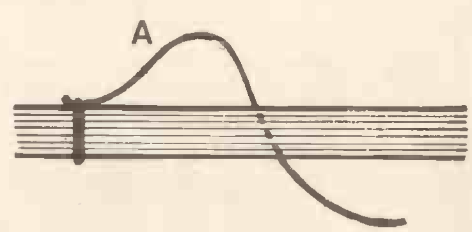
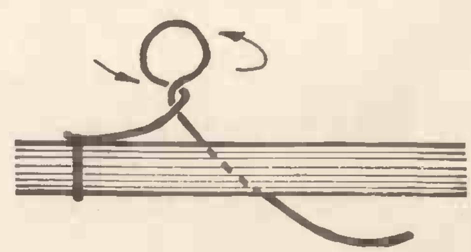


Figure 6



by the addition of a simple whip at the beginning and end of the loom. Again the process of making a whip is simple and straightforward but the results can be very pleasing and professional.

To begin a whip, first take an off-cut of lacing cord and tie the two ends together so as to form a loop about 2 inches in length. The loop is then laid along the loom, at the point where the lacing is to start, with the nose of the loop pointing in the direction that the lacing is to run — Figure 9.

Next take a length of lacing cord, which is long enough to lace the loom with and lay it against the cable form as shown in Figure 10.

Whilst holding the cord at 'X', with the tip of the thumb, begin winding the short end of the cord around the cable form, working the windings towards the nose of the loop, and ensuring that each successive turn around the loom butts up to the preceding one. Continue winding for about 8 turns but do not overlap the nose of the loop and ensure that after the last turn of cord, there is at least a ½ inch of cord still unwound. See Figure 11.

The short piece of unwound cord is then pushed through the nose of the loop and the loop is then pulled free, in the direction of the arrow — Figure 12.

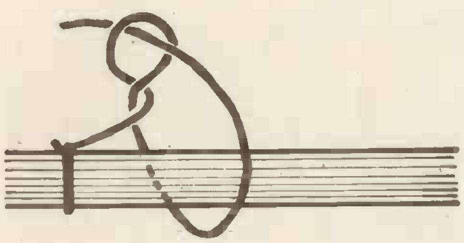


Figure 7

Figure 8

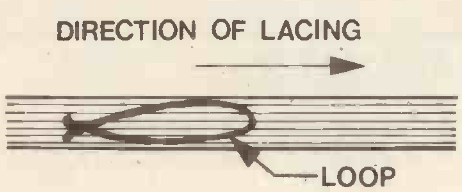


Figure 9

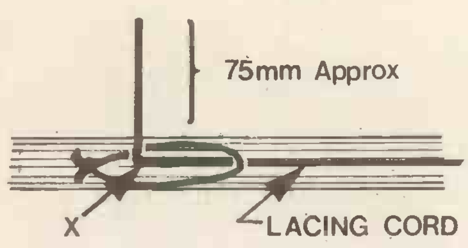


Figure 10

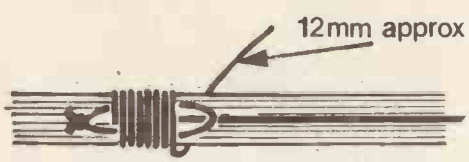


Figure 11

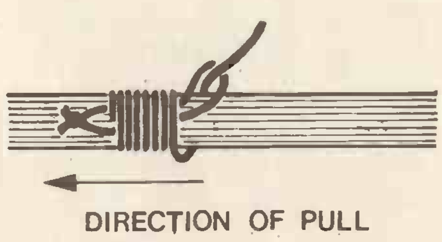


Figure 12

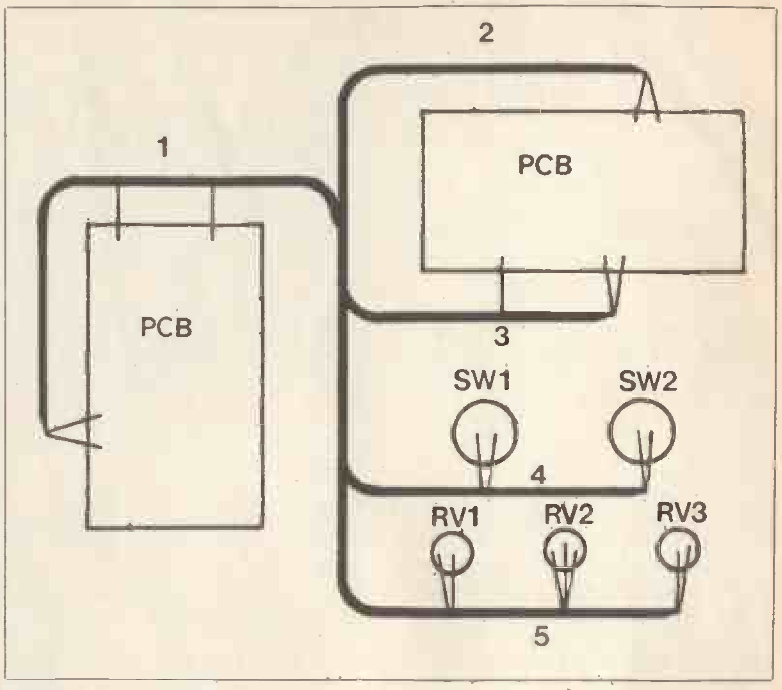


Figure 13

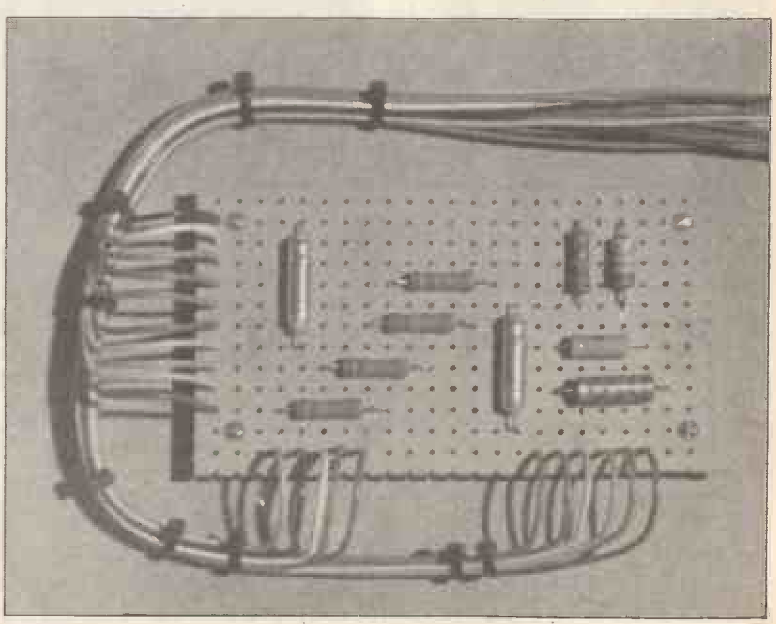
As the loop is pulled free, it has the effect of pulling the free end of the cord underneath the windings of the cord. All this takes longer to describe than to actually complete, and is a fairly simply operation to perform after a little practice. When the whip is completed, either of the two methods of lacing already described may be used to complete the lacing. At the end of the finished loom, a whip may be used to 'tie-off' the lacing cord.

Wiring a practical layout

Consider the layout shown in Figure 13. It comprises two circuit boards, two wafer switches and three potentiometers; and is possibly medium sized for an amateur project.

With the circuit diagram to hand, the wires are identified by colour or number and the cable layout is then decided upon. In this case, wires run from both the boards to the switches and there are several routes that they might follow. It is simply a matter of personal preference that they are laid as shown. In my opinion, when circumstances permit, a single larger loom often looks neater than several smaller ones. Having decided upon the cable runs, the next step is to decide at which point on the layout to begin the actual wiring. In this particular project, the wires running from the two circuit boards were soldered on first, so that the boards could then be fixed to the chassis. With the boards in position the wires are tidied up and held with a few tie-wraps in preparation for lacing. See Photograph 1. Note how the wires are brought out from the board in such a way so as to leave sufficient slack, for later removal if necessary. With the wires from both boards fixed in this way, the loom is ready for lacing.

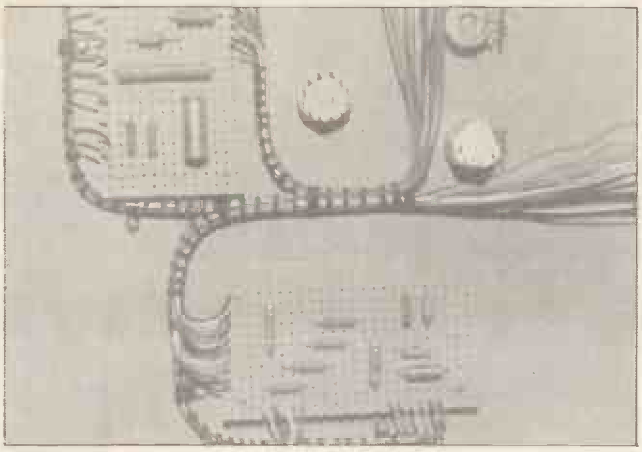
As can be seen from Figure 13, the loom consists of several branches which are numbered from one to five. This is the order in which they are laced. Beginning then with branch

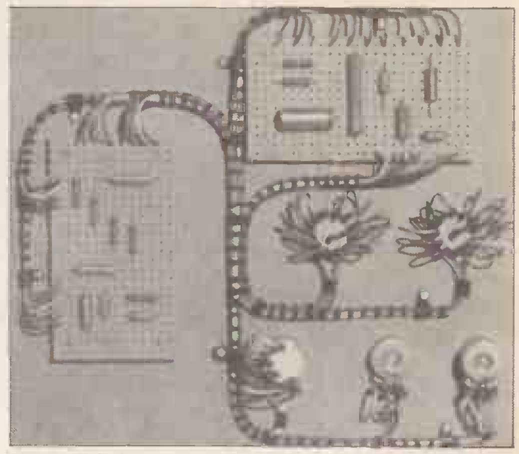


Photograph 1

no. 1. This is laced up to the point at which it joins branch no. 2. Branch no. 2 is then laced up to this point and the two branches are brought together. Branch no. 3 is laced next and the three combine to form the single loom. See photograph 2.

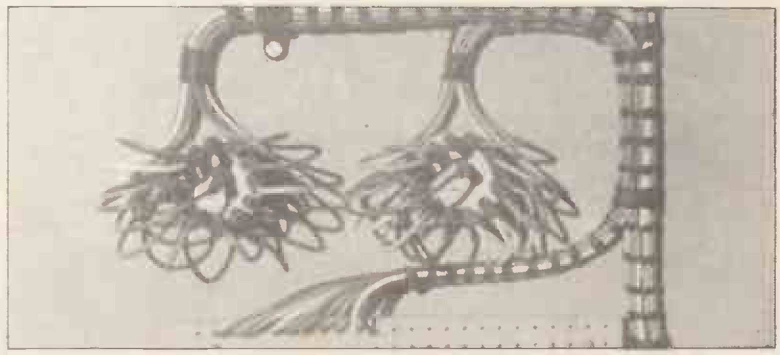
Where the branches come together, several laces are placed one on top of the other so as to strengthen the loom at these points. In this way the loom is built up, working from the circuit boards, towards the switches, with each branch being fixed down to the chassis with plastic 'P' clips. As the name suggests, these are plastic clips in the shape of the letter 'P', which are slipped around the loom and fixed to the chassis to provide support.


Photograph 2


Photograph 4

The last components to be wired are the switches, after each branch of the loom has been laced. As with the circuit boards, sufficient slack is left in the wires to allow for later removal. See photograph no. 3. Notice how the wires are made to 'flow' around the switches; rather than having them simply soldered on in any old fashion. Note also the use of protective sleeving over each of the soldered joints. This is to prevent short circuits between neighbouring connections and the sleeving is usually made of rubber or is of silicon composition. The sleeving may be eased over the joints by the discreet use of a small amount of lubricant, such as olive oil. Another type of protective sleeving that can be used is heat shrink sleeving. As the name suggests, this type of sleeving shrinks over the joint upon the application of heat from a hot air gun or even a soldering iron. When using this type of sleeving be careful not to damage the wire insulation by excessive heating. The completed loom can be seen in photograph no. 4.

There are other methods of holding a loom together, apart from the use of lacing cord. As already mentioned, plastic tie wraps can be used. These are self locking cable ties which are slipped around the cables; the tip is passed through the head and is pulled tight and the excess is then cut off. Tie wraps are available in several sizes. A suitable alternative to tie wraps is spiral cable wrap. This is an expandable plastic spiral binding which wraps around the cable form to grip it tightly. It is flexible and will follow any cable route. Short lengths of rubber sleeving can also be put to good use to hold a cable form together. The sleeving is simply stretched open, with a pair of pliers, and the individual wires are passed through it. When the pliers are removed, the sleeving shrinks, gripping the cables tightly.


Photograph 3

With a little practice and patience it is possible to produce a wiring layout which is not only functional but also pleasing to the eye.

E&MM

Micromusic

A series that focuses on using the popular microcomputers for making music.

Music on the Screen

Graham Knight

A number of readers have written in asking for an example program to be published which would draw the music on the screen and play a tune. The program printed draws the stave and the notes of the beginning of the tune "Amazing Grace" and as the tune starts the appropriate notes light up as they play. The printout from the screen shown in Figure 1 illustrates the type of display you can expect to see on the Sharp MZ-80K microcomputer.

The MZ-80K screen display is made up of 25 lines of 40 characters thus giving a possible 1,000 characters on the screen. Each character is made up of an 8x8 dot matrix and, using the SET and RESET commands, it is possible to define to a quarter of a letter giving a resolution of 4,000 programmable points. The picture element positions on the screen are allocated as decimal addresses from 53248 and to light up the notes as they are played it is necessary to use POKE statements. Many users get confused using this special command on the MZ-80K, but it is easy if you type the following statement: POKE 53248 + X,Y; X corresponds to the location on the screen and will be a number between Ø for top left and 999 for bottom right. The value of Y will be between Ø and 255 and this number selects the character to appear on the screen and is detailed in the display code table in the MZ-80K manual.

The program given here starts by assigning X as 53248, allowing the user to simply say POKE X instead of having a much longer line each time saying POKE 53248. The tempo is also defined in the first line. Lines 15 to 25 display the first five bars with the appropriate notes of "Amazing Grace" on the screen. Line 26 shows the equivalent notes in Sharp Music notation. Line 28 has been included to display the chord sequence on the screen so that if you are feeling ambitious you can accompany your microcomputer with guitar, organ or piano. Lines 30 to 42 are the POKE commands to light up each note as it is played and then to return that note to normal before going on to light up and play the next.

You can hear one of our readers playing a guitar accompaniment to a tune composed by his MZ-80K on E&MM's Demo Cassette 3.

Programs of this type can be extended and whole tunes can be programmed to be played and displayed. Many schools are now using this method to assist in teaching music and modern 'video' age pupils seem to respond well to this new tuition method.

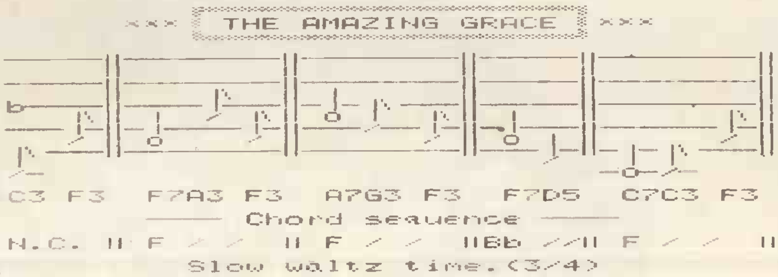


Figure 1. Screen display (using a printer in double size character mode to simulate results).

Previous issues of Electronics and Music Maker have detailed the special commands in the Sharp SP-5025 Basic which allows the programmer to select tempo, note and rest durations. A number of readers have written in with requests for certain tunes to be transcribed to a Sharp Basic program. A traditional tune like 'Greensleeves' is fairly simple especially as it has repeating sequences which can be assigned as a string. Three strings (G$,H$ and J$) are used in the 'Greensleeves' program thus enabling it to be written within 15 lines. Without the use of this technique writing music programs on the Sharp MZ-80K would be tedious and very repetitive.

The same string principle is applied in program 2, the 'Sailor's Hornpipe' - here all the music notes apart from those in lines 7 and 8 are in strings and assigned J1$, J2$, J3$, L1$, L2$, L3$. Some readers have written in asking how the tempo can be changed without continually writing tempo statements. Readers who are experiencing this difficulty should study lines 5,6 and 10 of the 'Sailor's Hornpipe' program as these lines contain the three changes of tempo required for this tune. The third program shown will play the 'Can Can' for you.

Careful study of these musical programs will soon allow readers to write far more complicated tunes as a Sharp Basic program. **E&MM**

```
10 X = 53248 : TEMPO 3
11 PRINT"▣▣▣▣▣▣▣▣▣▣▣▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒ "
12 PRINT"▣▣▣▣▣ ××× ▒ THE AMAZING GRACE ▒ ×××     "
13 PRINT"▣▣▣▣▣▣▣▣▣  ▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒ "
14 PRINT
15 PRINT"——————||——————————||——————————||——————||————————————||"
16 PRINT"      ||          ||          ||      ||            ||"
17 PRINT"——————||——————————||——————————||——————||————————————||"
18 PRINT"      ||     |\   || |        ||      ||            ||"
19 PRINT"b—————||————— |———||- |- |\ ——||——————||————————————||"
20 PRINT"    |\|| |  /  |\|| o |  |\|| |      ||         |\||"
21 PRINT"——— |-||- |——— |-||———/——— |-||- |————||——————————|-||"
22 PRINT"    / || o     / ||        / || o | ||          / ||"
23 PRINT" |\ ———||——————————||——————————||——— |-||- |- |\ ———||"
24 PRINT"|                                  /   |  |         "
25 PRINT"/—                                    -o-/-       "
26 PRINT"▣C3 F3  F7A3 F3  A7G3 F3  F7D5  C7C3 F3"
27 PRINT"▣▣▣▣▣▣▣ ——— Chord sequence ———"
28 PRINT"▣N.C. || F / / || F / / ||Bb //|| F / / ||"
29 PRINT"▣▣▣▣▣▣▣▣▣▣▣Slow waltz time.(3/4)
30 POKE X +560,71 : MUSIC"C3" : POKE X +560,45
31 POKE X +443,71 : MUSIC"F3" : POKE X +443,45
32 POKE X +447,71 : MUSIC"F7" : POKE X +447,72
33 POKE X +370,71 : MUSIC"A3" : POKE X +370,45
34 POKE X +452,71 : MUSIC"F3" : POKE X +452,45
35 POKE X +376,71 : MUSIC"A7" : POKE X +376,72
36 POKE X +418,71 : MUSIC"G3" : POKE X +418,45
37 POKE X +461,71 : MUSIC"F3" : POKE X +461,45
38 POKE X +465,71 : MUSIC"F7" : POKE X +465,72
39 POKE X +547,71 : MUSIC"D5" : POKE X +547,45
40 POKE X +591,71 : MUSIC"C7" : POKE X +591,72
41 POKE X +593,71 : MUSIC"C3" : POKE X +593,45
42 POKE X +476,71 : MUSIC"F3" : POKE X +476,45
```

Sample Music on the Screen program.

```
1 PRINT"▣▣▣▣▣▣▣▣▣▣▣▣▣":TEMPO4
2 PRINT"GREENSLEEVES---TRADITIONAL"
3 J$="A3¯C5¯D3¯E4¯F1¯E3¯D5B3"
4 MUSIC J$
5 MUSIC"G4A1B3¯C5A3"
6 MUSIC"A4G1A3B5#G3E4"
8 MUSIC J$
9 MUSIC"G4A1B3¯C4B1A3#G4#F1#G3A5A3A6"
12 G$="¯G4¯#F1¯E3¯D5B3G4A1B3"
13 H$="A4G1A3B5#G3E5B3"
14 MUSIC "¯G6",G$,"¯C5A3",H$,"¯G6",G$
15 MUSIC"¯C4B1A3#G#F#GA5A3A4"
```

Program 1. 'Greensleeves'.

```
1 PRINT"▣▣▣▣▣▣▣▣▣▣▣▣▣▣▣▣▣▣▣SAILOR'S HORNPIPE":REM TEMPO CHANGES
2 J1$="¯E1¯#D¯#CB¯#CBA#GA#G#FE"
3 J2$="E1#D#C_B#CE#D#FE#G#FA#G3E"
4 J3$="E3"
5 FOR K=3 TO 5
6 TEMPO K
7 MUSIC"¯E1¯#D¯E3E","E3B1A#G1E¯E¯#D¯E¯#G¯#F¯E¯#F3#F","#F3","#F1E"
8 MUSIC"#D1#FB#AB3¯#C1¯#D"
9 MUSIC J1$,J2$,J3$
10 NEXT K:REM K ASSIGNS TEMPO CHANGE
11 L1$="B1A#GB¯EB#GB¯EB¯#C3A3"
12 L2$="A3¯#C1B#A¯#C¯#F¯#CA¯#C¯#F¯#C¯#D3B"
13 L3$="B3¯#C1¯#D"
14 MUSIC L1$,L2$,L3$,J1$,J2$,J3$
```

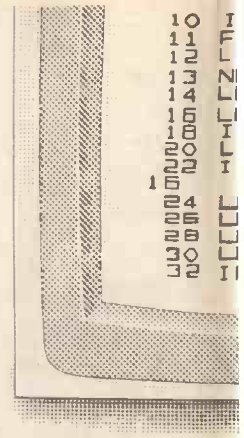
Program 2. 'Sailor's Hornpipe'.

```
1 TEMPO 5 :REM CAN CAN
2 MUSIC"G3¯D","¯D¯E¯D¯C","¯C¯E¯F¯A¯#B"
3 MUSIC"¯A3","¯A¯G","¯G5¯A3B","B3¯A¯G¯C","¯C¯E","¯E¯D¯E¯D¯E¯DBG"
4 MUSIC"G3¯D","¯D¯E¯D¯C","¯C¯E¯F¯A¯#B"
5 MUSIC"¯A3","¯A¯G","¯G5¯A3B","B¯A¯G¯C","¯C¯E","¯E¯D¯E¯D¯E¯D","¯D¯C"
6 MUSIC"¯C5"
7 G$="¯E5¯CAG¯G3¯D¯E¯F¯E¯D¯C5"
8 MUSIC G$
9 MUSIC"¯E5¯CAG#F3GAB¯D¯C","¯C5"
10 MUSIC G$
11 MUSIC"¯E5¯CAG#F3GAB¯D¯C","¯C5"
12 FOR T=1 TO 3
13 MUSIC"F5","F","G3#AAG¯C5","¯C","¯C3¯DA#AG5","G","G3#AAG"
14 MUSIC"F3¯F¯E¯D¯C#AAG"
15 NEXT T
16 MUSIC"F5¯CF","F7"
```

Program 3. 'Can Can'.

New! Sinclair ZX81 Personal Computer.

Kit: £49.95 complete



Reach advanced computer comprehension in a few absorbing hours

Built: £69.95 complete

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. At £99.95, the ZX80 offered a specification unchallenged at the price.

Over 50,000 were sold, and the ZX80 won virtually universal praise from computer professionals.

Now the Sinclair lead is increased: for just £69.95, the new Sinclair ZX81 offers even more advanced computer facilities at an even lower price. And the ZX81 kit means an even bigger saving. At £49.95 it costs almost 40% less than the ZX80 kit!

Lower price: higher capability

With the ZX81, it's just as simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, or to select a program off a cassette through the keyboard.

Higher specification, lower price – how's it done?

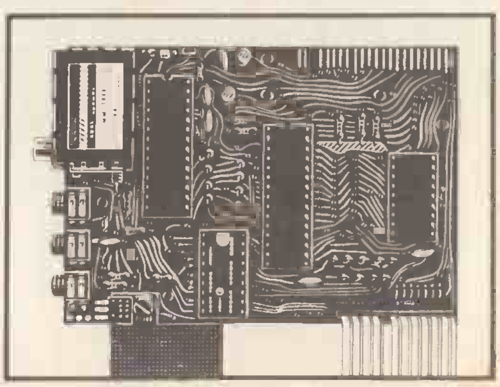
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

Kit or built – it's up to you!

The picture shows dramatically how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

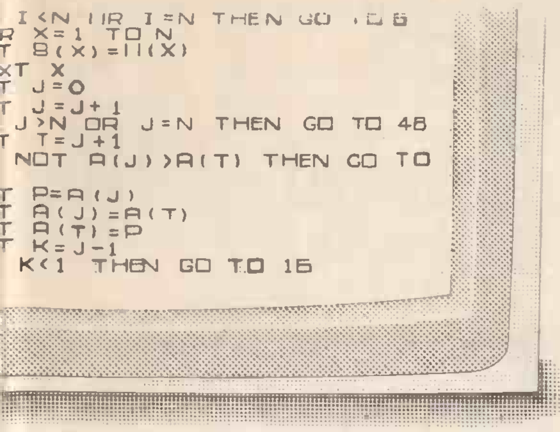
Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



Proven micro-processor, new 8K BASIC ROM, RAM – and unique new master chip.

New Sinclair teach-yourself BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs. You need no prior knowledge – children from 12 upwards soon become familiar with computer operation.



New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
- Cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer (not available yet – but coming soon!)
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

sinclair ZX81

Sinclair Research Ltd,
6 Kings Parade, Cambridge, Cambs.,
CB2 1SN. Tel: 0276 66104.
Reg. no: 214 4630 00

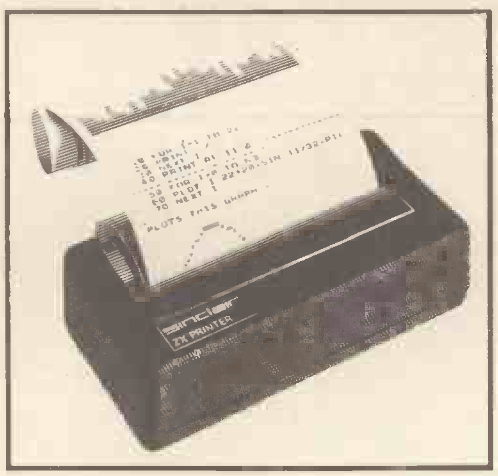
If you own a Sinclair ZX80...

The new 8K BASIC ROM used in the Sinclair ZX81 is available to ZX80 owners as a drop-in replacement chip. (Complete with new keyboard template and operating manual.)

With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 – including the ability to drive the Sinclair ZX Printer.

Coming soon- the ZX Printer.

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics across 32 columns, *and* highly sophisticated graphics. Special features include COPY, which prints out exactly what is on the whole TV screen without the need for further instructions. The ZX Printer will be available in Summer 1981, at around £50 – watch this space!



16K-BYTE RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

How to order your ZX81

BY PHONE – Access or Barclaycard holders can call 01-200 0200 for personal attention 24 hours a day, every day.
BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access or Barclaycard.
EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY. **Order**

Qty	Item	Code	Item price £	Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack(s).	18	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

TOTAL £ ______

Please tick if you require a VAT receipt ☐
*I enclose a cheque/postal order payable to Sinclair Research Ltd, for £ ______
*Please charge to my Access/Barclaycard account no.

*Please delete/complete as applicable. Please print.

Name: Mr/Mrs/Miss

Address

FREEPOST – no stamp needed. E&MM/8

BASICALLY BASIC

Graham Hall, B.Sc.

This regular series will attempt to teach BASIC to those who would like to use it for any home, business, scientific or musical application, but have no previous programming experience.

The RND and INT Functions

The RND function is a feature of the BASIC language that generates numbers that seem to be selected at random. It is one of the set of BASIC library functions which have been pre-written and stored in machine language to enable the programmer to perform common mathematical operations. The use of functions saves a large amount of space in a program and a corresponding amount in the computers memory. Later in this series the full set of mathematical functions, print functions and string functions will be described.

The following short program illustrates the use of the RND function to generate random numbers:

```
10  REM — PRESS BREAK TO STOP
20  PRINT RND (1)
30  GOTO 20
40  END
```

To execute the program type the BASIC command 'RUN'. The output to the terminal will be a continuous list of numbers between zero and one (but not including zero or one). Mathematically this can be stated as: 0 < RND (1) < 1. Lines 20 and 30 of the program compose an 'endless loop' — when line 30 is reached the program execution is directed back to line 20 by the GOTO statement, ad infinitum. Consequently the END statement is never reached. However, the program can be stopped by pressing the 'BREAK' key. The program could be modified to perform a controlled loop by using an IF THEN statement together with a counting variable as described in previous parts of BASICALLY BASIC.

Each time the program is run a different list of numbers is output. The distribution of the numbers is even — that is each number is as likely (or unlikely) to occur as any other. You may wish to write a small BASIC program to prove this. The program should calculate the average of say, one thousand random numbers generated by the RND function and print out the result. You will find that the result is approximately 0.5 since the distribution between zero and one is even.

It is not always convenient to use random numbers between zero and one. Different sets of numbers can be generated by combining the RND function with BASIC operators and other functions. For example, to generate random numbers between zero and ten but not including zero or ten:

```
10  REM — PRESS BREAK KEY TO STOP
20  PRINT 10*RND(1)
30  GOTO 20
40  END
```

This program multiplies the random numbers generated by the integer 10 so that they are in the range 0<10*RND(1)<10. Once again, after starting the program by typing 'RUN', execution will be stopped by pressing the BREAK key.

A possible list of numbers generated could be:

```
6.0087325
0.1324011
5.9763204
4.5331688
9.8752493
2.0467382
STOPPED AT LINE 10
```

The message 'STOPPED AT LINE 10' is output by the computer after the BREAK key has been pressed. The numbers consist of two parts, an 'integer' part to the left of the decimal point and a 'fractional' part to the right of the decimal point. For example, the integer part of the number 6.0087325 is 6 and the fractional part is .0087325.

The BASIC INT function separates the integer part of a decimal number from the fractional part. For example:
INT (0.1324011) is 0, and
INT (9.8752493) is 9

The contents of the brackets immediately following the word INT are called the 'argument' of the function. The INT function will accept a *constant*, variable, function or any expression as its argument. The following example generates a list of random integers (an integer is a number without a fractional component).

```
10  REM — PRESS BREAK TO STOP
20  PRINT INT (10*RND(1))
30  GOTO 20
40  END
```

The argument of the INT function is '10*RND(1)' which is an expression consisting of a constant, 10, multiplying a random number generated by the RND function. The program prints a list of random integers between zero and nine (0 ≤ INT(10*RND(1)) ≤ 9). It contains an endless loop so execution must be terminated using the BREAK key.

Now suppose that, instead of random integers within the range zero to nine, a program requires integers within the range one to twenty inclusive. The statement:
10 PRINT INT (20*RND(1))
prints a random integer between zero and nineteen when included in a BASIC program. To change the range to one to twenty the constant, one, must be added to each of the numbers generated. The one can be added to the random number either before or after taking the integer part of '20*RND(1)'. For example, the statements:
10 PRINT INT (20*RND(1)+1) and
10 PRINT INT (20*RND(1))+1
both generate a random number within the range one to twenty inclusive (i.e. 1 ≤ INT (20*RND(1)+1) ≤ 20 and 1 ≤ INT (20*RND(1))+1 ≤ 20).

Many BASIC games programs make extensive use of the RND function. A simple example would be a program which included a statement that generates integers from one to six. This could be the computer's equivalent of casting a die. For example, the statement:

```
10 LET D=INT (6*RND(1))+1
```

assigns to D an integer value between one and six.

Later in this article the above statement will be used in a BASIC program with the ON GOTO statement in order to check that each number is generated with the same probability (frequency of occurrence).

The ON GOTO Statement

The GOTO statement has already been used to implement an unconditional branch and with an IF THEN statement to implement a conditional branch. Now we will look at how the GOTO statement can also be used as a semi-conditional branch by writing it as 'ON GOTO'. With the ON GOTO statement, a branch can be made to one of a list of specified lines depending on the result of an expression. A BASIC statement line with ON GOTO has the general form:
line number ON variable or equation GOTO list of line numbers.
For example:

```
10 ON X GOTO 50, 70, 100, 300
```

Based on the value of the variable X, the program branches to one of the list of alternative line numbers. This selection is made in numeric order. So, for the above example:
if X is 1 — the program branches to line 50
if X is 2 — the program branches to line 70
if X is 3 — the program branches to line 100
if X is 4 — the program branches to line 300

The number of alternative lines to be branched to is only limited by however many can be written on one program line. If the value of X is zero, negative or larger than the number of alternative lines, program execution will stop and an error message will be output by the computer.

RND Verification Program

The following program illustrates the use of the RND and INT functions and the ON GOTO statement. It uses the RND and INT functions to generate a random integer between one and six. This is repeated a pre-determined number of times and the probability of each number occurring is then output to the terminal.

```
 10  REM RND VERIFICATION PROGRAM
 20  PRINT "NUMBER OF TIMES FOR DIE TO BE CAST";
 30  INPUT C
 35  IF C<=100 THEN PRINT "INPUT A LARGE NUMBER": GOTO 20
 40  FOR L=1 TO C
 50  LET D=INT (6*RND(1))+1
 60  ON D GOTO 70, 80, 90, 100, 110, 120
 70  LET N1=N1+1:GOTO 130
 80  LET N2=N2+1:GOTO 130
 90  LET N3=N3+1:GOTO 130
100  LET N4=N4+1:GOTO 130
110  LET N5=N5+1:GOTO 130
120  LET N6=N6+1
130  NEXT L
140  PRINT  "PROBABILITY OF ONE OCCURRING=";N1/C
150  PRINT  "PROBABILITY OF TWO OCCURRING=";N2/C
160  PRINT  "PROBABILITY OF THREE OCCURRING=";N3/C
170  PRINT  "PROBABILITY OF FOUR OCCURRING=";N4/C
180  PRINT  "PROBABILITY OF FIVE OCCURRING=";N5/C
190  PRINT  "PROBABILITY OF SIX OCCURRING=";N6/C
999  END
```

The program is composed of the following lines:

Line 10 — The REM statement (REMARK) identifies the program. The characters following REM are ignored by the computer.

Line 20 — The PRINT statement outputs the message contained in quotation marks to the terminal. The semi-colon at the end of the message causes the INPUT statement on line 30 to output its question mark prompt on the same line as the message.

Line 30 — The INPUT statement halts program execution and awaits a response from the user. You should type in a large number (say, 5000) followed by the RETURN key. Program execution will then continue.

Line 35 — The IF THEN statement restricts the input to a number which is greater than 100. If the user inputs a number less than 100 the input request is repeated.

Line 40 — The FOR statement is a concise, convenient way of implementing a loop in a BASIC program. Previously an IF THEN statement, together with a counting variable, have been used to construct a loop. The FOR statement will be fully described later in this series. In this program the FOR statement with its associated NEXT statement on line 130 controls how many times lines 50 to 120 are executed.

Line 50 — This line generates a random integer between one and six and assigns it to the variable D.

Line 60 — This is the ON GOTO statement line which makes a semi-conditional branch based on the value of D. If the value of D is 1, the program is directed to line 70. If the value of D is 2, the program is directed to line 80 and so on.

Lines 70 to 110 — These are multiple statement lines. The variables N1 to N6 are used to store a count of how many times each number is generated by line 50. For example, initially N1 to N6 each contain zero (because the BASIC interpreter program automatically assigns the value zero to each variable when it is first used, unless it is initialised to another value). Now, say that line 50 generates a four. The ON GOTO statement directs the program to line 100. Line 100 increments the value of the variable N4 by one. The GOTO statement at the end of line 100 directs the program to line 130. N4 now contains the value 'one' showing that a four has been generated once. When another four is generated N4 will be incremented again so its value becomes 'two'. Each variable is incremented in this way when the appropriate integer is generated by line 50.

Line 120 — N6 is the variable which contains a count of how many times line 50 generates a six. Unlike lines 70 to 110 it is not followed by a GOTO statement to direct the program to line 130, since line 130 is the next line to be executed.

Line 130 — The NEXT statement increments the value of the FOR variable by one each time through the loop. In this case the FOR variable, which counts how many times the loop has been executed, is 'L'. When L reaches the value of C (the number which was typed as the number of times the die is to be cast), the loop is automatically stopped and program execution continues with line 140.

Lines 140 to 190 — The PRINT statements output the messages contained in quotation marks. The probability of each of the numbers between one and six occurring is given by the expression: (number of times number occurred)/(number of times any number was generated). For example, to calculate the probability of a six occurring, the contents of the variable N6 are divided by the contents of the variable C (N6/C). The probability value is calculated for each number and printed after its corresponding message on the same line by the PRINT statements.

Line 999 — The END statement signifies program completion. It is labelled with a high line number so that modification lines can be inserted if necessary.

If the RND function is generating random numbers with an even distribution the probability of each of the integers between one and six occurring is 1/6 (0.1677 . . .). Thus, when the program is run the answers should all be about 0.1678 (within the limits of statistical deviation). The higher the number input to the program, the closer the probability of each number occurring will be to 0.1678.

Number Guessing Game Program

Last month a BASIC 'number guessing game' program was described. The suggested modifications to the program will now be given. A variable 'N' has been added so that a count can be kept of how many attempts the program user takes to guess the number correctly. The program is stopped by inputting any negative number (a number less than zero), in response to the prompt which requests a 'guess'. The program can also be stopped, at any time, by pressing the BREAK key.

```
 10  REM NUMBER GUESSING GAME
 20  REM NUMBER TO BE GUESSED IS GENERATED BY THE RND + INT
     FUNCTIONS
 30  LET X=INT (100*RND(1))+1
 40  LET N=0: REM N STORES GUESS COUNT
 50  PRINT "I'M THINKING OF A NUMBER FROM 1 TO 100"
 60  PRINT "GUESS MY NUMBER"
 70  INPUT "YOUR GUESS";G:N=N+1
 80  IF G<0 THEN PRINT "GAME OVER": GOTO 999
 90  IF G<X THEN PRINT "TRY A BIGGER NUMBER": GOTO 70
100  IF G>X THEN PRINT "TRY A SMALLER NUMBER": GOTO 70
110  PRINT "THATS RIGHT! YOU GUESSED MY NUMBER ";
120  PRINT "IN";N;" GUESSES":GOTO 30
999  END
```

E&MM

WORDMAKER EXTRA

Following the tremendous response to E&MM's Wordmaker project in the June 1981 issue, here is a program written for the Tangerine Microtan 65 that was submitted by Chris Savage, Basildon, Essex.

```
  1 REM E&MM WORDMAKER/MICROTAN PROGRAM (NO BUSY CHECK)
  4 GOTO 150
  8 REM SELECT I/O PORTS & SET TO OUTPUT MODE
  9 REM PORTA=OUTPUT PORTB=CONTROL
 10 PA=49091
 20 PB=49090
 25 POKE 49100,153
 30 POKE 49089,0: POKE 49088,0
 35 REM POWER UP RESET
 40 FOR I=1 to 3: A=4: POKE PB,A: A=A-4: POKE PB,A: NEXT
 50 POKE PA,255
 60 FOR I=1 TO 3: A=7: POKE PB,A: A=A-4: POKE PB,A: NEXT
 70 REM END OF RESET
 90 RETURN
100 POKE PA,255-WL: POKE PB,20: POKE PB,4
110 POKE PA, 255-WH: POKE PB,12: POKE PB, 4
120 POKE PB,1: POKE PB,5: POKE PB,1
130 RETURN
140 REM WORD ADDRESS INPUT
150 GOSUB 10
160 INPUT "WORD ADDRESS (LOW BYTE)"; WL
170 INPUT "WORD ADDRESS (HIGH BYTE)";WH
180 GOSUB 100
190 GOTO 160
```

MICRO PERIPHERAL REVIEW

MTU Instrument Synthesis Software Package

RECORDED ON CASSETTE NO. 3

The Past

A computer may produce musical sounds either by controlling the operation of external analogue modules or by computing the sound waveform itself and outputting binary data to the outside world using a digital-to-analogue (D/A) converter to make it audible. The Microtan-based system 'Alphadac' featured last month in E&MM as a constructional project uses the former mode of operation and will probably offer some of the most sophisticated control options possible from a marriage between digital and analogue systems.

However, there is much satisfaction, of both a practical and aesthetic nature, to be gained from actually computing waveforms without the cost and complexity of patching the computer to analogue modules. Because of the difficulties in computing waveforms fast enough for real-time performance, the application of D/A converters and attendant software to single-board computers and the lower-price home computers has been somewhat limited. One problem is that the theoretical bandwidth (Nyquist frequency) of D/A conversion is approximately half the sampling rate, the frequency with which the output of the converter is updated. To get an acceptable frequency range with currently available 8-bit microprocessors requires highly efficient programs and, generally speaking, a few compromises as well. Micro Technology Unlimited first produced a high quality 8-bit D/A converter with filter and output amplifier in 1979. This hardware peripheral comes in two versions: one for the Commodore PET and the other for any computer having an 8-bit parallel output port. The principle of the D/A converter is perfectly straightforward and, in its simplest form, can take the form of a R/2R ladder converter that outputs a particular voltage in response to a particular numerical value sent along data lines. If the computer is outputting data from a list of numbers (waveform table) that has been calculated on the basis of a sine wave, then the waveform emerging from the basic converter would look something like that in Figure 1. If heard in this raw state, the waveform would appear 'rough' or distorted as the D/A converter is generating a stair-step approximation to the normal smooth audio waveform. To fill in these gaps and smooth-out the output waveform, a low-pass filter is mandatory. All multi-section filters with a sharp cut-off oscillate or "ring" when given the edge of a pulse wave, and it's this ringing that fills in the gaps between the samples outputted from the D/A converter. More trouble arises from the approximation or quantisation applied to the amplitude of the waveform (the so-called "round-off error") which produces quantisation noise throughout the audio spectrum. This limits the S/N ratio of the system, and, in the case of an 8-bit resolution system, is approximately 48dB.

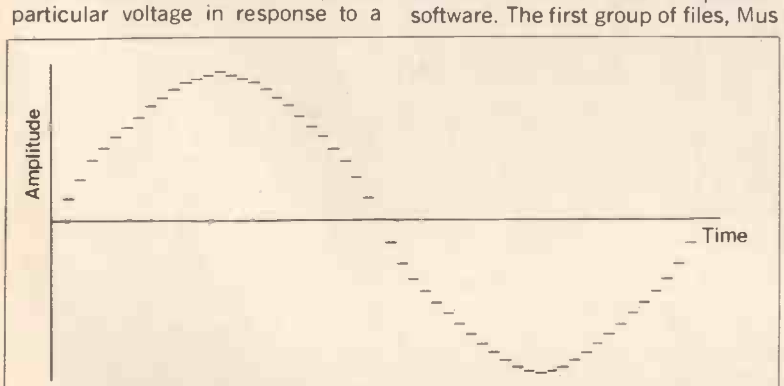


Figure 1. Stair-step sine wave from D/A converter.

MTU use a sampling rate of approximately 8 kHz, which gives a theoretical frequency response of 4 kHz, and, in practice, since no filter is 100% perfect, a usable response of 3.5 kHz. This is obviously fairly restrictive and represents one of the compromises that is necessary in implementing real-time digital synthesis in a low-cost system, but it's worth remembering that AM radio rarely goes beyond a bandwidth of about 5 kHz.

The original music software package produced by MTU in 1979 had the capacity to calculate a single waveform table, given the desired harmonic composition of a voice, and then use that table and three others as the instruments with which to play a 4-part musical score. Photo A shows the list of MTU files in present software. The first group of files, Mus Monitor / Mus Entertainer / Mus 76 Trombones, refers to the original 'Advanced Music Software', with the Monitor program including the machine language monitor (MLM), music playing routines, Fourier synthesis routines, and four voice tables. The remaining two files provide music data.

The synthesis routine is fairly simple and allocates 3 bytes of data to particular memory locations representing harmonic number, amplitude and phase shift. The Fourier coefficients provide the conditions needed to set-up an unscaled waveform, which, after construction, has to be 'scaled' so that the sum of amplitudes of all harmonics at any point on the waveform does not exceed a certain value, as this overflow can lead to gross distortion of the audio output. The music playing routine incorporates a sequencer subroutine that interprets a string of commands relating to the use of refrains, dynamic tempo changes, voice assignments, and so on.

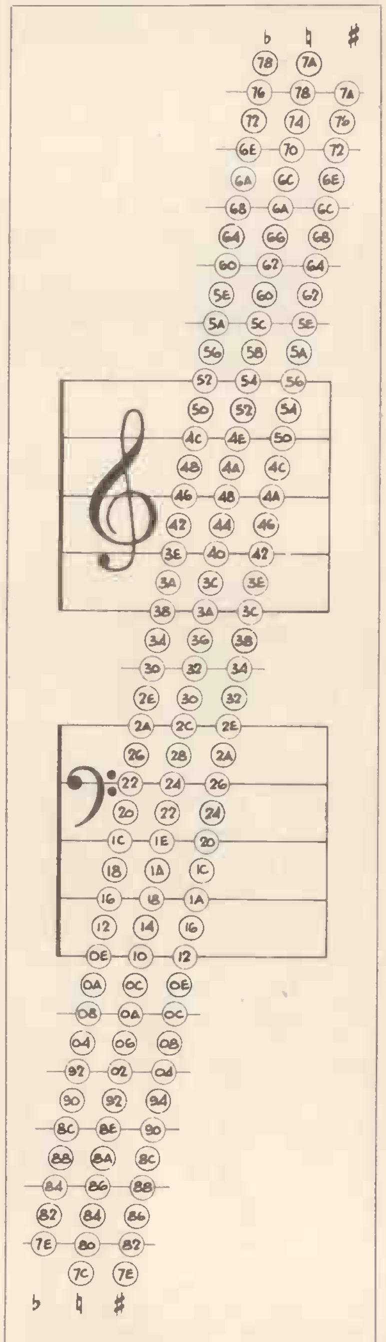


Figure 2. Hexadecimal pitch coding.

Putting all this into practice demands a considerable amount of time and patience, and the manual accompanying this original software package doesn't make any concessions to the interested non-musician unfamiliar with harmonic synthesis and the like. Hexadecimal is also required for the creation of music files with pitches and duration entered according to the coding shown in Figure 2. Taking the first few measures of J. S. Bach's Chorale No. 2, this is inputted using a hexadecimal sequence as follows:

					bar/ measure
20	44	3A	34	2C	0/1
20	44	3A	34	2B	
40	44	3E	34	26	1/1
20	44	3A	34	1C	1/2
20	44	3A	30	1C	
20	44	3A	2C	1E	1/3
20	44	3E	2B	1E	
40	46	3E	26	20	1/4

duration/part: 1,2,3,4

With the '79 software, the duration of an event is set by the shortest note; thus a group of two quavers played against crotchets requires all four parts for that event to be repeated as groups of quavers, with the result that the Bach in Figure 3a gets transmogrified into something like that in Figure 3b. Such decomposing is best left for Bach to get on with (sorry), and, with this brief 'historical' survey completed, it's time to look at MTU's latest software packages.

The Present

MTU's Instrument Synthesis Software Package was released in October, 1980 and really represents a considerable evolutionary step up the digital synthesis ladder. Like the '79 incarnation, the synthesis program acts as an interpreter in that it looks at binary coded strings of bytes in memory for instructions about what to do next. Also, implementation of the system requires some knowledge of memory mapping, hexadecimal coding of data, and use of the machine language monitor in whatever computer you're using.

The early MTU software, like that of Mountain Hardware (Apple Music System) and Syntauri (alphaSyntauri System) constructs waveforms on the basis of a 256-byte waveform table that is repeatedly scanned for the duration of a particular pitch. The sound is harmonically static in all three cases, but Mountain and Syntauri get around this to some extent by applying a sequence of amplitude and frequency offsets to each note's envelope which tricks the ear into thinking that harmonics are changing dynamically. These variations are all applied to the data once it has been accessed from the waveform table and each note is still described by only a single table. At present, to my knowledge, there are only three systems which provide dynamic harmonic changes: the Fairlight CMI, the Synclavier III (version 2.0) and this new MTU package. To get this 'timbral envelope' it's necessary to use a sequence of waveform tables. If the waveform tables are used properly, the envelope sampling need not be uniform over the required duration of a note; for instance, a number of waveform tables can be compressed into a short period of time ('squashed') when there's a lot of harmonic change, or expanded over a longer period of time ('stretched') when there's little harmonic movement. Sequenced tables actually kill two birds with one stone, as prescribing harmonic amplitude levels determines the amplitude envelope (ADSR equivalent) as well as the timbral envelope. In setting-up a waveform-sequencing routine, MTU use a waveform-sequence table holding 256 entries with each number corresponding to the page address of a waveform table (a typical instrument configuration uses around 20 tables). While notes are being played, a waveform-sequencer pointer moves through the sequence table, and, according to whether entries are stretched (lots of duplicate entries for a particular waveform table) or squashed (rapid movement from one table to another), the end product should be a reasonable approximation of 'real' instruments. However, the proof of the pudding is in the eating, and some price is paid for using such expensive ingredients. These harmonic subtleties take time to turn into sound generation, and, using a clock frequency of 1 MHz on the 6502 processor, the waveform-sequencing sample period takes about 128 microseconds, a sample rate of 7.81 kHz, which limits the upper frequency response to something less than 3.9 kHz.

The inevitable consequence of this upper limit is a restriction on the harmonic input to a particular sequence of waveform tables. Taking A above middle C as an example, you'd be restricted to the fundamental (880 Hz), the 2nd (1760 Hz), 3rd (2886 Hz) and 4th (3520 Hz) harmonics. Obviously, then, the limited high-frequency response limits the notes playable by instruments that have a reasonably complex harmonic spectrum, and these limitations have to be assiduously born in mind when orchestrating a piece.

With a system like this that's totally honest about its limitations, I wasn't really prepared for the surprising quality of the two examples (Bach: Sinfonia No. 14; Tchaikowsky: Dance of the Reed Flutes) that come with the present software. These are included on the 3rd E&MM demonstration cassette.

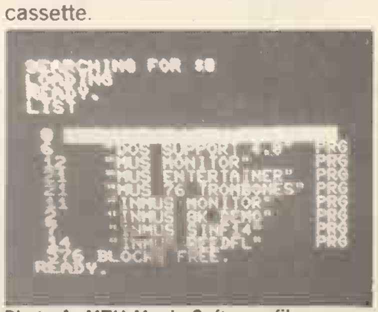
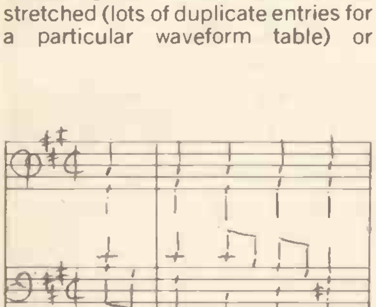


Photo A. MTU Music Software files.

Of course, there's quantisation noise and noise resulting from waveform-pointer truncation and waveform-table switching, but the real point is that the sounds are interesting and that's really half the battle in additive synthesis!



(a)

(b)

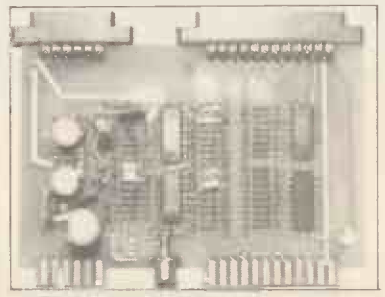
Figure 3. J. S. Bach, Chorale No. 2, before (a) and after (b) coding.

Putting Theory Into Practice

The construction of a timbral envelope is performed by a number of different command strings. Firstly, there's the Construct Waveform Set Command which specifies the envelope of each harmonic as a piecewise linear approximation. This avoids having to define the harmonic make-up of each waveform in the set individually. The format of this command string goes as follows:

```
F5  SS  EE  HN (PG AM), (PG AM),....FF
            HN (PG AM), (PG AM),....FF
            .
            .
            00
```

where F5 is the operation code byte, SS is the 'start' byte specifying the address of the first waveform, EE is the 'end' byte specifying the address of the last waveform in the set, HN specifies the harmonic number in binary code, and (PG AM) are pairs of bytes used for specifying, respectively, the X-coordinate of the harmonic breakpoint as a waveform address relative to SS, and the Y-coordinate of the breakpoint which corresponds to the harmonic amplitude at that moment in time. Once a waveform set has been constructed in this way, it's then necessary to construct a companion waveform sequence table. The music interpreter program provides three different commands for implementing this in a less laborious fashion than actually filling in the 256 entry waveform sequence table by hand (so to speak) with the addresses corresponding to the components of a waveform set.


MTU D/A Converter.

The first, the Arbitrary Waveform Sequence Table Command, simply uses the waveforms in sequential order but compresses the time scale at the beginning and end whilst expanding it in the middle. The second, the Build Waveform Sequence Table Command, moves away from the linear time scale in the previous command, and allows a much more dramatic sort of time-warping with a couple of nibbles specifying the amount of stretch or squash (real Einsteinian time dilation stuff, this!). Finally, the Modify Waveform Sequence Table Command can be used to modify an existing 'source' table by copying a waveform sequence table into a 'destination' table but only for the first 50 or so entries in order to produce percussive sounds of limited duration.

The MTU software includes a very decent library of instrument definitions produced using the commands outlined above. Those relevant to the two examples on the demo cassette are listed below:

Sinfonia No. 14

1. Plucked catgut string instrument: harmonics 1,2,3,4,5,6,7.
2. Plucked metallic string instrument: harmonics 1,3,5,7,9,11,13.
3. "Watery" instrument: harmonics 2,3,4,5,6,7.

Dance of the Reed Flutes

1. Flute-like instrument: harmonics 1,2.
2. Reed instrument: harmonics 1,2, 3,4,5,6,7.
3. String bass-like instrument: harmonics 1,2,3,4.
4. Clarinet-like instrument: harmonics 1,3,5,7,9.

Music Files are created in the form of a Note String which the music interpreter uses in conjunction with the Command String and Instrument Codings to produce music. A processing loop (SOUND) is constructed during which the duration and pitch bytes of the next event are interpreted and various pointers are set up. The finite time taken to execute this loop actually introduces a gap in the sound generation and can be heard occasionally as a click, particularly when there's a change in tempo or voicing. This is where it would be ideal to have two processors sharing memory, with one generating the sound and the other interpreting the note and command strings (cf. the back-to-back 6800s in the Fairlight CMI).

Entering music is a rather more demanding operation than with the '79 software. As before, each event in the note string has a duration byte and as many pitch bytes as there are active voices. Where things really start to get complicated is in the coding of pitches; this time there's a choice of four different hexadecimal codings corresponding to three different attack modes and a sustain mode. The selection of certain attack modes allows a tone envelope to be continued from a previous event into a current event thereby tying notes and producing a more musical counterpoint of different duration values between parts.

The Future

On the music entry side, a music compiler, or "human interface", is promised by MTU in the very near future. We hoped to have this update for the present review, but development problems appear to have put its launch rather behind schedule. However, it will probably allow two methods of music entry: a graphical entry mode and a more conventional alphanumeric entry mode for large pieces. This software should also fully implement a stereo facility, whereby, at the top of the SOUND processing loop, voices 1 and 2 are averaged together and sent to one D/A converter, and, later on in the program, voices 3 and 4 are sent to another D/A converter. There's still the problem of the limited bandwidth to be considered, and it's difficult to see how MTU can significantly improve on this in an 8-bit system if they stick to their guns in using a time-consuming waveform-sequencing program for timbral variety.

The Instrument Synthesis Software Package was developed and written by Frank Covitz and Cliff Ashcraft, though much of the praise due to them should also go to their associate, Hal Chamberlin, who has probably made a greater contribution than anyone else to this exciting field. His superb book, "Musical Applications of Microprocessors" (Wiley, 1981), demonstrates this (reviewed last month) and should be required reading for every contemporary musician!

Dr David Ellis **E&MM**

Acknowledgements: to Baroness International for loan of the Pet 3032, to Commodore for the 3040 Disk Drive, and to IJJ Design Ltd. for the MTU D/A converter and software packages.

Cost and availability: the Advanced Synthesis Software (1979) and D/A converter is priced at £57 + VAT, and the Instrument Synthesis Software (1980) at £30 + VAT. This pricing is likely to change (for the better) in the near future and enquiries should be directed to IJJ Design Ltd., 37 London Road, Marlborough, Wilts SN8 2AA (0672 54487).

Software

Congratulations to Mr W. Smith, of Sheffield, who after much deliberation, is declared winner of the June Software competition; your prize will shortly be on its way. I must thank everybody who sent in their entries and gave me many hours of enjoyable sorting. It is a great pity that only one person can win, but I am sure that you will agree that both Mr Smith's presentation and solution to the problem are elegant and above all very usable.

This month's problem:

Write a program that will perform all the common Ohm's law calculations, i.e. work out voltage from current and resistance, power from current and voltage etc.

Colour code program

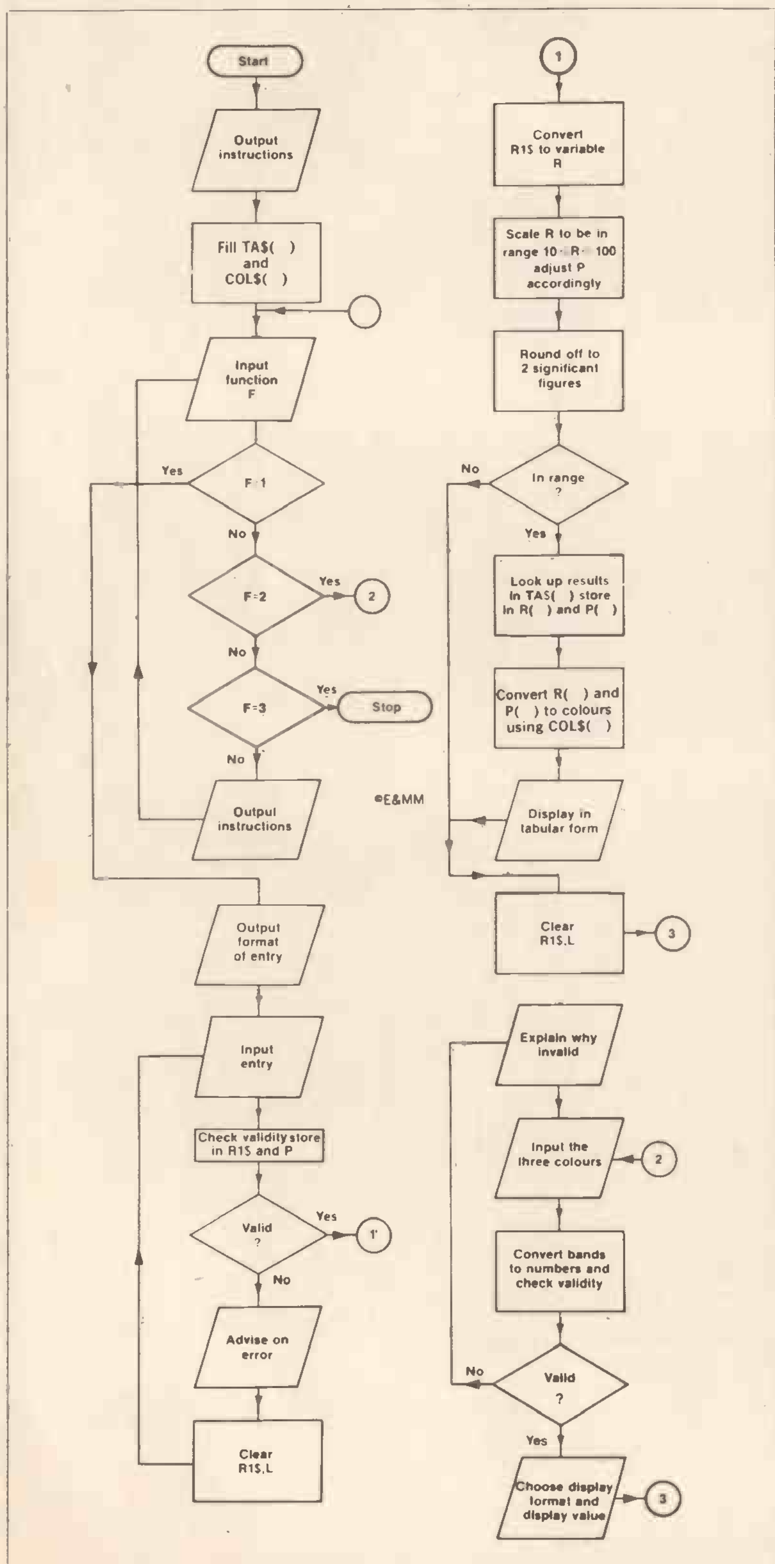
The main object of my program (which is written for the Sharp MZ-80K) is to make it as easy as possible for an uninitiated operator to enter the correct value. The values entered are all in the modern format i.e. 2k7 instead of 2.7k, as are the values which are returned by the program.

A brief description of the DATA is in order because it looks so meaningless. The DATA consists of all possible answers to function 1 and works like this: the first number in a block of data is the total number of resistors needed to give that particular solution, call this A. Then there will be A more numbers which give the actual *tens* and *units* values of the resistors. A final character (S or P) gives the method of connection (series or parallel). For an example, the data which would be stored in row 85 or TA$( ). The first figure is a 3 so there are 3 more numbers: 82, 1.2, 1.8. These when totalled give 85. The multiplier is the same as the multiplier of the value entered by the operator. The final character is S, which means that the above values have to be connected in series to give 85.

E&MM

```
10 REM****RESISTOR CALCULATOR****
20 GOSUB10000
30 REM****ENTER TABLES OF DATA****
40 DIMTA$(99,5),B$(3),B(3),R(5),P(4),COL$(11)
50 FORA=10TO99
60 READTA$(A,1)
70 FORC=2TOVAL(TA$(A,1))+2
80 READTA$(A,C)
90 NEXTC
100 NEXTA
110 GOSUB11000
120 INPUT"Enter the function number";F
130 ONFGOTO150,850,17090
140 PRINT"Function out of range":GOSUB 10020:FOR C=1 TO 2000:NEXT:GOTO120
150 REM****FUNCTION 1 - COLOUR CODES FROM RESISTANCE****
160 PRINT"▒Enter the value of your resistor"
170 PRINT"using the modern format on the left."
180 PRINT"       4R7 = 4.7  Ohms"
190 PRINT"       47R = 47   Ohms"
200 PRINT"      470R = 470  Ohms"
210 PRINT"       4k7 = 4.7k Ohms"
220 PRINT"       47k = 47k  Ohms"
230 PRINT"      470k = 470k Ohms"
240 PRINT"       4M7 = 4.7M Ohms"
250 INPUT"Enter your value now. ";R$
260 PRINT"The value you have input is ";R$;"."
270 INPUT"Is this correct ? ";Y$
280 IFLEFT$(Y$,1)="Y"THEN320 .
290 IFLEFT$(Y$,1)="N"THEN160
300 PRINT"Please answer the question using Y or N. ":GOTO260
320 FORA=1TOLEN(R$)
330 T=ASC(MID$(R$,A,1))
340 IFA=1THENIF(T<48)+(T>57)THEN12000:REM***FIRST CHARACTER IS NOT A NUMBER***
350 IF(T>=48)*(T<57)THENR1$=R1$+MID$(R$,A,1):NEXTA:GOTO400
360 IF(T=75)+(T=169)THENL=L+1:P=3:R1$=R1$+".":NEXTA:GOTO400
370 IFT=77THENL=L+1:P=6:R1$=R1$+".":NEXTA:GOTO400
380 IFT=82THENL=L+1:P=0:R1$=R1$+".":NEXTA:GOTO400
390 GOTO12060:REM****CHARACTER WRONG****
400 IFL>1THEN12140:REM****TOO MANY LETTERS****
410 IFL=0THEN12190:REM****NO LETTERS****
420 REM****VALID NO. IN R1$ & POWER OF 10 IN P****
430 REM****ROUND NO. OFF TO TWO SIGNIFICANT FIGURES****
440 REM****FIRST CONVERT FROM STRING TO NUMBER****
450 R=VAL(R1$)
460 IFR>=100THENR=R/10:P=P+1:GOTO460
470 IFR<10THENR=R*10:P=P-1:GOTO470
475 R=INT(R+0.5):REM****ROUNDED TO TWO SIG. FIGS.****
480 IF(R>10)*(P>=6)THENPRINT"The value is invalid as it is >10M":GOTO 510
490 IFP<0THENPRINT"The value is invalid because it is <10R":GOTO 510
500 GOTO 540
510 REM****SET VARIABLES TO ZERO****
520 FOR Z=1 TO 3000:NEXT Z:R1$="":L=0
530 GOSUB10020:GOTO120:REM****GO BACK TO "INPUT FUNCTION"****
540 REM***VALID VALUE IN CORRECT RANGE****
560 FOR A=2TOVAL(TA$(R,1))+1
570 R(A-1)=VAL(TA$(R,A))
580 NEXT A
590 M$=TA$(R,A)
600 REM****VECTOR R() CONTAINS VALUES OF RESISTORS WHICH GIVE R****
610 REM ****A-2=NUMBER OF RESISTORS****
620 REM****M$=MODE(SERIES OR PARALLEL)****
630 REM****MAKE A VECTOR FOR P AS WELL****
640 FOR C=1 TO A-2
650 P(C)=P
660 IF R(C)<10 THENR(C)=R(C)*10:P(C)=P(C)-1
670 IF R(C)>=100 THEN R(C)=R(C)/10:P(C)=P(C)+1
680 NEXT
690 REM****TENS AND UNITS IN R() AND MULTIPLIER IN P() FOR EACH RESISTOR****
695 IF M$="S"THEN M$="SERIES"
696 IF M$="P"THEN M$="PARALLEL"
700 PRINT"▒The following";A-2;" colour codes represent"
702 PRINT"resistors which when connected in"
704 PRINTM$;" give ";R$
710 PRINT"▒▒▒RES VAL","BAND 1","BAND 2","BAND 3"
720 PRINT"————————————————————————————————————————"
730 FOR C=1 TO A-2
740 T$=COL$(INT(R(C)/10))
750 U$=COL$(R(C)-(INT(R(C)/10)*10))
755 IF P(C)=-1 THEN P$="GOLD":GOTO 780
760 P$=COL$(P(C))
780 GOSUB 13000:NEXT C
790 PRINT"▒▒▒A fourth band of gold will give a toler-ance of 5%"
800 REM ****FUNCTION 1 TERMINATED****
810 REM ****SET ALL VARIABLES BACK TO ZERO****
820 R1$="":L=0
830 GOTO 120:REM****GO BACK TO "INPUT FUNCTION"****
850 REM****FUNCTION 2-VALUE FROM COLOUR CODE****
900 PRINT"▒Enter the colour code separating the    colours with commas "
901 INPUT B$(1),B$(2),B$(3)
910 FOR C=1 TO 3
920 FOR D=0 TO 9
930 IF LEFT$(B$(C),3)=LEFT$(COL$(D),3)THEN B(C)=D:OK=1
940 IF (LEFT$(B$(C),3)="GOL")*(C=3)THENB(3)=-1:OK=1
945 IF LEFT$(B$(C),3)="PUR"THEN B(C)=7:OK=1
950 NEXT D
960 IF OK=1 THEN OK=0:NEXT C:GOTO 980
970 GOTO 14000
980 REM****THREE VALID COLOURS****
990 PRINT"The value is ";
1000 ONB(3)+2GOTO1010,1020,1030,1040,1050,1060,1070,1080,1090,1100,1110,1120
1010 PRINTB(1);"R";B(2):GOTO 1130
1020 PRINTB(1)*10+B(2);"R":GOTO 1130
1030 PRINT(B(1)*10+B(2))*10;"R":GOTO 1130
1040 PRINTB(1);"k";B(2):GOTO 1130
1050 PRINTB(1)*10+B(2);"k":GOTO 1130
1060 PRINT(B(1)*10+B(2))*10;"k":GOTO 1130
1070 PRINTB(1);"M";B(2):GOTO 1130
1080 PRINTB(1)*10+B(2);"M":GOTO 1130
1090 PRINT(B(1)*10+B(2))*10;"M":GOTO 1130
1100 PRINTB(1);"G";B(2):GOTO 1130
1110 PRINTB(1)*10+B(2);"G":GOTO 1130
1120 PRINT(B(1)*10+B(2))*10;"G"
1130 GOTO 120
10000 PRINT"▒▒▒▒▒▒▒▒▒▒▒▒▒          RESISTOR CALCULATOR"
10001 PRINT"          ——————————————————————"
10010 FORC=1TO2000:NEXTC
10020 PRINT"▒▒▒▒▒The program has the following functions"
10025 PRINT"- - - - - - - - - - - - - - - - - - -"
10030 PRINT"1-To calculate the colour code(s) of a"
10040 PRINT"resistor or resistor combination, given"
10050 PRINT"a value."
10060 PRINT"2-To calculate the value of a resistor"
10070 PRINT"given its colour code."
10075 PRINT"3-To terminate the program."
10080 PRINT"————————————————————————————————————————"
10090 PRINT"Please note that for function 1, the"
10100 PRINT"value entered will be rounded off"
10110 PRINT"internally to 2 significant figures."
10120 PRINT"This gives at most an error of 5% (when"
10130 PRINT"the first three digits are 105), but"
10140 PRINT"this is offset by the 5% tolerance of "
10150 PRINT"normal .3W resistors. The colour codes"
10160 PRINT"given all occur in the E12 range of "
10170 PRINT"resistors. The limits on function 1 are"
10180 PRINT"        10Ohms<=value<=10MOhms"
10190 RETURN
11000 REM ****ENTER TABLE OF COLOURS****
11020 FORA=0TO9
11030 READCOL$(A)
11040 NEXTA
11050 RETURN
12000 REM ****ERROR FOR FIRST CHARACTER BEING A NUMBER****
12010 PRINT"Value invalid as the first character"
12020 PRINT"should be a number. There may be other"
12030 PRINT"errors. Please check."
12050 FOR Z=1 TO 3000:NEXT:GOTO12240
12060 REM****ERROR ROUTINE FOR TOTALLY WRONG CHARACTER****
12070 PRINT"Value invalid as the program does not"
12080 PRINT"recognize the character you have input"
12090 PRINT"at character position ";A;". The"
12100 PRINT"programme only recognises the digits"
12110 PRINT"and K (or k) R and M. There may be "
12120 PRINT"other errors. Please check."
12130 FOR Z=1 TO 7000:NEXT:GOTO 12240
12140 REM****ERROR ROUTINE FOR TOO MANY LETTERS****
12150 PRINT"Value invalid as there should only be"
12160 PRINT"one letter in the value. There may be "
12170 PRINT"other errors. Please check."
12180 FOR Z=1 TO 5000:NEXT:GOTO 12240
12190 REM****ERROR ROUTINE FOR NO LETTER****
12200 PRINT"Value invalid as there should be one"
12210 PRINT"letter in the value to represent the"
12220 PRINT"multiplier. There may be other errors."
12230 PRINT"Please check."
12235 FOR Z=1 TO 5000:NEXT
12240 REM****SET USED VARIABLES TO ZERO****
12250 L=0:R1$=""
12260 GOTO 150
13000 REM****SUBROUTINE TO PRINT "RES VAL"****
13010 ON P(C)+2 GOTO 13015,13020,13030,13040,13050,13060,13070,13080
13015 PRINTINT(R(C)/10);"R";R(C)-(INT(R(C)/10)*10),T$,U$,P$:RETURN
13020 PRINTR(C);"R",T$,U$,P$:RETURN
13030 PRINTR(C)*10;"R",T$,U$,P$:RETURN
13040 PRINTINT(R(C)/10);"k";R(C)-(INT(R(C)/10)*10),T$,U$,P$:RETURN
13050 PRINTR(C);"k",T$,U$,P$:RETURN
13060 PRINTR(C)*10;"k",T$,U$,P$:RETURN
13070 PRINTINT(R(C)/10);"M";R(C)-(INT(R(C)/10)*10),T$,U$,P$:RETURN
13080 PRINTR(C);"M",T$,U$,P$:RETURN
14000 REM****ERROR HANDLING FOR FUNCTION 2****
14010 PRINT"The programme does not accept the"
14020 PRINT"colour ";B$(C);" at band";C;". Please"
14030 PRINT"recheck.":FORSS=1TO3000:NEXTSS:GOTO900
15000 DATA1,10,S,2,10,1,S,1,12,S
15001 DATA2,12,1,S,3,1.8,2.2,10,S,1,15,S
15002 DATA2,15,1,S,3,1,1,15,S,1,18,S
15003 DATA2,18,1,S,2,10,10,S,3,10,10,1,S,1,22,S
15004 DATA2,22,1,S,2,12,12,S,2,10,15,S,3,22,1.8,2.2,S
15005 DATA1,27,S,2,10,18,S,3,27,1,1,S
```

```
15006 DATA2,15,15,S,3,27,1.8,2.2,S,2,22,10,S
15007 DATA1,33,S,2,33,1,S,3,33,1,1,S,2,18,18,S
15008 DATA2,27,10,S,3,27,10,1,S,1,39,S
15009 DATA2,39,1,S,2,82,82,P,2,27,15,S,2,33,10,S
15010 DATA2,22,22,S,2,18,27,S,3,18,27,1,S
15011 DATA1,47,S,2,33,15,S,2,39,10,S,2,100,100,P
15012 DATA2,18,33,S,3,18,33,1,S,3,33,10,10,S
15013 DATA2,27,27,S,3,27,27,1,S,1,56,S
15014 DATA2,56,1,S,3,56,1,1,S,2,47,12,S,2,27,33,S
15015 DATA2,22,39,S,2,47,15,S,3,47,15,1,S
15016 DATA3,27,27,10,S,2,47,18,S,2,33,33,S
15017 DATA3,33,33,1,S,1,68,S,2,68,1,S,3,68,1,1,S
15018 DATA2,56,15,S,2,33,39,S,3,33,39,1,S
15019 DATA2,47,27,S,3,27,47,1,S,3,33,33,10,S
15020 DATA3,47,18,12,S,2,56,22,S,3,56,22,1,S
15021 DATA 2,68,12,S,3,12,68,1,S,1,82,S
15022 DATA 2,82,1,S,3,82,1,1,S,3,82,1.2,1.8,S
15023 DATA2,68,18,S,3,68,18,1,S,3,82,2.7,3.3,S
15024 DATA2,56,33,S,3,56,33,1,S,3,68,1,22,S
15025 DATA2,82,10,S,3,82,10,1,S,2,82,12,S
15026 DATA2,68,27,S,3,68,27,1,S,2,82,15,S
15027 DATA 3,82,15,1,S,3,56,33,10,S
15028 DATABLACK,BROWN,RED,ORANGE,YELLOW,GREEN,BLUE,VIOLET,GREY,WHITE
16000 REM****ON LINE 360 THE SECOND BRACKET SHOULD READ (T=107) BUT SHARP****
16001 REM****USE THEIR OWN FORM OF THE ASCII CODE****
17090 END
```



Flow diagram for colour code program.

INSTRUMENT REVIEW

Each month we review the latest Electro-Music Equipment — from synthesisers to sound reproduction and effects!

E&MM's special in-depth reviews look at what's new in the world of commercial music — a vital updating for both electronics designers and musicians.

Musico Resynator

Pitch to voltage converters and envelope followers are conventionally those synthesiser peripherals that attract little interest from most musicians, possibly because the average synthesist and synthesiser manufacturer is more concerned with trying to extract the maximum information from the way the keyboard is played than considering any other type of human input. Moving away from this restricted point of view, there's obviously great potential in providing an interface between the sounds of the instrument, with the human input that initiates it, and a synthesiser to reinterpret the original musical intentions. A number of manufacturers, Gentle Electric, for instance, make very good pitch to voltage converters that will more or less faithfully track any pitched information fed into it from voice or instrument, and then produce a control voltage with which to control a chosen synthesiser. This sounds fine in theory, but many musicians that aren't suckled on synthesisers find problems in relating their technique to an electronic instrument that needs a considerable amount of knob-pushing to get anything interesting or useful out of it. I wouldn't be surprised if this explains the rather chequered career of guitar synthesisers and the like.

So, the first step that Musico have taken with their Resynator is to integrate a synthesiser section within the same package as the interface and then normalise the functions of the synthesiser so that it is totally geared towards the performing musician wishing to expand his instrumental horizons without subverting his technique to the potentially (for him, at least) dehumanising demands of synthesisers.

Pitch to voltage conversion can be effected by a variety of means, including the use of a phase-locked loop which locks onto an input frequency and adjusts an internal VCO until the frequency difference is nulled. The voltage necessary to do this can be sampled and then used as a control voltage for a synthesiser, but the limitations imposed on the sampling technique and rate invariably lead to mistracking of the input frequency.

Musico go way beyond this level of technology by using a Digital Frequency Analyser that converts pitch to bits of digital information at a fast but variable sampling rate for processing by a microprocessor. Sampling of the input occurs every 40 microseconds, which results in very accurate pitch tracking. I couldn't ascertain what routines were being used to process the pitch data, but I presume that a clean-up operation is performed, the fundamental pitch being sorted out from overtones. The digital data from the CPU is then converted to an analogue control voltage with which a principal VCO, offering sawtooth, square or variable pulse waveforms, is controlled, in addition to a second VCO, called a 'FXO' (effects oscillator), which can be configured to provide harmonising, phase-synching, or various types of overtone synthesis as a result of being modulated by the principal VCO.

An excellent facility that the Resynator possesses is the ability to set the tuning relationship between the two VCOs by merely pressing a footswitch and playing a note which is then compared to an internal A440 reference, the FXO then being automatically returned to the new interval.

A standard analogue envelope follower, patched to a VCA, tracks the dynamics of the input signal pretty accurately as far as I could tell from the demonstration I heard using guitar and voice input. An important feature is that decay time follows the input signal unless it's overriden by using a footswitch.

So far, we've covered the pitch and envelope analysis performed by the Resynator; what about timbral considerations? It's here that I feel that Musico haven't gone far enough. Practically everyone must have heard the products of analysis of voice formants in the shape of that pie in the blue sky, the vocoder. In analogue terms, this involves a lot of bandpass filters and envelope followers and is usually pretty limited in terms of sampling accuracy. Digital frequency analysers, on the other hand, produce some fairly remarkable results when applied as vocoders, as evinced from work being currently carried out at Stanford University in the States. I'd have thought that it would be valuable to use the DFA in the Resynator for VCF control by using the processor to analyse harmonic or timbral information. This doesn't mean that one is forced to copy the input signal faithfully; instead, really interesting and potentially useful sounds could be derived from digitally cross-patching the results of timbral analysis, i.e., low harmonics could trigger a high filter sweep and high harmonics a low filter sweep.

What Musico do use, though, is a VCF that can be patched to eight different 'filter envelopes' ("Select a Shape" in the photo).

The filter envelopes consist of a variety of more or less complex filter sweeps initiated by respective stepped control voltage patterns stored in ROM and controlled by a second microprocessor. Musico call this their 'Timbral Image Modulator', and it is very effective in animating the output of the synthesiser in a way that's far less predictable and infinitely more interesting than most filter sweeps. The idea isn't unique, though, as the Phase-filter produced by Blacet Music Research in the States uses the same principle: in their case a 14-step variable digital waveform generator controls a Curtis Electro-Music VCF chip to shape the frequency content of a signal fed into it. To sum up: the Resynator tracks a variety of input sources with terrific accuracy, though I haven't heard its performance with signals of high transient content or ultra-rapid pitch variation, but it is strictly a monophonic device and makes no attempt to perform any timbral analysis on the input signal, which, it seems to me, is a serious omission considering that its main selling point is the digital frequency analyser. As a live performance addition its range of footswitch controls and easily-comprehended panel controls must make it a very attractive proposition to the musician normally scared-off by synthesisers. To my ears, the basic sound isn't wildly different to that from other quality monophonic synthesisers controlled by an external input, and for a UK price of approximately £1,200 it is very expensive.

David Ellis

The Musico Resynator is distributed solely by Syco Systems, 20 Conduit Place, London W.2 (telephone: 01-723 3844).

CASIO VL-TONE

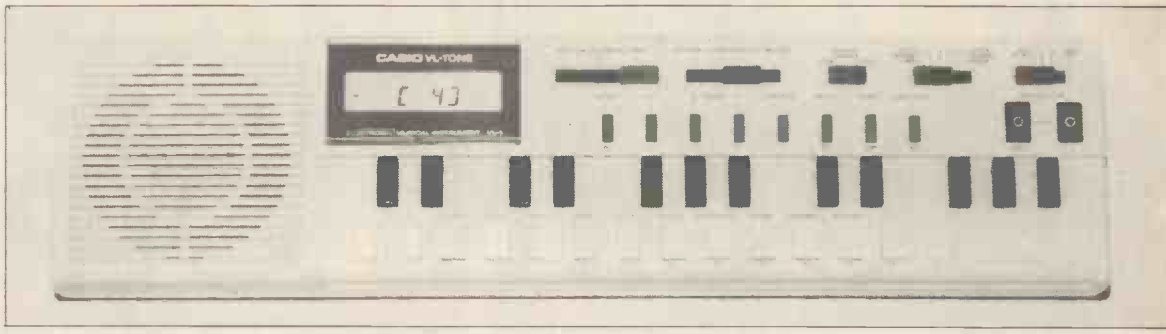
It's hard not to feel incredibly jealous of a company like Casio; packing all that the VL-Tone does in one 64-pin chip is pretty remarkable by any standards of such VLSI technology, and doubtless the age of the technodegradable, if not biodegradable, keyboard is close at hand. The VL-Tone may also be a manifestation of the inscrutable Japanese sense of humour, in that it's taunting both the consumer as to what the future holds from Casio and their competitors to come up with something better.

One of the many interesting features provided by the VL-Tone is a numerical read-out of the pitches entered from the push-button keyboard. The display shows the last three notes entered with the last note pressed on the right. However, the numeric code doesn't follow the standard alphanumeric convention for designation of notes, though it's perfectly easy to understand, and I wonder how useful it is in practice. Playing the keyboard in real time demands super-agile fingers, as the inter-octave distance is only about half that of a normal keyboard, and digital flights of fancy aren't really practical or to be recommended unless you've got half-size hands.

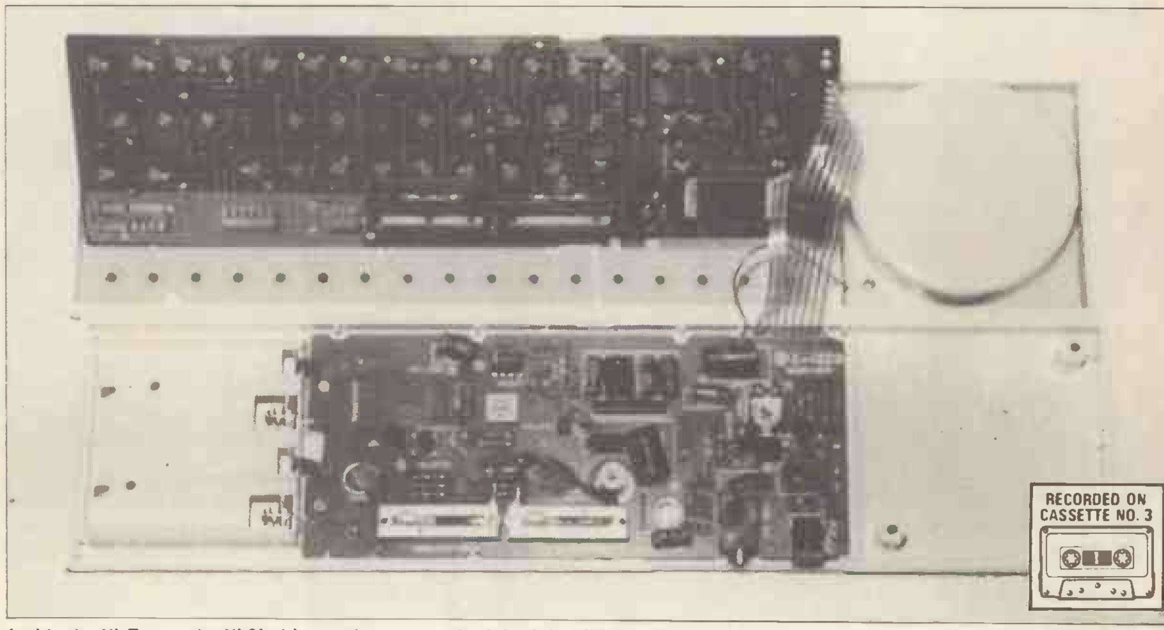
The presets on offer give a reasonable variety of sounds that are fairly usuable as they stand, though the quality tends to depend on the octave setting chosen. The five pre-programmed instruments are: Guitar (good in low register, but poor elsewhere), Flute (fairly rich in low and middle registers, but thin in high), Violin (rather unpleasant throughout all registers, but just about okay in low register), Fantasy (better in high than low register, but doesn't do anything for my fantasies), and, finally, Piano (the best of the lot as far as all three registers are concerned). All these presets in their various registers can be heard on the 3rd E&MM demonstration cassette, and the low piano is used to provide the top line in the Bach example.

The sixth position on the instrument select switch points to the feature that sets the VL-Tone apart from other regurgitating music machines. This option provides the user with the ability to program the chip to produce sounds with a prescribed envelope, vibrato and tremolo. Casio split the standard ADSR into five different parameters (see Figure 1), each of which can be assigned a value of 0 to 9. To perform this envelope shaping, you first have to catch your waveform, and Casio provide another nine varieties of this, ranging from those used in the presets to cor anglais and three falling under the description of "electro-sound". The list of programmable variables is completed by values for vibrato and tremolo, which gives you in toto:

a = waveform type
b = attack time
c = decay time
d = sustain level
e = sustain time
f = release time
g = vibrato speed
h = tremolo speed



Casio VL-Tone.



Inside the VL-Tone – the VLSI chip can be seen to the left of the ribbon cable.

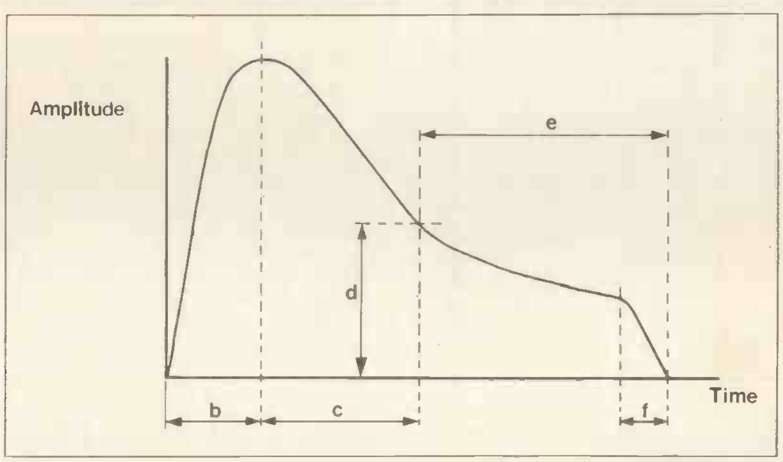


Figure 1.

By selecting the 'CAL' function at the same time as 'ADSR', after pressing 'MC', the string of eight values can be entered from the keyboard and then stored, by pressing 'M+', in the same memory as that used for the VL-Tone's alter ego, the calculator, of which the less said the better. Switching back to 'PLAY' or 'REC' then allows you to use the newly programmed instrument. Some typical programmed examples might consist of the following values:

Cor anglais: 61079130
Synth: 70099924
Flute: 33099130

As Casio point out in their multilingual instruction booklet, there are an awful lot of combinations possible; they suggest a figure of 80 million, which is fine if you're a pedant, but optimistic in practice. Anyway, it all goes to make the VL-Tone less of a toy and more a real instrument. However, this impression of its capabilities doesn't extend to the auto-rhythm side. The usual quasi-percussive fodder is provided, with some quirky additions like "Beguine" probably designed to beguile you (sorry). The chiffs of digital noise are better than normal in producing hi-hat sounds, but the armoury is let down by some awful bongo sounds which are too high and too tuned to be comfortable.

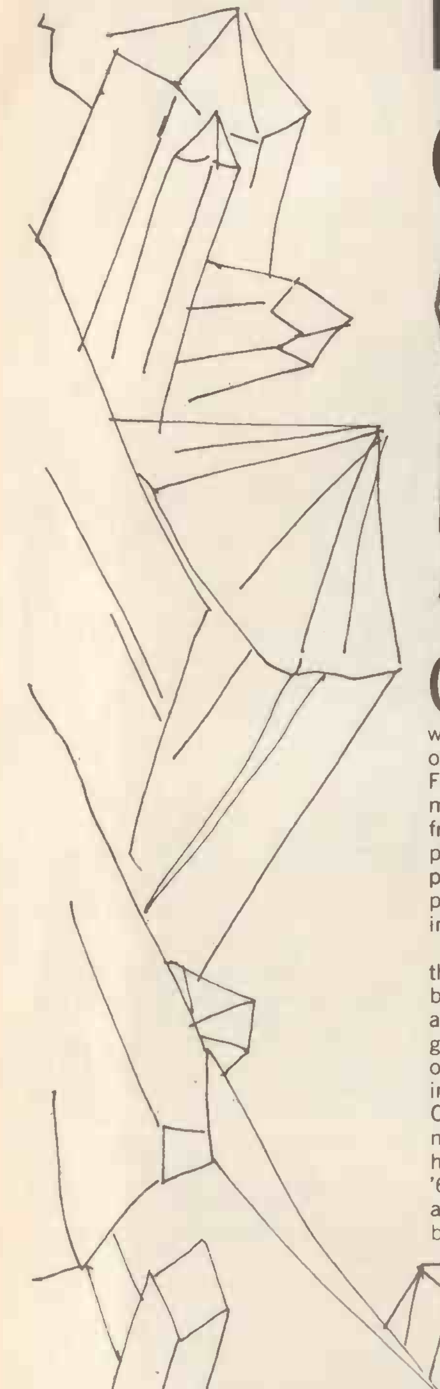
As there's no attempt to produce any bass sounds, let alone a kick drum, the whole thing sounds rather tinny and lacking in substance. It's a great shame that Casio haven't extended the VL-Tone's programmability to the percussion side as well.

The VL-Tone also incorporates a 100-note sequencer that can be programmed and run in a variety of ways. After selecting 'REC', entry of a sequence can be effected either by real-time playing or by a one-note-at-a-time mode of entry. If the former method has been used, selecting 'PLAY' and pressing 'AUTO PLAY' will result in the sequence playing back as recorded. The tempo of playback can be adjusted from -9 to +9 and the instrumentation and octave select varied during playback. There's also a "one key play" feature that allows a sequence to be stepped through, note by note. Given the limitations imposed by the keyboard on virtuosity, it's actually more practical to enter notes step-wise and then rhythmically step through the sequence using the two "one key play" keys. Apart from a single run-through of a sequence, the VL-Tone can also be programmed, by pressing 'DEL' and then 'AUTO PLAY', to repeat the sequence four times. With the right ADSR programming, the VL-Tone would make a pretty reasonable general purpose sequencer but for the fact that the sequence stops after four plays; a big drawback, this.

The VL-Tone offers a tremendous amount for its low cost, although several of its limitations could have been put right in the design stage from a few chats with musicians. Certainly, it includes facilities that will no doubt be developed by Casio to make it the 'record a tune anywhere' instrument. Over 100,000 VL-Tones are being sold per month in Japan alone and in the UK, reports from Turnkey Ltd. and Tempus Ltd. show outstanding sales, in particular to younger musicians.

David Ellis **E&MM**

IRMIN SCHMIDT ON HIS TOY PLANET



WHEN IT ARRIVED FROM ETERNITY. OUTER SPACE, IT HAD NO LAUGHTER, NO WISDOM NO AGE. THEN WITH THE MOVEMENT OF PLANETS IT DISCOVERED TIME, RHYTHM, AND SOUND, AND IT STARTED TO SING. FOR A SHORT MOMENT OF ITS ETERNAL LIFE IT PLAYED GAMES AND BECAME LIKE A CHILD. AS IT TURNED INTO DARKNESS AGAIN IT LEFT TOY PLANET WITH A RING OF LIGHT. IN THE LAP OF THE UNKNOWN YOU WILL SOMETIMES FIND STARS WITH A SHIMMER OF A SMILE...

One of Irmin Schmidt's concepts about making music is putting people together in a group who would not normally play together in order to induce new musical ideas. For example, in his last piece of film music for TV, he took an accordionist from a Belgian dance orchestra and put him with a free jazz trumpet player. The mix of different styles, personalities and musical experience initiated new ideas.

Spontaneity and collaboration are therefore key words for Irmin. His background as a classical musician and member of the German 'Can' group has given him a unique wealth of musical experience. He has been influenced in many directions: by Can's approach to playing modern music in a free spontaneous way; by his association in New York during the '60's with La Monte Young, Terry Riley and other 'avant-garde' composers; by his performing and conducting operatic and orchestral works from classics to Debussy, Ravel and Cage; and his special liking for impressionism, ethnic music and jazz. He also studied with the Hungarian composer Ligeti and undoubtedly his tuition in orchestration over several years - experimenting with tone colours and instrumentation - helped put this kind of album together.

His collaboration with Bruno Spoerri came from his use of Bruno's studio in Zurich, only to find that Bruno had much to contribute. Irmin's natural desire towards 'collective' composition led to their successful partnership on the album. He identifies his approach to Toy Planet with Debussy's three 'Images' and 'Jeux' pieces, that do not contain development in the classical sense, but rather have music that portrays one image that is explored. 'You don't leave this picture to go elsewhere - it's like being in a room and looking around, for every wall is different, but you never leave the room. Mahler has this feeling for me in his second movement of the 4th Symphony where everything seems to be based on the first eight bars. I also enjoy the orchestral works of Messiaen. So classical developments are not for Irmin and emulating Baroque and Classical styles with synthesiser simply because it is a new instrument is not the way he feels electronic music should be going.

Toy Planet came about like most of his music, in a spontaneous way. All its conception may appear to have been very carefully composed and totally organised from the outset, but this is not so.

'I'm not interested in having a concept, writing it down and then getting as near as possible to the original idea. I'm much more interested in the process of making, through spontaneous steps. Toy Planet pieces were all made from this kind of spontaneous composition, from Bruno and myself contributing ideas. When you are collecting ideas you always come to a point where the image is settled, maybe long before the piece is finished, and it's the material that gives you the image - not that you conceived a title and worked rigidly to achieve a work based on this title. Then it's important to explore that world - the more you do that, the stronger and the more satisfying the piece will be.

'What you have to be careful not to do is simply to produce in the end a piece that is merely a collection of effects. If you go back to the early days of Stockhausen and Boulez, technical progress was thought to be the actual process of using electronics to make music - the scientific applications were more important than new ideas in musical composition. So the final image is not so much a soundscape that gives a visual picture, but rather affects human emotions in different ways.

RECORDED ON CASSETTE NO. 3

Irmin Schmidt and Bruno Spoerri in Zurich.

TOY PLANET

"Basically, I still feel I'm a rock musician (it is the element of rhythm that is important) even though my background is classical.

'Here's a point about listening and evaluating. You *must* listen from a distance. When I lived in Bruno's house in the basement room with the studio right above, I used to hear my recorded music in a different way, and what I had considered to be the strongest rhythms were often dominated by other elements I had not even thought about. If you're sitting in front of the loudspeakers, you can easily focus on particular sounds which become the main rhythmic elements, whilst the general listener will have a different impression altogether.'

Instruments and Equipment

Irmin is the first to admit that the musical equipment used to make Toy Planet was nothing out of the ordinary. There was a Prophet 5 synthesiser along with the large EMS Synthi 100 studio model which Bruno had much improved to reduce system noise. Its dual 60 × 60 patchboards are very versatile and the peculiar interfacing has its advantages for Irmin.

'That's what I mean by pre-conceptions - if you just use the electronic equipment you have to create your sound, forgetting anyone elses "interesting ideas" and simply see what you can get out of your equipment. Even noise inherent on an inferior set-up can be utilised as part of the music!'

All the choirs on Toy Planet are done by a special keyboard that uses disc programs - one for violin and one for choir were used on the recording. 'Aah' sounds were changed later with filtering techniques so you might think you are hearing vocal words, but in fact it is all from this basic 'aah'. With the piece Toy Planet, I began to imagine certain words myself and probably people would quickly begin to make their own native language connections.

Other instruments that are important on the LP are the Eminent Organ, which incidentally did not give the strong plane rumbling between two tracks on side two as you might suppose. This was a combination of low pitched choir voices, a deep tone made through various filters, and also sounds from the Prophet and EMS synthesisers. De-tuning is employed to create the pulsating, phasing effect. The superb reverberation depth throughout the record comes from the Lexicon Digital Prime Time delay. The reverberation created gives the necessary depth to the images, making the sounds stretch to a distant aural horizon.

Multi-Layering

I asked Irmin how he created sounds that appeared to contain vast amounts of multi-tracking.

'A lot of this is obtained from using such effects as the British AMS delay and harmoniser, as well as the Syntovox Vocoder from Holland which was used for the "train" piece for example. Here it was triggered from a real train recording inputted to the Prophet, Vocoder and then to tape. Both phasing and frequency shifting were used throughout the album, and the complex rhythms were derived from three different drum machine outputs. These were controlled by Bruno using triggered filtering from the EMS Synthi 100 (which also sent triggers to control the drum machines) and this would take out certain patterns and allow considerable changes to be made. Meanwhile, I was working with the Frequency Shifter, moving the pitch of congas, bongoes and other drum sounds up and down. "Seven Game" gets most of its rhythm from my spontaneous reaction to the rhythms being generated.

'Sometimes we would make up tape loops with these recorded rhythms. In "Toy Planet" piece we used the tape loops that were recorded as individual tracks at full volume on our 24-track machine and then faded these in and out at mix-down stage. The problem with this technique is the same as adding drum machine layers - getting accurate synchronisation of these from one trigger pulse. In "Seven Game", 12 complete "percussionist" tracks were merged together and this was quite a difficult task as our trigger pulse was operating at high speed and tape drop-outs or any fluctuations would cause errors in synchronisation. This meant starting over and over again to get it right.

'Once again, we might find by chance a new combination of rhythms would be created through these errors and so we would keep these.

'Bruno plays both Lyricon instruments (1 and 2) on the record, along with Tenor Sax and Sopranino, the latter only used on "Yom Tov" for the solo and on "When the Waters Came To Life". The more metallic high-pitched filtered sounds came from the Lyricon or the Prophet 5. Otherwise all other sounds are electronically derived (except for the rhythm guitars on Yom Tov).'

Planet Making

Bruno's studio, where Toy Planet was recorded, is in fact quite small and not over-sophisticated. Irmin reminisced to the days when Can started by making records just on two Revox stereo tape machines and little supplementary technical equipment. Irmin emphasised, 'As long as you accept the limits of your instruments, then any music can be made. Toy Planet would be absolutely impossible to reproduce again - for a live performance or even another studio recording.

'This record is done in a way I've never tried before and the next will be different again.' A sign of the times surely, for so many electronic music composers feel this way.

'I'm always seeking adventure and exploring new methods and I'm not interested in repeating previous ideas. Often there is pressure on a composer to repeat a successful style or approach, but even when Can started over 12 years ago, we tried different styles on each of our early albums and yet they all retained the feeling of Can and couldn't be anyone else.

'The record took around four months to complete, for Bruno and I had other work to do in between. I always have quite a lot of film music to prepare and I enjoy this very much - the scripts give me so many new ideas to work with. My approach to composing for films is to find musical themes and ideas that inter-relate and thus link up scenes and the whole film generally.'

Exploring the Planet

I discussed my own general analysis of pieces on Toy Planet with Irmin, who commented as I went along.

The Seven-Games

This begins with a 'water bubbling' background that is purely electronic and a 'whistle' motive repeated freely. Free drum rhythms emerge from the constant 'crickets' buzz as the volume of the forest life on the Planet increases. Slowly a steady rhythm becomes a driving force for a haunting synthesiser theme accompanied by off-beat Prophet 5 chords. The theme is repeated *à la Ravel* with multi-textured sounds. The Tenor Saxophone from Bruno (who in many ways provided the main ideas for this track), plays a series of syncopated notes interjected through the continuing percussion and chords.

Irmin pointed out: 'The first technical step was to record a "pulse track" which came from hearing one day a record with a bass drum line that made us try and get a more realistic effect, yet still electronic. It is at times like this when trying to choose the best effect that Irmin's wife, Hildegarde, also adds her criticisms and ideas.

'I like my pieces to generally start and end in the same key and I enjoy quoting from other works.'

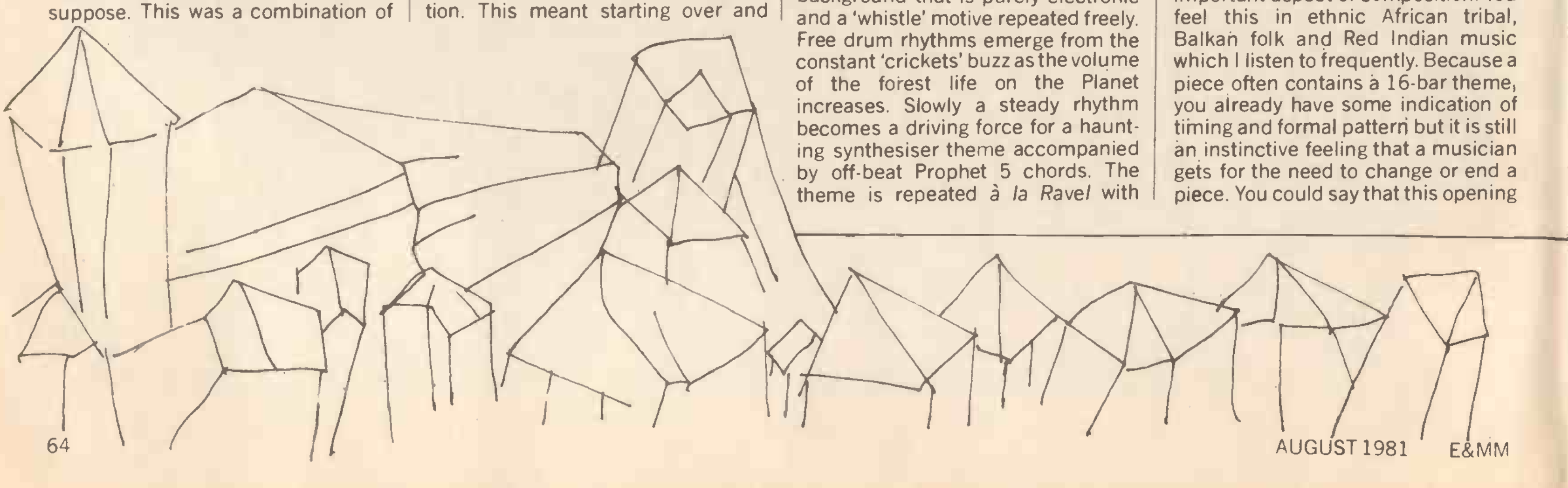
So the piece starts and ends in A minor and at this point it begins its first change of key (up) for a repeat of the melody again - sax improvising with it. Another change of key again upwards and a full band effect provides the melody, almost like a trumpet line-up (it's actually the Lyricon with nine overlays). On the third change of key, as the music works to a climax, the added reverberation gives a feeling of space from the 'forest' as the sax improvises and the electronic drum soars up in pitch.

The next change of key uses synthesiser strings; flute and other preset sounds that improvise weaving melodies with the sax and finally reach a major triad ending, reminiscent of Beethoven's Pastoral Symphony (last movement). The saxophone has the last word on a very smooth sustained echo (a seventy second delay on the Lexicon) that lleaves a gentle tinkling and atmospheric rustling in the distance.

I asked Irmin whether he felt that his wide musical experience gave him more scope for 'producing better music': 'I wouldn't really judge it in terms of quality, because there are plenty of younger composers who are untouched by classical music and yet come out with music that is so surprising and contains such strong ideas.

'The complex rhythm track (built up on our 24-track machine) inspired us with the idea of a melody that comes again and again over this rhythm, and the actual theme was eventually derived from Bruno's experimentation. Whenever Bruno improvised solos, these often took place at widely spaced periods of time and then one day it would turn out to be the right one.

'Being aware of time is another important aspect of composition. You feel this in ethnic African tribal, Balkan folk and Red Indian music which I listen to frequently. Because a piece often contains a 16-bar theme, you already have some indication of timing and formal pattern but it is still an instinctive feeling that a musician gets for the need to change or end a piece. You could say that this opening



music on Toy Planet has a structure that rises to a peak and then fades away. This process of fading out the end of a piece still has to make musical sense. For example, a fade is ideal for giving the feeling that the music can go on for ever.'

Toy Planet

From the atmospheric rustling, distant voices approach (like Holst 'Planets'), forming a beautifully refreshing and space-like sound that stretches across the stereo field, and ebbs and flows through a mixture of echoed chords and solo voices. The echo effect gives the momentum for the piece, making the tinkling percussion "beat" in time. Filtered peaks wander through harmonics as the voices continue – a new chord is heard that returns with harmonics built up through the centre voices echoing with left and right melodies. The music reaches a hilltop and then sinks again to start once more. It's hard to define a key feeling, but all the time the music seems to move to another tonal level. As it dies away, voices almost produce words and finally wander away, leaving the tinkling.

I questioned Irmin about the harmonic structure. 'This track took several weeks to produce and the first harmonies came from us playing melodic lines that were made into tape loops for layering into sequence patterns and chords. By changing the playback speed of the loops and mixing these with the original, we produced a very complex harmonic structure. For each loop and each step we overlaid as many as 16 loops and of course you then create some strong dissonance effects. Don't forget that every loop had its own specific pattern to begin with as well! The choir voices also are always single lines that have been overlaid to achieve harmonies.'

An interesting point is that all the overlays get their own particular position in the stereo field, from left to right with the pan control, and front to back by using increased reverberation depth.

'When you work with electronics, there are strong psycho-acoustic effects created which come much more from what you associate – from your brain picking up certain patterns that are associated with natural events, and this makes you feel that a sound is far away or near to you when its aural proximity has not really changed at all! Just as visual patterns can suggest shapes that really don't exist. The secret of making, say, 20 loops is to make just one, listen to it, experiment and then decide on whether you want another loop or not to go with it. This way, every element, every step is spontaneous and of your creation – but still balanced with your awareness of building a form.

'When Bruno and I were working on the record in Zurich, we always started at 10.00 a.m. and worked all day until around 8.00 p.m. Sometimes I worked with the sound engineer, who played an important part in setting up the levels and images for the LP, but most of it was done with Bruno working alongside. The recording was made on a 24-track A800 Studer machine with a large MCI mixing desk (see photo), with the final mix in stereo.

Two Dolphins Go Dancing

This has strong Euro-disco style drums from the EMS with a dominating metallic 'scrape' that adds to these rhythms. There's a short theme on typically filtered synthesiser sounds from the Prophet against steady 2-beat Prophet chords, whilst the rhythm continues against plenty of syncopation in the background. The Tenor sax melody contains a Ravel quote (produced spontaneously here by Bruno) and finally becomes an improvisation over what appears to be a repeated 2-chord pattern a semitone apart.

Irmin explains: 'The metallic scrape came from some 30 overlays that included tracks from the "tinkling" effect in "Toy Planet" and a number of "horror" type rattling, screaming sounds. These were pulse-gated to achieve the metallic "slice".

'The final dual chord effect is really just a single B major seventh chord that has its alternating feeling from emphasising lowest or highest notes of the chord.'

Yom Tov

This is an old Russian gypsy theme based on the chords: Cm G7 Cm C Fm F G G. A romantic saxophone theme opens with strings accompanying. Irmin gets this superb string effect from at least six overlays done with separate deep, mid and high tracks with or without phasing. High pitches are particularly important and very gently provide that extra realism.

'When I came to Bruno's studio, I was in fact intending to make a solo record and I had already recorded this gypsy piece for use as a basic track. The three guitars from the gypsy band were treated through the vocoder and the Prophet was added as well.'

The title is a Hebrew one meaning 'Happy Day' and certainly the piece contains this feeling and excitement from the various Lyricon and Prophet solos against the persistent guitar theme. After this seemingly wild improvisation there's an abrupt yet typical folk ending to this exciting dance style piece (that might seem out of place here), but it has a warm and enjoyable effect that is an ideal contrast at this point.

Springlight Rite

The whole record is like a fantasy of invented cultures, feast and rites and in the previous track 'Yom Tov' you have perhaps an ethnic flavour for the Planet. Now 'Springlight Rite' provides the ritual spring feast and, although formalised like the 'Toy Planet' piece, uses sequences created over several days that all tend to merge their rhythms and harmonies at particular points. Here's one instance where you could just not have recorded this piece in a studio when time is a premium. 'Tibetan horns' come from the Lyricon and seem to echo to each other from mountain tops in different spatial positions.

'Writing and notation is so difficult, we even tried to photograph the settings with a Polaroid so that we'd get it right the next day – yet temperature, minute adjustments and even your own listening can still change the whole sound image. Reverberation is added here on the individual tracks although it's sometimes left until mixdown of a larger group of sounds. It ends with a magical "fire" and "bubbling" effect, which came by chance during a recording of the Eminent organ using several mics. As we played it back, we heard this "whispering" effect from the tape that was really a subtle feedback from the mics and unanimously decided to use it. Irmin appreciates that "music, like emotion, is often dependent upon the inter-action of people".'

Rapido de Noir (Last Train To Eternity)

Irmin has always been facinated by the sound of trains. 'I have always heard voices from train sounds and wanted to use this "train" element on the record. Bruno happened to have this "train-over-the-tracks" sound on tape. All through the piece, the rhythm of the train wheels on the railway line is evident.

'Initially, we built up a six-minute train sound from various recorded loops of the real thing. Two methods of treatment were then used – first we sent the sound through various devices including Vocoder, EMS and Frequency Shifter. We then kept overlaying these train sounds so that we created an interesting image. Second, by filtering we removed certain parts of the train sound and used this as a trigger for gating sustained Prophet chords. The Vocoder chords were also triggered in this way. The result was to make all the music appear to become part of the train noise. The last stage was to mix these in various forms so that the listener finds it hard to perceive music/train changes.'

Hildegarde was in London at the time and when she received a copy of the tape, did not like it at all so that Irmin felt obliged to do it all again!

After a short time, a distorted guitar/violin solo sound (actually done on the Prophet) has wah-wah treatment and the strong resonance produced from the peaked overtones gives movement to the sounds. 'Rapido de Noir' is a fascinating atmospheric piece which musically conjures images of travelling across a mysterious Toy Planet.

When the Waters came to Life

Irmin achieved the largest number of overlays he has ever created in this piece – 112 layers! So the 24-track was used five times over for mix downs. The more common orchestral kind of sound available on preset synthesisers just didn't provide enough animation for Irmin and this was the only way he could achieve his orchestral images. Once again, spacial placement of sounds is important and moving images can be heard that are overlaid at twice speed. These were gradually multi-tracked into two tonal groups and as this 'backing' was playing, Bruno would improvise.

'Whenever I felt it was right, I would change tonalities by fading in the other group of channels. So here I was playing "Sliders"! The last chord of B major has 112 layers to achieve this very rich feeling and was a conscientious reference to Wagner.

'The track begins with a link from the previous train piece that has a deep melancholy sound. For me, it's as if the whole sky held this rumbling intense tone under its dome – a sound of some huge plane.'

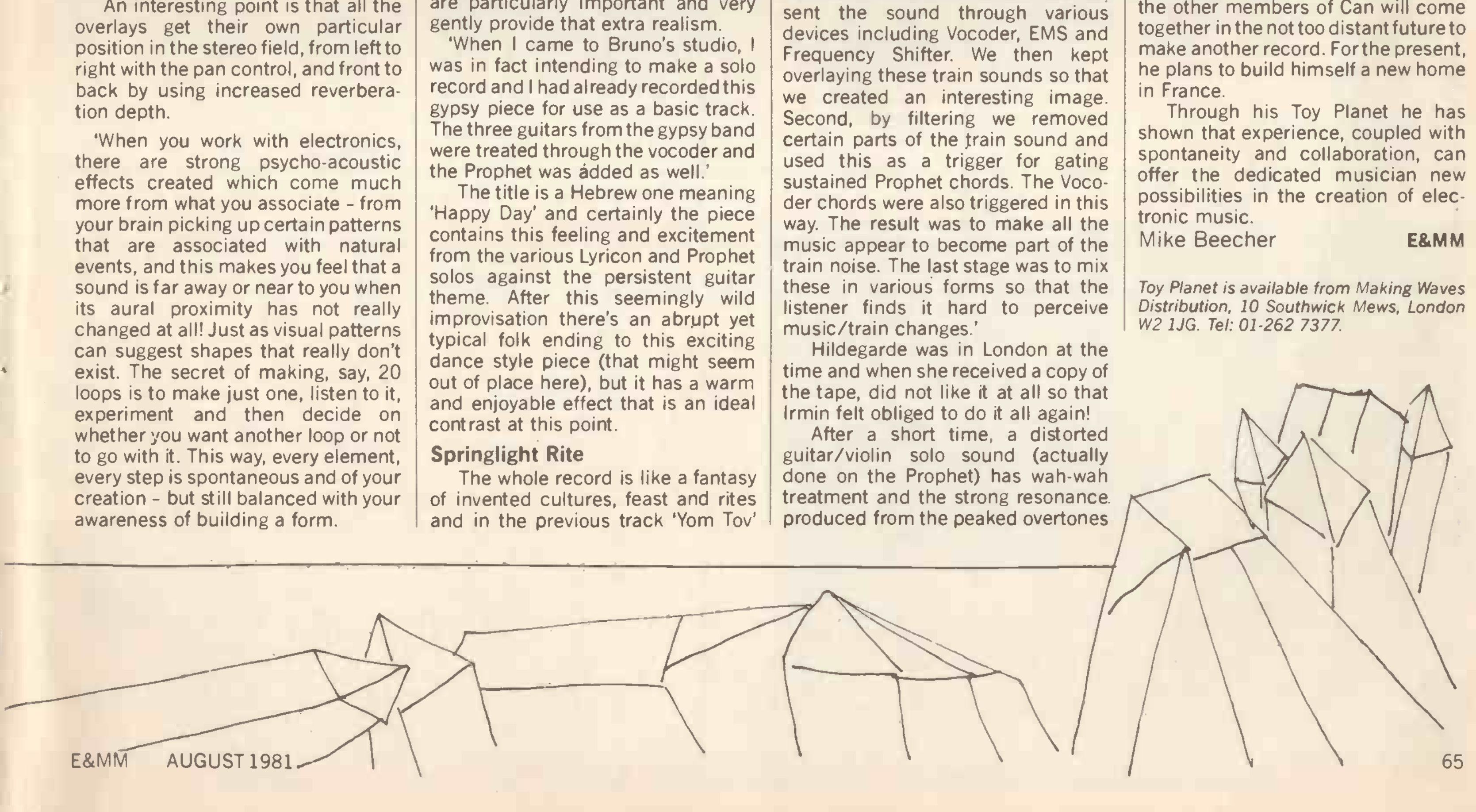
Once again, getting final balance just right is so important. 'Using electronics is inventing instruments at every step – not using them just as a "brave new world" feeling that we all have when playing new instruments. The basic problem of working with synthesisers is that you don't work with a musical instrument that has grown over hundreds of years – each time you use a synthesiser you invent an instrument and in that moment you use it.'

Irmin is now in his early 40's (and Bruno too) and it is likely that he and the other members of Can will come together in the not too distant future to make another record. For the present, he plans to build himself a new home in France.

Through his Toy Planet he has shown that experience, coupled with spontaneity and collaboration, can offer the dedicated musician new possibilities in the creation of electronic music.

Mike Beecher **E&MM**

Toy Planet is available from Making Waves Distribution, 10 Southwick Mews, London W2 1JG. Tel: 01-262 7377.



Organ Talk

CARE & MAINTENANCE

Ken Lenton-Smith

Electronic keyboard instruments are somewhat like cars in that maintenance can tend to be neglected if all is going well. In both cases, this policy is short-sighted for fairly obvious reasons so it seems well worth while mentioning a few points concerning the care and maintenance aspect.

The condition of the cabinet will largely determine the trade-in value of any instrument: its covering is usually a high-quality wood veneer, which can be damaged easily. Some instruments are finished in laminates similar to Formica and, although cheaper and more durable than wood, are possibly less attractive to the eye. An organ is often the focal point of a room's furnishings and should be accorded the same treatment as a good suite of furniture.

Woodwork

The owners guide may contain recommendations but otherwise a proprietary wax polish will be suitable. A secondhand instrument in dirty condition should first be wiped down with a wash leather, then given a wax polish treatment.

If a veneer is struck hard enough by anything - including a vacuum cleaner - it may lift locally. In due course this will catch on clothing or a duster and probably come adrift and a piece will get lost. At the first indication of loose veneer, mix up a small quantity of warmed Araldite and insert it between veneer and body woodwork with a thin knife blade. Press the surfaces into close contact and Sellotape the edge tightly until the epoxy resin has set. Excess resin can be taken off with a damp rag at the time or removed before the resin has fully cured.

The factory finish is often a sprayed mixture of stain and polish, so that scratches will often appear lighter than the surrounding woodwork. These call for patient work with a very fine brush (say No. 0) and a suitable wood stain to disguise the blemishes. The same brush can be used again later to apply a line of polyurethane varnish over the stain: eggshell varnish will probably be less noticeable than the gloss variety. Although dents on a level surface can be 'filled' with a blob of varnish, rubbing down the work will disturb the neighbouring finish so they are probably best ignored.

Installation

Avoid a position with nearby radiator. Heat should not affect solid-state electronics up to a point but it will damage woodwork eventually. The height of the pedals above floor level varies slightly from make to make. If the instrument can be played comfortably on a parquet floor but the pedals feel spongy in a carpeted room, cut pieces of thick plywood which will not be noticeable when placed under the ends of the console.

If the organ is constantly transported for 'gigs', cabinet work is at risk unless it uses a strong vinyl finish designed for this purpose. Shuffling down a passageway with a heavy instrument is hard work and usually results in bruised ankles. If two large pipe brackets are screwed to the back of the console, a pole can be passed through them and the organ carried in 'Sedan Chair' mode. A piano or organ trolley makes lighter work of the task, as does a tail-lift truck. Road surfaces and cornering make it essential to rope the instrument inside the van. Most organs are completely top-heavy and only a few weeks back I heard of an organ toppling over in transit, with consequent damage to the pedalboard.

Always keep the instrument's back in place when moving it as it is only too easy to damage circuit boards when trying to find a good handhold. Spring reverberation units should be locked to avoid damage when moving and owners of tone-wheel organs must lock the generators. In these earlier Hammonds, the generator assembly is suspended on coil springs: by reversing the sleeves on four bolts found under the generator shelf, the generator is pulled down into contact with the shelf for transportation. Without this precaution, the valuable (and now irreplaceable) tone-wheel generators will be free to react to every bump in the road, with consequent damage to frame and drive mechanism.

Keyboards & Controls

Relatively few commercial instruments have a fall to cover the keyboards, which does help in excluding dust from the contacts. Keys and controls are best kept clean by occasional use of a damp cloth. Unless trying to repair minor damage, abrasive polish should be avoided as it can remove the lettering from tabs and controls. Naturally, water should not be allowed to run between the playing keys but other liquids spilled accidentally can be very troublesome as they are likely to be sugary. Performers with a glass of beer perched on the keyboard cheek should definitely be discouraged: they might also be chain smokers and it is impossible to disguise cigarette burns on playing keys!

The key itself is usually a plastics casting with a metal extension to the pivot point. Though fairly robust, the key surface can become scratched. Gentle polishing with a small amount of 'Bluebell' will remove anything less serious than a major scar. In a solid-state organ, these are the moving parts and have to take punishment. Really heavy-handed players have been known to break keys: replacement by a competent serviceman will be the remedy here although a clean fracture might be suitable for the use of cyanoacrylate glue (which has no filling power).

Intermittent contacts can usually be accessed by lifting the keyboards on their hinges. As plastics are used extensively, carbon tetrachloride is not the best choice for key contacts. The precious metal surfaces (rhodium, gold or silver) can be treated with a brush moistened in methylated spirit until the fault has cleared. Tabswitch contacts are usually accessible but rocker switches often have their contacts buried in a plastics casting: sometimes it is possible to remove the rocker itself, by pushing out the pivot, so exposing the contacts inside the box.

Both the clearances and shaping of contact springs are often critical so the cleaning operation demands great care.

Circuitry

Owners of self-designed instruments will know this aspect intimately, possibly having dreamed up the whole system while having a bath! Commercial organs are not always accompanied by circuit diagrams when purchased but it is well worth trying to obtain this information even if only to be warned where CMOS devices are incorporated.

Maybe you have used 4011s, treated them with abandon and got away with it but the complex LSI devices in organs cost considerably more than 20p to replace! The connecting comb on a PCB should be regarded as an extension of the IC, so tread warily. Your nylon carpet cannot be changed in a few seconds, but it takes no time to get out of a nylon shirt and put an earthed bracelet on the wrist.

Today's trend towards digital operation results in fewer connectors. Even so, the likely cause of missing notes or functions is normally due to poor connections, so PCB sockets should be checked to ensure that vibration from the internal speaker has not disturbed them. Manufacturers sometimes use solid conductors and, if the wiring to a plug is bent too frequently, it can break *inside* the p.v.c. covering. If the suspect can be traced from the circuit diagram, sharp needles on the ends of a meter's probes can be used to pierce the p.v.c. and diagnose lack of continuity.

Filter components are unlikely to fail (unless the op. amp. of an active filter has given up) so that an inoperative stop is normally due to a poor connection somewhere. Missing notes can be due to connectors in mother/daughterboards systems.

Voltage regulators are normally very reliable but any failure here can cause untold damage to the rest of the circuitry. Today's sophisticated instrument requires accurate voltages for its divider/keyers, T.O.S. etc, so that any sudden surge in voltage levels can lead to a very expensive result. For these reasons it is worth checking voltages from the PSU, assuming the correct figures are known.

The earthing system, especially when stereo channels are involved, is usually complex. A form of 'pink noise' can be caused when the bare screens of adjacent coaxial cables touch each other, or a screen becomes disconnected.

Most swell controls work on the lamp and l.d.r. principle so that, if the instrument suddenly develops uncontrollable full volume, a circuit diagram is hardly required to fault-find here. Simply check that the lamp operates and that the light path to the l.d.r. is clear of dust and dirt. With a top octave synthesiser, tuning presents no problems: vibration, either from the speaker or the effects of transportation, may have shifted pitch very slightly, calling for a small adjustment, usually by means of a preset internally.

Faulty potentiometers become so because they are frequently used. The speed control of the Rhythm Unit is a likely candidate here and at the first hint of an erratic set of speeds it should be replaced (making sure the law is correct). Although it may seem desirable to leave pots and drawbars in set positions ready for the next gig, this can cause extra wear and possible noise at these points. A few rapid turns of a pot may help to clear any noise present.

Lubrication

A trace of oil on the Swell pedal pivots (and also on the pedalboard pivots if they are accessible) is a useful exercise. Leslie tone cabinets also need lubrication occasionally. Apart from the rotor and horn bearings, the motors themselves require oiling. These are fitted with porous bearings with felt oil reservoirs and it is necessary to look closely to find the oil holes: they are often underneath so it is best to remove the motor temporarily to lubricate it.

Tone-wheel generators of earlier Hammonds need to be oiled annually, filling each cup on top of the housing about threequarters full. These are only funnels and, if filled repeatedly, the inside of the cabinet and amplifier chassis will become saturated with oil. If the generator cover is removed to carry out this operation, take great care with the capillary threads which feed oil to the motors and various shafts. Breaking them can cause the system to seize up.

Most of the foregoing is obvious and common sense, but there may be something here that eluded the reader previously. Anyway, I have no doubt that it pays to look after an instrument that can give the owner and his family so much pleasure.

E&MM

HARMONICS

by Ewen Flint, B.Sc.

A note of the same fundamental pitch sounds quite different when played on a violin, a trumpet, or a flute. This is because all musical instruments produce notes of other frequencies along with the fundamental note. These are called harmonics or overtones. Strings and columns of air (brass and woodwind) produce harmonics whose frequencies are simple numerical multiples of the fundamental, whereas drum skins and solid objects (bell, cymbal and triangle) produce harmonics with no simple relationship, so their sounds are musically discordant. The character of an instrument's tone depends on the presence and relative intensity of these harmonics and is called the timbre of that sound. Fourier's theorem shows that any sound wave can be built up using a sufficient number of pure tones of the correct frequencies and amplitudes. It is these harmonically related frequencies whose amplitudes are controlled by the drawbars on large organs, which allow the player to build up any sound he wishes.

Let us examine first the waveforms which can be produced electronically. **The Sine Wave:** this is the basic pure tone, the most simple form of vibration possible. Mathematically the sine wave describes the oscillations of a pendulum or any similar object. Musically, the only instrument which produces a sine wave is a tuning fork or a softly blown flute.

The Triangle Wave: This is the waveform produced by an integrator ramping alternately positive and negative by equal amounts and at the same rate. Analysis of its harmonics shows that it contains only odd multiples of the fundamental frequency, i.e. a triangle wave of frequency 100 Hz contains sine waves of 100, 300, 500, 700, 900.....Hz (f, 3f, 5f, 7f, 9f...). The amplitude of each harmonic is inversely proportional to the square of its harmonic number, i.e. if the fundamental is at relative amplitude A, then 3f is at A/9, 5f is at A/25, 7f is at A/49. This can also be expressed by saying that the harmonics decrease by 12 dB per octave. Thus although it contains all the odd harmonics, most of them are too faint to be heard; however beats between adjacent harmonics may contribute to the overall sound. Something approaching a triangle wave is produced when a string is plucked exactly at its mid-point. Figure 1 shows how the triangle wave can be built up.

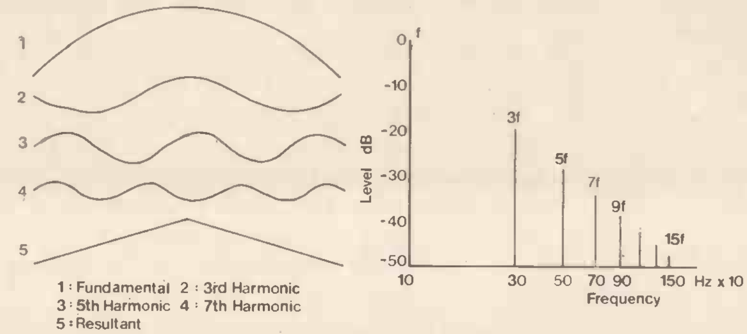


Figure 1. Frequency spectrum of triangle wave, showing harmonic content.

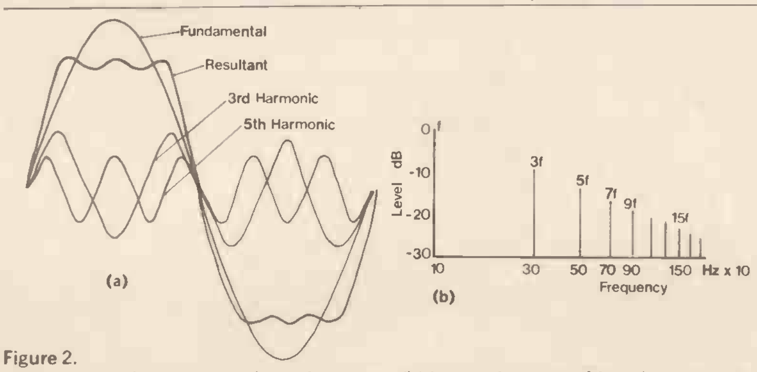


Figure 2.
(a) Synthesis of square wave from sine waves. (b) harmonic composition of square wave.

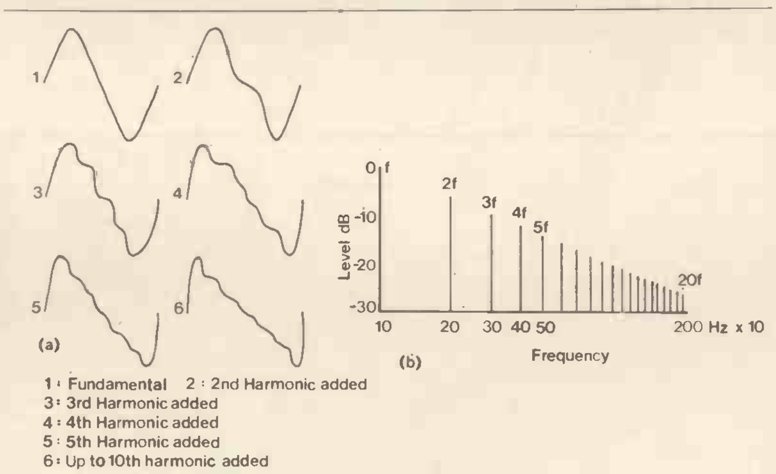


Figure 3. (a) Synthesis of sawtooth (ramp) wave, showing number of harmonics present. (b) Harmonic composition of sawtooth wave.

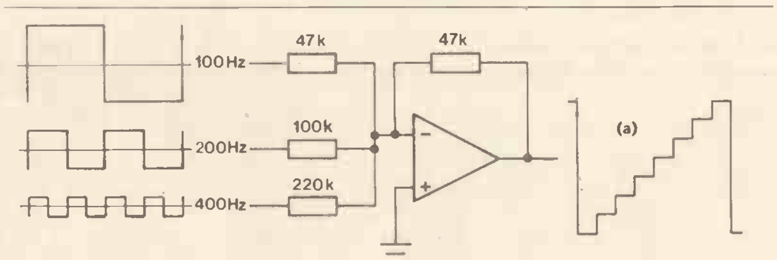
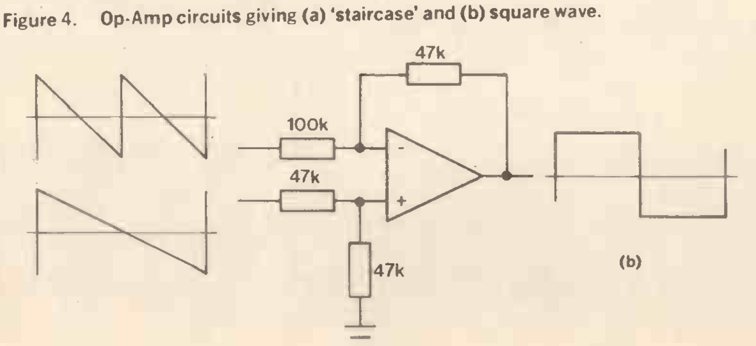


Figure 4. Op-Amp circuits giving (a) 'staircase' and (b) square wave.



Square and Rectangle (pulse) Waves: These are all members of the same family and a simple rule explains their harmonic content. The ratio of the proportions of high and low, or on and off is called the duty cycle or mark:space ratio. Thus a wave which is high for 25% of the time has a duty cycle of 25% and a mark:space ratio of 1:3. The reciprocal of the duty cycle is called the L-number, and for a duty cycle of 25%(=¼), L=4. A rectangular wave contains all the harmonics except those divisible by the L-number, in this case 4f, 8f, 12f etc. The amplitudes of the high harmonics are very strong.

The square wave is a special case; its duty cycle is 50%, giving L=2, so it contains only odd harmonics. Their amplitudes are inversely proportional to the harmonic number (3f=A/3, 5f=A/5 etc.). This means that the harmonics fall off at 6dB per octave (compare with the triangle wave). See Figure 2.

The Sawtooth (ramp) Wave: This very useful waveform contains all odd and even harmonics, and their amplitudes are inversely proportional to the harmonic number, just like the square wave (6dB per octave fall-off). In a good quality sawtooth up to about the thirtieth harmonic will be detectable. See Figure 3.

Interconversion of waveforms

Most organs use bistable dividers and therefore have available large numbers of harmonically related square waves, but no sawtooths. Proper synthesis of many instrumental tones requires even as well as odd harmonics i.e. sawtooths but these can be created electronically by staircasing. A 200 Hz square wave contains odd multiples of 200 Hz (600, 1000, 1400 etc.) which are even harmonics of a 100 Hz tone; similarly a 400 Hz square wave contains also 1200, 2000, 2800... Thus by adding together square waves of 100 Hz at amplitude A, 200 Hz at A/2, and 400 Hz at A/4 a staircase with 8 steps is produced, which contains all the harmonics required in a 100 Hz sawtooth except for the 8th, 16th, 24th, etc., and they are all of the correct amplitude. A simple circuit for doing this can be made from a 741 op-amp. See Figure 4(a). A similar circuit can be used to produce a square wave from two sawtooths an octave apart; all the harmonics of the higher sawtooth are even harmonics of the lower one, so by subtracting 2f at amplitude A/2 from f at A, only the odd harmonics are left, and this constitutes a square wave. See Figure 4(b).

Consider now the sounds of actual instruments: their timbre depends not only on the harmonics present in the waveform, but also on the effect of the formant. This is a band of frequencies, fixed for each instrument but varying even between different specimens of the same type of instrument, and any harmonics falling into this frequency band sound at a loudness level higher than that expected for their harmonic number. This effect is a form of resonance, and it explains why a Stradivarius has a richer tone than a cheap fiddle - the formant of the Strad is unusually wide and extends to higher frequencies. The same effect can be applied to an electronically produced sound by the use of a resonant band pass filter with adjustable centre frequency and 'Q'.

E&MM

The Wasp

(£199 inc. VAT) Incorporating everything in the Gnat plus the following features–2 oscillators with pulse and width control and variable pitch. Separate digital white noise and control. Filter A three band filter consisting of low pass, band pass and high pass. Separate positive and negative controls from the low frequency oscillator and the second envelope shaper. Both envelope shapers have individual sustain, repeat and delay functions. Two link outputs and headphone outputs.

The Spider

(£199 inc. VAT) A digital micro computer based sequencer designed for use with the Gnat and the Wasp synthesisers. Two modes of operation–

1. Pulse Time with 252 note storage capacity.
2. Real Time with 84 note storage capacity.

Variable speed playback in both modes. Note editing facilities, tape synchronising facilities (sync/pulse input) Digital to anologue voltage converter which produces trigger and control voltage for other makes of synthesiser. Memory is retained when power is turned off.

The Caterpillar

(£149 inc. VAT) A three octave four voice digital moving keyboard controller designed for use with Gnat and Wasp synthesisers. Up to four synthesisers can be connected and played polyphonically. Three modes of key assignment unison, normal polyphonic, and cycle polyphonic.

Completely portable–Long life from a PP3 internal battery. The caterpillar allows the Gnats and Wasps to be built up polyphonically as required, simply by adding more together. Thus making a very cheap and versatile four voice synthesiser at a fifth of the cost of other makes.

Coming Soon

The Flea Sequencer (£99 inc. VAT) A smaller version of the Spider Sequencer.

Special Offer

Available for every unit purchased. A free holder bag for your instrument. Specially custom designed to protect against dust.

How to order

Telephone orders for payment by Barclaycard / Access, tel 01-584 1008 Ext 1620

By post–payable by cheque, P.O. Barclaycard or Access ; by filling out the coupon below. Either way please allow 14 days for delivery.

To: Quasar. P.O. Box 233. London SW3 3DQ

Qty	Item	Code	Item Price £	Total £
	Gnat	G	99	
	Wasp	W	199	
	Spider	S	199	
	Caterpillar	C	149	
			Total	£

Please tick if you require a VAT receipt ☐

*I enclose a cheque/postal order to Quasar. for £

*Please charge to my Access/Barclaycard no.

Please print

Name: Mr/Mrs/Miss ____________________

Address ____________________

____

____________________ E&MM/8

All products are fully guaranteed against normal use for 12 months.

Quasar

Quasar
P.O. Box 233
London SW3 3DQ

WORKING WITH VIDEO

Andy Emmerson

This month's article is concerned with tape and value for money - I guess most video enthusiasts should be involved with these.

Do you buy pre-recorded films? I don't think anyone will deny these are quite expensive items, and after you have handed over your £30 or more you do at least expect to get what you paid for. Unfortunately this is not always the case, and several of the films on sale are 'mutilated'. For one reason or another they have been cut from the original length and various scenes are missing. If you compare the stated running time with the original length as quoted in the reference books you can rapidly assess whether you are getting the whole film or a shortened version. Sometimes the scenes have been taken out in order to make the action snappier, sometimes they have been 'censored' to make the film acceptable for screening on TV. Occasionally the original version is no longer available, so the curtailed version is the only one available.

Now, however, another complication emerges. Warner Home Video in the States had a problem in that films were just too long to fit onto the normal length tape cassette, which in the States is two hours. They were reluctant to issue films as twin-packs because this raised the cost price to an uneconomic level and the public would never pay the eventual retail price. Their first reaction was not to release films lasting longer than 120 minutes, but that was short-sighted. There were many excellent films which would sell well but lasted longer than the prescribed 120 minutes. With typical American ingenuity they have now come up with an answer. The problem was partially solved by producing longer blank tapes lasting 150 minutes - pretty obvious that, the clever bit is a new time compression technique which enables more viewing time to be put onto a tape. By speeding up the projection of the film during the film to video transfer they can now get almost 65 minutes' worth of action into 60 minutes playing time on tape. Speech and other sound is digitally processed to maintain normal pitch; voices sound normal, though in fact the performers are talking slightly faster.

In the past year Warner Brothers' and VidAmerica have applied this technique to literally thousands of cassettes sold and presumably nobody has complained. It has to be used very carefully in musical programmes and has created a new dilemma for the marketing people: which running time do you put on the cassette? If you put the original running time of the film you are liable to offend the trading standards people for misrepresentation, and if you put the shortened time you could lead film buffs to think they are getting a cut version of their favourite film.

As you may well know, there are far more films available on sale in the USA than over here. Prices are lower and feature films are generally available on tape at the same time as they are released in the cinemas. In fact the American video public is getting quite accustomed to buying films for their entertainment - it may have something to do with the mediocre level of television programming in general. Over there considerable interest also exists in old films and even TV programmes from the vintage years of the fifties. This has led to a small boom in backstreet film to video transfer merchants, peddling dubious copies of ancient films. I am not sure what the copyright situation is there, but as far as the advertisements would lead you to believe, it is no problem. One outfit calls itself Public Domain Video, which of course leaves you in no doubt as to where they got their material but even then it is no guarantee of quality. In fact the old film business has got itself such a poor reputation, most collectors will only buy at shops where they can view the tape first. Prices are higher than the mail order merchants but at least you can avoid being ripped off.

If you wish to get a bit of this action, as we have said before, you will need a multistandard video recorder. This usually adds about £150 to £200 to the price, and many of the specialist dealers in London have these converted machines in stock. In addition you will also need a dual standard TV set, though if you are prepared to forego colour, you can get a black and white picture on most modern UK standard sets. Of course, you *may* only be interested in black and white films . . .!

In May I told you that head-cleaning tapes were not 100% effective and a dealer could probably do a better job of head-cleaning than you could. (This assumes *he* does not just run a head-cleaning tape through a couple of times . . .). Earlier than this, the leading manufacturers in the VHS camp had issued a very strong condemnation of head-cleaning tapes. The distributors of the Allsop head-cleaner - which uses fluids - made a complaint which, surprisingly, was sufficient to make the VHS manufacturers issue a revised statement. In the public interest it is set out here and says "The Allsop, if used correctly, will not cause damage to either the record/replay heads of VHS machines or to tape used in current models. If used incorrectly, the Allsop product and other head-cleaners currently available are, in our opinion, not only ineffective but may cause damage. We reiterate that we cannot endorse the use of head-cleaning products as a substitute for regular servicing by a qualified and VHS-approved engineer".

Those are the words of the oracle. I would just add that if you do use the Allsop, let the alcohol dry off completely before you run a tape through the machine. Otherwise the tape might stick to the wet head-drum, and that would *not* be nice.

Finally, here is a word of advice to anyone trying to track down the new E-240 four hour VHS tapes - and, I suppose, for National Panasonic who make them. In London's Tottenham Court Road, arguably the video capital of Europe, the going price for these is £18.95. Now I am prepared to concede this represents only the normal retail markup on the trade price, but it does seem excessive. Considering that you can get an E-180 by the same manufacturer just across the road for **£8** it would appear that your money would be better spent on two E-180s, with more than enough change to buy your lunch at Macdonald's at the top of the road! **E&MM**

Hot Wiring your GUITAR

One of our recent readers letters, from deepest Wales, asks for general advice on rewiring a Wilson Rapier 33 (does he mean the revered and historic Watkins, I wonder?) from three pick-up to two, the object being a general and experimental hot-up. The letter highlights a whole area that deserves discussion here rather than on a few bits of Basildon Bond and I'd be interested to hear from anyone else with ideas on an overall approach to this type of project.

So meanwhile, dear Mr. Wilson or Watkins owner, and fellow enthusiasts...

I don't know the Wilson Rapier 33 particularly, but I would guess that it would benefit from some physical sorting out before you start on the electrics. As you have other guitars around to cover your gigs, you may as well take your time and go the whole hog on this one. As far as brass hardware is concerned, expert (and "expert") opinion is fairly evenly divided for and against. What I would say is that some guitars have physical characteristics that give good enough results without the help of brass, but most don't, and there's not a lot of point in going to town on your wiring if the guitar is physically stodgy. So I would go for a brass nut right away, fatter frets, and as much brass mass as is practicable at the bridge. All these things have, in my certain experience, the ability to *at least* lift top end and even-out (rather than necessarily increase) sustain. While on the bridge, check out your string earth. You must have a good contact with the bridge (or the tail-piece, usually done through the guitar body to one of the pillars, and therefore usually not a problem) and if you have gone for plenty of mass, you'll probably end up effectively trying to solder a wire to a very efficient heatsink. A better way of attaching the string earth firmly to the bridge is to drill and tap a small hole somewhere discreet for a more reliable screw contact. I would suggest M3 size, which requires a 2.50 mm drilled hole. An M3 taper and plug tap pair will set you back somewhere between one and two pounds for HSS, but if you only intend to use it once or twice on brass, then the cheaper carbon steel types will do. Make sure you oil the taps when cutting.

I assume you're going to go for humbuckers - personally I see no point in limiting the guitar to two single coil pick-ups. However, I would recommend that you retain the centre pick-up as you already have the space; it is a very valuable mixer. I don't think you need a humbucker here. I have a centre humbucker and find I rarely use it untapped, and a single coil will save space and money. The Dimarzio SDSI is powerful enough here to mix reasonably comfortably with humbuckers. Alternatively, the Lawrence Strat type pick-up is in fact a centre weighted humbucker, with the appearance of a single coil. It also collects harmonics from a small area like a single coil and thus has *some* similar tonal characteristics. Top end is not a major consideration in the centre slot, as top will dominate a pick-up mix more effectively than sheer volume and generally speaking, you don't really want this position to do any dominating, rather it is a good place to collect a few extra harmonics to influence the sound of another pick-up.

Jack Bruce with Aria SB 1000 bass guitar.

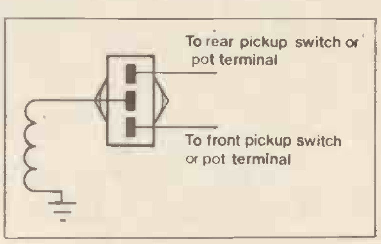


Figure 1. Centre pick-up wiring details.

I think you should be able to mix a centre pick-up with either front or back pick-up separately, and have found that the simplest control set-up to use is to rig the guitar as a normal two pick-up system but with a routeable centre, so the centre should be wired to an on/off/on SPDT as shown in Figure 1. I don't believe that a separate volume or tone control for centre serves any useful purpose whatsoever (musically).

I have already covered a number of partial and complete humbucker taps in earlier issues of E&MM, I think you'll also find some useful ideas in a little book I have written, Customising Your Electric Guitar, which will be published around August/September by Kaye and Ward, and distributed by Stentor Music – your local music shop should be able to get hold of it for you.

If you really don't want to use a centre pick-up, then the siting of your rear (bridge) pick-up requires thought. Siting close in to the bridge will give you more high harmonics, and a sharper edge to the sound. Siting further forward can, with the right tap, take you closer towards a Strat centre and rear mix (the classic "out of phase Strat sound") but will gradually lose the high, sharp harmonics. Using a phase reverse switch on this pick-up in conjunction with an earth-type tap can help cover the area a little better as you will then have a choice of coils but experimenting to find the best spot will entail extra routing of body cavities and recutting of scratchplates. Which is precisely why I recommend going for a centre pick-up and a close set rear pick-up in the first place!

In fact the more I think about what to suggest, the more a centre pick-up seems essential if you want a wide range of sounds. For example, coil phase reverse on a front pick-up can add some useful nasal qualities to a sound, but sounds weedy on a solo, pick-up, and doesn't mix terribly well with just a rear pick-up. However, mix a centre pick-up in with it, and if you've got the overall phase of the front pick-up the right way round, you're half-way to a Dobro sound. Or maybe add a parallel coils option to the front humbucker's reversed coil phase, and you can slip a breathy little razor edge into a three pick-up mix whilst retaining the body of the sound and the essential quality of the rear pick-up. If you start juggling the mix a little, or biasing it, that is, a .001 bypass on one pick-up and not the other two, or vice versa, life can start to get very exciting tonally.

Compared with the possibilities available from a three pick-up rig, a two pick-up guitar is positively mundane - and remember, this is all still without batteries. On choice of pick-ups, the loading and cancellation effects of some of the more complex parallel mixes and phase reverses can cause volume drops, so go for powerful pick-ups. High-power pick-ups also allow you to exploit a treble bypass capacitor more effectively.

Also, when using in-phase coils on a front pick-up (normal humbucker is out, remember) volume drop as you bend away from a pole-piece will be more than usually severe, so use bar pick-ups if you're a bender. Note that when choosing a production custom humbucker, variation in the number of conductors fitted may restrict your options. High power humbuckers, for example the Dimarzio X2N comes four conductor and shield as standard, so all the options are open; the Schecter Superock comes three conductor and shield for overall phase-reverse and tap, but is very easily rewired to either: three conductor and shield, suitable for series/parallel/tap without overall phase reverse, or fully to four conductor and shield. The Lawrence L500 comes three conductor and shield for overall phase reverse and tap, and cannot have its conductors re-attached or added to as the whole unit is sealed in epoxy. Other makes also vary, so check out carefully as you buy. **E&MM**

HI-FI

Jeff Macaulay

What motivates someone to do-it-themselves? This may at first seem a strange question to ask in a Hi-Fi column, but it has some relevance. In an age when the market is saturated with relatively inexpensive imported equipment it is surprising the number of people that are still prepared to spend plenty of spare time building kits or projects from journals.

Mind you it's much easier for the home constructor now that most projects come complete with their own PCB and the easily obtainable parts. at comparatively low cost. Bearing this in mind I feel that there is another market yet to be exploited in the DIY electronics field. I refer to making equipment completely from ready assembled modules.

At first sight this may seem a strange idea, but consider the attractions. First, the specifications can be guaranteed from unit to unit. Second, the actual amount of hard graft in making, for example, a tuner amplifier is reduced to correctly interwiring PCBs. Since this is so, the constructor whose competence would not stretch far enough to correctly assemble a kit amp would have little difficulty in assembling a complex piece of equipment. Last, but by no means least, this method is sometimes cheaper than actually building everything from scratch.

In any case a saving over buying the shop-built equivalent will be made. This method of construction takes us into system building where the important thing is to correctly interface the modules. Unfortunately the last thing usually considered is the interfacing and a little work on this aspect of design often works wonders!

Getting away from this idea, slightly at least, I thought that I might turn to the problems of interfacing from another angle. In particular, the equalisation required by magnetic pick-up cartridges.

The modern microgroove record poses many problems for the designer which range from getting large amplitude signals onto the vinyl, to the flatness or otherwise of the completed product. Unfortunately this last problem appears to have become insoluble within the last few years.

Since the oil crisis, vinyl has become increasingly more expensive. The record companies' response has been to decrease the thickness of the record. Inevitably the quality has suffered. Modern pick-up cartridges are easily capable of reproducing warp signals. These are subsonic and of large amplitude.

Once they have entered the stereo system they cause havoc. Being subsonic they cannot be directly heard. However the wanted signal is carried 'piggyback' fashion on top of them. The result is premature clipping. Where this occurs on the waveform being reproduced is dependent on the amplitude of the warp.

Large subsonic signals are also bad news for the output stage of the amplifier which wastes power reproducing them. Possibly more important is the intermodulation distortion between these signals and the bass. It must be said though, as a rider to the last observation, that little research has been done in this area. The usual solution to such problems is to use a high-pass filter or a rumble filter in front of the power amp. Unfortunately, these are often badly designed. Either the cut-off frequency is too high, losing valuable bass, or the rate of cut-off is too low resulting in inadequate rejection of unwanted signals.

A simple rumble filter that can be constructed on a piece of Veroboard is shown in Figure 1. A word of explanation is in order.

Most musical signals contain little information below 40Hz. The main exceptions to this rule are organs and bass drums. For example, the bottom note from an organ can be as low as 16Hz. Orchestral bass drum has a fundamental down to 35Hz.

Record warps however occupy the 2-10Hz region. A suitable compromise cut-off frequency for our filter is 20Hz. This coincides with the low frequency limit of human hearing. The rate of cut-off can be 12db/octave allowing the use of the well tried Sallen and Key filter configuration. It is also important that the device used doesn't degrade the performance of the amplifying chain in any way. For this reason a J-fet op-amp (the LF351) is used. This device has a fast slew rate, 12V/us, and used in the 100% feedback mode, has a distortion of less than 0.002% at 2V RMS output across the audio band.

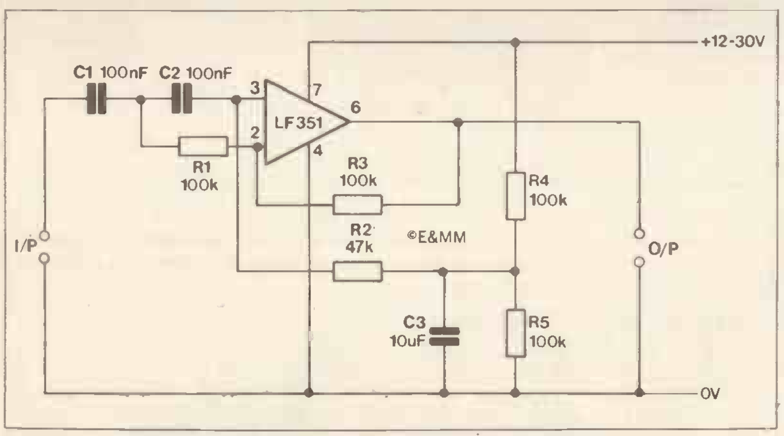


Figure 1. Suggested rumble filter circuit (one channel shown).

No problems should be encountered as long as the output and input are well separated physically. Power can usually be obtained from the power line in the amplifier or pre-amp. The unit should be placed between the pre-amp and power amp.

In order to preserve a good S/N ratio, records are cut with treble pre-emphasis and bass de-emphasis. The latter is required since bass signals generally have a larger amplitude than those in the mid-range and treble.

If the bass were to be recorded at its normal level then the groove spacing would have to be greater to prevent breakthrough between tracks.

In order to reproduce a flat signal from a record, a filter network is required to de-emphasise the top and emphasise the bass. The required curve is standardised with the turnover frequencies being set at 50Hz, 500Hz and 2.1kHz. What happens is that the response is flat from 20-50Hz and then falls at 6dB/octave. At 500Hz the response is 3dB up with reference to 1kHz. Between 500Hz and about 1.5kHz the response is flat but falls away again towards the top end being 3dB down with reference to 1kHz at 2.2kHz.

Since the introduction of linear ICs, manufacturers have aimed to produce high quality devices that would simplify the design of audio front ends. Until recently their efforts have only approached the performance that can be obtained from a good discrete design. Within the last year though, Hitachi have introduced the first of a new generation of front end ICs.

The new device is the HA12017. The distortion generated by this device is extremely small - 0.002% at 20kHz! Combine this with a 10V RMS output capacity and a quoted signal to noise ratio of -72dB giving you a potential world-beater. Moreover the device is not that expensive being in the region of a pound. Unlike the now familiar dual pre-amps, you'll need two ICs for stereo and the circuit is slightly more complex than usual. Even so the chip is certainly value for money.

Whilst we're on the subject of front ends it may be as well to dispel one myth in particular - disc signal to noise ratio. Most people would assume that the lower the noise from the pre-amp the better. In general terms this is sound logic but there are special considerations which apply to disc inputs.

All pick-up cartridges generate their own noise which is proportional to their impedance. Without filling the page with calculations it can be shown that about 1uV is generated by the average moving magnet designs.

This means that the best signal to noise ratio that can be obtained practically is -65dB for a 2mV input. Unfortunately to obtain this level of performance the pre-amplifier must be noiseless!

By an extraordinary set of coincidences I met Simon Bantly recently, the designer of the Black Triangle speaker system. These were recently demonstrated at a London exhibition and showed their unusual performance and excellent bass response.

The speaker system itself is a three drive unit design with infinite baffle loading on the bass unit. Despite the loading and relatively small volume, the speaker can deliver a usable output at 20Hz! Not unnaturally, Simon did not care to divulge how this was accomplished and several patents are pending on the principles involved. Since we live only ten minutes walk from one another, I took the opportunity to go and listen to a pair in domestic surroundings. I was impressed with the overall response and the only fault that I could hear was some slight sibilance on vocals. The mid-range was nicely detailed and the bass was reproduced with its proper weight and without any boominess.

One of the major problems encountered by those who possess speakers with a good bass response is the excitation of room resonances. this problem has been to a large extent overcome in this design by employing a 'suck-out' filter that operates in the 40Hz region. This frequency coincides with the main resonance of many domestic rooms.

As with all things audio, the only way that it can be properly assessed by the potential purchaser is to listen closely and judge by what you hear. As these speakers are expensive (£1,400 per pair), nothing less than a home demonstration should be demanded before parting with your money.

Another interesting characteristic of these speakers is that they are at least partially omnidirectional. Stereo, as we have come to know it, is light years away from the live experience where direction location information is largely absent. How much the image means is dependent on the individual listener. As an interesting footnote to the above Simon uses as his reference source a VMS20E MkII fitted in the Acos Lustre arm. This combination he believes offers all that can reasonably expected from disc. As I use this combination myself I tend to agree!

E&MM

HI-FI SUPPLEMENT

This article by Mike Skeet suggests that simple techniques using just a few microphones can produce fine results even in the "pop" field, the most likely place to find "the mic for every instrument situation". His specialisation in 'Dummy Head Binaural' is well known in the Hi-Fi world and this introduction should give some ideas for making lower budget recordings.

ARE ALL THOSE MICROPHONES NECESSARY?

Having begun my own small record label three years ago with the main objective of issuing material recorded with more simple microphone techniques (which generally means less microphones) than other studios, I was attracted to try binaural recording with a Dummy Head. The results proved that here was a low cost means to assist in launching recordings of new composers and performers in modern and classical music. Moreover, using binaural techniques retained significantly the original atmosphere of the location, from churches, concert halls to clubs and pubs.

Mic Placement

It does of course depend on what is being recorded, i.e. the instrumental line up. For this article I have in mind the "pop" music line up of lead, rhythm, bass, drums, vocals and possibly keyboards.

My drawing in Figure 1 shows a likely Multimic layout and Figure 2 shows the proposed set-up using fewer mics based on the use of a couple of crossed directional pairs with additional "spot" mics for bass, drum and vocals.

In case it is necessary to cover the point I must define Multimic and Multitrack. The latter implies the use of the former of course, but where the individual mic outputs are kept separate for later mix down to panpotted 'stereo' or by 'simulsync' overdub of individual musicians. For both Figure 1 and 2 I am assuming a direct mix into two track stereo of the "live" performance. As far as multitracking with microphones is concerned, I feel that 16 track is a minimum (not forgetting that many studios exist as 24 or 46 track) and that 8 track is too restricting, with 4 track not worth considering.

Crossed Pairs

Cardioid or Hyper Cardioid pick-up pattern mics are required as the stereo information is directly achieved by the intensity differences produced by their polar patterns, provided that the diaphragms are as coincident as possible. The best that can be obtained is to mount them one above the other at around 110° as shown in Figure 3. Crossed figure of eight mics are also possible and here 90° crossing is the norm - care must be taken to keep in the 90° quadrant as out of phase signals are produced outside this, although it only becomes a real worry if analogue disc cutting is finally envisaged.

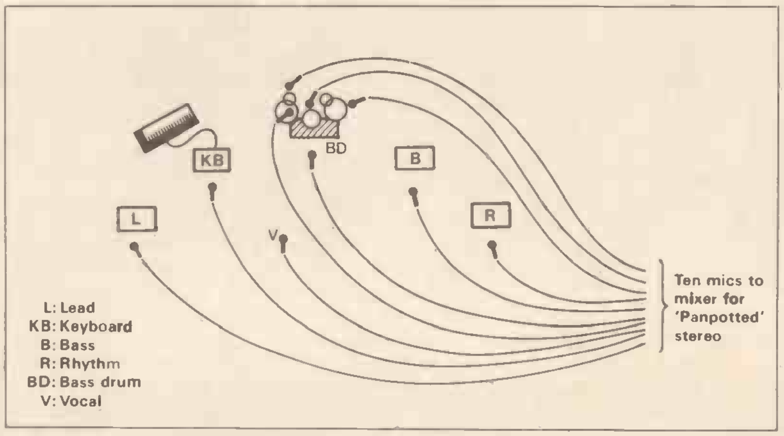


Figure 1. Multimic layout.

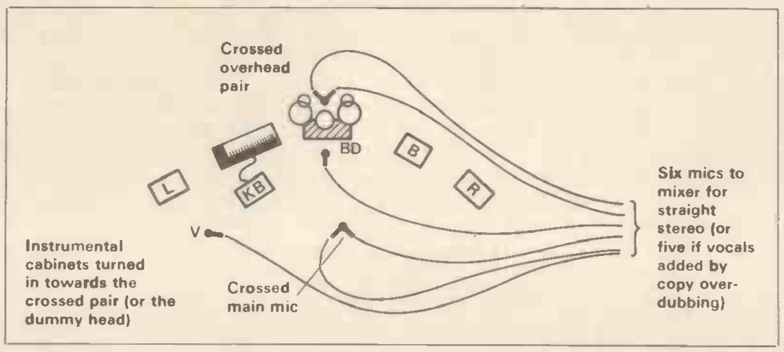


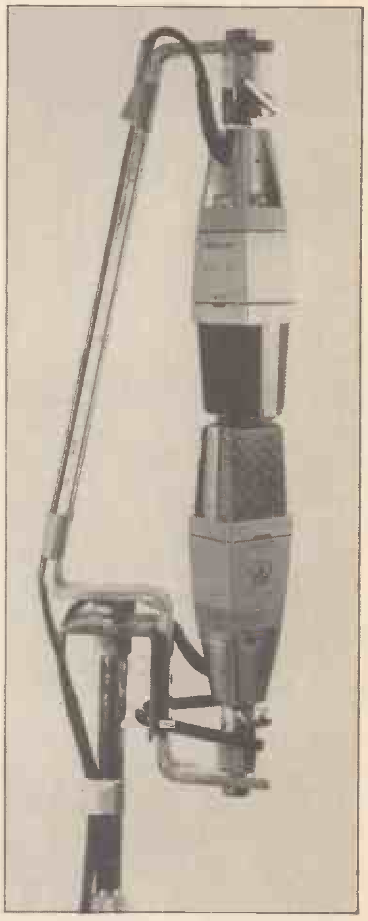
Figure 2. Crossed pair layout.

Why Dummy Heads?

Being a bit of a fan of headphone listening is the main reason. It is probably not all that well known that a couple of omni microphones spaced around 140mm apart and separated from each other by a baffle of approximately 190mm diameter (see Figure 4) can produce surprising "out of head" or binaural effects when listened to on headphones and also a very effective "stereo" on loudspeakers.

The Means!

Now I'm not going to suggest that one takes any old pair of mics and a portable cassette recorder and straightaway you are the new recording vogue of the 80s! The minimum one needs is around five low impedance mics, a mixer with at least that number of channels, a couple of reel to reel recorders (to allow copy overdubbing), suitable mic stands and booms, long enough mic leads to reach a separate room for monitor-



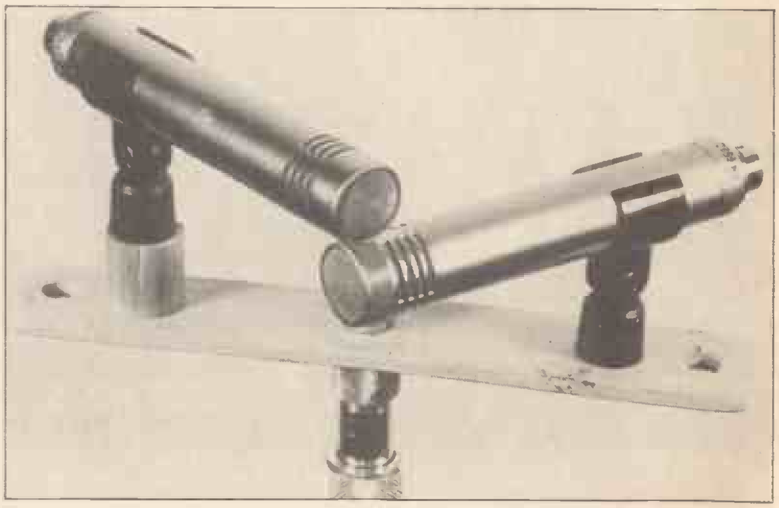


Figure 3. Crossed 'coincident' pairs. Shown above is AKG C414 Capacitor (switched to Cardioid or Hypercardioid or even 'figure of eight'), and below: Calrec CM652 Cardioid Capacitor pair.

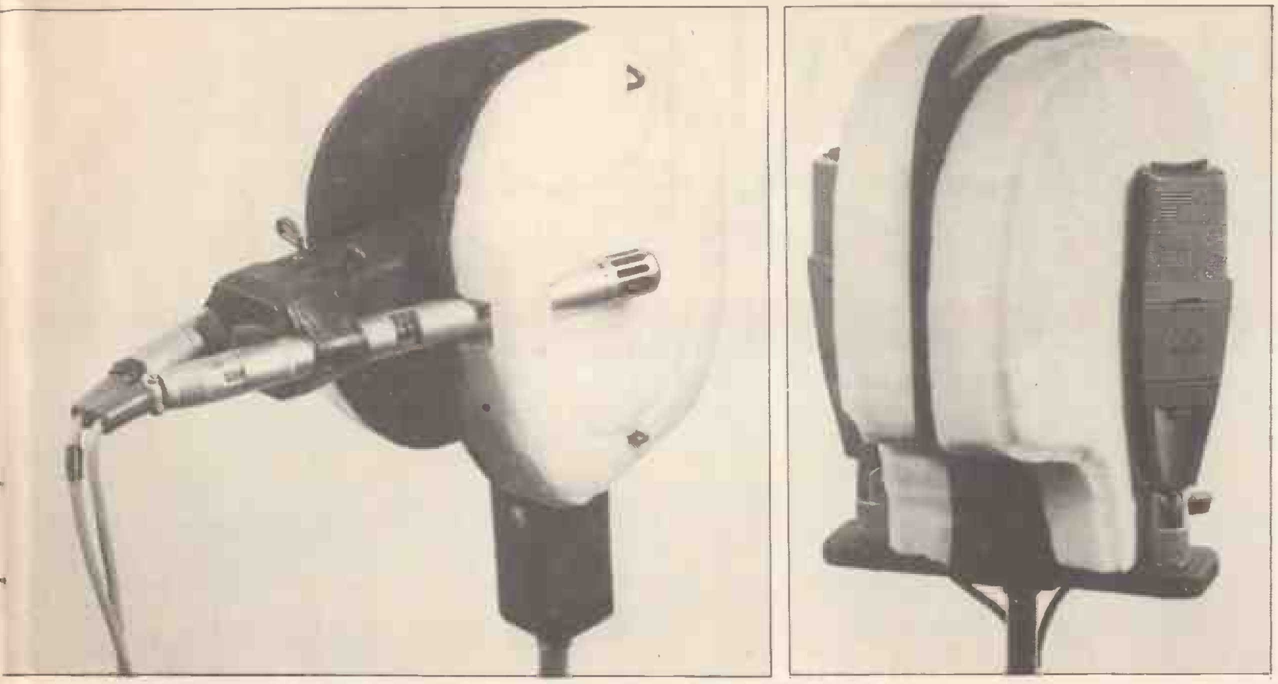


Figure 4. Omni mics baffled from each other for 'dummy head' binaural. Sennheiser MKE203 Electret Capacitor (left) and AKG C414 Capacitor set to omni.

Figure 5. A really effective low cost dummy head using Omni tie clip (RS components 249-463) element mics in chipboard/foam/windshield construction.

ing, a means of monitoring on site, preferably with decent loudspeakers and amplifiers. Then there is "talk-back" to instruct the performers and even "foldback" of what is being recorded on headphones. This latter can however often be done by the band themselves — preferably on phones as foldback loudspeakers can "colour" the sound in the "studio".

On quality aspects, each link in the chain will need a pedigree at least up to the standards expected. Notwithstanding that however, there's nothing like gaining experience with what one has got around you. I've found that good results can be obtained using just two omni mics (in a dummy head) and a stereo cassette recorder, provided that instruments have been carefully positioned, along the lines of Figure 2, and the control levels of each instrument have been suitably adjusted.

How is Balance Obtained?

Straightaway it must be stated that BALANCE is the operative word. One is trying to achieve a balance of the relative levels and perspectives of the instruments against each other and in the case of crossed pairs or dummy heads, also against the acoustics of the room being used. With the multi-mic approach, the closeness of the mics (usually themselves directional) means that the room acoustics recede in the pickup. The resultant panpotted stereo presentation produces, for me, the abhorant leaping out of 'unrelated to each other' sounds. My favouring simpler mic techniques is not just on possible economic grounds - it's more to feel on playback that the sound stage is a unified whole and not a fragmented jigsaw of close-up sounds.

So to balancing when crossed pairs or dummy head pairs are in use. The separate miking of the drums and vocals allows conventional "mixer" level control. The instrumentation grouped around the main mic has to be balanced by the performers, although basically with a layout like that in Figure 2 they need to be at a high enough level relative to the drum kit, to prevent the main mic acquiring too much drum sound. With directional crossed pairs one could place the drum kit behind the main mic and take advantage of the 20dB or so back rejection available. However, in small rooms this is only partially achieved due to reflections (the whole room becomes a sound box) and also, if omni mics are used in a dummy head, one has not got any directional effect in terms of pick-up level.

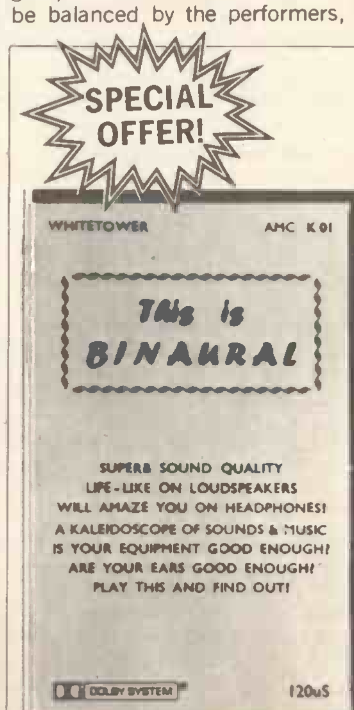
Giving the performers "control" of the balance can be the death knell of the good intentions! Each musician will in turn, after every subsequent playback, try and get his or her instrument loudest! While I certainly favour the band having their say about the balance, there has to be a discipline about how it is done. Initially I get them to play at a normal practice level or moderate "gig" level and balance, record it and judge the changes needed on playback. Then leaving the bass alone, if satisfactory relative to the drums, I appropriately make adjustments to the other instruments. It's a good idea to get players to note their level settings. They soon learn that an otherwise good take can be ruined by an accidental change in someone's level and the engineer can do nothing but wish possibly that he had multimiked the whole affair!

Remember also that in crossed pair or dummy head main mic situations, moving an instrument's cabinet position can also be used to "adjust" its level, provided the change in perspective is acceptable.

Finally, some kindred aspects. Some amplifying systems produce annoying hiss, or worse, hum levels. In my experience this can often be due to inappropriate settings on "pre" and "main" amps. Also I like the cabinets to be raised off the floor to avoid honking. The aim is to get the high frequency output "firing" straight at the main mic.

E&MM

Figure 6. Even low budget recordings can amass some gear! Used for a Whitetower session with 'The Crew' band.



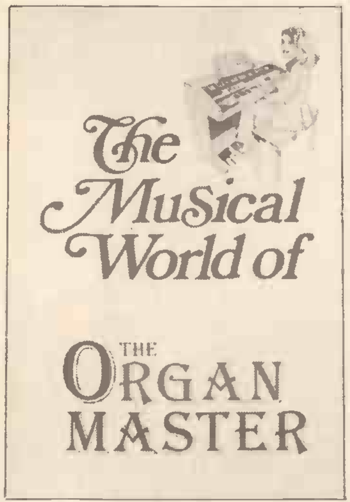
Should any reader want to sample the ideas described, there are several sampler cassettes available on Mike Skeet's own Whitetower record label. Problems normally encountered with high speed cassette duplication (both sides at once) are avoided by copying in 'real time'. The quality and variety of examples should convince you of the merits of binaural techniques. Listening on headphones can give a very strong sensation of sounds all around you. Mike has kindly offered his 'This is Binaural' cassette to readers at the special price of £3.75 including VAT, post and packing. Send your cheque made out to 'Whitetower Records' (E&MM Offer), to 2 Roche Gardens, Bletchley, Milton Keynes, MK3 6HR. It contains 40 minutes of music and sound effects, with church, classical, pipe band, jazz, pop pieces recorded at different locations that impose their own special atmosphere through these techniques, and trains, cars, planes, speech and fireworks showing the realistic sound fields created.

EDUCATION

Electronics & Music Maker looks to the future by choosing projects that use up-to-date technology and features that inform its readers of the latest developments in electronics and electro-music.

Education in its broadest sense is therefore one of the key aspects of this magazine.

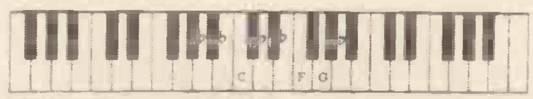
It is also exciting that it will be read by teachers and pupils alike through its wide circulation in this country and many subscriptions abroad.



COUNTER MELODY is created by a movement of notes underneath a melody. If the notes move in Semitones it is referred to as a 'Chromatic Movement', if the notes move in Tones it is referred to as a 'Tonal Movement'. COUNTER MELODY is usually played as a descending movement of notes on either the upper or lower manuals. COUNTER MELODY should be used sparingly.

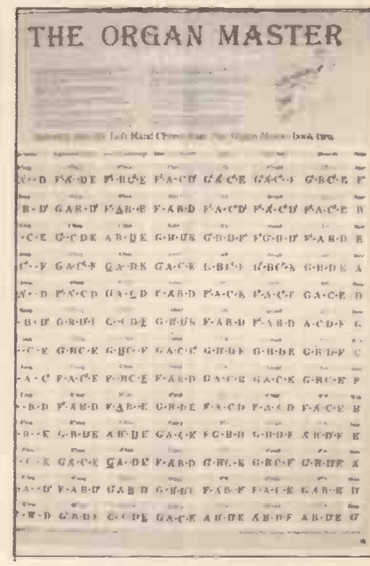
One form of COUNTER MELODY is created underneath a melody when the 3rd Note of one chord resolves to the '7b' Note of the next chord. In the following illustration a 'Chromatic Movement' is created between the 'G', 'F#', 'F' and 'E' Notes as each note movement is in Semitones.

In the 1st Bar the COUNTER MELODY Note is 'E', the 3rd Note of the 'C' Chord



NOTE NUMBERS:–	1 2	3 4	5	6	7 8	
THE 'Ab' MAJOR CHORD:–	Ab	C	Eb			1, 3 and 5 of Major Scale.
THE 'Ab7' CHORD:–	Ab	C	Eb		Gb	Whole Tone below '8'.
THE 'Abmaj7' CHORD:–	Ab	C	Eb		G	Semitone below '8'.
THE 'Ab6' CHORD:–	Ab	C	Eb	F		6th Note added, Tone above '5'.
THE 'Ab' MINOR CHORDS:–	B					Third Note flattened to change chords to MINOR CHORDS.

The Root Chord of 'Ab' Major and 'Ab' Minor and the 3rd Inversion of the 'Ab7', 'Abmaj7' and 'Ab6' are played between 'F' and 'F' on the lower manual. The 'Ab' pedal is played with all the Chords of 'Ab'. The 'Ab' can be omitted from the Inversions of the 'Abmaj7' Chord to avoid the Semitone Discord between the 'G' and 'Ab' Notes. Do not omit to play the 'maj7' Note of 'G'.

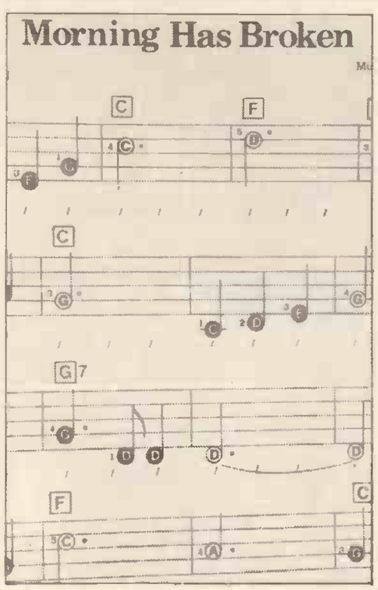


The Musical World of The Organ Master is a teaching course for the modern Electronic Organ. Two music books, two theory books and two chord posters provide the opportunity for beginners to acquire a knowledge of basic music theory whilst learning to play the organ. They will be suitable for many of the constructors of our popular Matinée organ who have little playing experience.

Music Book One starts with an introduction to the manuals and pedals of the organ. The first four tunes are written in 'Easy Play' notation and the remaining music is in normal 'Single Stave' with chord symbols. Many popular tunes illustrate the musical information and playing techniques introduced

throughout the book, including arrangements in the keys of 'C', 'F' and 'G'. You'll also find a tune arranged in two keys of music.

Music Book Two introduces Bass Pedal Rhythm Variations, with helpful illustrations preceding each tune. As in Book One, the 'Timing' is shown by oblique lines under the treble stave to



represent the 'Beats in each Bar'. Two new keys of music, 'Bb' and 'D' are introduced and one arrangement is written with a change of key.

A special feature, which makes the Organ Master a complete self-teaching system, is the cross reference between the music and theory books. As each new item of musical information is introduced in the music books a reference is made to 'Suggested Reading' in the theory books, where a more detailed and fully illustrated explanation is given including Left Hand Chord formation, Right Hand Chords, Counter Melody and Bass Pedal sequences to name but a few.

Brenda Hayward has written the course as a result of her long experience in teaching music and has realised the difficulty that beginners experience when following established organ tutor books that do not teach traditional theory, but rely on colours, labels, shapes or numbers to get you started. The main problem here is that once you have played the set of books using a particular method you may not have enough knowledge to turn to other music in traditional notation.

Whilst modern electronic music performance on synthesisers does not always seem to require a good training in the fundamentals of musical theory, playing an electronic organ well certainly needs this requirement. Most music schools in the UK expect students to know their theory as well as their practical playing on orchestral instruments (and piano) and for classical (church) organ pupils, a level of Grade V Associated Board of the Royal Schools of Music on piano and theory would be suitable preparation before even beginning to play the organ.

Most of us play the organ at home as a hobby and therefore do not want this kind of training – all we want to do is play well enough to enjoy all kinds of music. We'll keep you informed of new music courses and in the meantime the Organ Master will help you find all those intriguing left hand chords that make playing so much more interesting as well as giving you advice on right hand 'counterpoints' (adding extra melodies to the main tune) and solo playing.

Brenda Hayward will be teaching at the first National Home Electronic Organ Festival being held at Pontin's Tower Beach Holiday Camp, Prestatyn, North Wales, from the 29th August to 5th September 1981 (see Events).

The two music books, two theory books and two free chord posters are available as a complete box pack in this month's special offer. Individual books (price £2.50 each plus 50p p&p) can be obtained from Organ Master Publications, Metfield, Harleston, Norfolk IP20 0LH. These publications can also be purchased from most organ dealers.

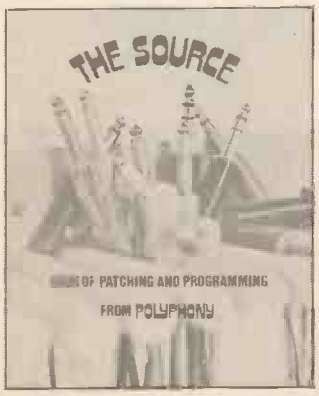
E&MM

BOOK REVIEWS

The Source (a book of patching and programming)

Published by Polyphony
Price $4.00

This is a compilation of the best synthesiser patches devised by Polyphony readers from 1975 to 1978. Polyphony is the house magazine of the PAiA Company which



manufactures synthesiser and computer/synthesiser modules (see April's E&MM for a review of their 8700 computer/controller). It is a fun book!

The Source, quite naturally, has a heavy tendency towards PAiA equipment and, in fact, all the patches are designed to be used with PAiA modules but don't let that put you off. The patches are presented in a schematic and symbolic form so rather than show the front panel of a particular synthesiser, symbols are used to represent the VCOs, VCFs, ADSR units and trigger sources etc. A list of 'symbology' is included and the universal patch diagrams really are easy to follow. Allowances will have to be made depending on your synthesiser but all the basics are there.

The book is in five main parts. Part one consists of tonal-melodic patches resulting in sounds you would use in tunes (hopefully). Part two consists of atonal patches and sound effects. My favourites include a jungle patch — complete with drums and flying birds — a laughing hyena (I kid you not) and a drill (this won't hurt a bit . . .). Part three describes various techniques usually incorporated into a patch rather than resulting in a sound themselves, although many do. This section applies more to the characteristics of the PAiA modules than the others but there are goodies here too including a "Beat the Sequencer" game. Section four is concerned solely with the Gnome, a ribbon-controlled micro-synthesiser manufactured by PAiA (selling for $59.95 in kit form). In spite of the specialisation of this chapter, you can usually follow the signal path to create similar effects on other synths. I can recommend the bull frog and the helicopter but didn't quite manage to squeeze a sneeze out of *my* synth. The last chapter is devoted to software for their computer equipment and includes a program for composing 4-part harmonies.

As far as I am aware, The Source is only available directly from Polyphony (which involves sending a dollar-draft — no trouble, see your bank). It's worth every penny. If, like me, you enjoy experimenting and generally messing about with synthesisers to see what happens (very unprofessional, I know, but we need *some* relaxation), then The Source will provide you with dozens of ideas to use, develop and improve upon. Anyone with even basic synthesiser knowledge should be able to adapt the diagrams to their own equipment.

Buy this; you will use it and enjoy it.

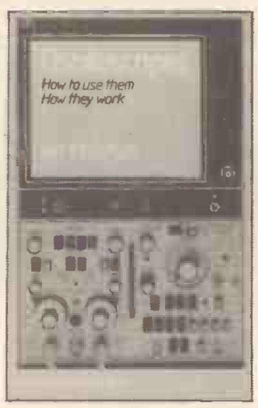
Ian Waugh

PAiA Electronics address: 1020 W. Wilshire, Oklahoma City, OK 73116.

Oscilloscopes How To Use Them, How They Work

by Ian Hickman
Published by Newnes Technical Books
Price £4.20

Many amateur constructors have reservations about purchasing an oscilloscope, feeling that either it is too complicated to use or that it is an over-estimated luxury for the cost incurred. I think Ian Hickman has managed to put the record straight in an admirable and



concise manner when compiling this book.

In his opening paragraph, the author proves his authority not only in the subject matter, but of etymology and route derivation (this is totally by-the-way and of no practical value to the average reader). The first two chapters describe the basic theory and application of the instrument, with chapter three culminating in an overview of the more dedicated and expensive scopes that are not often seen or used outside the profession. The fourth chapter examines the many specialised accessories that can be purchased to compliment the oscilloscope. This section tackles not only probes but cameras, which can be used to make a photographic record of the trace, calibrators and graticules. To most people the graticule is simply a grid from which the measurement can be expressed in real terms, however, the text accompanying this heading proves that this small part of the overall unit can play a large part in the usefulness of the instrument.

The next two chapters detail the use and handling of 'scopes and are as explicit as most of the instruction booklets that would accompany your purchase as far as modus operandi is concerned. It is in the final chapter that the author briefly discusses how the circuitry is actually employed and delves a little into the electronics behind the screen. All-in-all a useful book for the constructor's bookshelf.

Nigel Fawcett

Auto Electrics

by Joss Joselyn and Bob Krafft
Published by Newnes Technical Books
Price £5.65

This book is a must for the practical car owner. It assumes no previous knowledge of wiring or electrical equipment associated with cars and starts with an explanation of basic electronics, which can probably be skipped by most amateur constructors. The authors have taken a very systematic and logical approach which ensures complete understanding, and with some of the regular maintainance procedures included, will enable the reader to get their car in perfect working order and free from unnecessary electrical failure. The authors have impressed that practical maintenance, fault-finding and repair can be done cheaply.

Briefly, the main points covered are: wiring, battery, starter-motor, dynamo, alternator, ignition, lighting, instruments and wipers and other accessories. The following two chapters deal with the optional extras that can be added such as radios and tape cassettes. The final chapter in addition to giving a trouble-shooting guide, explains where you stand with your car electrics and the law.

The general layout of each chapter is bold, easy to follow text and a profusion of excellent diagrams on the right-hand side of the page leaving the left-hand column for clear reference headings and the occasional schematic that would have been distracting or isolated if carried on to the next page. (This is an excellent approach and one I have rarely seen elsewhere — it is perpetually annoying to find figures referenced within the text located on a completely different page, which constantly causes one to lose one's place.)

If I were asked to judge the book on its merits I would award it top marks, for it is excellently presented and easily digested.

Nigel Fawcett

Electronic Projects For Beginners

by F. G. Rayer
Published by Bernard Babani
Price £1.35

All newcomers to the subject of electronics seem to effervesce with an unrestrained enthusiasm that can only be satiated by wielding the soldering iron and churning out forms of electronic contrap-

tions that seem to mystify all bar the budding constructor himself. With this pent-up eagerness and the need to keep on building, it is imperative that the overall cost of each project should be minimal and that the required literature to provide the enthusiast with his construction data should be within the range of his pocket. Here's an inexpensive book that's packed full of simple but useful projects.

The book has been divided into four sections, the first of which is devoted to projects that can be built *without* the aid of a soldering iron. The author describes how to construct baseboards with nuts and bolts to act as terminals and yet, with this 'Stone-Age' approach manages to outline 12 circuits including an intercom, a simple radio and some amplifiers. The second section headed 'Miscellaneous Devices' gives a brief introduction to soldering and is followed by some of the usual projects to be found in this type of book (water level indicator, flashers, sirens and treasure locator).

The third section is concerned with radio and audio frequency circuits and explains how to build radio signal boosters, pre-amplifiers, tone controls and mixers as well as three different amplifiers. The final pages are assigned to power supply circuits, the last chapter giving a table of semiconductor equivalents.

I think it is an excellent book for the price and should give the new constructor hours of fun as well as a greater insight into the subject.

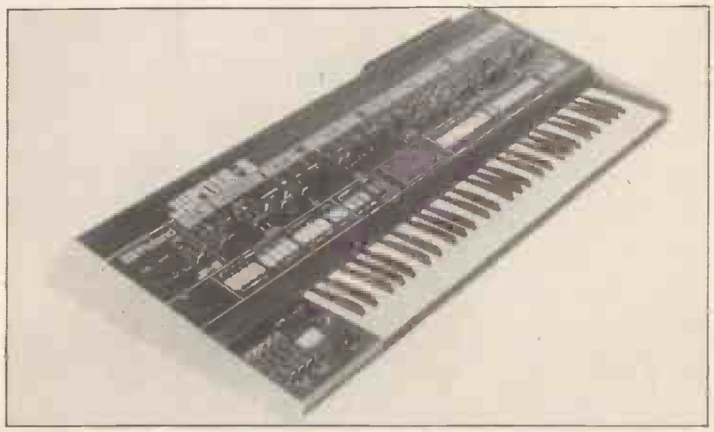
Nigel Fawcett

E&MM

MUSIC MAKER EQUIPMENT SCENE

FORMULA SOUND QUE-4. The QUE-4 represents a new approach in monitoring techniques. It is a stereo studio foldback system for use with medium impedance (200Ω) headphones into which it can deliver six watts per channel. The system is designed to interface directly with the studio mixing console and is usually connected to four foldback send outputs from the mixing desk. Recommended price £185 ex VAT.

From Formula Sound Limited, 3 Waterloo Road, Stockport SK1 3BD

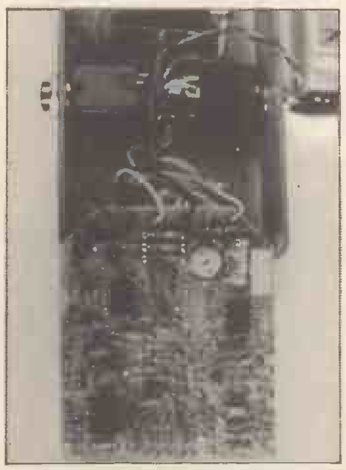


ROLAND JUPITER 8. The Jupiter 8 is an 8-voice polyphonic synthesiser with 16 oscillators, 64 user-programmable memories and a 5-octave computer assigned keyboard which may be split into two polyphonic synthesisers with different patches, used in dual mode for layering two patches for each key, or played as a whole with up to eight fully independent notes from the same patch. The keyboard computer also provides an arpeggio section, which operates in real-time from keyboard notes played - a useful effect in the split keyboard mode. Synthesiser functions are user-programmable and can be stored through a built-in interface on to external tape. A 'verify' button confirms correct tape storage. The synthesiser has a full range of functions and also offers 8 preset patches. Recommended Price: £3,499 inc. VAT

From Roland (UK) Ltd., Great West Trading Est. 983 Great West Road, Brentford, Middx. TW8 9DN

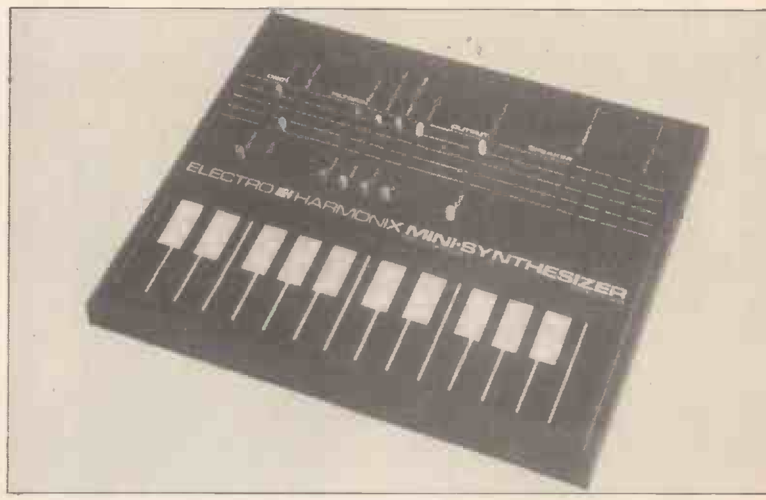
NOVATRON T550. The Novatron T550 is a portable Mellotron. It is built into a sturdy flight case which features a hinged keyboard lid, top panel, and back panel and the front panel can be removed to provide "knee room" when sitting at the machine. The Novatron is a series of controlled tape machines manipulated by the keyboard. Each key relates to, and, when played, activates a tape on which a single note of an orchestral instrument has been pre-recorded. The standard unit comes with three basic sounds: Flute, Violins and Cello recorded on three tracks of a ⅜" wide magnetic tape.

From Streetley Electronics Ltd., 338 Aldridge Road, Streetly, Sutton Coldfield, West Midlands B74 2DT



MXR MICRO CHORUS. The Micro Chorus is designed for in-line connection between a musical instrument and an amplifier or mixer. The unit is battery powered and provides a range of chorus and vibrato effects with analogue delay circuitry; the controls are a bypass switch and a rate control. The rate control reduces the sweep width as the sweep rate is increased. The Micro Chorus works well with guitar, thickening the sound considerably at slow rates and providing vibrato at faster rates. Its usefulness with keyboards is limited to the slowest rates. A nice feature is the rubber top supplied to enable foot control of the rate. Recommended Price: £71.40 inc. VAT.

From Atlantex Music Ltd, 34 Bancroft, Hitchin, Herts SG5 1LA



ELECTRO-HARMONIX MINI-SYNTHESISER (MODEL EH0400). The Mini-Synthesiser is attractively presented in a light weight, slim, black case and is powered by two 9v batteries. Its main features are the easy-to-use controls and flat keyboard. The keyboard is touch-sensitive with the generated control voltage available for pitch and tone modulation. In addition, by sliding your finger along the upper portion of the white notes you have continuous pitch change instead of an individual note glissando.

From Electro-Harmonix, 27 West 23rd Street, New York NY 10010

RAVEN EQ27. Peavey's EQ-27 is a ⅓-octave single channel graphic equaliser where the audio spectrum is split up into 27 bands each providing a ±15dB control range. The unit is a sturdy 19" rack unit with a cast front panel and features balanced inputs and outputs to enable interfacing with other professional grade equipment.

From Peavey Electronics (UK) Ltd., Unit 8, New Road, Ridgewood, Uckfield, Sussex TN22 5SX

SEQUENCE SYNTHESISER SQ-01. The SQ-01 lets you perform by easy score-processing, storing and retrieving each note. The memory capacity is 1024 notes, which are divided into 16 channels and sequenced controls consist of tempo, release, bar, play, write, transpose etc. and the synthesiser has filter, oscillator and envelope controls.

From Firstman International. All Firstman products are available from John Hornby Skewes, Salom House, Garforth, Leeds, LS25 1PX

ZEUS MINI-AMP 8401. The Mini-Amp is a versatile miniature amplifier which is designed to produce true guitar sound with all the tone, sustain, and variable distortion of a full-size amplifier, yet small enough to fit into a guitar case of pocket. It delivers a clean 1 watt of power and features separate volume, tone, and pre-amp controls. The unit can be powered from its internal batteries or an AC adaptor and there are also external speaker and pre-amp out sockets.

From Zeus Audio Systems, 511 S. Palm Av. Alhambra, CA. 91803

America

Tim Schneckloth

All those mallet percussionists who feel inferior to their synthesist friends can take heart. Star Instruments have come up with a mallet-activated instrument that can sound just as peculiar as a keyboard synth. It is a four-octave, polyphonic instrument called the SYNARE MP, and it's capable of doing most of the things expected of a keyboard-activated model. The marimba-like keyboard can be split, allowing the player to sound two distinct voices at once — one in the top two octaves, the other in the bottom two. The SYNARE MP also boasts a four note polyphonic sequencer that is capable of remembering up to 16 different patterns of 32 notes each.

Other U.S. synthesiser manufacturers have been busy as well lately, trying to come up with competitive, low-priced models. Sequential Circuits' entry is the Pro-One, a mono synthesiser that puts a wide range of features into a compact package. It includes 2 VCOs with sawtooth, square and pulse width wave shapes, not to mention a 24 dB low pass filter with its own 4-stage envelope generator.

The Pro-One's digital sequencer is built-in and features 2 sequences and up to 40 note storage between them. Other standard features include an arpeggiator for up or up/down arpeggios, pitch and mod wheels, single and multiple triggering modes, etc. Its audio input with pre-amp lets the musician use microphones, guitars, other keyboards and instruments in conjunction with the Pro-One.

The latest idea from Oberheim is a polyphonic axe called the OB-Xa. It retains all the capabilities of Oberheim's OB-X while adding a few extras.

One of the new additions is a split keyboard function that allows the user to play one sound on the lower half of the keyboard and another sound on the upper half. There is also a doubling mode that lets the synthesist make two sounds with one finger. Other features include two-pole and four-pole filters, programmable transposition of either half of the keyboard, improved noise generator, filter envelope generator, pitch modulation of VCO 2 and a hold footswitch. The OB-Xa is available in four, six and eight-voice models.

E-mu Systems, a company known for its big, elaborate synthesiser setups, has come up with a small keyboard unit that does a lot. They call it the Emulator and say that it's 'a computer-based instrument that allows the musician to digitally record any sound — either live from a microphone or from a line level source — with up to eight-note polyphonic capability.'

It has a split keyboard function and a built-in disk drive that allows the player to store sounds on convenient 'diskettes' for recall later. The Emulator includes a library of pre-recorded sounds, more of which will be available from E-mu later. The company also plans to make some special function software (including a real time multi-track sequencer) available in the future.

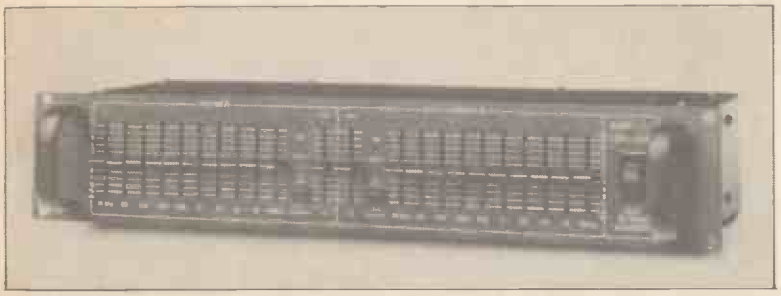
U.S. sound modification people have been trying to stay on top of things, too. One of the newest devices from MXR, for instance, was created to meet the demand for a 'compact and cost effective chorus unit that produces realistic chorus effects and vibratos with a unique, automatic, one-control format.' MXR calls the product the 'Micro Chorus' and it has proved an instant success in the States. Also new from MXR are the Distortion II (which, the company believes, sets a new standard for approximating that warm, tube-amp distortion) and the Limiter, which produces a remarkably noise-free sustain.

Analog/Digital Associates, a small firm that has been making innovative devices in Berkeley, California, put a new flanger on the market recently. It includes an even/odd harmonic selector that 'brings a new dimension to flanging the ambience simulation,' according to the company. The flanger also has a voltage control input which lets the user control the delay time with either an externally applied voltage or the A/DA control pedal. And, the company feels, the flanger's special circuitry has totally eliminated background noise.

Another California manufacturer, Morley, also has a new line of effects boxes. The unique thing about them is the fact that they are both battery and

Demonstrator with SYNARE MP.

E-mu Emulator.



Sunn 10-band Equaliser.

Morley Noise Gate/Line Drive unit.

AC operable. The six models include a compressor, deluxe phaser, noise gate/line drive, flanger, distortion plus and deluxe distortion.

All models include two light emitting diodes. One indicates that the effect is being used; the other indicates that the power is on but the effect is not in use. According to Morley, this feature helps eliminate battery and power drain.

New from Sunn is the SPL 4120 Dual 10-Band Equalizer, which is suitable for sound reinforcement and recording applications. It has two identical channels that feature a 15 dB cut or boost at ten ISO center frequencies, a level control with a 40 dB range, dual LED level sensing, balanced and unbalanced inputs, and a bypass switch that completely disconnects all electronics from the signal path, allowing level matching between the equalised and unequalised signal.

Whirlwind, a Rochester, New York firm that specialises in cords and

Dean Markley "Artist" transducer.

cables for a wide range of musical applications, recently came out with the Medusa Multiple Wiring System, a product designed to make life easier for those cursed with the task of setting up p.a. and recording systems. The system includes a rugged cast aluminium stage box, riveted chassis mounted jacks and wire mesh strain reliefs. Each lead at the console end is reinforced at the stress points and provided with in-line cable grips and neoprene heat shrink jackets to provide reliable connections. The cable systems are all colour-coded for easy identification and all connectors for bi, tri and five-way systems are individually stamped for easy identification.

Acoustic guitar players who yearn for a natural sound at extreme volumes will be interested in two new transducers from California companies. One is the Barcus-Berry 'Insider', which is designed for permanent installation. The actual transducer mounts quickly inside the instrument without any need for tools or modification of the instrument, since a special water-activated adhesive holds the transducer beneath the bridge of the guitar. The output jack can be clamped to the rim of the sound hole or, for those who insist on complete invisibility for output jacks, an optional strap button jack is available.

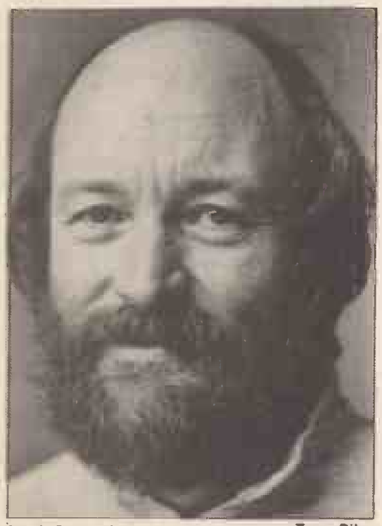
Another transducer for acoustic pickers is the Dean Markley 'Artist' model, which boasts 'Inertia Mass Construction design for reproduction of both horizontal and vertical planular vibrations,' according to the company. The model is compatible with any amplifier; a preamp is not necessary. A special adhesive, which will not harm the instrument's finish, is used for temporary installation, and kits are available for permanent installation.

Companies and manufacturers mentioned:

Star Instruments, Inc., P.O. Box 145, Stafford Springs, CT 06076.
Sequential Circuits, Inc., 3051 N. First Street, San Jose, CA 946-5240.
Oberheim Electronics, Inc., 1455 19th Street, Santa Monica, CA 90404.
E-mu Systems, Inc., 417 Broadway, Santa Cruz, CA 95060.
MXR Innovations, Inc., 740 Driving Park Ave., Rochester, NY 14613.
Analog/Digital Associates, 2316 Fourth Street, Berkeley, CA 94710.
Morley, 6855 Vineland Ave., North Hollywood, CA 91605.
Sunn Musical Equipment Co., 19350 S.W. 89th Ave., Tualatin, OR 97062.
Whirlwind Music Dist., Inc., P.O. Box 1075, Rochester, NY 14603.
Barcus-Berry, Inc., 5381 Production Drive, Huntington Beach, CA 92649.
Dean Markley Strings, Inc., 3350 Scott Blvd., Santa Clara, CA 95051.

E&MM

RECORD REVIEW



Terry Riley

Shri Camel
by Terry Riley
CBS 73929

For an artist and musician with relatively few record releases - and very little publicity - Terry Riley is one of the better-known musical revolutionaries of the age.

"Shri Camel" is the first generally-available record by Terry for about ten years and develops the musical style evident in "Rainbow in Curved Air". For the pigeon-holers, it could be classed as trance-music with floating, swirling figures and percussive riffs darting over a drone-bass, but its apparent simplicity can be misleading. The music is often structurally quite complex.

The whole album was recorded live, in real time, with Terry playing his Yamaha YC-45-D electronic organ. His friend and technical advisor, Chet Wood, modified the organ in two ways. First, he added a computerised digital delay device which enabled Terry to play duets, trios etc. with himself. In fact, several times during the record there are up to sixteen different organ voices and figures playing together. Their relationships are obviously complex but they combine to an overall simplicity which makes the music very accessible and easy to listen to. You can also dissect the more involved sections for a greater understanding of the harmonic and melodic structure.

The second modification involved the alteration of the organ to produce a scale of just intonation as opposed to the equal tempered scale we are more used to in the West. The scale of just intonation only employs intervals found in the harmonic series and is harmonically more accurate but problems arise because about 30 discrete frequencies would be required per octave to play in different keys. Our scale of equal temperament simply divides the octave into 12 equal tones and is a good compromise. Terry's scale of just intonation gives a distinctly Eastern flavour to the music and some of the intervals sound almost micro-tonal to our ears. He studied North Indian raga singing for many years and the influence of the East is quite evident.

The subject of just intonation and different tunings is a very interesting one and certainly an area in which digital synthesis has a lot to offer. Some computer-controlled synthesisers already offer the musician a variety of tunings and as these instruments become more widely available (and cheaper) we may hear more music composed around such tunings. This opens up a whole new world of 'harmony' without resorting to atonal notation and thus keeping the music within a tonal frame and it could well be one of the more promising paths to be taken by musical pioneers.

The album has a mix similar to "Rainbow" - the individual voices bounce across the stereo image adding yet another dimension to the music. Wait until Terry Riley goes quad!

The numerous Terry Riley fans, followers and devotees will already have this record. To anyone interested in music in any shape or form, they owe it to themselves to listen. You can approach it on two levels: what you hear and what you feel. The listener will find it interesting and if you can both listen to it *and* absorb it, you will want to repeat the experiences.

Ian Waugh

In C
Terry Riley CBS 61237

Many years ago, before I had heard any Terry Riley compositions (about the time, in fact, when Mike Oldfield was being accused of plagarizing "Rainbow in Curved Air" for "Tubular Bells"), I asked a friend to describe his music. He said, "Riley writes the sort of music that goes on and on and on, eventually ending up where he began;" from which description I can *now* infer that he knew as much about Terry Riley at that time as I did. It is one man's view, of course, but unfortunately, the sort of description which evokes little in the way of musical comprehension. It did at least make me listen to Terry Riley.

"In C" is one of his '60's compositions (as is "Rainbow in Curved Air") and features Terry on saxophone along with members of the Center of the Creative and Performing Arts in the State University of New York and it is performed on a variety of instruments: oboe, bassoon, Jon Hassell on trumpet, clarinet, flute, trombone, David Rosenboom on viola, vibraphone and marimbaphone.

The percussion begins (and ends) the work with the repetition of a single note and this forms the foundation upon which the other instruments build. They all play short rhythmic phrases, often only 2 or 3 notes long, each interweaving with the other so that at most points in the performance you can usually discern a basic 4/4 or 3/4 time signature. The 'beat' is constant throughout. As you listen, you hear the instruments go 'out of sync' and the accents will shift from the 1st and 3rd beats to the 2nd and 4th. Then perhaps, the shift in phase results in a 3/4 figure or something which you are unable to work out at once but which resolves itself a few beats later.

There is a sense of growth and progress right through the piece. It is concerned with the pattems and textures of sound which can be built up using the instruments primarily in a solo capacity (but playing ensemble) and it is concerned with the motions of these patterns and textures as the piece progresses. The changes are changes of evolvement rather than development resulting in something merely different as opposed to something necessarily more complex.

So often do we play records as background music, as an accompaniment to other activities; eating, reading, talking etc. So rarely do we give a piece of music our full attention. "In C" is not musak. It demands attention. An effort must be made to become involved with the music and this is something we are not accustomed to doing. Many people will find it difficult - a few, impossible. Do *not* play this while chatting to friends - there is no point. *Do* play it *with* friends, sitting silently, and observe reactions.

The cover notes (by Paul Williams, Editor and Publisher of "Crawdaddy" Magazine) begin; "I'm not here to justify this record, or to explain it, or to in any way connect it with anything else that already exists on the face of this earth." (It is, of course, a compliment). Further comments refer to "In C" as an 'experience' and a 'trip'. An 'experience' - yes, I would certainly agree. It could possibly be classed as 'trance' music as other Terry Riley works have been classed, but is of the 'native drum' type as opposed to the more lyrical 'floating melody' type.

It was new and different when it was written and it is still defying classification - for those with pigeon-hole minds. I feel some of the epithets attached to Ravel's Bolero could apply even more literally to "In C": 'hypnotic', 'boring', 'nerve-wracking' and 'captivating'. As might have been said, "It's certainly art, but is it music?" I suggest you experience it for yourself and find out.

Ian Waugh

"Masterworks"
K-tel ONE 1093

Since Walter Carlos proved it could be done, and done well, all manner of 'classics' have been recorded and interpreted by synthesists. Impressionist works, by their nature, have generally adapted well, especially under the direction of such synthesists as Tomita.

Music is, usually written for the instruments of the time and apart from improvements in instrument manufacture and artistic ability, we hear classical music as it was intended to be heard by the composer. If Beethoven or Ravel or Borodin were writing music today they would undoubtedly write for the piano or for the orchestra or for the synthesiser. Different instruments require different compositional techniques and although piano works have been orchestrated (and vice versa) it is difficult to imagine how 'normal' classical performances can be improved.

All the tracks on this album are 'conventional' classics: Also Sprach Zarathustra, Widor's Toccata, Adagio from Beethoven's Sonata Pathetique, Eine Kleine Nachtmusik, Ravel's Bolero, Grieg's Piano Concerto in A minor, Borodin's Polovtsian Dances, March of the Toreadors, Flight of the Bumble Bee and the 1812 Overture. All rely for their appeal upon their melodies which, perhaps with the exception of Flight of the Bumble Bee, most people could hum or sing.

It is difficult to adapt these works or otherwise alter their 'orchestration' without producing something which appears a parody of the original or without producing something 'disagreeable' to anyone who knows the originals. A lot of time was spent in recreating the sounds of real instruments and most tracks, noticeably Zarathustra, Polovtsian Dances, Bolero and March of the Toreadors sound so much like a real orchestra that you may wonder why they both ered with synthesisers at all. One must admire the programming expertise of the synthesists but thanks to digital technology (none of which is mentioned on the album) it is now possible to produce sounds completely indistinguishable from real sound sources.

The equipment used on the album is mainly Roland with a Sequential Circuits Prophet 5 and additional instruments by Polyfusion, Moog, Korg, Yamaha, Oberheim and R.M.I. The synthesists are credited as follows: Richard Harvey, Nick Glennie-Smith, Andrew Pryce-Jackman, Jeff Jarratt and Don Reedman with additional programming by Mel Wesson.

I doubt if any of the interpretations could be called 'offensive' — all are tastefully and carefully worked out. Choirs are added, percussion is added and artistic licence is taken with most tracks — noticeably the Pathetique as it was originally written for piano, and Flight of the Bumble Bee, much, I feel, to its credit. Electronic arpeggios, the swish of white noise in Grieg's Piano Concerto, the lilt of portamento in Ravel's Bolero, and the sweep of voltage across filter are all evident in small degrees, only enough, perhaps, to barely qualify the album as *sounding* electronic.

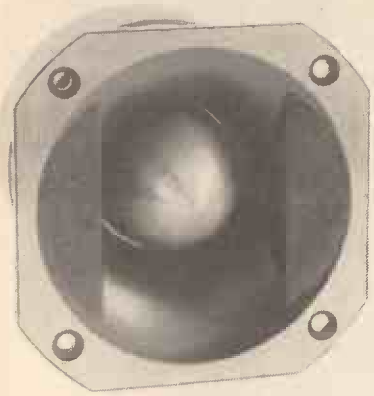
Because of the very conservative approach, necessitated perhaps by choice of music, there is little new or different to excite the listener.

The performances, synthesiser programming and playing, and technical production cannot be faulted. Such an approach and attitude towards original compositions or works which are not, by their nature, so restrictive should reap rewards.

As a technical exercise, "Masterworks" undoubtedly succeeds but it is neither an 'electronic' nor a 'classical' record and, failing to bridge the gap, it hovers quite indifferently on the fringes of interest.

Ian Waugh

E&MM



INDUSTRY PROFILE

Fane Acoustics Limited

One of the most vital links in any sound reproduction system is the loudspeaker and yet, because most people buy the finished product, the design and craftmanship used in its manufacture is often overlooked.

Very few manufacturers of hi-fi, PA, disco and group equipment actually make the loudspeaker for their systems and thus rely on specialist companies to supply this product. One such company is Fane Acoustics, who have been making loudspeakers for the home hi-fi and television industries since their establishment in 1958 by Dennis Newbold and Arthur Falkus. Leading hi-fi manufacturers at the time, such as Daystrom, Tannoy and B & W, used Fane's early 12 inch diameter hi-fi loudspeakers and gradually the range was increased to cover 8, 10, 13 × 8, 15 and 18 inch models as well.

However, the outstanding success of the company came from its decision to specialise in high power loudspeakers in 1967, when Arthur Falkus designed the present highly successful high power voice coil.

Fane Acoustics is based at Batley in West Yorkshire, England with over 120 staff employed at its large manufacturing plant, nearby administration offices and despatch warehouse. Recently, I was privileged to spend an informative day at the plant with Dennis Newbold and David Briggs.

Making a Loudspeaker

First, the chassis is made up from pressed sheets, strips or blanks of steel. Up to eight operations produce the chassis which has been shaped up, trimmed and pierced. This is sent via an overhead conveyer system to the magnet assembly area. The magnet, together with front and rear plates and pole piece (also made in the press shop) are glued together using special adhesive or a semi-automatic machine. The whole unit is electrostatically sprayed and passed (on the conveyer) through an infra-red oven and out to the start of the main assembly line.

Glass Fibre Voice Coils

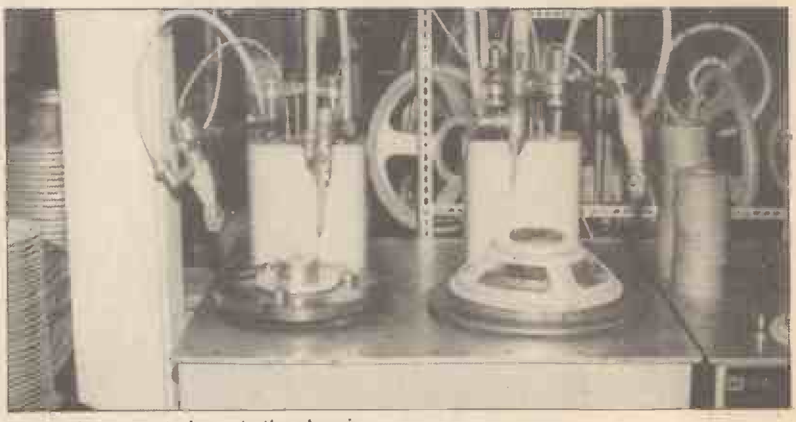
Fane's special high power voice coils are made of glass fibre (instead of having wire wound on the standard paper former) in another section of the factory. Aluminium has been tried as an alternative former, but although quite successful was subject to huge eddy current losses resulting in less power output.

The main advantages of the glass fibre coil is its ability to withstand the high temperatures developed from high power outputs, its minimal distortion without bubbling or even burning as some plastic or paper formers can do, and its consequent greater reliability. It has enabled Fane to put a lifetime guarantee on their products in recent years. Incidentally, it is very easy to see whether a speaker has been 'abused' by stripping it down and examining the layers of wire on the voice coil which will show a distinct pattern of burn marks.

In production, the thin fibre glass former is treated with an epoxy resin — one of the few materials that will adhere to it. The problem is to hold the turns of wire in the epoxy resin (which has a consistency that's little thicker than water) whilst it cures and hardens over 45 minutes, without sticking the holding device at the same time!

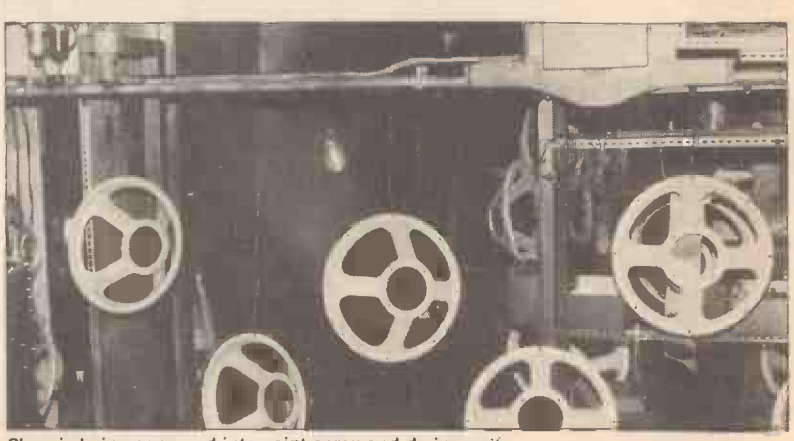
The prepared voice coil is inserted into the chassis — other manufacturers put in the complete cone, suspension and voice coil as one piece at this stage — but Fane's way is to use the mechanical unit as the 'jig' for assembly. Then follows the suspension and the cone, with the latter already having had its two connecting leads threaded into its surface. Adhesive is applied to secure these and the 'gasket' material is also glued round the front edge of the chassis.

The large machine shop for chassis pressing.



Gluing the magnet pieces to the chassis.

Various stages of pressing the loudspeaker chassis.



Chassis being conveyed into paint spray and drying units.

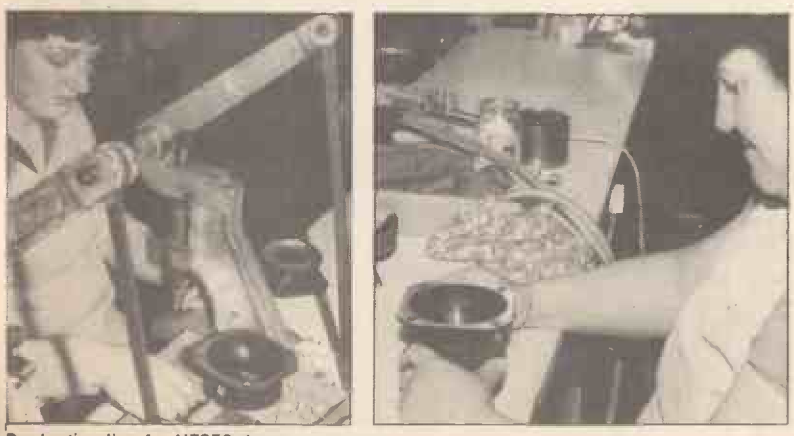
FANE

Next the loudspeaker is air dried over some 24 hours and any dust present is blown off the magnet and the front dome is glued in place to avoid particles of metal re-entering after the next step — 'magnetising' the magnet pieces. The machine for this operation generates a large amount of energy with a copper coil that weighs almost half a ton. The process takes about three seconds whilst the current rises to between 70 and 80 amps on a two-phase 400V supply before cutting out. The strength of magnetisation has increased dramatically over the years with a pre-war pound weight magnet now equivalent to just one ounce of ceramic. It is interesting to note that both top and bottom plates are made with a smaller diameter than the magnet to actually increase the flux strength.

Voice-coil winding area.

Loudspeaker cones.

Soldering wire connections to cone.



Production line for HF250 dome tweeter.

All finished speakers are checked in the test room for correct frequency range, impedance and sensitivity and also to ensure that no defects are present in the electro-mechanical construction. Spot checks are also made on batches to ensure the frequency response characteristic matches the original specification (any discrepancy is unlikely unless by chance a wrong component has been used). This is done in an anechoic chamber which is also necessary for the initial research and development that produces the final loudspeaker design.

Fane's Loudspeaker History

From the outset of producing a domestic hi-fi speaker system in 1958, the company carried out much further development with its small group of research engineers. Many of the industrial loudspeakers are 'made to measure' from the basic range of over 50 models, with specifications agreed by sampling to cover the variations of cones, cone weights, coils, dust domes etc. required by the customer. The 12" speaker alone can be produced from over 1000 different types!

The voice coil is made in different weights to suit its power/instrument application and this affects the coil's movement through the centre hole of the magnet assembly. Lead guitar will use a light weight and bass guitar has a heavier coil.

The special plasticised paper or linen edge of the cone is designed to allow large cone excursions without breaking the cone itself, or inducing distortion through movement out of alignment or actually touching the magnet assembly. The cone centre dome often simply fills the gap with minimal effect on performance and is made from aluminium or linen — with the latter sprayed silver if required.

Cones are made for Fane from different types of pulp, so that fibres can be of varying length and additives can be put into the 'mix' to strengthen cones, as well as coloured dyes. Cone edges can be of different material and characteristics: both the edges and the cone itself have to be of a certain thickness to suit the resonance required; damping of the natural resonance of the cone by use of a thicker pulp mix allows higher power outputs; the plasticising treatment of the cone edge helps to overcome 'dips' in the response (from the edge and cone area being out of phase with each other).

Chassis are usually made from pressed steel using girder construction for extra strength, although an alternative has been aluminium to reduce weight. Another factor is impedance which should be maintained at the speakers rated 8 or 16 ohms and Fane's experience has proved invaluable in the design of speakers that keep inductance down and provide flat impedance over the frequency range.

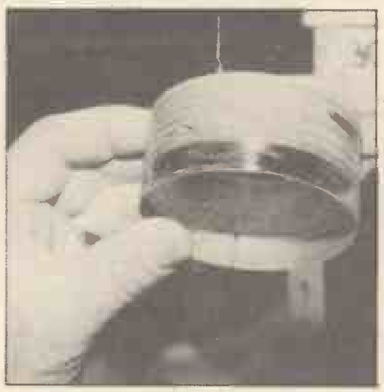
Attention to the appearance of the loudspeaker has been an important feature as well and the Fane chassis now uses standard black stove enamel finish with an optional new metal grille that is glued on to 10, 12 or 15 inch speakers. This not only adds the finishing touch but gives extra protection on the road.

Surprisingly, the speaker parts are mainly glued together — the ceramic magnet, the front plate, the base plate and the pole piece all fit concentrically together. Things that can go wrong with a speaker are the cone, the voice coil, the suspension, or the leads coming out, but if the magnet has been constructed so that it is concentric there is no reason why the unit should ever need 'ungluing'. Once the magnet moves out of concentricity then it is not likely to be of any use. However, cones on the more expensive speakers can be re-centred if necessary after a period of time.

Two lines of distribution are pursued by Fane — one to the hobbyist or musician through retail outlets and the second is to the industrial user with 'custom building' to a specification.

Five main groups of loudspeakers are produced by Fane:

a) Classic series — which are produced in various types for group and



Completed voice coil on glass-fibre former.

Loudspeaker prior to voice coil insertion.

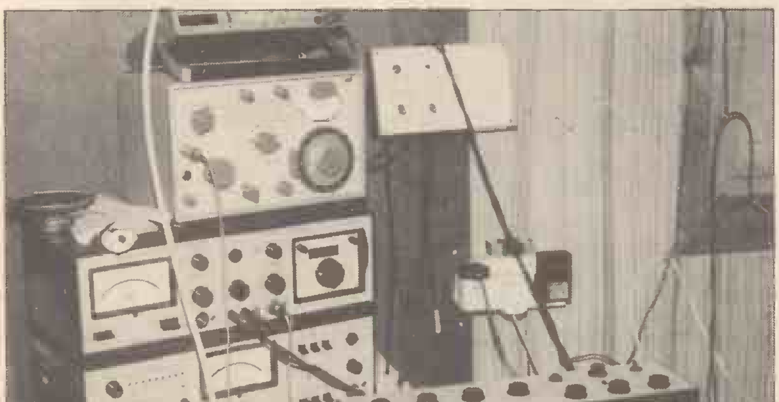
The magnetising unit.

disco covering full or mid-range.
b) Specialist series — these are professional quality and finish, with high sensitivity.
c) Crescendo 'E' series — give extra high power and sensitivity and include the large 15 and 18 inch 300 watt 'Colussus' units often used for outdoor concerts.
d) 'J' series horns — includes horns, drivers, tweeters that extend the high frequency range, and passive crossover 12 or 18dB filters for linking low/mid/high units together.
e) Studio series — primarily for tailored flat response systems that cover full range monitor applications, like the American JBL and Electro-Voice speakers.

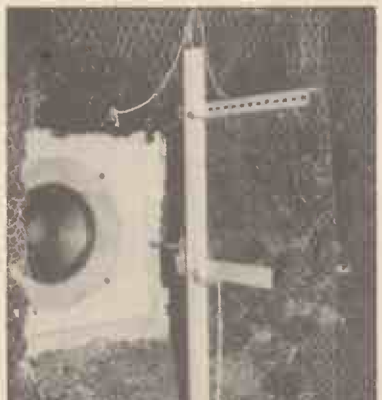
The Studio 12L speakers are 200 watt rated and with the new HF 250 dome tweeter make a very powerful monitor/performance combination (see Figure 1). We'll be presenting these as a complete speaker system project that's ideal for the electro-music studio or concert PA.

Final gluing of magnet outer case.

Checking completed loudspeaker.



Making reference charts in the anechoic chamber.



Inside the anechoic chamber.

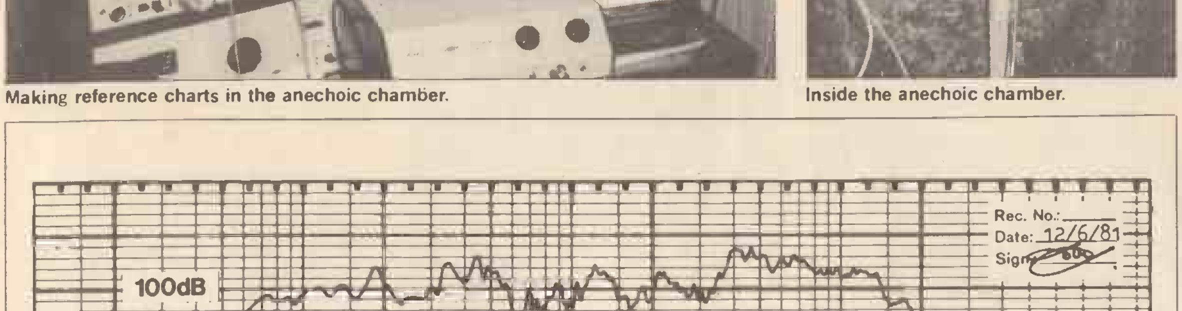


Figure 1. Response chart for Studio 12L & HF250 Crossover HPX4 taken at 1 watt/1 metre in the anechoic chamber. (The dip in response at 600kHz is due to the very small 1½ cu. ft. cabinet used in the test.)

Future Plans

It is unlikely that the fundamental design of a loudspeaker will change in the near future. For example, using rarer magnets instead of the moving coil implies the use of a moving magnet system. With the present techniques the mass of the moving parts would be too great.

Naturally, one of the main aims of the company's research and development team is to continue to produce speakers that outperform equivalents from other manufacturers. Every facet of their design is carefully considered and even though the result may be only a half decibel improvement in power output, over a longer period this will significantly increase the overall sensitivity — a prime factor. This attention to the engineering of magnet assembly has helped to increase the average sensitivity and total sound pressure levels and explains why some 100 watt loudspeakers sound louder than other 200 watt units. Alternatively, and of course more desirable, is the situation where a 200 watt unit is only being used at half-power output, yet outperforms another similarly rated speaker that is used 'flat out'. Fane's policy is to under-rate loudspeakers in terms of RMS output which usually enables good matching to amplifiers (also often conservatively rated).

The cosmetic appearance of a loudspeaker is considered important for the future. As well as the new grilles, new 12 and 15 inch chassis of cast alloy reduce weight whilst maintaining strength through 8 ribbed arms.

It's quite probable that at one time or another nearly every leading UK musician has played through a Fane unit — including Pink Floyd, Genesis and The Who — although the particular loudspeaker cabinet is manufactured elsewhere.

David Briggs, Arthur Barnes and Dennis Newbold.

David Briggs, the Sales Director, exports over 50% of Fane products to more than 50 countries, directly as separate items or indirectly in speaker cabinets. Recently, very large orders have come from Latin America and two areas that offer new markets for the company are East Africa and the Far East.

Dennis Newbold is still the driving force behind the company as its present Technical Director and Company Secretary and enthusiastically comments that 'with only one exception, every main UK equipment manufacturer uses Fane loudspeakers'. Quite an achievement, that's come from much research and development or to put it more bluntly, through plain hard work and dedication!

Mike Beecher **E&MM**

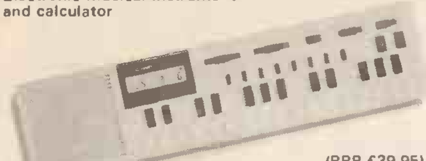
CUBE MANIA–FREE OF CHARGE!

With purchases totalling over £17.50 Only on request, when ordering. Offer closes 31/8/81. Subject to availability

BECOME AN INSTANT MUSICIAN NO EXPERIENCE NECESSARY

The success story of 1981. Hundreds sold already! As featured on "Tomorrow's World" Create your own music with a VL-Tone. You combine the sound, rhythm and tempo and the VI-1 plays it back . . . beautifully!

CASIO VL-TONE (VL-1)
Electronic Musical Instrument and calculator



(RRP £39.95)
ONLY £35.95

V1-1 records and plays back up to 100 notes as a melody. One Key Play or Auto Play of Piano, Violin, Flute, Guitar and Fantasy, or create your own unique sounds with **A.D.S.R.** 10 built-in **Auto Rhythms** and **Tempo control.** LCD digital readout of notes and tempo. Also a calculator. Battery powered with memory and program retention. Integral amplifier/speaker. Output jack. With Song Book. Dims: 1⅛ x 11¾ x 3".

CASIOTONE POLYPHONIC KEYBOARDS

With built-in amplifier and loudspeaker

MT-30

(RRP £115)
ONLY £95

22 instruments over 3 octaves. 4-position sound memory. Battery or mains. O/P jack. Dims: 2⅛ x 22¾ x 6½". 6lb.

NEW CASIOTONE CT-202

"Son of success... The two harpsichords demonstrate the Casiotone's talent for sparkling, crystal clear tones... Even more impressive is the clav..." (Melody Maker).

(RRP £325)
DISCOUNT PRICE £275

49 Instruments over 4 octaves. 4 voice memory function with push button selection. 3 vibrato settings and sustain. Pitch control. O/P jacks. AC only. 3⅝ x 34⅛ x 11 3/16". 15.8 lbs.

CT-301

(RRP £285)
ONLY £245

14 instruments over 4 octaves. 8 x 2 rhythm accompaniments. Vibrato and delayed vibrato. Start/stop, synchro start, tempo control, tempo indicator, and rhythm volume. Pitch control. AC only. O/P jacks. 4⅝ x 31⅜ x 12⅞". 27 lbs.

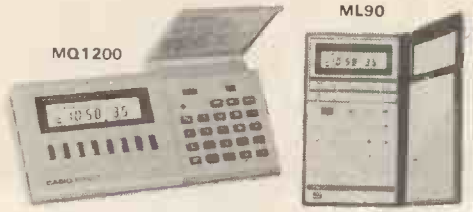
CT-401

(RRP £345)
ONLY £295

As 301 plus following: 16 rhythm accompaniments, with fill-in. Casio Auto Chord for one finger or auto accompaniment. Plays major, minor and 7th chords with bass. Balance control, C.A.C. lever, chord lever, memory lever and octave switch. Dims as 301. Weight 28.2 lb.

CASIO MELODY ALARM CLOCK CALCULATORS

MQ1200 ML90



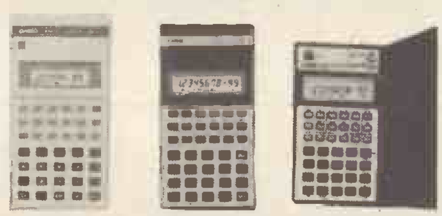
MQ1200 12 melodies, 2 alarms, hourly chimes, date memories, anniversary memories, calendar. 1 9/16 x 6 x 2¾". 19.95
ML-90. Wallet version of above, with stopwatch £14.95
ML-75. Card version of ML-90. 3/16 x 3⅝ x 2⅜" £15.95
ML2000 Office version of MQ-1200 1¾ x 4 x 6¼" £22.95

UC 365 UC360

UC365. 3 melodies, universal calendar, date memories, two date alarms, daily alarm, hourly chimes, countdown alarm/stopwatch, time memory. ¼ x 4½ x 2½" £19.95
UC360. Card version of above. 7/32 x 3⅝ x 2⅜" £19.95
UC3000. Office version. 1¾ x 4 x 6¼" £27.95

CASIO SCIENTIFIC CALCULATORS WITH LIQUID CRYSTAL DISPLAY

for long, long battery life



FX81 FX100 (FX550)

FX81. 8 digits. 30 scientific functions. 4,000 hours battery life. Auto Power Off. ¾ x 3 x 5⅝" £12.95
FX100. 10d, 44f. 7,500 hrs. A.P.O. ¾ x 3 x 5⅞" £16.95
FX550. Replaces FX510 shown above. 1 lithium battery lasts 13,000 hrs. A.P.O. 10d, 50f. ⅜ x 2⅞ x 5¼" £19.95

SUPER SCIENTIFICS WITH TIME DIMENSION

Fx8100. 46f. Clock, calendar, alarm, hourly chimes, countdown alarm, stopwatch, ¼ x 2¾ x 5⅛ £24.95
FX7100. Card version without calendar £24.95
FX6100. Hand held version of FX7100 £17.95

CASIO PROGRAMMABLES

with A.P.O. and memory and programme retention.

FX180P FX3500P (FX602P)

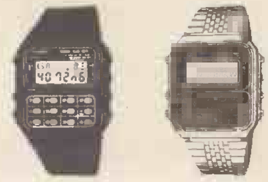
FX180P. 10d, 55f. 2 programmes, 38 functional steps. Integrals and Regressional analysis. ¾ x 3 x 5⅞" £19.95
FX3500P. As FX180P but 61f. 9/32 x 2⅞ x 5¼" £22.95
FX602P. As FX501P shown above but with alpha-numeric display. 10+2d, 51f. 256 steps, 22 memories. 10 unconditional jumps, 9 subroutines (9 levels) 18 parentheses (6 levels) £74.95

THESE SPACE INVADERS WILL ALARM YOU - THE PRICE WON'T

Casio's most amazing watches ever!

CA-90 (left)
£24.95

CA-901 (right)
£29.95



Time and auto calendar, calculator, alarm, hourly chimes, stopwatch, dual time. **DIGITAL SPACE INVADER GAME.**

100 METRE WATER RESISTANT WATCHES

with alarm and stopwatch

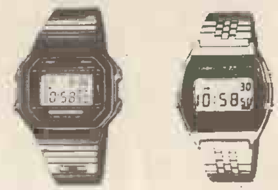
W-150 (left)
£32.50

W-150C (right)
£25.95

Time and auto calendar, alarm, hourly chimes, countdown alarm timer with repeat memory function, stopwatch. Time is always on display, regardless of mode. Stainless steel.

W100 (left)
£19.95

UC50W (right)
50m W/R
£19.95



W100. Resin case/strap version of W150 (same specification). UC50W. 50 metre water resistant with universal full month calendar display with forward/backward stepping. Alarm, hourly chimes and stopwatch. Stainless steel.

12 MELODY ALARMS AND STOPWATCH

M12 (left)
Resin
£17.95

M1200 (right)
S/S
£29.95

7 daily melodies, one for each day, 3 anniversary melodies, 2 date memories, hourly chimes, countdown alarm timer with countup after zero, or stopwatch.

LCD ANALOGUE/DIGITAL with amazing "starburst" display. Dual time (analogue and digital), alarm, hourly chimes, countdown alarm timer, stopwatch, auto calendar. **AA81** Chrome **£29.95. AA82** s/s **£39.95. AA81G** gold **£49.95**

MA-1
£9.95
Mozart No 40 or buzzer.
Hourly chimes.
Snooze facility
1¾ x 4½ x 3".

SEND 20p FOR OUR ILLUSTRATED CATALOGUE OF SELECTED CASIO AND SEIKO PRODUCTS

Price includes VAT and P&P Send your company order, cheque, P O or phone your ACCESS or BARCLAY CARD number to

TEMPUS

Dept E&MM/8, FREEPOST,
164-167 East Road, Cambridge CB1 1DB
Tel: 0223 312866

"THE WALL" concert by 'Pink Floyd'

June 13th Earls Court, London

PINK FLOYD

The theme for this concert was the double album "The Wall". The concert was very much a feast for the ears and the eyes, with the combination of visual effects and music providing an excellent evening's entertainment, particularly in its technical expertise.

At the start, the stage was set with a partially built wall across the front. Once the introduction was complete there was a loud bang with several flashes and the band started with equal impact. The music of the first half consisted of the tracks from the first album of 'The Wall', except for a few additional sound sequences.

On stage there were two drummers, two guitarists, two bass guitarists, two keyboard players and four backing vocalists, including Roger Waters (bass guitar), Richard Wright (keyboards), Nick Mason (drums) and Dave Gilmour (lead guitar).

Interesting visual effects were constantly being used and the lighting employed light banks above, behind and in front of the band. There were also two fully mobile hydraulic lighting platforms on stage which were lit underneath and had spotlights operated manually on top. As for visuals, the opening sequence included a rather large model aeroplane flying across the ceiling and crashing into the wall, and a large puppet representing the Schoolmaster went for a walk across the front of the stage! To complement the music at points in the first half some excellent animations were projected onto a large screen behind the band. During this half the wall on the stage was gradually added to, obscuring the band, until, just on the interval, the last brick was fitted precisely into the wall.

For the second half most of the action took place in front of the wall, where the band had since moved all their instruments. This half included some very good solo pieces, one of which takes place in a lounge scene set into the wall, with an armchair, coffee table and TV showing a war film, the sound track of which was heard over the PA. There was one heavy rock number that made use of a very large batten of lights controlled by a sound to light system. Once again, this was complemented with images from three movie projectors using the wall as a screen with pictures and animations including the well known sequences as seen on BBC TV's 'Top of the Pops'. The appearance of a huge pig from behind the wall was spectacular to say the least as it proceeded to dance about above the audience. In the finale, the wall was pushed down and the evening ended with the band walking on as strolling players with acoustic instruments including an accordion, guitars and an oboe. This last scene earned the band a standing ovation.

The sound quality was very good, with just a few first night 'rumbles' at the start. The PA was not too loud (even at 120kW for the bottom, flying and back stacks), and the multichannel system gave tremendous interest to the music, especially when the sound was swept from one PA stack to another. The dynamics achieved were strong and the interrelation of acoustic and electronic instruments portrayed the enormous range of emotion that Pink Floyd create in their music.

The effects gave plenty of variation, with echo, ADT and Leslie rotor sounds the most noticeable, as well as flanging and phasing. The keyboard players shared between them instruments that included an acoustic Grand Piano, a Yamaha CP80 Electric Grand, a Fender Rhodes Piano, a Wurlitzer Organ, a Solina String Synthesiser and a Prophet Synthesiser.

The control desk of the concert was also impressive with five mixing boards and rack upon rack of amplifiers, crossovers and control units. The mixing boards made use of the Midas mixer modules and the mixers were grouped for various applications. The control area (shown in the photograph) included a large lighting board and several tape decks which ranged from a cassette deck to large multi-track machines used for playback of the numerous sound sequences and live recording.

The concert was very impressive and it was well received by the huge audience. There was certainly never a dull moment and if your interest wandered you may easily have missed something.

Glenn Rogers **E&MM**

James Guthrie, Robbie Williams and Nigel Taylor with Britannia Row's 106 channels of Midas used to mix 'The Wall'.

EVENTS

July 8th-12th AUDIO VISUAL EQUIPMENT EXHIBITION, World Trade Centre, Singapore. Further information from Bob Hackett, European Sales Manager, ITF International, Ratcliff House, Blenheim East, Solihull, W. Midlands. Tel. 021-705 6707.

July 15th-18th NATIONAL FESTIVAL OF MUSIC FOR YOUTH, Fairfield Hall, Croydon. Tickets £1.50 (60p under 19) at the door.

July 19th SUSSEX MOBILE RALLY, Brighton Race Course - Trade stands dealing in all forms of electronics, including amateur radio, microprocessors, components and C.B. Entrance 50p (with free lucky draw ticket). Commences 10.30 a.m.-6.00 p.m.

July 26th AMERICAN THEATRE ORGAN SOCIETY, London Chapter presents Hector Olivera at the Granada Kingston. Commences 1.00 p.m. admission £1.50. Further details from Mrs J. Taylor, 19 Holroyd Road, Putney SW15.

July 29th-31st MICRO COMPUTER SHOW, Wembley Conference Centre, London. Aimed at both the hobbyist and trade. Tickets £1.50 on the day or three for £1.00 from Online Conferences Ltd, Argyle House, Joel St, Northwood Hill, Middx. (cash and S.A.E. required with order).

Aug. 18th-22nd HOME, LEISURE AND MOTOR SHOW, Leisure Centre, Haslet Ave, Crawley. Entrance 50p.

Aug. 29th-Sept. 5th NATIONAL ELECTRONIC ORGAN FESTIVAL, Pontins Tower Beach, Prestatyn, North Wales. The programme for this residential event will include: daily concerts by "star" organists - teach-in sessions - sheet music and book sales - exhibitions and demos by leading manufacturers - synthesisers, rhythm units and rotary speakers. Accommodation from £78 for two people. Ring (07456) 2244.

Courses

Sept. 12th-19th STUDIO ENGINEERS COURSE, University of Surrey, Guildford. This residential/non residential course provides information on a wide range of technical subjects relating to recording operations and by bringing together engineers of differing skills and specialities from all over the world, create a forum for interactive discussion in the exchange of ideas and experience. Further information from The Secretary, APRS, E1L. Masek, 23 Chestnut Avenue, Chorleywood, Herts WD3 4AH.

Sept. 1981 'O' LEVEL ELECTRONICS. St. Vincent Centre, Gosport, is offering a one year 'O' Level Electronics course beginning in September 1981 and leading to the A.E.B. examination in June 1982. The course, which is on Wednesday evenings 7-9 p.m., is suitable both for those who are interested in electronics as a hobby, and wish to pursue their interest and share their enthusiasm, and those who wish to gain a qualification. The course fee is £20.75 (£10.38 for under 18's and O.A.P.'s). Leaflets with full details are available from Mrs. Thorpe, St. Vincent Centre, Mill Lane, Gosport.

INTERNATIONAL SYNTHESISER TAPE CONTEST. Roland (U.K.) Ltd. are currently holding their 5th Synthesiser Tape contest. This contest is open to anyone interested in synthesiser music. Full details can be obtained from Roland (UK) Ltd., 983 Great West Road, Brentford, Middlesex TW8 9DN. Tel. 01-568 4578. Closing date is August 31st 1981.

DENNIS EMSLEY presents a small item about electronic music every Wednesday evening on the local community radio station in Milton Keynes on cable radio. The item lasts about 15 minutes and goes out at approximately 5.15 p.m. as part of the programme 'Ad Lib'.

We shall be pleased to publish news of forthcoming electronic and electro-music exhibitions, clubs - also special electronic music concerts.

THIS MONTH'S SPECIAL OFFERS

Each month, Electronics & Music Maker gives special offers to its readers that represent a substantial saving on normal retail prices.

Two of our offers are shown here and details of our third offer are given on Page 77.

DRILL PACK

An indispensable tool for the hobbyist. This drill includes the Reliant Mini-Drill, mains adaptor (240VAC), four collets to fit any drill up to ⅛th inch, sixteen twist drills, one radial and one axial brush, and one polishing pad.

Normally £19.78

Offer Price £14.95

(Overseas customers please add 34p extra for postage-surface mail only)

Closing date 31st August 1981 - Subject to availability

ORGAN MASTER BOX PACK

Here's the teach-yourself organ compendium reviewed on our Education page that will help budding organists get started. It comprises two music books, two theory books and two chord posters.

Normally £10.00

Offer Price £8.00

Send this coupon and cheque/P.O. to:
ELECTRONICS & MUSIC MAKER (Special Offers)
282 London Road, Westcliff-on-Sea, Essex SS0 7JG.

Please send me:

Quantity	Item	Item Price £	Total £
	DRILL KIT	14.95	
	ORGAN MASTER PACK	8.00	

I enclose a cheque/P.O. payable to:
Electronics & Music Maker for: £..
PLEASE PRINT
Name: Mr/Mrs/Miss ....
Address ....
.... E&MM8/81

All prices shown include VAT, postage and packing

Complete this Order Form for either or both of our Special Offers.
Please allow 28 days for delivery.

Overseas payments including Republic of Eire should be covered by Bankers draft in pounds sterling.

NEW PRODUCTS

SPEAK AND MATHS

Texas Instruments Ltd have just introduced a new electronic teaching aid called 'Speak and Maths', designed to be used by children aged 5 onwards. The child is familiarised with mathematical expressions through the electronic voice, as well as the visual display.

'Speak and Maths' is pre-programmed with over 100,000 randomly selected problems, covering basic arithmetic and decimals as well as introducing the more advanced subjects of geometry and algebra. One of three levels of difficulty may be selected so that problems can be made progressively more difficult as the child's ability develops. Learners can therefore go at their own pace.

Operation is simple. The unit sets a problem, the child keys in an answer, and 'Speak and Maths' announces whether the attempt was right or not - praising correct answers and encouraging another try when answers are wrong. After two tries the correct answer is displayed and announced; a score is displayed after 5 problems.

There are a number of special features: 'Word problems' helps strengthen recognition of common spoken expressions related to mathematical concepts, such as decimals, remainders and basic geometry. 'Greater than/less than' helps compare totals rather than merely calculate them, and 'Write it' helps sharpen the ability to write spoken numbers in numeral form. Also included is the 'Number Stumper' game in which the operator is asked to guess a secret number in as few attempts as possible.

For further info contact Nick Hills, MS36, Consumer Marketing Dept., Texas Instruments Ltd, Manton Lane, Bedford MK41 7PA.

VIDEO WITH STYLE

Using their expertise, acquired as one of the largest manufacturers of professional TV broadcast video cameras, Hitachi have developed a brand new colour camera for the domestic market which embodies professional style features and facilities. The camera is aimed at the serious video enthusiast who wants the best results possible from a lightweight camera.

In their new camera, model VKC 800, Hitachi have used a saticon pickup tube, a type normally associated with cameras designed to meet broadcast standards. This type of tube ensures a high standard of picture clarity and resolution even in dim lighting conditions and eliminates residual picture lag when panning.

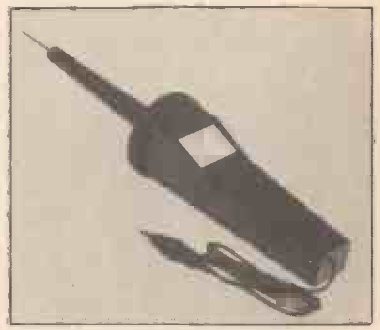
The high picture quality also results from the use of a high grade, f1.4 zoom lens which has a 6:1 ratio - 12.5mm to 75mm. It is coupled to an electronic auto-focus mechanism using micro-chip control. Alternatively the user can operate the focus manually and, using the macro facility, focus down to a closeness of 4 tenths of an inch!

Also features two-speed zoom, multi-function electronic viewfinder, fitted uni-directional microphone, left and right handed user option, battery power and automatic picture fade.

The camera can be mounted on a tripod for studio use but for on location filming, can be shoulder mounted. An adjustable shoulder pad enables the camera to be adjusted for comfort and stability is achieved by adjusting the wrist strap.

The VKC 800 weighs only 6.83 pounds and has a power consumption of 9.5 watts with a power requirement of 12 volt DC or can be used via a Hitachi AC mains adaptor. The price is £799 inc VAT.

VOLT LEADER



Leader have recently released a high-voltage meter probe with a built-in meter movement.

The unit measures up to 40kV, has an input impedance of 20kΩ per volt and an accuracy of ±3%.

Manufactured in high impact polystyrene, the LHM-80A is 385mm long, weighs 300g and costs £16 + VAT.

For further details contact:

Sinclair Electronic Ltd., London Road, St. Ives, Huntingdon, Cambs. PE17 4HJ.

MORE SPEECH

Campbell Collins Ltd., franchised distributors for General Instrument Microelectronics, have recently released the G.I. speech synthesiser module VSM2032. The module is supplied, built and tested with an on-board audio amplifier and a 32k ROM containing the 32 word vocabulary.

The 'clever bits' in the module are the PIC1650A microcomputer and the SP0250 speech synthesiser, making interface quite simple, requiring only one 8-bit PIO for both control lines and address lines, and for monitoring the busy line. The module would normally require 7 address lines but with the vocabulary supplied, the two most significant bits are always zeros, therefore freeing two PIO lines for other tasks.

On power-up, the module requires resetting which is simply two successive low to high transistors on the reset line. This could be achieved using software control of the PIO, but could also be taken care of by a small hardware reset.

After resetting, making the board speak is simply a matter of checking the status of the busy line and waiting for it to go high, then setting up the address and taking the strobe from high to low.

The vocabulary supplied with the module is designed such that any number less than one billion can be enunciated, as well as the four arithmetic operators, and the words equals, error, it is, AM, PM and OH. Power supply requirements are +5V ±5% at a maximum current of 210mA (assuming full audio output).

The user guide for the VSM2032 gives connection details and a short program for interfacing the module to the printer part of the TRS-80 model 1 and information on word addresses, etc.

The VSM2032 measures only 5" x 3¼" and costs £49.50 built and tested.

A compatible 15-pin edge connector and speaker plus full operating instructions are also available from: Campbell Collins Ltd, 162 High Street, Stevenage, Herts.

READ ALL ABOUT IT

John Bull News

John Bull Electrical Ltd have recently released a new form of bi-monthly newsletter, giving information about new lines and helpful hints for the hobbyist.

Copies of current newsletters are available free of charge to our readers and may be obtained from:

J Bull Electrical Ltd, 34/6, America Lane, Haywards Heath, W Sussex RH16 3QU.

Doram News

Another new publication for the electronics hobbyist is the Doram summer '81 catalogue. Included in the 44 pages are comprehensive ranges of discrete components and semiconductors and over 70 'project packs' based on both magazine articles and in-house designs.

The catalogue costs 40p and is available from:

Doram Electronics Ltd, Fitzroy House, Market Place, Swaffham, Norfolk, PE37 7QH.

West Hyde News

West Hyde Developments Ltd have recently announced the release of their latest '81 catalogue.

The catalogue includes 75 pages of stock items with a host of new products added to the current ranges and new lines such as Mentor Opto-electronic components and computer terminal housings from Bopla. This new 'cat' should provide the answer to hobbyists enclosure problems. Available from:

West Hyde Developments Ltd, Unit 9, Park Street Ind Est, Aylesbury, Bucks, HP20 1ET.

NEXT MONTH — September Issue

on sale at your newsagent from August 14th

★ THE PARTYLITE

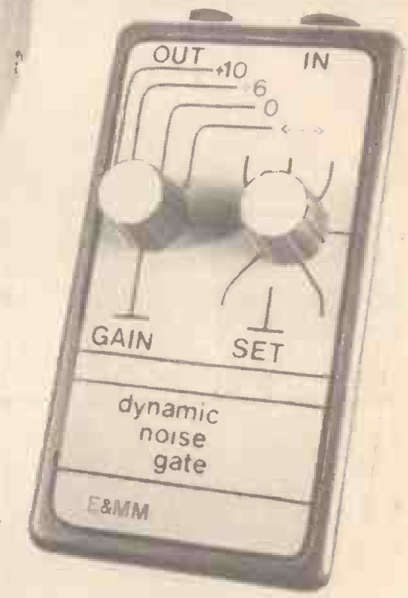
Add this exciting low cost light unit to your home entertainment equipment. No connection to your sound system required — simply plug into mains supply. Automatic level adjustment eliminates all controls and provides bright 3-channel operation from any level of music.

★ TAPE-SLIDE SYNC

Sit back and enjoy your slide shows by synchronising each slide with your recorded dialogue and music using this straightforward project.

★ NOISE GATE

Use this popular studio device to reduce background noise during pauses in performance or recording. Ideal for organ, synthesiser and other electronic keyboards, percussion and guitar.



★ BATTERY ELIMINATOR

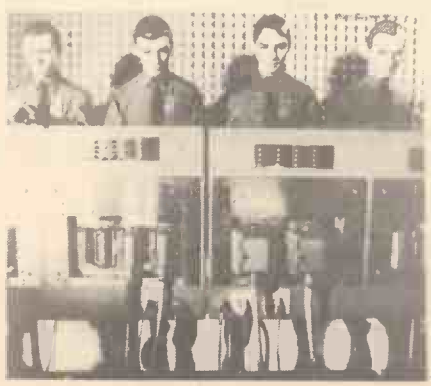
The "Starting Point" series for newcomers to electronics shows you how to construct a battery eliminator to cut down expenditure on batteries. Suitable for use with our popular Syntom and Synwave projects.

★ PA SIGNAL PROCESSOR

Completion of this high quality modular system for PA control.

★ KRAFTWERK

A special feature on this well-known German electronic music group.



Plus our regular articles covering Electronics, Computing and Electro-Music.

Coming Soon!!

NEW! ELECTRO-MUSICIANS DIRECTORY FREE FOR SEPTEMBER!! NEW!

We have had many requests from readers to run a column that enables musicians interested in making electronic music to contact each other. E&MM invites you to submit your contact information in a way that should allow us to insert a large number of musicians names each month. If you feel that important classification names have been omitted we shall be pleased to hear from you.

To fit the maximum information on a line please use the following codes:

INSTRUMENT
K=KEYBOARDS
O=ORGAN
G=GUITAR
E=ELECTRIC BASS
D=DRUMS
V=VOCALS
S=STRINGS
W=WOOD
B=BRASS

LEVEL
B=Beginner
M=Average
A=Advanced

TYPE OF MUSIC
C=CLASSICAL
J=JAZZ
P=PROGRESSIVE
R=ROCK
E=EXPERIMENTAL
B=BEAT
R=REGGAE
O=ORGAN
V=VARIOUS

Send your information in the format below for your FREE directory ad next month (closing date 25th July).
(Fictitious example)

NAME	TOWN	COUNTY	TELEPHONE	INSTRUMENT	LEVEL	TYPE OF MUSIC
BILL JONES	SOUTHEND	ESSEX	0524-61232	K	M	E

Offer subject to available space.

CLASSIFIEDS

FREE! **THIS MONTH'S SPECIAL 15 WORDS FREE!**

Rates: Semi-display £4.00 per scc; Classified lineage 20p per word (min. 15 words); Box No. 60p extra.
All advertisements must be pre-paid. Closing date: 25th July for September issue.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request).

SEMI-DISPLAY

single column £4.00

2 cm single column £8.00

3 cm single column £12.00

DISPLAY

3 cm x 2 columns £25.00

4 cm x 2 columns £33.00

8 cm single column £33.00

ELECTRO-MUSICIANS DIRECTORY

Remember to send your Free Directory Advertisement for September issue

CLASSIFIEDS ORDER FORM

E&MM8/81

Please insert the advertisement below in the next available issue of E&MM for............................insertions

I enclose Cheque/P.O. for £............................

(Cheques and Postal Orders should be made payable to Maplin Publications)

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15
16	17	18
19	20	21
22	23	24

Enter each word of your classified lineage in each block

Name ....

Address ....

....

....

Tel. No. (Day) ....

Send together with your cheque to:
Sue Forster
E&MM Classified
282 London Road, Westcliff-on-Sea
Essex SS0 7JG

Up to 15 words free on any classified lineage (i.e. run-on advert). Thereafter, 20p per word. Underline words required in bold. Add 5p extra per word.
All adds to be received by 25th July for September issue. Classified Lineage only. Submit Semi and Full Display separately with this Order Form.

MUSING by STICHOS

We applaud the kind of music that microchips attain,
Though the Muse's scornful voices unite to make it plain
That sterile syncopations of electrons in a can
Are broken-tongued harbingers of the Spirit that is Man.

Send 'Woofers' back to the Dog Pound
Make 'Tweeters' fly only in trees,
Restore to country-quiet the sound
Of 'Hum-buckers' corralling their bees.

Electrons, all unfeeling in their sub-atomic flight,
Are as remote from human warmth as stars that stud the night.
Their actions are predictable — obey the Law they must —
Knowing naught of Pain or Mercy, but only what is Just.

This is a Drum — and you thump it —
And this is a Bugle to blow,
Just as you should with a Trumpet,
And all Woodwinds, too, as you know.

When pipes are made from spire-clumped reeds where rippling waters run
Each chosen wind-tossed stem has been star-stroked and soaked in sun.
Then heart and art combined can make an instrument unique
Through which the sharp-eared Listener can hear Man's Spirit speak.

'Smooth Fuzz' are better on beat-time;
With quiet, knee-bending composure
Arresting those committing crime —
Such as 'Digital Exposure'.

Now give that sound to experts in modern compuphonics
To analyse and dissever into sine-waves and harmonics
And produce, *semper fidelis*, the patterns they have 'scoped;
The sounds they'll do quite nicely; but the Spirit has eloped.

A Harp is just a hole with strings
That you cuddle close and stroke;
But the silvery song it sings
Pale Naiads of the hills evoke

"It's wasting bloomin' time then, is the nub of your harangue?",
Not quite: for paying Mammon homage by the cash-desk's clang
As the Moguls and Performers exploit each new-found toy
Forces Commerce ever onwards fresh wonders to employ.

Not juice in our 'Apples', but noise;
'Floppy Tapes' that can't tie up bibs;
Let's gather up all of our toys,
And put 'Wah-Wahs' back in their cribs

There'll be a fertile future-time, whether far off or near,
When quiet-eyed men of music who possess the Inward Ear
Will come and make Computers blazon forth the Spirit's fires;
As they have done with Vibraphones, Pianos, Harps and Lyres.

This is a Band for the joining
By those mortal earthlings who choose
To lay the Joys they are coining
As gifts at the feet of the Muse.

CORRIGENDA

The following errors and omissions have been noted in previous issues of E&MM and are brought to your attention:

MAY ISSUE
NOISE REDUCTION UNIT. Page 7, Figure 2. C30 should read C20. Page 10, Parts list. R7....etc., quantity should be 26; C6....etc., quantity should be 34; C29,30 should be 100n.
CAR DIGITAL TACHO. Page 11, Figure 1. Add capacitor C6 between pin 5 of IC3 and -IN Line. Page 12, Figure 2. I/P and - transposed on the legend.

JUNE ISSUE
MOSFET AMPLIFIER. Page 22, col. 1, line 11. 2S348 should read 2SJ49.

JULY ISSUE.
SYNWAVE. Page 21. Figure 2. Insert C12 between junction of C6,R12 and junction of R16, TR4 base and TR1 collector. Page 22. Figure 3. C9 shown with reversed polarity.
USING MICROPROCESSORS. Page 55, Figure 2. IC10 pinout was incorrectly given: IC10 pin 11 should go to IC4 pin 14; IC10 pin 16 should go to IC1 pin 22; IC10 pin 1 should go to 0V.
The address for Steve's Electronics Supply Co. was incorrect. It should be 45 Castle Arcade, Cardiff CF1 2BW. Tel: 0222-41905.

The Editorial staff apologise for any inconvenience that may have been caused to our readers. **E&MM**

ADVERTISERS INDEX

NEW REDUCED PRICES

EXTENDED GUARANTEE BY COMPUCARE

16K £449 }
32K £499 } + VAT

RRP £795 for 32K

The PEDIGREE PETS Very popular for home & business

use 8K Microsoft Basic in ROM. 8K Pet 32K & 16K with new improved keyboard

Cassette Deck £55 extra Interface PET IEEE – Centronics Parallel Decoded £77.00 + VAT

NOW IN STOCK THE NEW & *EXCITING* TRS80 MODEL III

EXTENDED GUARANTEE BY COMPUCARE

16K **£559** +VAT 32K **£589** +VAT 48K **£619** +VAT

The Radio Shack TRS-80™ Model III is a ROM-based computer system consisting of:
● A 12-inch screen to display results and other information ● A 65 key console keyboard for inputting programs and data to the Computer ● A Z-80 Microprocessor, the "brains" of the system ● A Real-Time Clock ● Read Only Memory (ROM) containing the Model III BASIC Language (fully compatible with most Model I BASIC programs) ● Random Access Memory (RAM) for storage of programs and data while the Computer is on (amount is expandable from "16K" to "48K", optional extra) ● A Cassette Interface for long-term storage of programs and data (requires a separate cassette recorder, optional/extra) ● A Printer Interface for hard-copy output of programs and data (requires a separate line printer, optional/extra) ● Expansion area for upgrading to a disk-based system (optional/extra) ● Expansion area for an RS-232-C serial communications interface (optional/extra)
All these components are contained in a single moulded case, and all are powered via one power cord.

WE ARE NOW STOCKING THE *AUTOSTART* APPLE II AT REDUCED PRICES

EXTENDED GUARANTEE BY COMPUCARE

16K **£549** }
32K **£579** } + VAT
48K **£599** }

Getting Started APPLE II is faster, smaller, and more powerful than its predecessors. And it's more fun to use too because of built-in features like:
● BASIC – The Language that Makes Programming Fun. ● High-Resolution Graphics (in a 54,000-Point Array) for Finely-Detailed Displays. ● Sound Capability that Brings Programs to Life. ● Hand Controls for Games and Other Human-Input Applications. ● Internal Memory Capacity of 48K Bytes of RAM, 12K Bytes of ROM; for Big-System Performance in a Small Package. ● Eight Accessory Expansion Slots to let the System Grow With Your Needs.
You don't need to be an expert to enjoy APPLE II. It is a complete, ready-to-run computer. Just connect it to a video display and start using programs (or writing your own) the first day. You'll find that its tutorial manuals help you make it your own personal problem solver.

SPECIAL SCOOP GET YOURSELF A NEW MX80 PRINTER AND SAVE A FORTUNE

EXTENDED GUARANTEE BY COMPUCARE

only **£299** + VAT

Interface Cards for Apple, Pet, TRS80, Nascom and Compukit – RS232 Interface Cards not necessary for parallel. £49 + VAT

Full TRS80/Genie Graphics

EX-STOCK

THE VIDEO GENIE SYSTEM

Ideal for small businesses, schools, colleges, homes, etc. Suitable for the experienced, inexperienced, hobbyist, teacher, etc.

EXTENDED GUARANTEE BY COMPUCARE

EG3000 Series

WITH NEW EXTRA KEYS!

16K **£279** + VAT

● 16K user RAM plus extended 12K Microsoft BASIC in ROM ● Fully TRS-80 Level II software compatible ● Huge range of software already available ● Self contained, PSU, UHF modulator, and cassette ● Simply plugs into video monitor or UHF TV ● Full expansion to disks and printer ● Absolutely complete – just fit into mains plug.
The Video Genie is a complete computer system, requiring only connection to a domestic 625 line TV set to be fully operational; or if required a video monitor can be connected to provide the best quality display. 51 key typewriter style keyboard, which features a 10 key rollover. Supplied with the following accessories:- ● BASIC demonstration tape; ● Video lead; ● Second cassetee lead; ● Users manual; ● BASIC manual; ● Beginners programming manual. Write useful programs in the BASIC computer language yourself.

SPECIAL OFFER FOR MODEL III PURCHASERS

We will take keyboards only for TRS80 Model I and Level II in part exchange.
There will be refurbished Model I and Level II keyboards available later in the year – Phone for availability and price.

APPLE DISC II 3.3 Dos

Disc with Controller **£349** + VAT
Additional Drives **£299** + VAT

EXTENDED GUARANTEE BY COMPUCARE

● Powerful Disk Operating Software Supports up to 6 drives ● Name Access to Files for Ease of Use ● BASIC Program Chaining to Link Software Together ● Random or Sequential File Access to Simplify Programming ● Dynamic Disk Space Allocation for Efficient Storage ● Individual File Write-Protection Eliminates Accidental File Alterations ● Loads an 8K Byte Binary Image in 6.5 sec. (1.2 sec. in Pascal) ● Storage Capacity of 116 Kilobytes (143K Bytes with Pascal) on Standard 5¼" Diskettes ● Powered Directly From the APPLE (Up to 6 Drives) for Convenience and High Reliability ● Packaged in Heavy-Duty, Colour-Coordinated Steel Cabinet

NEW CENTRONICS 737 DOT MATRIX PRINTER

EXTENDED GUARANTEE BY COMPUCARE

only **£399** + VAT
including cables

Standard Features
● 80 CPS – Proportional Spaced Mode ● 50 CPS – Monospaced Mode ● Proportional Spacing, Plus 10 CP1 and 16.7 CP1 ● N x 9 (Proportional) or 7 x 8 (Monospaced) Dot Matrix ● 7 x 8 Dot Matrix ● 3 Way Paper Handling System ● 96 Character ASC11 plus 6 European character sets ● Microprocessor Electronics ● Expanded Print ● Right Margin Justification ● Print Underlining ● 9-Wire Free Flight Print Head ● Bidirectional Stepper Motor Paper Drive ● Full One Line Buffer ● 21 LPM With 80 Columns Printed ● 58 LPM With 20 Columns Printed ● 6 Lines Per inch Vertical Spacing ● Paper Tear Bar ● Centronic Colours and Logo

NEW MICROLINE 80

only **£299** + VAT

EXTENDED GUARANTEE BY COMPUCARE

● 9 x 7 dot matrix ● 96 ASC11 and 64 graphic character set ● Selectable line spacing ● Condensed, double width print ● Friction or pin feed ● 40/80/132 columns ● Upper and lower case ● Centronics parallel interface

VIDEO GENIE EXPANSION BOX

EXTENDED GUARANTEE BY COMPUCARE

Complete with RS232 interface and floppy disc controller. O memory. £225 + VAT.
Memory expansion card (S100) 16K £110 32K £159 + VAT
Further S100 cards available later in the year.

NASCOM 2 GAMES TAPE

EXTENDED GUARANTEE BY COMPUCARE

featuring Space Invaders and Android Nim, Re-numbering program and other goodies!

£7.50 + VAT

THE NEW ANADEX DP9500 and DP9501

EXTENDED GUARANTEE BY COMPUCARE

A PROFESSIONAL PRINTER

● Bi-directional printing ● Up to 220 chars/line with 4 print densities ● 500 char buffer ● RS232C and Centronics Parallel interface built in ● Full software control of matrix needles allowing graphics capability ● 200 chars/sec ● Adjustable width tractor feed.

DP9500 – ONLY **£795** + VAT
DP9501 – ONLY **£845** + VAT

HITACHI PROFESSIONAL MONITORS

EXTENDED GUARANTEE BY COMPUCARE

9" – ~~£129~~ **£99.95**
12" – ~~£199~~ **£149**

● **Reliability** Solid state circuitry using an IC and silicon transistors ensures high reliability. ● **500 lines horizontal resolution** Horizontal resolution in excess of 500 lines is achieved in picture center. ● **Stable picture** Even played back pictures of VTR can be displayed without jittering. ● **Looping video input** Video input can be looped through with built-in termination switch. ● **External sync operation** (available as option for U and C types) ● **Compact construction** Two monitors are mountable side by side in a standard 19-inch rack.

TV GAME BREAK OUT

Has got to be one of the world's greatest TV games. You really get hooked. As featured in ETI. Has also 4 other pinball games and lots of options. Good kit for up-grading old amusement games.

MINI KIT – PCB, sound & vision modulator, memory chip and de-code chip. Very simple to construct. £14.90 + VAT
OR PCB £2.90 MAIN LSI £8.50 Both plus VAT

ENGLISH COLOUR TV/ AMERICAN NTSC COLOUR MONITOR

EXTENDED GUARANTEE BY COMPUCARE

Suitable for Apple, Atari and Texas 99/4 **£295** + VAT

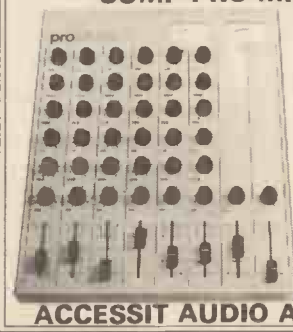
RRP £540 only **£399** + VAT

EXTENDED GUARANTEE BY COMPUCARE

ANADEX DP8000

Super Quality – Low cost printer. Tractor Feed with full 96 ASCII character set. Accepts RS232C at baud rates between 100 and 9600 and Parallel Bit data.
Attaches either directly or through interfaces to Pet, Apple, TRS80, Sorcerer, Nascom, Compukit etc.

COMP PRO MIXER



Professional audio mixer that you can build yourself and save over £100.
Only **£99.90** plus VAT for **complete kit.**
Plus **FREE** power supply valued at £25.00

ACCESSIT AUDIO ADD-ONS

NEC SPINWRITER

EXTENDED GUARANTEE BY COMPUCARE

only **£1390** + VAT

NEC's high quality printer uses a print "thimble" that has less diameter and inertia than a daisy wheel, giving a quieter, faster, more reliable printer that can cope with plotting and printing (128 ASCII characters) with up to five copies, friction or tractor fed. The ribbon and thimble can be changed in seconds. 55 characters per second bidirectional printing – with red/black, bold, subscript, superscript, proportional spacing, tabbing, and much, much more.

NOBODY CAN GET NEAR OUR PRICES EXCEPT OUR CUSTOMERS

FREE 10 C-12 CASSETTES

WITH ORDERS OVER £100.00 –
ENCLOSE THIS COUPON WITH ORDER