— EXTRA! —
NEW RICK WAKEMAN
MUSIC TO PLAY

Electronics & Music Maker

DECEMBER 1981 75p

RICK WAKEMAN IN 1984

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Aria

BASSES — ALL ACES
Specifications:

THE ARIA SB 1000 Price £485.74 in case + VAT
Designed as an ideal studio instrument. The Maple/Walnut laminated neck has a Jacaranda fingerboard available either fretless or with 24 nickel silver frets. The solid Ash body has Oak or Natural finish. Moulded type MB1 pickup gives outstanding performance and wide tone range enhanced by 6-position tone selector. The Active Noise Killer Circuit reduces unwanted hum and noise without adverse effect to high frequencies.

THE ARIA SB 700 £354.20
Body specification and timbers as SB 900. Equipped with one MB 1 double-coil pickup with one volume and one tone control, plus coil tap switch.

THE ARIA SB 900 £444.20
Maple/Walnut laminated Transmit neck, 860mm Rosewood fingerboard, with 24 nickel silver frets, Ash/Maple/Ash solid body finished in Natural, Oak or Walnut. Two MB 1 double coil pickups, two volume controls, a single tone control and a 3-position pickup selector switch. Also phase and coil tap switching.

THE ARIA SB 600 £296.44
Maple 3-piece neck with 860mm scale, and Rosewood fingerboard with 24 nickel silver frets. Laminated Maple body. Pickup and controls as SB 700.

PRICES INCLUDE CASE

What musicians say about their

Aria

SB 1000
Stewart Cochrane 'Best bass guitar on the market'
Gavin Smith 'Before purchasing, I tried every make of bass I could find. The SB 1000 was the best'
Jack Bruce 'A bloody good axe'
Paul Reveley 'Makers of some of the finest instruments in the world'

SB 900
Edward Caldwell 'Professional bass all round. Excellent price tag'
Ray Ferguson 'My second Aria but this beats all. Excellent'
Chris Adnett 'I am amazed at the quality within the price range'

SB 700
J W Stretton 'Excellent sound, superb finish. Best money value there is'
Neil Pitcher 'Superb craftsmanship and great value for money'
M G Salter 'I found all the Aria basses excellent to play'

SB 600
Sam Bolton 'The excellent reviews are well justified'
John Buxton 'Nothing compares for value for money'
Mark Boage 'Excellent value for money'

THANKS FELLAS — ENJOY THE GIGS

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..... E&MM/12

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See our other ads. in Melody Maker, Musician's Classified, Electronics and Musik Maker for full listings of current stock.

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Rocky gives you six of the best...

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Sole U.K. agent 400B bass system £895 complete

Californian-made and built to last! The first shipment of the famous 400B bass stack has just arrived: it features a unique 4 × 12"/two folded horn cabinet with two additional direct-radiating 10" speakers for increased top response.

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— Amazingly, the 400B system has such a wide tonal response that it is ideal not only for great bass sounds but also for a multi-keyboard set-up including synthesizers/moog Taurus pedals etc.

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— The 'Session' combos and the Roland valve 'Bolt' combos give the kind of sound that most people are looking for nowadays: we also stock **Music Man, Marshall** and **Vox** valve combos, so why not come and compare them yourself?

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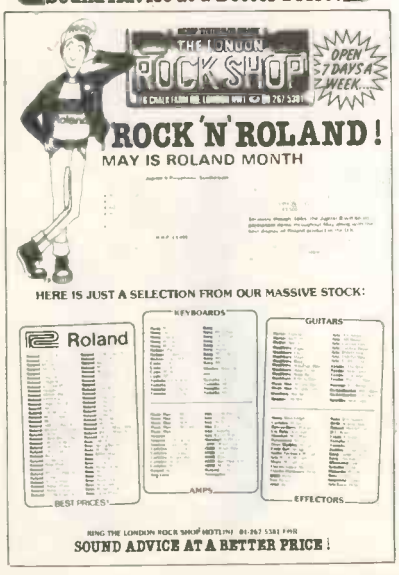

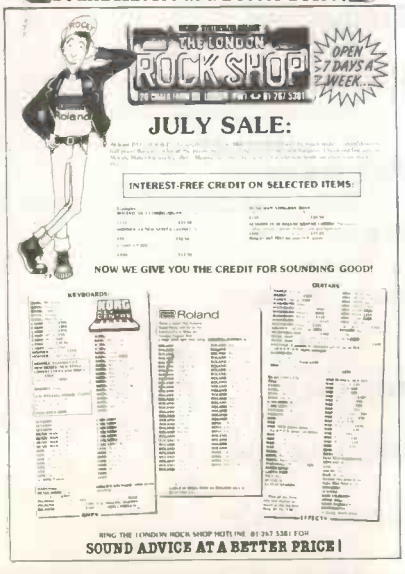

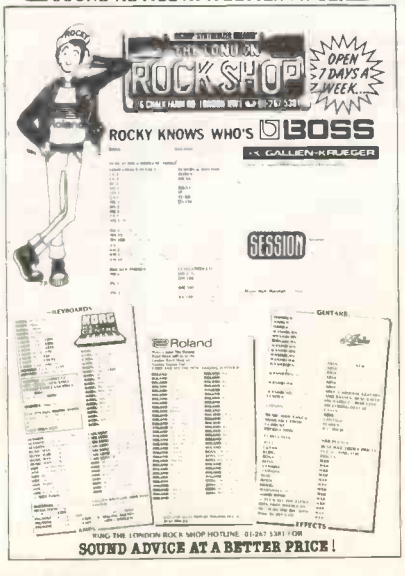

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VOLUME 1 NUMBER 10
DECEMBER 1981

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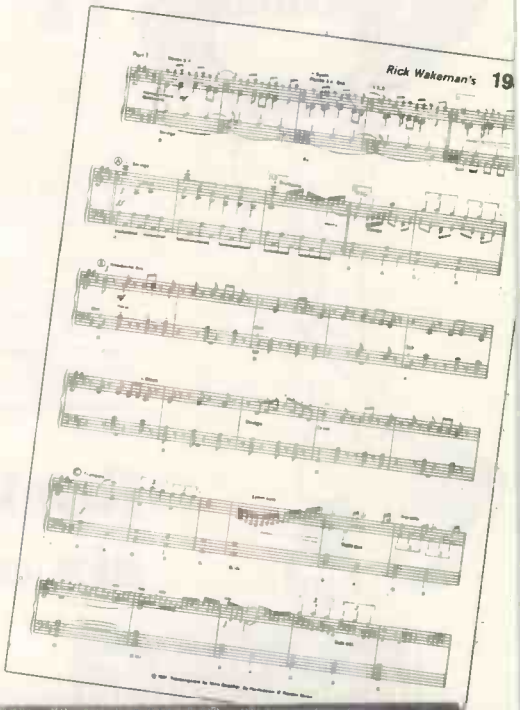

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EDITORIAL

Since the launch of E&MM in February of this year, we have been enthusiastically received by musicians and electronics engineers in many parts of the world and have established the magazine as one that links three large areas of development for the future — music, computing and electronics.

Our emphasis of the 'electro-musician', who uses electronics for music-making, points to new styles of composition and new concepts of performance. These are progressing at a tremendous rate, through the emergence of the micro-computer and its technology consequently being applied to the design of musical instruments. The music industry needs to be aware of the up-dating in electronic design and presentation of instruments and their method of playing and control. Similarly, musicians can only benefit from a magazine that aims to educate all those making music with electronic and electro-acoustic instruments.

E&MM's coverage of this electro-musical world should also be of direct interest to the electronics engineer or constructor involved in the design and maintenance of musical equipment, from instruments and computers to composition and video.

Now that high quality 'personal multi-track' recording is within reach of many musicians, understanding the interfacing and applications of musical instruments is fast becoming an essential part of 'doing-it-yourself'.

Projects will still be an essential section of E&MM, but the emphasis will be on cost saving designs of the high quality expected from the No. 1 Electro-Music magazine.

Finally, we hope you like the new look of E&MM. We've tried to pack its 100 pages with as much editorial as possible. All the regular articles remain — but in addition there are new reviews, workshops, features and music to play.

Comment from a major distributor in the UK: "What we see in the future is the increased use of leisure time in a constructive and creative way, and E&MM is highlighting the direction of the expanding frontier for the music industry".

Quite simply the best way to make "MUSIC"

POWE

TRANSCENDENT 2000 SINGLE BOARD SYNTHESISER

Cabinet size 24.6" x 15.7" x 4.8" (r
3.4" (front)

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 ca t 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 £159.00 + VAT!

TRANSCENDENT DPX
MULTI VOICE SYNTHESISER

Cabinet size 36.3" x 15.0" x 5.0" (rear) 3.3" (front)

COMPLETE KIT ONLY £295 + VAT

The Transcendent DPX is a really versatile 5 octave keyboard instrument. These are two audio out whlch can be used simultaneously. On the first there is a beautiful harpsichord or reed sound – polyphonic, i.e. you can play chords with as many notes as you like. On the second output there wide range of different voices, still fully polyphonic. It can be a straightforward piano as a honky piano or even a mixture of the two! Alternatively you can play strings over the whole range o keyboard or brass over the whole range of the keyboard or should you prefer – strings on the top o keyboard and brass as the lower end (the keyboard is electronically split after the first two octave vice-versa or even a combination of strings and brass sounds simultaneously. And on all voices you switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louc sounds – just like an acoustic piano. The digitally controlled multiplexed system makes practical tc sensitivity with the complex dynamics law necessary for a high degree of realism. There is a ma volume and tone control control, a separate control for the brass sounds and also a vibrato circuit variable depth control together with a variable delay control so that the vibrator comes in and only a waiting a short time after the note is struck for even more realistic string sounds.

To add interest to the sounds and make them more natural there is a chorus/ ensemble unit whicl complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effe this is similar to that of several acoustic instruments playing the same piece of music. The ensei circuitry can be switched in with either strong or mid effects. As the system is based on digital circ data can be easily taken to and from a computer (for storing and playing back accompaniments wi without pitch or key change, computer composing, etc., etc.).

Although the DPX is an advanced design using a very large amount of circuitry, much of it sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boa which interconnect with multiway connectors, just four of which are removed to separate the keybc circuitry and the panel circuitry from the main circuitry in the cabinet.

The kit includes fully finished metalwork, solid teak cabinet, professional quality components resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug.

TRANSCENDENT POLYSYNTH
EXPANDABLE POLYPHONIC SYNTHESISER

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

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.

COMPLETE KIT ONLY £275 + VAT
(single voice)

PLUG IN EXTRA VOICES ONLY £39.50 + VAT

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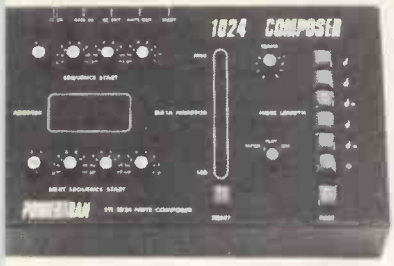
SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusiv per kit.

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

RTRAN ELECTRONICS

024 COMPOSER



Programmed from a synthesiser, our latest design to be featured in Electronics Today International, the 1024 COMPOSER controls the synth. with a sequence of up to 1024 notes or a large number of shorter sequences e.g. 64 of 16 notes all with programmable note length. In additiona a rest or series of rests can be entered. It is mains powered but an automatically trickle charged Nickel Cadmium battery, supplying the memory preserves the program after switch off.
The kit includes fully finished metalwork, fibreglass PCB, controls, wire, etc. – complete down to the last nut and bolt!

COMPLETE KIT ONLY £85.00 + VAT!

BLACK HOLE CHORALIZER

De Luxe version (dual delay line system) also available for **£59.80 + VAT**
Cabinet size 10.0" x 8.5" x 2.5" (rear) 1.8" (front)

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a "spacey" feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLES), introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity, has high signal/noise ratio obtained by an audio compander and is mains powered – no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure.

COMPLETE KIT ONLY £49.80 + VAT!
(single delay line system)

DJ90 STEREOMIXER

COMPLETE KIT (as shown in centre of console) only £97.50 + VAT

s featured in Electronics Today International — July Issue!

iis versatile new mixer, shown here fitted to our console, has 2 stereo puts for magnetic cartridges, a stereo auxilliary (e.g. cassette or jingle achine) input and a microphone input. The decks can be automatically inned either fast or slow and all 3 music inputs can be mixed with slider ntrols. There is a 5-section graphics equaliser and a beat-lift control. Also ere is a voice-over unit (ducking) and an override button for interrupt nnouncements. The microphone input can be modulated at a variable rate produce 'growl' effects and there is monitoring of any music input (pre-de listen) via the stereo headphone socket and a pair of LED PPMs. The ixer kit includes fully finished metalwork fibreglass, PCBs, controls, wire c. — complete down to the last nut and bolt!

e console is shown fitted with two 19" panel units

a Chromatheque 5000 lighting controller

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 **£29.50 + VAT each.**

ETI VOCODER

eatures as a construction article in Electronics Today International this design enables a vocoder of great versatility and high telligibility to be built for an amazingly low price. 14 channels are sed to achieve its high intelligibility, each channel having its own vel control. There are two input amplifiers, one for speech either om microphone or a high level source e.g. mixer or cassette deck nd one for external excitation (the substitution signal) from either gh or low level sources. Each amplifier has its own level control nd a rather special type of tone control giving varying degrees of ass boost with treble cut or treble boost with bass cut. The level of ie speech and excitation signals are monitored by LED PPM eters with 10 lights – 7 green and 3 red which indicate the level at dB steps. There are three internal sources of excitation – a noise enerator and two pulse generators of variable frequency and ulse width. Any of the internal sources and the external source an be mixed together. There is a voiced/unvoiced detector which ubstitutes noise for the excitation signal at the points in speech here the vocal chord derived sounds of the speaker are ubstituted for by the unvoiced sounds of sibilants, etc. There is a lew rate control which smooths out the changes in spectral alance and amplitude enabling a change of the speech into inging or chanting and other special effects. A foot switch is rovided to permit a complete freeze in spectral balance when the reeze is in operation.
n output mixer allows mixing of the speech, external excitation nd vocoder output. The majority of the components fit into the arge analysis/synthesis board with the rest on 8 much smaller oards with the controls and sockets mounted on them for ease of onstruction. Connectors are used for the small amount of wiring etween the boards.
he kit includes fully finished metalwork, professional quality omponents (all resistors 2% metal oxide), nuts, bolts, etc – even a 3A plug!

COMPLETE KIT ONLY £175 + VAT!

MPA 200 100 WATT (rms into 8 ohm) MIXER/AMPLIFIER

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features an adaptable input mixer which accepts a wide range of sources such as a micrphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.

COMPLETE KIT ONLY £49.90 + VAT!

SP2-200 2-CHANNEL 100 WATT AMPLIFIER

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!

COMPLETE KIT ONLY £64.90 + VAT!

CHROMATHEQUE 5000 CHANNEL LIGHTING EFFECTS SYSTEM

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!

COMPLETE KIT ONLY £49.50 + VAT!

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

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DEPT. E&MM/12

Readers Letters

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

Dear Sir,
I am writing with reference to the article, 'Kraftwerk Revealed', especially as I too was at the Hammersmith Palace. I am requesting an article to be done in similar style, i.e. a good look at the equipment, on Tangerine Dream. After all they have just toured here, have just released an album 'Exit', and the film 'Violent Street' is now on release, for which of course they did the soundtracks. I'm sure this will be to the same standard as your article on Kraftwerk.
Finally, regarding the Harmony Generator in the October issue, is instability so undesirable? Surely it could produce some interesting effects, or have I missed something? Keep up the good work.

Dave King
Culcheth

The Tangerine Dream interview is our feature for the January issue. The group is at an important stage in their development and should give electro-musicians plenty of incentive to experiment with sequencers, including the Synclock project this month. The Harmony Generator has great potential for stretching your basic oscillator sounds. If you keep it in the synth output line to your mixer it can be used at any time as an 'effects' treatment. (Use the 'mix' pot to balance out the effect when not required.) You are quite right that the instability caused by rapid jumping from one note to the next, which occurs only on certain envelopes and with mixed pitches, could be used for unusual trills and effects. You might even class it as a new type of 'note bending'! I've put some of the more musical possibilities on to our Demo Cassette No. 4.

Dear Sir,
I have just finished building a Digisound 80 Modular Synth which now needs calibrating. If anybody has a Digital Voltmeter/Frequency meter (and preferably, an oscilloscope) and is willing to give me access to their equipment for about an hour or so I'd be most grateful to hear from them.
Finally, keep up the good work with the magazine, though I find the 'spread' of interests too large, I being mainly interested in DIY electronics as a way to save money and enable me to extract parts to customise designs to suit my needs.

Nick Broom
Brundall, Norwich

Dear E&MM,
I am writing to express my concern regarding the Spectrum. Could you please up-date me on the situation?

J. Gillman
Guernsey, Channel Islands

All your problems should soon be rectified as we have worked solidly on remaking the Spectrum Synthesiser since its appearance in our first issue. The instrument is now up to its original specification with some very advanced sync modulation facilities that will almost convince you there's a sequencer built-in as well! We have kept the original power supply and keyboard as published so that anyone who started the project should not have wasted their time and money. The cost is still around £200 plus case. I'll be showing the instrument at Breadboard and the Hands On Show (see Next Month p74). A complete construction book will be available at the shows, although the project will be presented in its entirety in Jan/Feb E&MM. It will also be on an E&MM demo cassette shortly.

Dear Sir,
May I refer to Ken Lenton-Smith's comments in the October E&MM concerning the playing position at keyboards, especially the organ.
As a bifocal-wearing, organ-playing optician, I entirely agree that bifocals are quite unsuitable for use at the organ console. A reading pair, as suggested, may be better, especially if they are an old prescription which is likely to have a longer focal range. However there is an even better solution of which your readers may not be aware.
Place a piece of music on the music rest and sit at the organ in your normal playing position. Hold one end of a tape measure to the bridge of your nose and ask someone to measure the distance to the centre of the music. Give this figure to your optician and ask him to make you a pair of single lenses optimised for this distance. With them you should be able to clearly see not only the music, but manuals, stop tabs, and even the pedals (not that you should be looking at them!)
I hope this suggestion will be of help to some of your readers. After all, if one has spent hundreds or thousands of pounds on building or buying an organ, it must make sense to spend comparatively few more pounds in order to see well enough to play it.

B. D. Arnold
Worthing, Sussex

Dear Sir,
Your reader, R. Stapleton of Hounslow, whose letter appeared in the October issue of E&MM, may be interested to hear that a 'Music Typewriter' has existed for a long time operating on the lines of his suggestions 1 to 6.
The read-out is in the modern Klavar notation which avoids the difficulties of conversion to duration symbols, accidentals, double sharps and flats etc. which occur in the traditional Old Notation.
I have seen only a photograph of the machine. It is probably in Holland where Klavar originated and has been adopted extensively. Mr. Stapleton may obtain further information possibly on the machine and Klavar from Klavar Music Foundation of G.B., 171 Yarborough Road, Lincoln LN1 3NQ. Although Sir Colin Davis and Sidney Harrison are amongst the patrons of this Foundation, it is regretted by Klavar supporters that this magazine presented the Klavarscribo system of notation unfairly. A simplified direct system of notation surely would seem to be complementary to today's microprocessor based music systems.

F. Hayes
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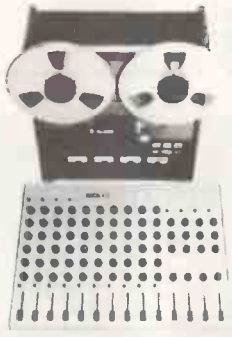

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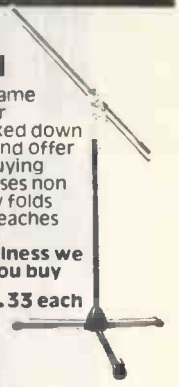

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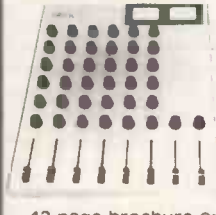

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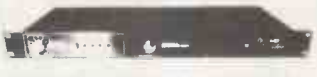

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RICK WAKEMAN IN 1984

Rick Wakeman band with vocalist Steve Harley.

Multi-keyboardist Rick Wakeman brought out his first solo recording in 1973. It was his impression of the characters of 'The Six Wives of Henry VIII' and this was listed in Time Magazine's best recordings of 1973.

This turning point in his career was the culmination of years of gigs and recording sessions with such artists as Cat Stevens, T-Rex and David Bowie, playing in three and four-piece bands and his own trad jazz band. A lot of this was done as a means of supporting himself whilst he studied at the Royal College of Music, London in the 60's with the hope of becoming a concert pianist. Eventually Rick joined the Strawbs for just over a year, recording two albums with them before meeting vocalist Jon Anderson, bassist Chris Squire, guitarist Steve Howe, and drummer Bill Bruford in 1971 to complete the 'Yes' group.

Rick's solo career continued with his large scale interpretation of 'Journey to the Centre of the Earth', recorded on January 18th 1974. This was followed by 'The Myths and Legends of King Arthur and the Knights of the Round Table', 'No Earthly Connection', 'Criminal Records', 'Rhapsodies', plus the soundtracks to Ken Russell's film 'Lisztomania', the 1976 Winter Olympics film 'White Rock' and a new horror film 'The Burning'.

Recently he signed up with Charisma Records and although he has dropped many of his external company interests, he still retains a large flight case manufacturing company.

His latest achievement '1984' took nearly two and a half years to produce and is written in the Wakeman tradition of merging the rock band with symphony orchestra, choir and vocalist.

Stage view during rehearsal.

"'1984' was built up from an idea I'd had for a long time to get back to the old syndrome of working with other musicians and using electronics within orchestral musicians and instruments. I've always believed that an instrument, like a musician, should not get typecast.'

"Looking at the history of the orchestra, you find that new sounding combinations of instruments often become accepted as 'the next step' and this is what I've tried to do by integrating electronics into the orchestra."

Rick studied orchestration with Philip Cannon at the Royal College of Music, London and is keen to write his music for any acoustic vocal or electronic instrument combination that he feels is suitable.

"'1984' also came about because I wanted to try to get into the future. I've done plenty of historical things before so I wanted to get into the 80's. The 1984 idea came from the George Orwell book, even though I first thought the book was lousy. Probably, its success was due to '1984' being of more symbolic significance than an actual year. George Orwell *did* get a lot of things right — people *are* becoming robots, there *are* deep recessions, there *is* the proliterian attitude, and there *are* race and religious problems.

"I naturally became much more interested in '1984'. Although it is basically a sort of love story, at the end they put together all the things right and wrong with society and decide that blowing themselves up is the only answer! But of course, if you can face up to these problems you're being optimistic and that's how I looked at my interpretation of '1984'. It's quite light-hearted in lots of places as a result.

"Tim Rice then took my literary ideas and got them right for the album lyrics (these are printed on the album cover sleeve along with all the instruments and performers for each piece). I do write a lot of words myself, but really could not get these right.

"The actual composition of '1984' took nearly two years from start to finish, not just in writing but in coordination as well. The recording was done at Morgan Studios during February and March of this year.

"I tried to use the best singers and musicians for the pieces and in fact I managed to get my first choice for all of them. To try and get together at any one time the choir, the orchestra, Chaka Khan (who

Rick's keyboards.

lives in America), Steve Harley (who was in Brazil with his new wife), Tim Rice (in the Far East at the time), Kenny Lynch, Jon Anderson, plus the band was very difficult! At the beginning, I also had to get them interested by explaining what was in my mind without being able to physically play them anything. Most of the people I'd known previously, although it was the first time I had worked with Steve Harley of Cockney Rebel."

Rick spends a lot of time doing gigs and last year he did a UK tour for a month and prior to his latest undertaking, recently appeared at the Hammersmith Odeon, London where he performed '1984' pieces and selections from his other albums. The accompanying (and cover) photographs were taken from this concert.

In between the tours he has been composing music in his South of France home at Beaulieu near Monaco. He's been married twice and his present wife is Swiss/French with a young son.

Rick's performance image has changed with '1984'. Away goes the cloak and long hair — at his wife's suggestion.

"The theatrical image *is* very important because when you're listening to a record, you're concentrating on the music, and when you go to a concert, you still want to hear the music, but don't expect to see performers just standing or sitting there — you want some visual enhancement as well."

Composing

"People approach their composing in different ways — my best time for writing is when I am feeling very happy or have just had an absolute disaster. What happens in the latter case is I don't lose my temper but get really miserable. So I sit at the piano and it flows out like there's no tomorrow. I don't write it down right away but wait a day and if I can still remember what I played I then keep it on manuscript.

"'Julia's Song' was interesting to do because of comparisons I made between my wife's situation and Julia within the book. We were going through a difficult period and I was very low, but the result was that I wrote 'Julia' straight off in just a few minutes. I really wrote it for my wife and for the recording I told Chaka what the song was all about; she sang it once on stage and the next day we tried another recording and that was it. It had to be sung with feeling and this seemed the only way to do it.

"The written music would be in a keyboard format, although I always have in mind what I am going to use for it — I can 'hear' the instruments and vocals as I write. The interesting thing out of all the pieces, in other words the test of the album for me, was to take chunks off the album and put them together as a final piece — would it sound just that or become a reasonable piece of music in its own right? If so, then that's '1985' (using all the ideas of '1984' to show the way for '1985'). I was pleased with the music, so this then became the last piece of the album and only a misprint gave it the title '1984' instead of '1985'."

We discussed how the '1984' pieces often contained jumps from one section to another without a more traditional development. Often the last bar before the change had an irregular beat count.

"This is not a tape splice error as you might think (only one edit took place, during the final piece of the album with a 4/4 sequence in tempo to insert a better take at the finish), but it's the result of me liking the surprise of switching prematurely into the new section. I don't think of doing gradual transitions for their own sake but like putting what is right at the time. The voicing is also important to carry the changeover in the right way.

"Writing at a piano is an advantage for me, for if it's sounding good at this stage, everything else from there on is an absolute additive — in other words, you've painted your sketch 'by numbers' and now it's a question of looking round at various instruments and finding the right textures of 'red or blue' to complete the musical picture."

I asked Rick about his use of different

Left hand side keyboards.

Right hand side keyboards.

tempos — from very slow speeds with heavy reverberating drum in the background to very fast driving 'growling' guitar tempos that jump almost unpredictably from one to another during a piece.

"Yes — I like extremes! It's probably a reaction to my college days when I found I liked consecutive 5ths and used them for my choir writing 'against the rules'! A good composer takes in his musical experiences and draws upon them in a way that makes all writers different. But of course he or she has to draw on the past and can't draw musically on what hasn't been discovered yet. Instruments have become increasingly important and it's the technology of the new instruments that enables people to expand the whole area of composition. The diehards *will* acknowledge this in 10 years time.

"There's a great need for the classical musician to be integrated into the developing electronic music scene to become part of 'today's music'."

Bass guitarist Steve Barnacle.

Rhythm guitarist ▶ Tim Stone.

Drummer Tony Fernandez.

Orchestration

Certain musical writing techniques are evident in Rick's music — the descending bass line, often used rhythms and cross rhythms. "The latter weren't from any particular jazz tuition in the past (even though my art teacher at school was Mike Westbrook, better known as a jazz musician), but really came from me experimenting with, say, 5 bars of 4/4 and then I'd put down another line over the top which was 4 bars of 5/4 and then possibly 6 bars of 3/4, making it blatently obvious with accents, and a bar of 2/4 at the end.

Several sequences show this effect in '1984', particularly in the Overture part 2, where a cymbal crash comes on different beats, against woodwind and drummer's cymbals.

"I like the way this makes a sort of crossroads that gives a lovely warm feeling when you get to the other side. What was amusing was the reaction of the orchestra with 'are you sure that's right — we're in 4 and the flutes are in 5?'. At the beginning of the Overture I had a few problems with the orchestra, where the clarinets and bassoons are theoretically playing in 3/8 with the oboes playing on 2nd and 3rd beats, whilst the horns and harp reinforced by timpani play in 4/4, all with sustained lower strings. Originally I wrote this in 3/8 because I thought it would be easier to follow, but in the end I had to put it as these 3/4 and 5/4 bars."

String parts are well spread out and Rick likes to give the inside parts something interesting to play (from his experience as 2nd clarinet at the RCM). I like the bass to have melodic lines to play — not just bass notes. I don't write drum parts — Tony has been so long with me that we soon work out the sequences."

With the large number of key changes in the work, Rick always inserts signatures rather than add flats or sharps as the music progresses. He actually prefers to laboriously write out the full orchestral score himself! — an uncommon practice these days, usually left to professional orchestrator/arrangers — but obviously it results in a very 'personal' orchestration. "I get knocked quite a lot by the music press — they say I'm over indulgent, but I take this part of composing very seriously."

On the score the choir, band, vocals and synthesiser parts are not shown. The choir is written out separately in four parts SATB with two alto parts but no words (most of it is 'aah'). Choir crescendos are actually done at mix stage on the faders. Vocals and group basic parts are virtually learnt on the spot and Rick's synthesiser parts are all learnt from memory. I do have some early sketches written out but I don't use them now.

In the backing group, Steve Barnacle makes his own (Fender) bass lines from the material I give him, along with Tim Stone on (Gibson) guitar and Frank Ricotti on (Ludwig) drums. In 'Proles', Gary Barnacle plays an interesting line on (Selmer) sax.

I asked Rick why he had chosen a live choir for '1984'. "I often use a real choir when finance is available. There's a big difference between the electronic Vocoder and Novatron (Mellotron) type of voice and the real thing."

Repeated notes are a popular part of Rick's orchestrating, often using well known sequences like A-G-F-E, and we considered what his typically scored passage often contains: a string backing (tremulando) with the choir singing 'aah', the piano playing arpeggios, the solo or polysynth playing the lead line with drums beating heavily at centre stereo with full reverb depth, and probably a very strong bass guitar line using overdrive and sustain. "Yes, you've pretty well summed it up there, in full flight!"

The music wasn't written in any particular order and although the music appears to jump from one idea to the next, it's interesting to find that they're often variations on the main themes.

"There is one tape reversal effect used on 'Robot Man', which is actually augmented 4th piano arpeggios plus my 3-year-old son banging things over the piano. I'll tell you something about tape reversals — if you don't play the right notes they can sound horrible — you can't just put in anything!"

"In 'Proles', there is a Bb/F# enharmonic change — I love all that when I'm considering key changes. I don't have true perfect pitch but I can hear certain keys very clearly — warm keys like Db, Gb, Ab and extremities like B and E. I don't bother about using flat keys for brass and sharp keys for strings. D major and Am, Gm, Cm, F# major are all used in '1984'. 'Journey' was also a lot of D, 'Arthur' was a lot of Cm and E, 'Henry' was Cm and Am, but when I sit down at the piano and start putting melodies together, I do find that the key comes along with it — I don't think, now I'll use Cm and so on."

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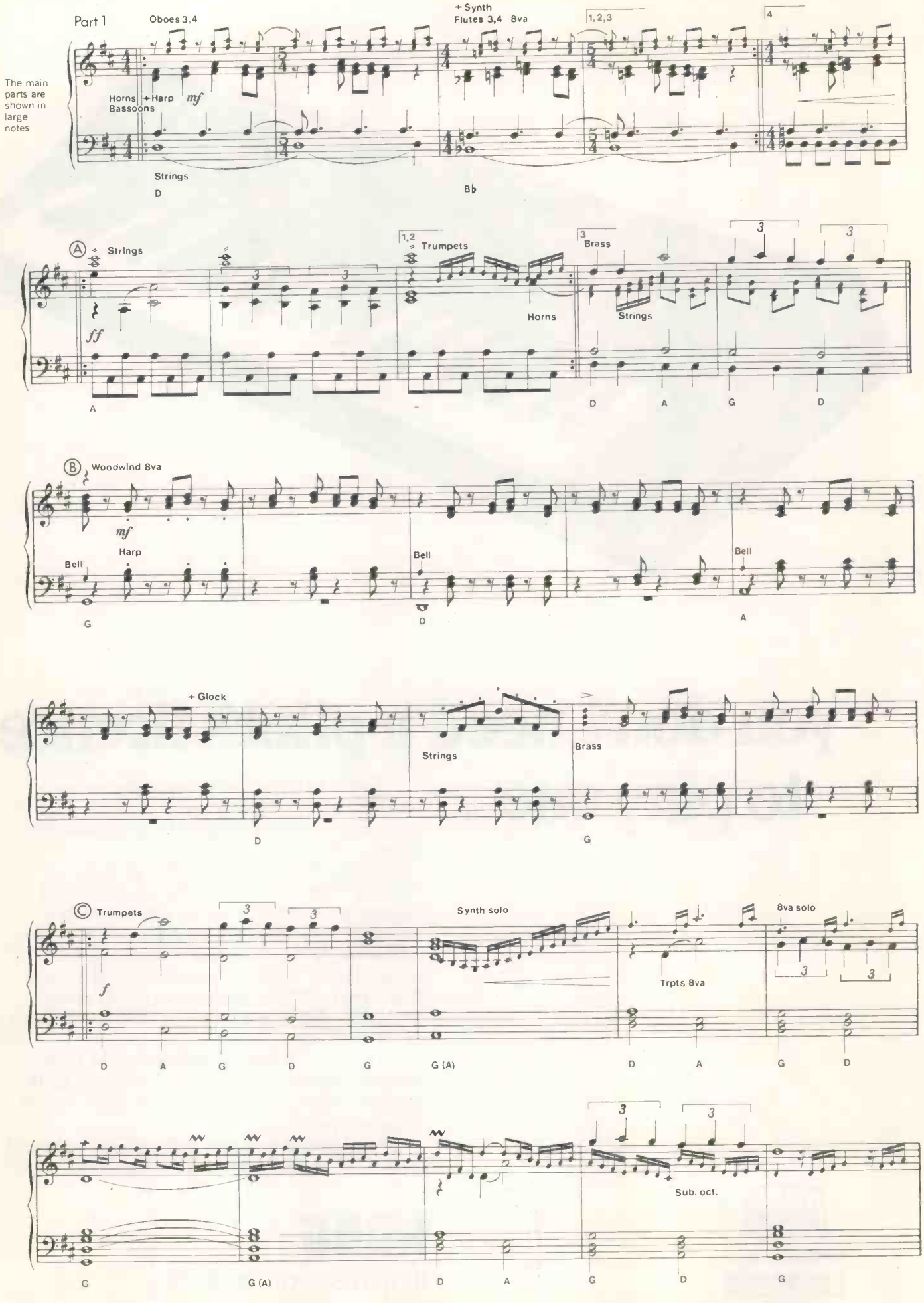

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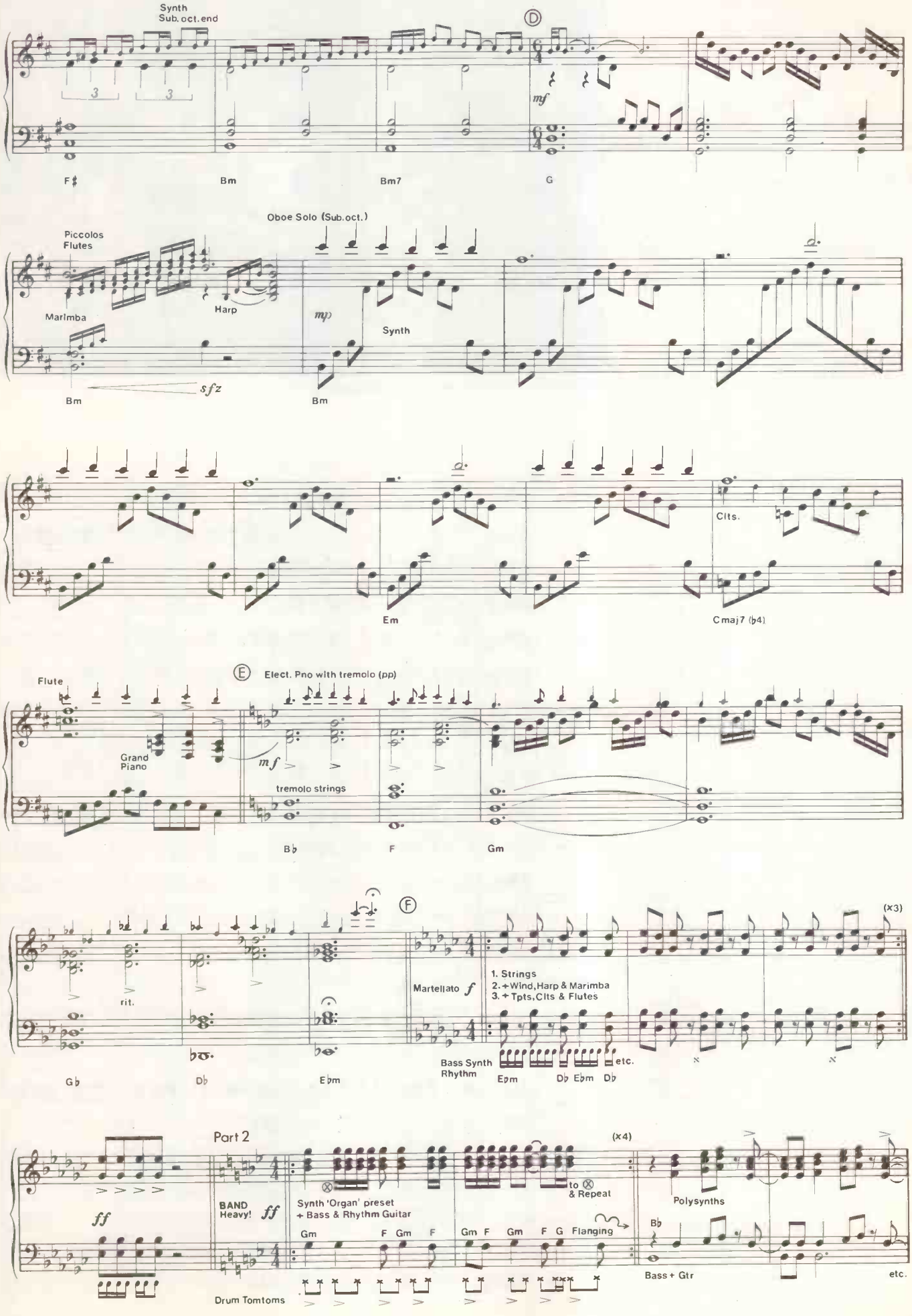


Rick Wakeman in '1984'

Rick receives a warm reception from the audience.

'1984' Instruments

Rick has listed all the '1984' musicians and instruments on the record cover, along with Tim Rice's lyrics and the names of the players and the studio people.

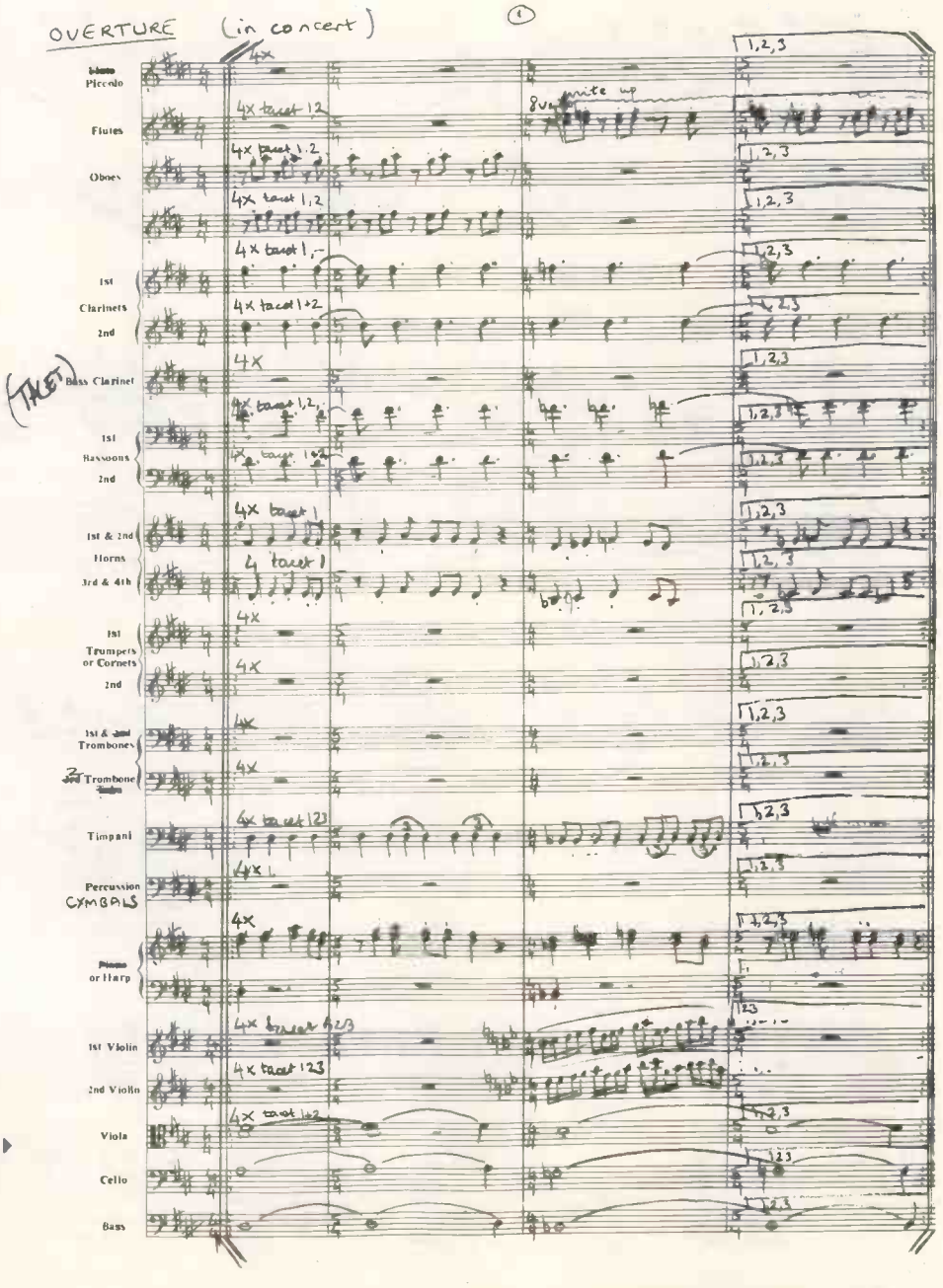
"I was having terrible trouble because I wanted to replace a lot of my instruments — I knew some of the sounds I wanted and I'd ordered a lot of new stuff from Korg, but it didn't come in time for the album.

"I do use new gear on stage now with a lot of Korg instruments. These are two Sigma Performing Synthesisers, two Lambda Polyphonic Ensembles, two LP-10 Electric Pianos, the BX-3 Organ, the 3200 Programmable Polysynth, the Trident Polysynth, plus SE-500 echo and other effects along with a Yamaha CP80B Electric Grand.

"For the album I had to use some of my own instruments and we borrowed and hired some as well. I like the Prophet 5 and 10 and helped in the early days with the panel-board design of these.'The Room' used a Hammond organ solo with Leslie mechanical rotor. The flute solo was done on the Prophet. I had been using my Moogs and Prophets for donkeys years before the change, but it came to the crunch a few months ago when I sold the lot. So I went out and bought the new stuff and set up the gear differently at the same time. I went to Japan to visit Korg's manufacturer, Keio Electronic Laboratory Corp. in May, during which I chose some instruments. We had a celebration party and a good session with Japanese musicians to coincide with my 32nd birthday on May 18th.

"It's been great to have a change and even the band have commented 'you're playing better than ever before'. Of course, you eventually get to the stage where you don't want to carry and use any more instruments than are absolutely necessary. I love using the MiniMoogs — but Moog don't even make them any more. Please don't take this egotistically, but I don't think even Bob Moog could teach me any more about the MiniMoog. I know the instrument inside out and backwards. There is nothing left for me to do with it anymore even though I've got nothing against it. Coming back to piano, in the studio I used a Steinway Grand, and I used the CP80B on stage. I've used the Yamaha string machine and I've also made up my own strings using a Prophet.

"To get my electronic string sound, I put down a basic string machine track on tape. I then add Harmoniser treatment to detune and chorus it further. I then use the Yamaha electric piano with all the attacks on full and all its sustain off and put this on the front for



Rick's original orchestration for the opening of his "1984" overture.

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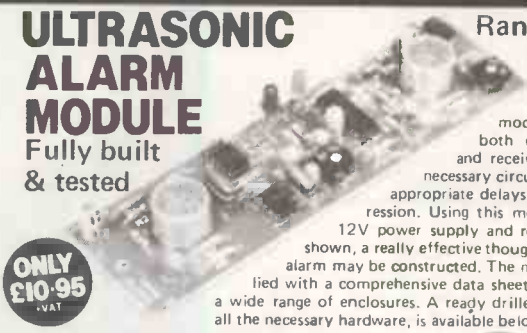

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Rehearsing a vocal number with the Dirtetts singers.

the attack. I put a strong echo on as it's mixed on to another track. Finally, I bring the echo of the string machine up front, cutting off the echo at the end so it's a more natural sound.

"A large amount of orchestral percussion was used for '1984' with bells, glocks, timps, tamborine, xylophone, cymbals, marimba, vibes and shakers.

"In the score I use the normal range of orchestral instruments including strings, brass (no tuba except in 'No Name'), woodwind (except Cor Anglais). The kettledrums give extra drive and are certainly a prominent feature in my music. The harp makes a significant contribution, too, but I like it to be heard clearly otherwise I won't use it. The banjo in 'Forgotten Memories' was just added on the spur of the moment, and the sax on 'Proles' was used through the Roland SPV-355 pitch to voltage converter which has got a 3 VCO synthesiser built in.

"I haven't used a Novatron for nearly six years — on stage I used the Korg Vocoder for the choir. I really like the sound I get from this — it's done with chorus effect on the vocoder along with heavy fast vibrato to give an extremely thick choral sound. I also let through a little of my voice for extra sibilance on the top.

"The effects I use on stage are the Moog 12-Stage Phaser and two Korg SD-200 Analogue Delays — that's really all I use although I've got ten foot pedals for volume control of the various machines and, of course, reverberation is added for the PA reproduction plus some echo. On stage the foldback is not very loud — around 400 watts (!), compared with a thunderous 4000 watts out front. Our PA at the London concert was done by Concert Sound. If you put this show on with full orchestra and choir, you're talking about £20,000 for one performance and all the rehearsals."

'1984' cost just under £100,000 to complete. Rick got an advance from the record company to produce an album with no deadlines, since they were confident he'd come up eventually with something good.

Rick has just embarked on a series of tours that will last some 7½ months covering Chile, Argentina, Venezuela, Uruguay, Brazil, Canada, America, England, Europe, Japan, Australia, South Africa, China, Puerto Rico, Phillipines, Bankok and Thailand.

The Music

Overture Parts 1 & 2

Part 1 opens with full orchestra playing in true overture style. The syncopation leads to a climax of fast repeating notes on strings, with trombones echoed by horns and trumpet flourishes hinting a new theme. Flutes and woodwind continue this rhythmic syncopation with harp and strings until the trumpets burst forth again with the main theme. Now Rick's solo synth emerges with quaver/semiquaver runs against full sustained strings.

A lyrical theme on oboe in 6/4 contrasts well at this point and is picked up briefly by clarinet and flute, before tremolo lower strings make the background for electric grand and synthesiser arpeggios.

Another change follows in Gb, with a strong rhythmic pattern on strings, then with added woodwind, brass (including piccolo trumpets), marimbas and harp.

Part two begins after two beats rest with the group playing a primitive style sequence that leads to a strongly syncopated synth/bass/drums passage that's 4, offbeat 2 and 3 effectively accented. There's a nice gutsy organ added before the main theme returns. A synth solo against strings links to an orchestral version of the syncopated passage (held together by the drums).

Sweeping piano notes announce briefly Julia's theme before the group returns in a powerful rock beat entry to 'War Games'.

War Games

A great feel to this song — well executed by Chaka Khan, who stretches the melody with her clear voice. There's plenty of swirling fast phase treatment to the sound. A flute-like Prophet adds the theme to the singer's counter harmony and a short polysynth transition modulates to B minor for the lyrical theme first heard in the overture on oboe. Here it's on synth backed by sustained choir voices and the group, including Rick's electric grand.

An abrupt downward run takes us back to a faster tempo in A minor on a ♫ motive. Then the opening 'War Games' returns with vocals, all based on A-G-F-E sequences. The Hammond organ solos into a reminder of the overture main theme over some fast cymbal patter and off-beat piano note clusters. Choir once again appears for the closing bars as piano and synth reflect the lyrical theme. It ends with an upward portamento on synth over sustained Yamaha string machine sound.

Julia's Song

This song was written very quickly by Rick on the spur of the moment and is effective because of its simplicity and natural warmth. Starting off gently, it adds a tinkling semi-acoustic flanged guitar as it gains momentum. A drum fill announces the synthesiser repeat of the theme with rhythm, piano arpeggios and strings. Brass comes in for the middle 8 over tremolo strings, while the solo synth continues. The vocals lines are reinforced by violins and oboes against repeated viola/cello quavers as the music builds up to a rhythmic climax. A subtle reverberation on the words 'take that away' does just that.

Hymn

Jon Anderson sings this as if it could only be for him against the simple 3-chord harmony of the choir, piano and bass. An interrupted cadence throws in the band who break into a set improvisation and a hint of 'Journey' on the MiniMoog solo line. At first the abruptness unsettles you, but then you almost wait in anticipation of the next change!

I like the 'Haydn' woodwind section — it's hard to tell the piccolo synth from a piccolo, and the dynamics would have given even Haydn a surprise! Back comes the 'Hymn' with strings in full strength and rather out of place drums. Brass band sounds fill in and if you listen hard you'll pick out some nice clarinet runs in 3rds. Choir and vocalist

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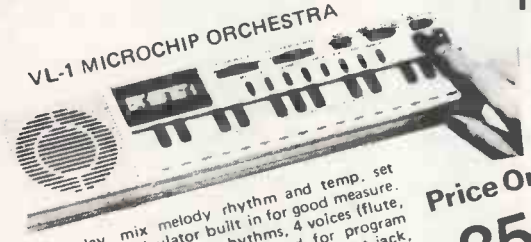

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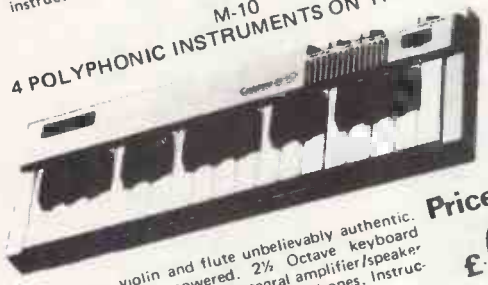

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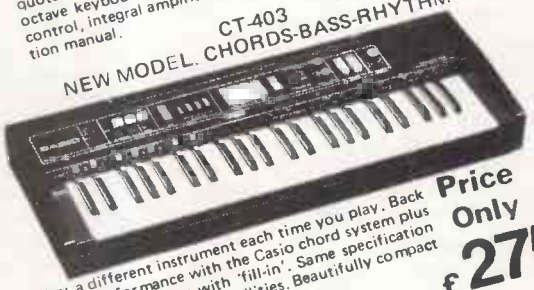

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round the piece off sympathetically.

The Room (Instrumental)

After the dramatic start over repeated quavers in C minor the organ (Yamaha CS80) improvises for 16 bars before the opening theme returns. The tempo slows into a heavy sequence over 'chorale' Leslie. Once again we hear the theme, in Eb this time, which gives a chance for solo synth melodies and clear bass lines.

A repeat of the C minor version in shortened form leads to another change, with a beautiful 'pan-pipe' solo from the Prophet (heavily reverbed) over bass broken chords, and exquisite washes of synthesiser in the background echoing in the distance. Choir 'aah's' crescendo and fade and one ominous synth sliding note adds the final comment as the background notes echo away.

Robot Man

The rather choppy opening beat has a hidden melody which was followed by a tape reversal splice introducing Chaka Khan's vocals. The funky beat continues with the Dirtetts vocal group complimenting well. It's a good sound (listen to the drum 'Skulls') and Kenny Lynch continues the dialogue, sometimes with flanging on his voice. Exciting synthesiser, organ tremolo and vocal shouts drive it all along. Definitely good rock musical stuff!

Sorry

Piano starts the piece in true Wakeman style (or is it Elton John?) with choir 'aah's' filtering in. Strings with drums back the synthesiser lead and a standard chromatic sequence in the bass over Bb minor/G7/A7/Dm, with vibes and horns adding depth to the harp arpeggios. The section is repeated and piano, bass and choir finish off quietly. It's a short lyrical piece that is a pleasant contrast.

No Name

A bright introduction in pop style, for Steve Harley's singing. The synthesiser solos with Wakeman triplets/semiquavers and the music picks up as the vocal group echoes 'No Name' from Steve's vocals. There is a rather muddy sequence that follows which eventually echoes away.

Forgotten Memories

Synth and Piccolos bandy a melody around to start and the L/R stereo panned side drum (with snare off) gives that medieval feel again (King Arthur?). Hornpipe flourishes switch to strings and polysynth harmonies over piano, before a repeat of the start again. Orchestral bassoons, bass trombone and tuba drive ever downward for another repeat. Although Rick's score specifies full orchestra, it is in fact played on the Prophet 5 and 10 with banjo (yes, banjo!) and string machine. Not particularly inspired, this one.

Proles

This is a group number that gives Tim Rice a chance to make one of his rare singing appearances. A fast driving number that has the vaudeville atmosphere with a menacing undertone from the words and treated voice passage. The middle section is real operatic comedy with vocal shrieks (in tune, of course!), over fairground organ style accompaniment. Back comes the shouting, singing Tim Rice and the 'underlings', leading to a poly solo and suitable comments from the sax throughout that gives it all a real brashness. It has a typical ending — you'll know it when you hear it! Good fun.

'1984'

Written by Rick away from the keyboard, it begins with a retrospective piano/synth

and soft maraca shakes. Bass enters and the slow heavy reverberating drum beat moves it along. There's pleasant harmonies as the orchestral part begins with strings reaching a climax. Piccolo trumpets state the main overture theme with full orchestra and choir. It's the big sound once again that shows Rick's writing skill and has the feel of an expansive film music score.

The triplet theme returns and a very polished synthesiser run leads to another new theme with interesting bass accompaniment. Next follows a synth passage with rhythm guitar and orchestra and a short theme on oboes ends with effective horn sweeps and a change of tempo to the Robot Man sequence that builds up with vocal '1984's' and a bouncy organ solo. War Games music plays its part behind a synth lead and vocals — now the build up to the end seems to be on the way, but suddenly a Sullivan interlude on woodwind, bass, side drum and glockenspiel appears. There are more reminiscences to 'War Games' which shows Rick's determination to throw in the tunes, but we are brought back to earth with vocal mutterings of 1984 - four - four! What must be the coda plays the overture main theme until the piano with drums and timpani rolls brings in the whole orchestra on the 'Hymn' theme to end. It's difficult to imagine the work without an ending like this — somehow this particular movement does not seem to round everything off quite as well as it should. Certainly, there's enough happening to keep it all moving to its full orchestral climax.

Mike Beecher **E&MM**

RICK WAKEMAN WORLD TOUR 1981

1984 OVERTURE PART ONE
1984 OVERTURE PART TWO
WAR GAMES
ARTHUR OVERTURE AND SIR LANCELOT AND THE BLACK KNIGHT
SEA HORSES
JULIA
SIX WIVES OF HENRY VIII PART ONE (CATHERINE OF ARAGON, ANNE OF CLEVES AND CATHERINE HOWARD)
PROLES
JOURNEY PART ONE
DANIELLE
NO NAME
CHAMBER OF HORRORS
HYMN
ANNE BOLEYN
ROBOT MAN
MERLIN THE MAGICIAN
JOURNEY PART TWO
BIG BEN
WARNING MAN
WHITE ROCK

In Concert

At a recent concert given at Hammersmith Odeon, London, Rick performed the set list for his 'World Tour' that he has just about embarked upon. To save expense, the orchestra and choir were not used. Instead the opening overture was played on stereo cassette through the PA with closed curtains. On stage Rick played his keyboards with Tim Stone on rhythm guitar, Steve Barnacle on bass guitar and Tony Fernandez on drums. Gary Barnacle also joined in on sax for one number.

This electronic rock group played plenty of instrumental music interspersed with vocals provided by the backing singers: Stevie Lange, Vicki Brown and Soni Jones. Steve Harley and Cori Josias performed all the solo vocal parts.

With the show being televised and the inevitable technical difficulties that Toby Errington, Rick's engineer, had to sort out, the scheduled sound check was delayed. Around 4.00 p.m., the efficient activity of the stage team, brought rehearsals under way for a couple of hours. There was not really a lot of time for playing as the balancing of the vocalists was more important (and the costume changes and opening curtains had to be got right!).

The show commenced at 8.00 p.m. to a packed hall of enthusiastic fans — interestingly Rick's music draws to the concert hall a large following of 'rock' listeners despite the 'classical' images he often creates.

The performance was loud and became somewhat disappointing in its overall balance as the volume increased, with some of the vocal solos not always getting through clearly. Nevertheless, the audience were very appreciative and gave Rick and the performers a standing ovation at the end.

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A HISTORY OF ELECTRONIC MUSIC

To understand the recent revolutions in music it is necessary to examine previous ones.

The year 1900 was not only the beginning of a new century, but of a clearly defined cultural era as well. Early in the twentieth century the world had largely absorbed the implications of Max Planck's 'Quantum Theory', Freud's 'Interpretation of Dreams' and Einstein's 'Theory of Relativity'. The art world had been torn apart by the emergence of Cubism, and Kandinsky had painted the first non-representational picture. Frank Lloyd Wright revolutionised architecture, and Ezra Pound arrived in Italy. Technology produced the first motion picture theatre, as well as the Model T Ford cars, and the Wright Brothers made the first powered flight.

These, and other artistic developments, had come about as a gradual process. For example, the definition of music had been extended progressively from the Pythagorean concept of harmony (500 BC) to the natural music as defined by Regino. Francis Bacon mentioned 'sound houses' as places where all sounds exist as early as 1627, in 'The New Atlantis'.

The technological advances mentioned earlier, as well as others, gave rise to various new instruments: for example, in 1550 a mechanical organ with over 150 pipes was built. Later, 1555 saw the emergence of the 'Archicembalo', a keyboard instrument which divided the octave into 31 steps. It pre-dated the micro-tonal concept of music by several centuries.

As well as technological advances, research was being undertaken everywhere. The work of Herman Helmholtz — particularly his 'On the Sensations of Sound as a Physiological Basis for the Theory of Music', published in 1862 — provided plenty of avenues for theoreticians to explore. A French scientist, Joseph Sauveur, formulated many acoustical theories. Unquestionably the most important of these was the discovery of the 'overtone' series(1). He also researched into the aural perception of micro-tonal intervals. Other theorists left us with many notable achievements, including the work of Rameau(2), Oplet(3), and Drobisch(4).

One major advance, however, enabled the initial experiments of electronic music to get under way. It was the work of Alexander Graham Bell. He was responsible for the electrical transmission, storage and reproduction of sound, in 1876. Within a decade we had Berliner's telephone, and Edison's phonograph.

Running parallel to this technological revolution was an artistic one. The need to leave the tonal system that had been in existence since the 17th century was beginning to show in the works of the Romanticists. Several early Modernist composers challenged the established language of music, including Wagner, Debussy and Charles Ives.

The first important musician to concern himself with what Edgard Varèse was later to call the 'liberation of sound' was Ferrucio Busoni (1866-1924). Born of German/Italian parents, he lived mostly in Berlin. He made his name as a controversial arranger of the works of Bach. As a conductor, however, he was responsible for introducing the new music of Debussy, Faure, Sibelius and Bartok to the Berliners. His home was the gathering place for many young artists, and his remarkable foresight made him extremely popular with these young people. His realisation that 'Music was born free and to reach freedom is its destiny'(5) was an inspiration to many.

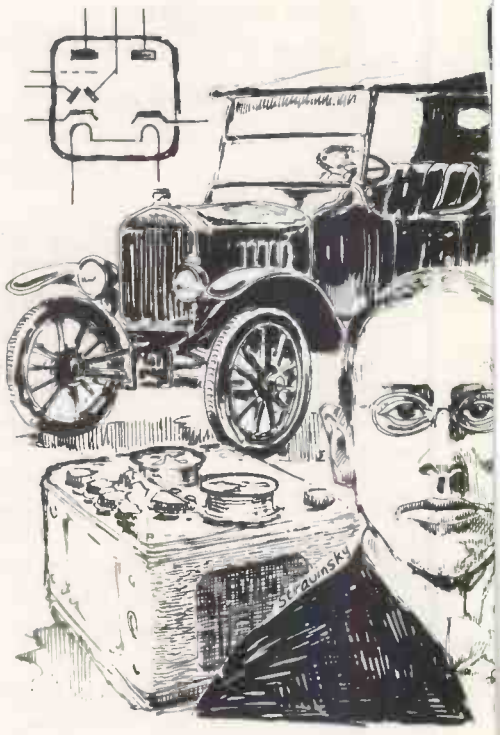
Contemporary with Busoni was the formation of the Italian Futurist Movement, founded by Filipo Marinetti. Its manifesto initiated a series of events which influenced composers such as John Cage and Karlheinz Stockhausen. It stated that '. . . a roaring motor car was more beautiful than the Victory of Samothrace'. It suggested that the music of the period should echo 'the age of the aeroplane, etc'.

The futurists were an avant garde of writers, painters and musicians who professed radical theories about all of the arts, including painting, sculpture, dance, music and the cinema. The glorification of machines, speed, strength, and the destruction of all things past — particularly monuments of a historical nature — created a lot of unrest.

This turbulent atmosphere was later exploited by Mussolini and the Fascists. Primary correspondences between Futurism and Fascism included the abolition of the monarchy and the advocacy of war. However, the growth of the Futurist Movement was hindered by both economic and political unrest created by the First World War.

One of the more important members of this movement was Luigi Russolo. Although primarily a painter, he was an advocate of what is today referred to as 'music from found sources' — i.e. the use of noise. He went as far as to produce a 'mechanical' noise instrument known as the 'Intonaramori'.

He also devised a system of notation in which a horizontal line was used to signify



duration, as is still used today. Russolo's first 'art of noises' concert was held in Milan on April 21st 1914, and used the 'Intonaramori' as well as horns and megaphones. The last Futurist manifesto 'Futurist Radiophonic Theatre' mentioned concepts which are today commonplace in electronic music: for example, the amplification of normally inaudible sounds, and the use of 'brain waves' as a source of sound. Most Futurist works appeared between 1910 and the mid-1920s. They combined various art forms, including theatre, painting and dance. Russolo continued his experiments until 1930, eventually losing interest and leaving behind most of his machines in Paris, where they were later destroyed in the war.

The Futurist Movement was not, however, the only inspiration for composers of 'machine music'. An American, George Antheil, for instance, composed and performed his 'Ballet Mécanique'(6) using sounds derived from car horns, airplane propellers, saws and anvils. The notes on the sleeve of the recording referred to have this to say about it: 'Ballet Mécanique is a new aesthetic in music. If one has a mind to understand it, let him listen with new ears, as he must look at new architecture with new eyes. Rhythmically, aesthetically, materially and constructively, I feel aligned with our modern life.' George Antheil.

As well as 'Ballet Mécanique', a ballet by the Russian composer Alexander Mosolov, entitled 'Steel' was one of the most celebrated pieces of music in this field. The works of Edgard Varèse profited tremendously by the futurists delight in 'urban noise'.

by Derek Pierce

Music was born free and to reach freedom is its destiny. *Ferrucio Busoni*

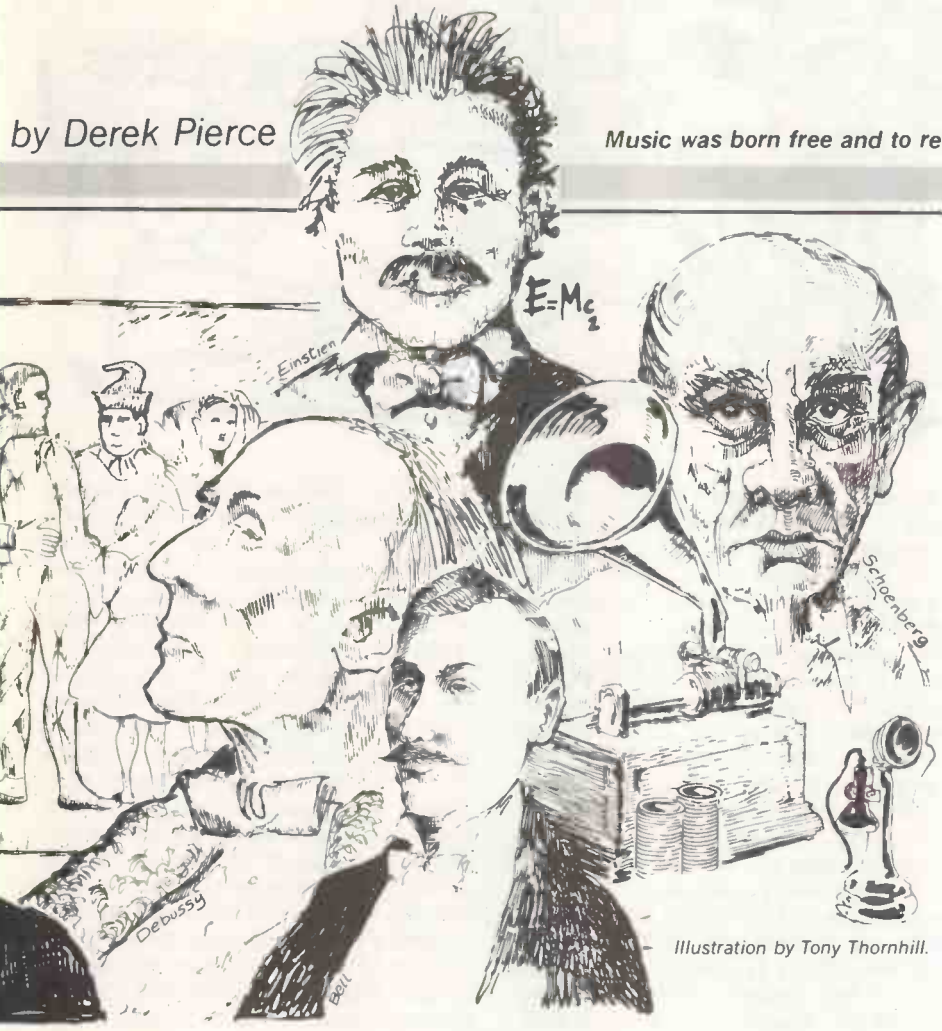


Illustration by Tony Thornhill.

Edgard Varese.

Varèse was responsible for 'Ionisation'(7), the first Western percussion-only piece — apart from some folk music. It was said at the time to 'have an impact like a sock on the jaw'.

Edgard Varèse later wrote 'I am no longer able to compose for old instruments. I am handicapped by the lack of adequate electrical instruments for which I can conceive my music'. Varèse conceived music which existed in space; he heard music in three dimensions. He struggled on composing music which was inevitably played on conventional instruments, but it was not until much later that he was hailed as the 'Father of Electronic Music'. Meanwhile, the Bauhaus, founded in 1919 by the architect Walter Gropius, was also comparable to many aspects of Futurism. Although concerned primarily with the visual arts, there was one exception, the theatre. Theatre enabled the use of syntactic and semantic modification, in addition to the musical and other sounds used.

One director, Oskar Schlemmer, preempted the 'free dance' to be found much later in history in his 'Gesture Dance'. Three actors coordinate their movements with sounds produced by an undirected group of musicians using gongs, timpani and a fanfare played on a phonograph.

In a later work, 'Man and Art Figure' (1924), Schlemmer explored further the possibilities of sonorous transformation. In this work he specified the use of various kinds of technological equipment. He probably meant equipment such as the Theremin, or devices that produced sound from oscillators. The latter of these had been developed by Lee De Forest in 1915. The oscillator produced sound waves electronically, and although now transistorised, it still remains the basis of the modern synthesiser. The Theremin is also an oscillator, but its frequency is controlled by distance of the operator's hand from its antenna. The Theremin was used as late as 1966, by 'Lothar and the Hand People'(8) — Lothar being the nickname of the Theremin. It also makes an appearance on the Beach Boys 'Good Vibrations' single of 1966.

As well as the work of the Bauhaus movement and Futurism, one other group of artists, known as the Dadaists, shaped the future of electronic music — although not an artistic movement, but rather a state of mind. It was summarised by Andre Breton: 'Dada is a state of mind . . . Dada is artistic free-thinking . . . Dada gives itself to nothing'. Several of its members worked with the Futurists, and Bauhaus artists. Tzara, for instance, had been in contact with Marinetti; Ball had worked with Kandinsky. Dadaism spread as far as New York, and was revealed in the works of Marcel Duchamp, Man Ray, and Max Ernst. Its (Dadaism's) use of collage, chance, and simultaneity, appear in the works of John Cage, György Ligeti, and Pierre Henry, as well as many other electronic music compositions.

It will be seen that modern electronic music's concept and indeed realisation goes back a long way. The period from 1876 to 1930 laid the basis of much of our present-day electronic music, as well as the basic technology that we now take for granted. By the 1930s virtually all the pre-requisites for the realisation of electronic music had been satisfied. Scientific advances had been so numerous, that Joseph Schillinger had compiled a survey of them by 1931. A year later Leopold Stokowski published a special 'New Horizons in Music' which called on scientists and musicians to work together.

Next month I will look at the period 1930 to 1960. I have listed several references which are worth checking out. **E&MM**

References and Discography

(1) Système General Intervalles des Sons, et son application à tous a Systèmes et à tous les Instrument de Musique (1701)

(2) Rameau's Traité de l'Harmonie Reduite à ses Principes Naturels (1722); Noveau Systeme de Musique Theorique (1726); Generation Harmonique (1737) Code de Musique Pratique (1760).

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(4) Drobisch. (Further division of the octave into 43 and 74 intervale.)

(5) 'Sketch of a New Aesthetic' (1907) New York, Dover Publications, 1962.

(6) Ballet Mécanique. CBS. AML 4956.

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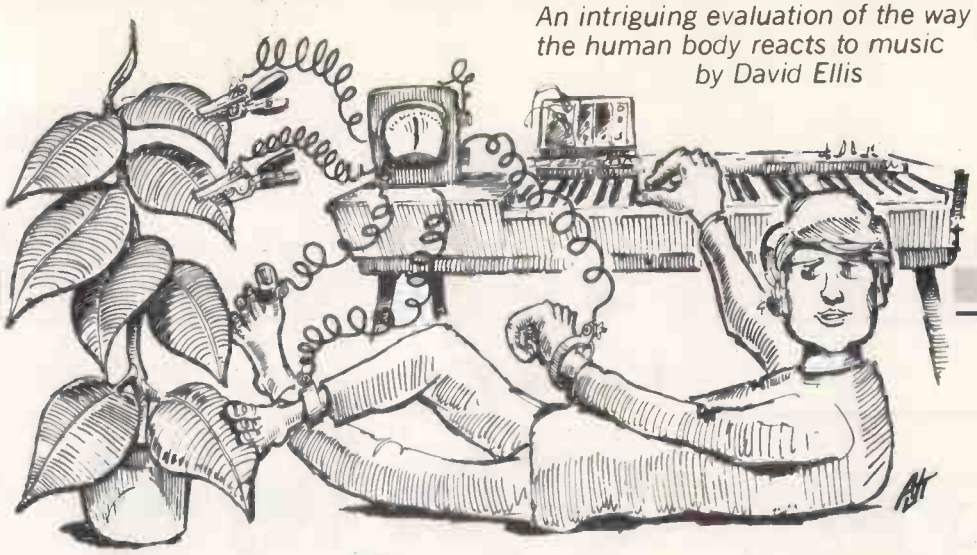
(8) Lothar and the Hand People. Capitol SM 2997 (Re-issue)

BIO MUSIC

An intriguing evaluation of the way the human body reacts to music

by David Ellis



Seeing that psychedelia is all set to make a comeback, this month's Advanced Music Synthesis is all about putting life back into music or, rather, getting music out of life. Actually, 'advanced' is a misnomer, because we'll be looking at waveform generators that were around for thousands of years before the first sine wave oscillator crawled out of the primeval electronic sea into Stockhausen's lap - namely, Man's own biological rhythms. Before leaping into this quagmire of quirks and quacks, we'd do well to analyse the rhythmic connection from the musical starting-point. This less contentious angle has been the subject of a fair amount of work and reveals some pretty interesting insights into how our bodies react to music.

The plot thickens

As well as music being the food of love, it also goes to parts of the body that the other Arts don't seem able to reach. This is particularly true when one gets down to measuring such pointers to one's well-being as blood pressure, pulse rate, respiration and other autonomic functions controlled independent to the conscious mind. Reference points are all important if we're looking for music-induced changes and Figures 1 and 2 show, respectively, the respiration plot (amplitude vs. frequency of breathing) and electrocardiogram (ECG) of a normal, resting subject. All this nice, reassuring regularity flies out of the window as soon as music enters the picture. Figure 3 shows the influence of a snare drum roll, split equally into crescendo and descrescendo portions, on a particular subject's pulse rate. What's rather interesting is that this type of pulse plot is fairly consistent when the same piece of music is played several times to the same subject, i.e., a particular musical 'device' is capable of repeatedly switching some aspect of the body's physiology away from the norm. Furthermore, certain rhythmic devices - in particular, syncopation - desynchronise the regular heart action illustrated in Figure 2 by causing an extra-systole ('systole' being the phase of the heart's action when contraction sends blood to the body) or premature beat. In the case of Figure 3, one actually observes a 'driving' of the pulse rate from dynamic changes in volume of the snare drum. The incessant pounding of African tribal drums or, on a more banal level, the 125 bpm (beats per minute) of disco singles produces a similar sort of synchrony between an external 'pacemaker' and pulse rate, thereby inducing a state of blissful ignorance, euphoria, or divine awareness, depending on which escapist camp you care to belong to.

An interesting point about the preferred speed of the disco beat is that this is the fastest external pacemaker that will reliably synchronise the pulse rate of the majority of the bopping population. Anything faster than 125 bpm actually has the opposite effect and slows down the heartbeat. So, there's obviously a fine balance between causing intense physical excitement and inducing a trance-like state when it comes to laying down a pace-making drum track - something that disco producers found out more by error than trial!

Music is also found to have a pronounced effect on muscle activity. Tapping one's feet is one more or less subconscious manifestation of this, but, more generally, there's a low level ticking-over of muscle twitches throughout the body when you're awake - even though there may be no obvious movement of the arms or legs. If electrodes are placed on the skin above a muscle or set of muscles, this activity appears as an electromyographic (EMG) plot (Figure 4), and one's actually observing the electrical activity of the thousands of fibres that make up each muscle in the body. This activity occurs at a fairly high frequency (100 to 500 Hz) and, for measurement purposes, it's usually integrated into a more convenient signal. Figure 4, then, shows the change in rate of muscle activity in the forehead region and in the legs in response to various musical conditions imposed upon the luckless subject. At the start (marked 'Beginning'), there's an equal balance between activity in the two parts of the body.

Moving to dance music, activity shifts to the legs (hardly surprising, perhaps, but remember that foot-tapping was verboten); with maths, the opposite occurs. Normal level Bach (Brandenburg Concerto No. 6) again predisposes the body towards activity in the leg muscles, but loud Bach sends the leg muscles off the scale into hyperspace - and this was still with no actual movement of the leg. Figure 5 shows both muscle activity (EMG) and pulse rate (P) coincident with different aural stimuli ranging from the nerve-grating

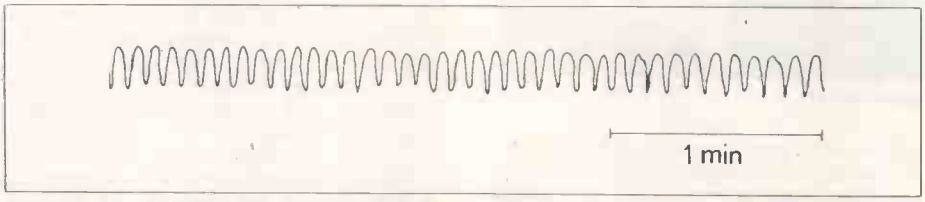


Figure 1. The respiration of a normal subject when resting.

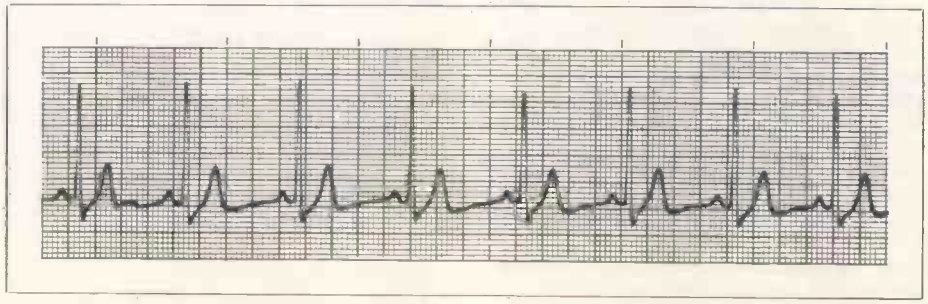


Figure 2. ECG of a normal, resting subject.

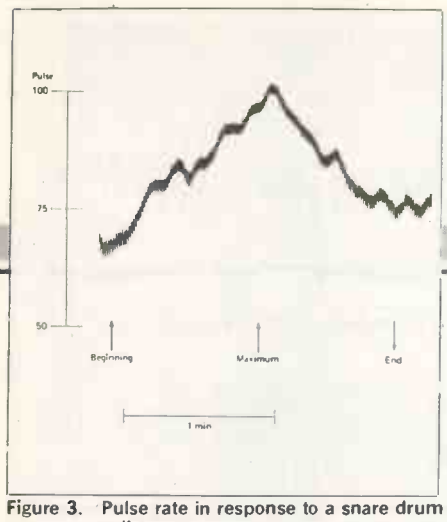


Figure 3. Pulse rate in response to a snare drum roll.

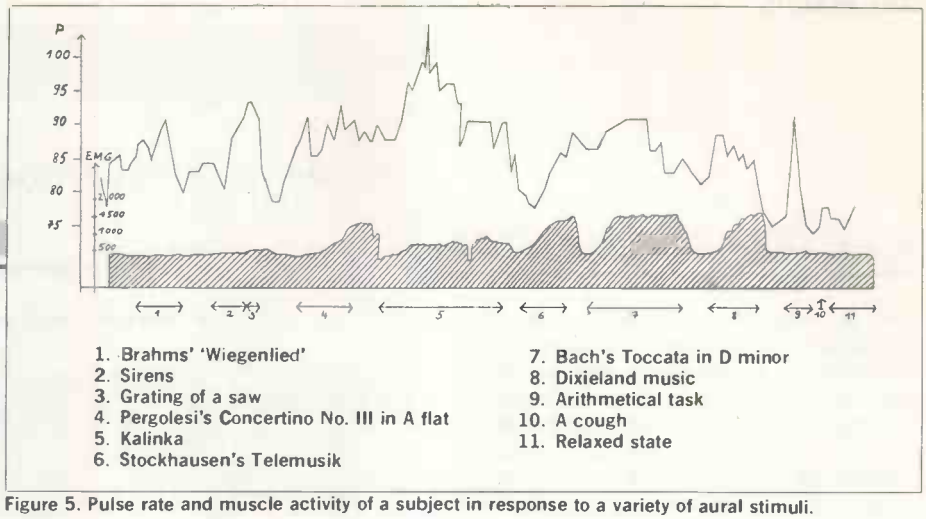


Figure 5. Pulse rate and muscle activity of a subject in response to a variety of aural stimuli.

to sublime. Once again, Bach scores high in terms of muscle activity, but Kalinka drum music wins outright with its devastating effect on pulse rate. These measurements can be extended to cover other parameters that the body gives up easily. We then end up with the multi-plot or polygraph shown in Figure 6, something that's very similar to those used in the U.S.A. for lie detection.

It's obvious, then, that music is capable of eliciting profound physiological changes - especially if certain rhythmic or harmonic 'tricks of the trade' are used to engineer a response from the listener. One of the national newspapers has recently been encouraging readers to submit their nominations for passages of music with high 'tingle quotients' (TQs), i.e., those that send a delicious shiver up the spine. Some of my favourites are the development section of the first movement of Rachmaninoff's Third Piano Concerto, the entry of the chorus at the start of Bach's St. John Passion, the "Maman" sung to a descending 4th at the end of Ravel's L'Enfant et les Sortilèges and the climactic end to David Bedford's Star's End. These TQs owe their effect to the craft of the composer and the alarming susceptibility of our bodies to the ultimate psychotropic drug - the manipulation of common-or-garden sound.

Feedback

The sure-fire test of a 100% guaranteed TQ would be to equip an entire audience with buttons and get them to fire them at the appropriate spine-tingling moment of a piece of music. If each button then triggered a light above the person's seat the orchestra would get a pretty immediate feedback on how they were doing as regards TQ communication. Not, perhaps, the most meaningful of exercises! Another approach might be to wire up the conductor with sensors so that his physiological reaction to the music he's conducting could be passed on to the audience via suitable displays.

In a paper published in 'Music and the Brain' (see acknowledgements), two psychologists suggest that the artist's capacity to relay an emotional impact may be actually more important than artistic perfection as far as success and acceptance by the public are concerned. So, maybe there's some sense in providing the audience with a short-cut to appreciating what's going on inside the mind (and body) of the performer.

Legitimate use of the body's autonomic response to music could also include light shows driven by sensors attached to each member of an on-stage rock group. Doing this might reveal quite a lot of information about how rock musicians interact with each other: for instance, a good drummer might have the ability to drive the pulse rates of the other musicians to an equal extent and therefore ensure synchrony of their autonomic responses as well as the basic rhythmic fabric of the music. Conversely, the average keyboard player might find himself stuck out on a less responsive limb because of the restrictions a multi-keyboard set-up imposes on freedom of movement.

Putting plots into practice

It's rather fortunate for those interested in experimenting with these ideas that the majority of autonomic functions can be measured with fairly simple apparatus. Figure 7 provides some information on the origin of these music-influenced functions, the changes that are observed, and how they can actually be measured. Temperature is probably the least useful function because any changes are slow to occur and rather dependent on the prevailing climatic conditions. How-

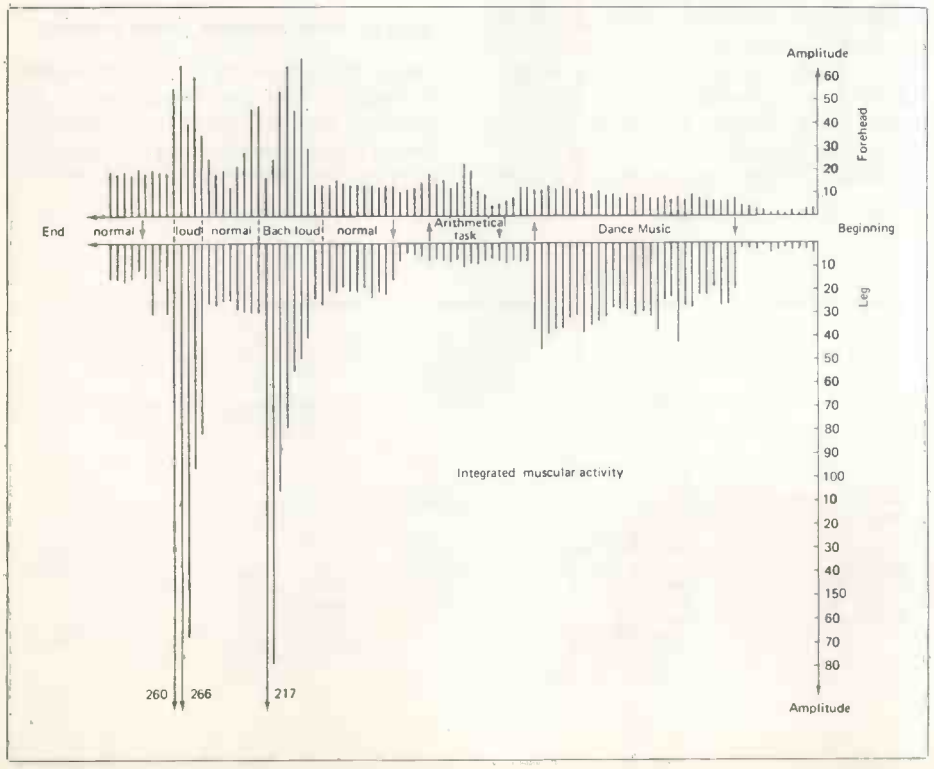


Figure 4. Muscle activity of the forehead and legs under various conditions.

ever, surprisingly large temperature fluctuations have been observed - especially if biofeedback assistance (pairs of thermistors, bridge and centre zero meter) is used to make you aware of differences as they're happening. Transcendental meditators actually developed this temperature offset trick to a fine art and were able to lower the temperature in one hand, with respect to the other, by as much as 2°C!

Galvanic skin response, as measured by skin resistance, makes much more sense for the type of applications we're interested in. Generally speaking, a relaxed body is reflected in a high skin resistance (which may go as high as 500k) and any anxiety or stress rapidly lowers it. This is easily proven with the simple circuit in Figure 8 built around a unijunction transistor. Reasonably effective electrodes can be constructed by wrapping wire around two fingers, though it's preferable to use proper skin electrodes attached to the palms of the hands with conductive jelly. The preset adjusts the initial pitch of the oscillator and this will be further lowered the more the resistance between the electrodes increases. Battery operation is essential in this and all other cases where electrodes are in direct contact with the body. I take no responsibility if you choose to do otherwise! Tone generators are all very well for biofeedback, but the galvanic skin response can be used much more effectively to control modules in synthesisers by means of the sort of voltage-processing circuit shown in Figure 9. This can be used quite successfully to superimpose a music-induced galvanic skin response on VCF tracking, LFO speed, or whatever.

Temperature and skin resistance are examples of aperiodic autonomic changes, i.e., there's no clear evidence of any short-term cyclic characteristics. In the long-term, though, humans (and other warm-blooded animals) do show small fluctuations of body temperature throughout the day and especially at night, but warm-blooded physiology demands that this diurnal rhythm is kept well in step and certainly

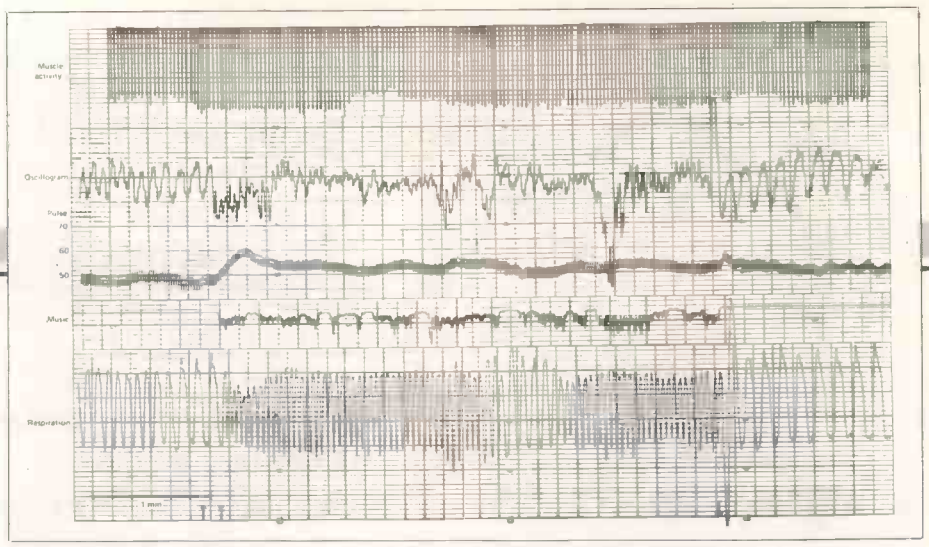


Figure 6. Polygraph of a subject listening to Bach's Brandenburg Concerto No. 1.

not too disturbed by something as frivolous as music!

Biorhythms more reminiscent of musical waveforms can be found in the other three autonomic functions described in Figure 7. Heartbeat provides a low frequency waveform that is by nature highly unsymmetrical owing to the biphasic contraction of the heart. Respiration produces a waveform that is more regular in shape but about a fifth the frequency of heartbeat. Muscle activity, on the other hand, gives relatively high frequency electromyographic signals.

Provided that one's content with a simple on-off pulse, the easiest of these three to measure is respiration. This is because Honeywell have recently introduced an ultrasensitive air pressure switch that is activated by an air pressure of only 0.02 psi (equivalent to a gentle puff from a distance of a few inches). The only drawback of the switch is its limited current rating of 10mA DC, which means that, in most applications, external buffering will be required. To use the switch, one merely has to tape a length of narrow gauge tubing (e.g. aquarium tubing) under a nostril and attach the other end to either the high (0.05 psi) or low (0.02 psi) port of the air switch. And, if you're

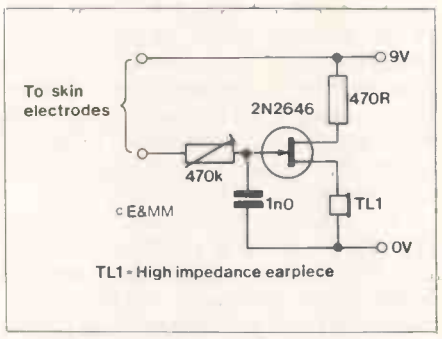


Figure 8. A simple skin resistance monitor.

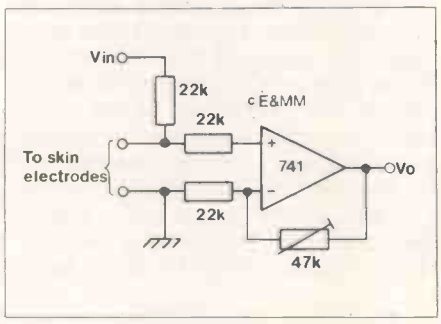
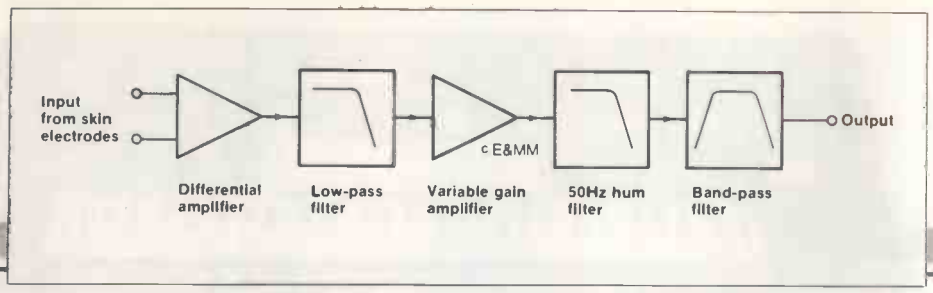


Figure 9. A skin resistance voltage processor.

clever, two of the switches can be used in parallel with one triggering on expiration and the other on inhalation! These respiration-derived pulses could be used for triggering lights via a SCR,

Autonomic function	Origin	Main features	Measurement	Effects of music
Heartbeat	Intrinsic pacemaker in heart	Periodic (≏1.2 Hz) and biphasic ('systole' - blood pumped to body; 'diastole' - blood returns to heart)	Optoelectronic sensor attached to thumb measures IR absorption by blood	Frequency (pulse rate) and amplitude (blood pressure) increases
Galvanic skin response (GSR)	Variable skin resistance due to ionic contents of skin cells plus moisture on surface of skin	Aperiodic	Skin electrodes attached to equivalent of Wheatstone Bridge	Resistance generally decreases
Electromyographic activity (EMG)	Continuous stream of nerve impulses from motor cortex in brain 'fires' muscle fibres	Periodic (≏100 to 500 Hz)	Skin electrodes over particular muscle or set of muscles	Frequency of firing increases and therefore so does amplitude of integrated EMG activity
Respiration	Autonomic control of breathing by brain stem (medulla)	Periodic (≏0.2 to 0.25Hz)	Air pressure switch triggered via tubing taped under nostril	Frequency of breathing increases, depth of ventilation decreases
Temperature	Constant body temperature (homiothermy) maintained by hypothalamus region in brain	Aperiodic	Thermistor in contact with skin attached to Wheatstone Bridge	Temperature may decrease or increase in hands or feet

Figure 7. Musical Pointers ▶



Processing electromyographic signals.

switching FX units on and off, stepping through a sequencer, and so on. Remember also that you'll then be putting yourself into a musical biofeedback position - the faster you play the greater the respiration rate the faster you play - until you collapse in a heap in the middle of the stage suffering from exhaustion!

This was, in principle, the basic idea behind a piece written by the oboist Heinz Holliger for oboe and electronics. Here the player uses his own amplified heartbeat to provide a click-track for his performance - faster playing raises the pulse rate and vice versa - hence the title, 'Cardiophonie'! This spiralling biofeedback situation is an example of positive feedback - the same stuff as chain reactions are made of - and clearly control elements have to be introduced into the loop to make it more meaningful and practical - from both the musician's and audience's point of view.

This brings us to the two conventionally "difficult to measure" autonomic functions, heartbeat and electromyographic activity. Fortunately, several electronics magazines have recently published good designs for monitoring both pulse rate and muscle activity. In clinical situations, cardiac electrodes are used to detect the electrical activity of the heart, and this gives an ECG (as in Figure 2) showing detailed information about how the heart is functioning. However, many isolation precautions may have been taken, there's always the outside chance that such electrodes could momentarily engage in a handshake with the mains and thereby cause cardiac arrest. Take heed from the tales of electrocuted guitarists and leave this technique to medically-qualified personnel!

A sensible way of picking up the basic characteristics of the heatbeat is to use the infra-red light-absorbing properties of blood. Since blood flows through capillaries close to the surface of the skin reflectivity at IR wavelengths is inversely proportional to the blood influx, and therefore changes cyclically with each heartbeat. Suitable optoelectronics in a light-excluding band attached around a thumb will extract this information painlessly, and then it's just a matter of conditioning the signal into a state suitable for human and/or musical consumption. In the case of the heartbeat, this involves filtering out noise (low-pass filter), removing mains hum (twin-T filter), and then subjecting the signal to high gain amplification and further filtering before it can be output to the waiting world.

Collecting electromyographic activity involves applying rather similar signal treatment, but here one has no option other than using skin electrodes and conductive jelly as these signals are fractions of a microvolt in amplitude. Figure 10 outlines the salient features involved in processing these types of bioelectric signals. Having extracted these signals, it's then necessary to consider how they can be used in our pursuit of getting music out of life.

Some clues as to a suitable approach can probably be gained from looking at the Bio Activity Translator (see Figure 12) produced by Jeremy Lord Synthesisers. This unit was originally designed for the somewhat dubious role of translating bioelectric potentials present on the surface of plant leaves into 'musical' sounds, though it's also perfectly feasible to use it for looking at muscle activity. Figure 11 shows the block diagram of the Bio Activity Translator. The conditioned bioelectric signal is used to increase the gain of a VCA via a simple diode envelope shaper. It also turns on a pulse generator, which in turn triggers a sample and hold to produce a stepped control voltage that tracks the bioelectric signal. The addition of a VCO in the chain results in pitch, speed and volume of the output all being controlled by the original input into the translator.

It would take a pretty fertile imagination to see anything remotely musical in the translated sounds of a plant, or my pectoralis major come to that, but that's really because taking pitch information from these bioelectric signals is bound to be a haphazard affair. What makes much more sense is to use these very rhythmic bioelectric signals in a way that complements the musical events that caused them to change in the first place. Controlling VCFs, VCAs, sequencers and light shows seems a less contentious application of all this bioelectric potential. A future bioelectric concert might consist of a trio wired up to banks of preprogrammed sequencers, synthesiser modules and lighting controllers, but without a single instrument in sight. Whether or not anything emerges that could be described as musical must depend on what musicians choose to do with the newfound self-awareness of how their bodies react to the music they're playing. Just remember that, in the words of *that* song, "the rhythm of life is a powerful beat"! **E&MM**

Sources: skin electrodes/conductive jelly from Wye Valley Electronics, 15 High Street, Lydney, Glos. GL15 5DP; Honeywell PSF 100A air pressure switch (cat. no. 41,623, price $7.00) from Edmund Scientific, 101 East Gloucester Pike, Barrington, NJ 08007, U.S.A.

Acknowledgements: Heinemann Medical Books for permission to use/adapt figures from a paper by Harrer and Harrer in 'Music and the Brain' (1977), pages 202-216; Jeremy Lord Synthesisers for loan of the Bio Activity Translator.

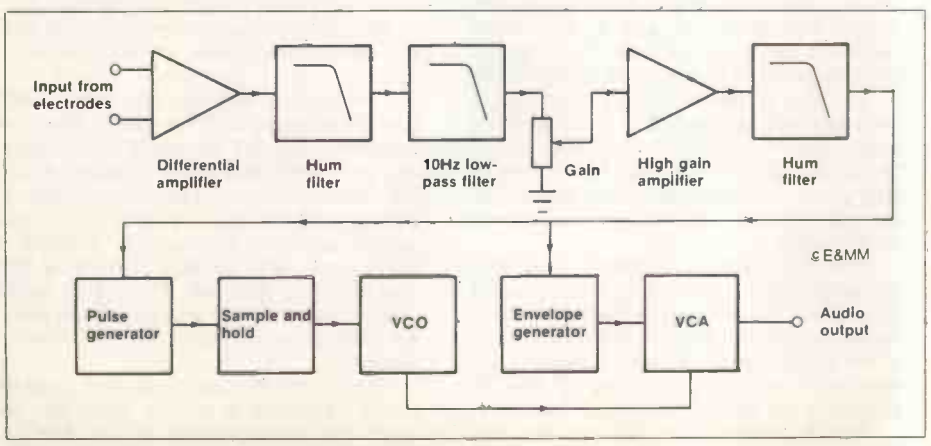
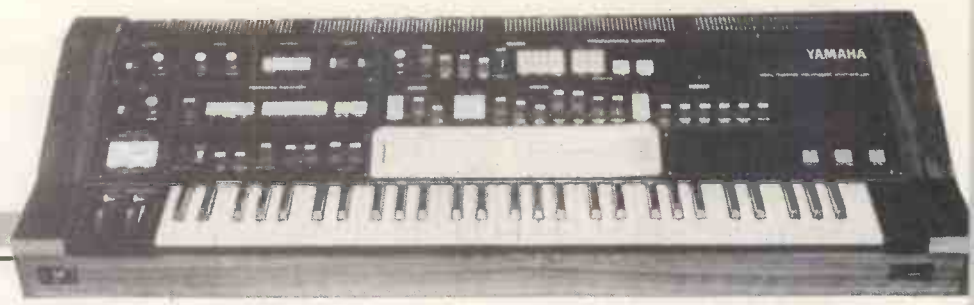


Figure 11. Block diagrams of the Bio Activity Translator.

The Bio Activity Translator from Jeremy Lord Synthesisers.

Yamaha CS70M

Programmable Dual Channel Polyphonic Synthesiser



The CS70M is a mixture of an update of the CS60 and the CS80. Keyboard-wise it doesn't supercede the CS80; it's more like the CS60 version but electronically it's better. It's two channel stereo with 12 oscillators, playing 6 notes on each separate channel output (or mixed mono if desired). Thirty different sounds can be programmed and stored via 30 buttons arranged in two rows of 15 on the main panel above the 61 note keyboard. Any sound from the top or bottom row can be selected, so Channel 1 button 2 can play with Channel 2 button 9 and so on.

In addition, there is a special magnetic data card system that extends the sound storage to the number of cards you possess. These fit conveniently into the small wallet supplied and hold two voices, one at each end of the card. The voice card selected is fed into the small slit just below the right hand end of the keyboard. The whole transfer operation takes just about a second and allows all the sounds in the CS70M's memory to be changed using 15 cards. Yamaha hope to supply around 30 cards with programmed sounds already on them, but you can also 'store' your own sounds on blank data cards or re-use cards included in the wallet.

The idea of this system is to eliminate the use of a cassette recorder and extra interfacing and it does make it possible to enter one or two new sounds between numbers (although the 30 memories should be sufficient for most performances and could be programmed by a set of cards beforehand). The same card system is employed on the new GS1 and GS2 instruments.

The GS70M is something of a departure from their norm for Yamaha. The heart of this particular beast is not one of their own in-house three thousand leg LSIs, but a very standard Z80 CPU!

Three EPROMs, each 2K x 8 bit, provides instructions for key assignment, programming and sequence modes. The machine has 5K x 8 bits of static RAM with battery back-up to facilitate storage of sound patches. A nice spin-off from using a micro is the 'auto-tune' button which fractionally adjusts the key voltages of the 12 VCOs to maintain highly accurate pitching. This is achieved by digital comparison between the master clock and the tone oscillators. Polyphonic sequencing is achieved by digital recording and playback of keyboard data.

The synthesiser has 12 VCO, 12 VCF, 12 VCA, 24 EG and 2 LFO functions. The individual tone generator blocks are essentially similar to the earlier CS range. However, the CS70M oscillators are a new design with far better tuning stability.

Each channel has a grey 'manual' button which makes available all the controls for one single VCO, VCF, VCA synthesiser, with extensive LFO modulation facilities. Using these 39 controls, a new sound can be programmed (or an existing sound edited) and stored in one of the 30 memories. The built-in memory has battery back-up for storage when the synthesiser is switched off. Alternatively programs can be loaded on to a magnetic data card for future use.

Another versatile feature is that any one of the programmed sounds can be put into 'edit' mode (even in keyboard split mode), so that its parameters can be altered using the manual controls. No information stored is changed until you actually move a yellow slider or touch a grey button in the programmable section and no change to the original sound will be made unless you 'write' the information in. A clear indication of edit mode is given by the flashing LED on the program button selected.

Sequencer and additional control facilities.

Programmable Parameters

The synthesiser section is almost completely digital in its control. You can hear this as you adjust e.g. volume by its stepped changes.

The sliders and specially designed touch buttons (with LED indication of their selection), can all be used to make the polyphonic synthesiser sound. The VCO section offers sine wave plus square wave, with up to 50% pulse width adjustment (manually or through modulation), or sawtooth wave, and noise is provided as the third mixable sound source. Oscillator basic pitch is chosen from 16, 8, 5⅓, 4, 2⅔, and 2 foot for both Channel 1 and 2 so that useful pitch mixtures can be obtained. These are selected using special sliders that have 'click-stop' positions.

Next we have Yamaha's very smooth filters which can be in low pass, band pass or high pass mode. The usual filter controls are available for setting attack, decay, release times and sustain level (ADSR) with variable EG depth, cut-off frequency and resonance sliders. The resonance in conjunction with cut-off frequency will give a very useful harmonic sweep without actually going into oscillation. ADSR times can be multiplied by 5 and the envelope generator shape it produces can be inverted to give maximum tone variation. I missed the CS50/60/80 layout of high and low pass filters here — they gave some superb tonal changes which are not possible with this new more usual arrangement.

The VCA has its own ADSR controls (with x5 option) plus a volume slider, positioned correctly at the far right as the final setting for the programmed sound. There have been some 'programmables' without this, yet it is essential for quick matching of the 30 presets to the desired levels in performance.

The LFO section is most comprehensive and gives a great many modulation possibilities, probably derived from the CS30 synthesiser. There are six basic treatments that can produce modulation and these can be sent to one or more of the four main 'destinations' — to change VCO pitch, to give pulse width modulation, to change VCF tone and to modulate the VCA.

LFO speed can be adjusted to give a steady modulation between one cycle every 10 seconds and 100Hz — a range that's wide enough for most performance purposes. In addition, the LFO speed can be made to speed up and slow down by use of the attack and decay time sliders respectively. Increasing the EG depth will give progressively wider variation of the basic 'speed' setting of the LFO.

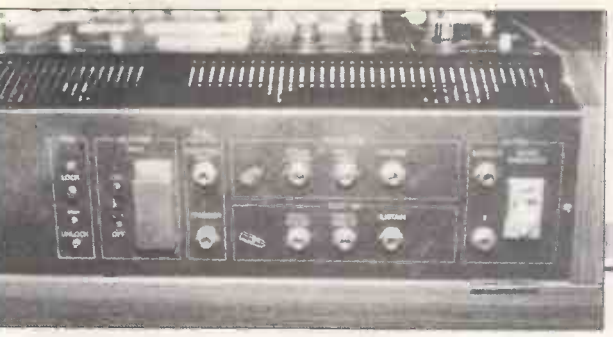
The amount of modulation that takes place can be programmed and the six modulation effects are sine wave, sawtooth wave, sample and hold, ring modulation and upwards or downwards glide to the notes played.

Non-Programmable Controls

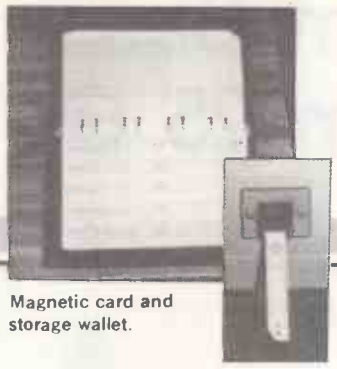
In the sections so far mentioned, all the controls are programmable and will be remembered on the chosen preset button. Other non-programmable controls provided includes a fine tune rotary control for LFO speed, a 1 or 1 + 2 select button for the LFO modulation, and a pitch modulation 'wheel' select button that overrides an extra LFO section (mentioned later) and sends the main LFO to vary the pitch of channels 1 or 2 or both. A 'hold' button keeps the VCA open for continuous playing of the synthesiser sound.

The balance between channels 1 and 2 can be adjusted and the overall filter tone brightness can be increased or decreased using the 'brilliance' slider. 'Sustain' can also be further extended from the programmed setting and the superb polyphonic 'glissando' effect is featured in addition to portamento, with variable jump time from one chord to the next. There is a further 'Master Volume' with a sound on/off switch for setting output levels to your mixer or amplifier.

In the Pitch Modulation section, to the left of the keyboard, a second wheel lets you 'play' the pitch between octave, fifth and third limits.



Rear connections.



Magnetic card and storage wallet.

Demonstrated by top Yamaha musician Dave Bristow on E&MM Cassette No. 5.

In Use

During setting up, the synthesiser outputs two voices, so if you're programming a new sound (or editing an old one) it's best to put the balance slider to the channel you're working on.

This dual system, operating from 15 presets and the panel, really stretches the sound creating possibilities. For example, a whistle can have its 'chiff' accurately set on Channel 2 without altering the basic whistle envelope and tone shaping parameters, which are obviously different, on Channel 1. Not only can dual pitch and tone combinations be used but, because of the 'stereo' output facility (Channel 1 = Left, Channel 2 = Right) you can create exciting panning and spatial changes, and complex sounds such as strings can be really exploited.

Programmable Split Keyboard System

The keyboard itself offers further scope for expressing the player's music. In 'Split' mode the CS70M's keyboard divides between the second and third octaves so that channels play separately for left and right hands. You can also choose another split point by simply pressing the 'split' key as you select the split mode switch. Since only 6 notes maximum are obtainable in the synthesiser, a choice of 2 or 4 notes for upper or lower split (and vice versa) is given. A 'unison' mode puts all the 6 notes on one for a very big sound — although in practice the normal dual channel mode over the whole keyboard is sufficient to give the same kind of effect.

Yet another important aspect of the keyboard is its touch control. Once you've played with touch/pressure sensitive keyboards (or indeed, learnt to play on the piano as most of us do) then this becomes an essential facility. Surprisingly on a sophisticated machine as this certainly is, the areas of control which come from pressing the key harder — the VCO, VCF and VCA — using the 'After Touch', are mixable but all at the same sensitivity. Although the overall pressure sensitivity is adjustable, using a rather out of place miniature rotary pot, it is quite a disadvantage not to be able to give e.g. a little pitch vibrato and tonal 'wah' whilst achieving a big dynamic change (back to the CS80!).

The after touch controls form part of a second LFO section, in other words, you're not just opening the VCF, VCA or VCO pitch — you are of course modulating it by the amount of pressure you apply to the note. There's a metal bar under the keyboard which operates a photo cell to give a varying control voltage (so pressing one note hard modulates all the others being played). This simple mechanism does work well and gives precise depth control once you've improved your playing technique!

LFO modulation 'speed' and waveshape (sine, sawtooth and square) can be chosen and routed at the same time or separately to the pitch modulation wheel and/or a foot pedal. This is a nice extra in that 2 LFOs effects such as slow PW modulation and fast vibrato can be used.

The usual tone control for overall pitch setting over a few semitones is provided, plus a Channel 2 'detune' that makes brass, strings and piano sounds much richer. I am surprised that Detune cannot be programmed — it's vital on many sounds. Incidentally, retuning with the autotune button takes merely a second without affecting the mode, program etc that you're using at the time. It's certainly the quickest tune-up in the business!

One more effect to go before we reach the sequencer. It's called 'Chorus' and is taken directly from the SK20/50 series to give 'Ensemble' (3-stage phased delay) that's essential for strings, and slow/fast tremolo for chorale and Leslie effects especially useful with an organ type of program. It has limited use with bright synthesiser sounds in ensemble mode as it reduces the upper bandwidth and definitely adds extra hiss to the signal.

4-bank Polyphonic Sequencer

Where there's a micro there's usually RAM and Yamaha makes use of both these items with the sequencer. Becoming more and more part of the 'high class' family of polysynths, the sequencer can memorise up to four different extracts played in real time on the keyboard — all with up to 6-note polyphonic playback if desired. What is innovative, is that if less than 6 note 'events' are used in a sequence, then the remaining voices can be played manually. In the split mode, you can play different pairs of voices with the sequencer and your hands.

No battery back-up means you approach this sequencer as a live performance facility — play a sequence once and after that just have fun playing your solo (or bass and lead) with it! It opens up new ideas in playing technique especially using the tempo control (and x2 button) to speed up 'events' faster than you can normally manage.

A sequence can be repeated for as long as you want and if set to CV only mode, it triggers presumably from the keyboard, or via the clock speed (tempo) set. 'Record' and 'Play' buttons operate the system and sequences A, B, C, D when recorded will play back in that order automatically. Hitting the play button at the right time at the end of the sequence is essential to keep the basic tempo correct when repeating.

There are 180 events (holding note pitch and on/off times) possible for each sequence. When you're reaching the end of the memory, the LED on the sequence button flashes. A busy 4-6 note chord sequence lasts only a few bars, so middle 8's and longer sequences have to be shared out, but a stored melody or bass line can be quite long. It's not really any problem on stage as the short sequence is all you need with the 'repeat' button in use, but its application in the studio situation would be more for repeating polyphonic sequences rather than recording a complete piece (especially as you can't take the instrument into a session with stored sequences).

If you're doing a single riff it's nice to do it in different keys on each sequence button so you can change keys during an improvisation just when you want. Or you could use the pitch wheel to do the same thing using one sequence only! Of course, the sequence can be replayed on any of the programmed voices. Doubling up with the 'x2' button is interesting too!

Rear Connections

Some interesting developments here. Besides the usual outputs jacks (including balance XLR mixed output), there's foot control sockets for modulation depth, brilliance and volume, and foot switch sockets for sequencer start, portamento and sustain. But more important is the provision of solo output control voltage (operating from highest note played) plus trigger, so that any Yamaha (or Korg) synth with external CV and trigger inputs can be played at the same time.

This extra control of 'mono from poly' is a feature on the new Yamahas and certainly emphasises their concept of 'one keyboard plays many instruments'. Yamaha take this a step further with a multiway 'keycode' input socket that allows you to play the CS70M from another Yamaha that has a mating output socket. To date, this means the SK30 and SK50D. I had visions of linking up my micro to control the synth but no circuitry, cable link or advice is available as yet.

Finally, as with most programmables, a lock/unlock switch is tucked away on the rear to protect all those precious programmes you've forgotten to store on magnetic card.

To sum up, the CS70M is exactly what it is meant to be — a first class performance instrument that has all the quality expected of Yamaha.

With 30 presets on board and a wallet of sounds in your pocket you should be ready for the charts! Touch sensitivity and sequencer are great facilities although other extras such as case (or lid), stand (music or legs) are not available. Its recommended price is £3,479 inc. VAT and foot pedals and switches are optional extras which can turn out to be expensive if you want to have as many as Rick Wakeman! Don't miss the chance of hearing it played by Dave Bristow on E&MM Cassette No. 5.

Mike Beecher **E&MM**

The CS70M is distributed in the UK by Kemble Organ Sales Ltd, Mount Avenue, Milton Keynes, Bucks MK1 1JE. Tel: 0908 71771.

Vox Custom Bass and Custom 25 Guitar

Vox amplifiers have been popular since the days of the Beatles; after all, with dozens of top players standing in front of their distinctive diamond grille cloths, how could they fail? Vox guitars, however, have not enjoyed the same level of esteem despite being used by several well known groups. Although Vox originally produced cheap beginners instruments, the early 1960s saw this company making some worthy professional guitars, notably the unusually shaped 'phantom' models.

The new Vox company, revitalised by Rose-Morris, have reintroduced the amplifiers to a new generation of musicians; rather than bring back the old guitar designs, however, they have started from scratch.

The guitars are all passive, relying on cunning pick-up switching rather than battery powered pre-amps to get a wide range of sound. The circuitry is, in fact, the responsibility of Adrian Legg (now where have I heard that name before?).

On the physical side, the six string guitars are available in two scale lengths, 24¾" and 25½". There are Standard and Custom versions of the guitars in each scale length, plus a Standard and a Custom bass, both long scale (34").

To clarify this question of scale (the length of the strings between nut and bridge) it may be helpful to note that Gibson guitars are generally 24¾" scale, whereas Fenders are 25½"; in fact, the Vox Standard 25 looks suspiciously like a Stratocaster copy to me.

It is generally thought that long scale guitars give a better sound, and have less floppy strings, due to the higher string tension; however, no manufacturer makes a guitar with a choice of scale length, so accurate comparison is difficult. Vox are no exception to this, since the long scale guitars are a completely different style to the 24s. Players will probably make their choice according to which body design they prefer, whether or not they want a 'tremolo' arm, and similar reasons unrelated to scale length.

The Custom Bass

This is a very attractive instrument, as you can see in the picture, although it's a pity it has that stripe running down the middle. The bass is made almost entirely from maple, about six pieces at a quick count; the three piece neck is laminated right through the body (hence the stripe) and has a separate fingerboard. The only non-maple bits of wood are four thin walnut slivers, two between the three slices of the neck and two between the neck and the halves of the body. The section of the neck which forms the

middle of the body has been made extra wide so that the pick-ups and bridge can be mounted entirely on it; although the 'all one piece of wood' concept is foiled by the neck being in three pieces.

The neck is nice and straight, especially considering its length; it has 24 frets, all accessible thanks to the smooth heel — one of the advantages of neck-through-body construction. What's more, all these frets are useable since the intonation is excellent right up to the top G, with only the E string being out. Along with the slim neck section, this means you can play chords right up to the end of the fingerboard if you wish; which is very handy if the lead guitarist falls off the stage in the middle of a manic solo.

The length of the neck could be a slight problem. Because the body doesn't have extra deep cutaways to allow the neck to be set further in than usual, that distinctive Vox 'spear' headstock is quite a long way from the player. Not only do you have to stretch a bit more than normal to reach the machine heads and the lower frets, but as you swing around in a cramped rehearsal room you are quite liable to lay out your guitarist, who has just bought a Roland guitar synth and is suggesting that you are now redundant . . .

The bass has been designed to give lots of sustain, which it does; in fact it's quite difficult to stop the strings vibrating! The bridge is creditably heavy, and the strings are fed through from the back of the body, causing some strain where they bend sharply over the bridge pieces. As an example of the attention paid to this guitar, it arrived already set up to play (the bridge is adjustable for individual intonation and string height); the Schaller style machine heads all worked smoothly; there were no sharp fret ends — all in all, very well put together.

There are two pick-ups, both DiMarzios: a P-bass type at the fingerboard end and a J-bass at the bridge end. Both these pick-ups have two coils, and are humbucking; a switch gives series or parallel connection of the coils and operates on both pick-ups simultaneously. In my opinion, the parallel position simply sounded weaker and I hardly used it. There is a third position on this switch which combines a bassy sound from the E and A strings, via the P-bass pick-up, with a treble sound from the D and G strings via the J-bass pick-up. This gives a great sound for playing alternate octaves, with a different tone on the two notes; however, this only works with the pick-up selector in the middle position — if it isn't two of the strings go dead, a most embarrassing effect!

My favourite sound was with both pick-ups on, and the coils in series. The depth and power of the P-bass pick-up combines very convincingly with the 'bite' of the J-bass pick-up, although I would have preferred separate volume controls to allow mixing of the two sounds. There is only one overall volume control, and a tone control which doesn't have as much range as that on a Precision but is still quite adequate. One last word on the electrics: the jack socket is on the side of the body where you can't see it, and although there's a metal surround, fumbling with your lead as you leap on stage to a thunderous ovation could play havoc with the 'attractive honey polyester finish'. It also causes nasty noises to come out of your amplifier.

The bass came with round-wound Rotosound strings, a good match; clangorous on full treble, and very effective on chords and 'lead' playing. This is the area the instrument is aimed at, I think: it's very definitely a rock guitar, designed to appeal to the new breed of 'out front' bass players. Your fingers seem to fall naturally on the upper frets (a deliberate design point, I wonder?).

To sum up, then, although the bass has several fashionable features (like a brass nut, which I won't even comment on) it is very well made and the overall feel is excellent. I enjoyed myself immensely, playing things I would normally only do on lead guitar. Worth every penny!

ROCK SOLID

Let us introduce you to the sensational range of solid body guitars from a name almost as old as rock itself – VOX.

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Three ranges of guitars were designed and exhaustively tested by musicians and our electronics wizards.

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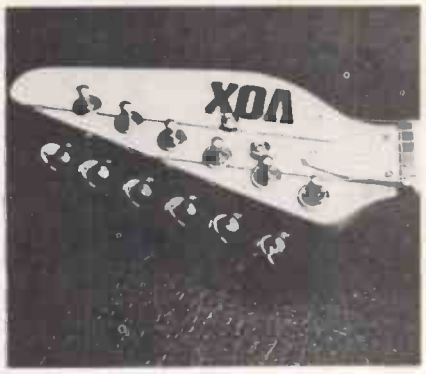
The Custom range of instruments were created for the performing artist whose fine technique would recognise a unique guitar. The two models available, both crafted from the best Hard Rock Maple, are the Custom 24 and Custom 25. Both models are fitted with the fabulous new Di-Marzio X2-N Power Plus pickups as standard, and are linked with

the most inventive electronic circuitry to give a tonal capability that can only be appreciated in performance.

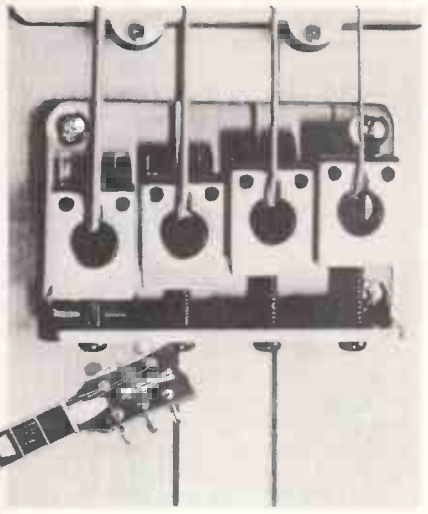
The two model Bass range, both of 34" scale length, have been designed to incorporate the very latest technology. The Standard Bass has a full specification

THE SENSATIONAL NEW VOX GUITARS



Custom 25 headstock

Di-Marzio P-Bass pickup, dual sound switching and is offered at a stunningly low price; while the Custom Bass,



Custom Bass bridge

constructed throughout from the finest Hard Rock Maple, has Di-Marzio J and P-Bass pickups controlled by a unique mode switch. All the hardware, including tailpiece and bridge are mounted on an exceptionally wide through neck for the ultimate response.

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VOX

Vox Custom Bass and Custom 25 Guitar

The Custom 25 Guitar

Referring back to the picture a moment, it's obvious that the guitar is constructed along the same lines as the bass, with a 'sandwich' of maple and walnut stripes; there are 24 frets once again, with good access all the way to the top E thanks to the cut away heel which you can't see in the photograph. I won't cover these points again therefore, and all of you who skipped the bass review, thinking that basses are just guitars that are easier to play, will have to retrace your steps. This guitar also sports a vibrato arm, which screws into a hole in the bridge; unfortunately, not only do the threads start right at the top of the hole, but the hole isn't vertical as you would expect it to be. For these reasons, it is very easy to try and cross the threads on your first few attempts; you get used to it though, you have to, because the guitar won't fit in its case unless you remove the arm. A simple plug in arrangement, perhaps with a nylon bush to give a bit of friction, would be preferable. In case you think I'm struggling to find something bad to say in order to seem unbiased, you're right, because the rest of the guitar is simply perfect.

To be honest, I was going to make scathing remarks about the way the vibrato arm only drops the pitch of the strings, but I've had second thoughts. Normal string bending can only raise the pitch of a note, of course, so the arm complements this nicely; also, this arrangement means there's no chance of breaking any strings by stretching them too far.

Tuning up is also made much easier, and there are no problems if a string does break. The bridge works very well, anyway, and I found it nearly impossible to detune the guitar no matter what I did to the arm. All the normal adjustments are there; this is a Stratocaster style bridge with individual string intonation and height adjustments, and making the vibrato work both ways is simply a matter of removing one or two of the springs that counteract the pull of the strings.

After I saw the initial information on the guitar, I was all set to be rude about the lack of switches; pick-up selector, two volumes, two tone controls and just one other switch? Why, I wondered, were they going on about the versatile circuitry? Once again, actually playing the guitar has changed my opinion.

The little card provided with the Custom 25 explains everything, but this is one instrument that allows you to get a good range of sounds without knowing a thing about how the system works; I gave the guitar to two non-technical members of my band to prove this point, and neither had any complaints on this score.

The single extra switch has three positions, which work simultaneously on both pick-ups, giving normal humbucking (with the coils in series), humbucking with the coils in parallel (more treble) and single coil (even more treble). Secondly, the bridge pick-up tone control also operates a partial tap on the coil nearest the bridge when turned to maximum treble; and finally, both

volume controls have small bypass capacitors. This means that when the volume is turned down a little, treble frequencies tend to go straight through and the result is a treble boost (or a bass cut depending on your point of view).

When both pick-ups are on, however, the fingerboard pick-up is un-bypassed; so this pick-up may now be used at reduced volume to add power to the bridge pick-up without contributing any extra treble of its own.

In short, the controls are cleverly designed to do just what you would intuitively expect them to; the pick-up mode switch can simply be thought of as treble boost, and the whole system is easy to use.

The pick ups themselves are DiMarzio X2Ns, which are described as 'loud and nasty'. Loud they certainly are - I measured 12 volts peak to peak when playing hard - and when this signal meets an effects box powered from a 9 volt battery, this is where the nastiness comes in. Either at least 3 volts is going to be chopped off the signal - probably more - or the poor old PP3 is going to be made redundant whilst the guitar powers the effects by itself!

Seriously though, whilst this sort of output is not going to occur during any normal playing, some poorly designed effects and amplifiers are going to be given a hard time. One advantage of such powerful pick-ups is that they may be set further from the strings than usual without severe loss of output; not only does this reduce the possibility of damage by a misplaced plectrum, but it discourages the powerful magnets used from trying to hold the strings still while you're playing. This effect can cause mistuning, completely spurious harmonics or just a generally 'dead' sound.

The price to be paid for such powerful pick-ups is usually lack of smoothness in the sound, and these DiMarzios couldn't compete with my 6dB quieter Gibson humbuckers on that score. By looks alone, of course, this is a rock guitar and its sound matches its appearance.

Having said that, I did manage to get mellow jazz tones, twangy country strumming, and even some nice fingerstyle playing thanks to the wide string spacing and good string tension; but none of these styles were what the guitar was best at.

The solid construction of the body, neck and bridge means that the sustain not only goes on for a long time, but is nicely even over the whole fingerboard. I tried the guitar on several amplifiers, including a Peavey 'Classic' and, of course, the Vox AC30 reviewed elsewhere in this magazine. Each time the guitar gave of its best and sounded at least as good as any other guitar that was around to compare it with. The AC30 was a particularly favourable match; without being distorted, the sound had both power and penetration, which I found really impressive (although the rest of Essex didn't enjoy it at all).

I don't usually play a guitar with a vibrato arm, and I must admit this was the first time I've used an AC30; the combination was stunning to say the least, and playing rock music suddenly seemed much easier. So this is how they do it, I thought, wondering whether rock stars get paid more than guitar reviewers.

Peter Maydew **E&MM**

The Custom 25 guitar and Custom bass are identically priced at £329 inclusive of VAT. Vox products are distributed in the UK by Rose-Morris & Co. Ltd., 32-34, Gordon House Road, London NW5 1NE. Tel: 01-267 5151.

Roland CR 5000 and CR 8000 Rhythm Units

This year's UK Music Trade Show saw the unveiling of two exciting new rhythm units from the Japanese Roland Corporation. Rhythm units have been going through a boom period over the past couple of years. Their attraction relies on their capability to give the musician that 'one man band' facility. The rhythm unit has become the focal point of many a home recording studio set-up as an erstwhile player can now do the lot, without having to get in other musicians, building drum booths, sound proofing etc. One little box will solve so many problems, and nowadays, not only can the rhythm unit be used to generate percussive patterns, but it can also be used, in conjunction with a sequencer, to provide the bass and accompaniment to almost any composition. No wonder Roland now have six different drum machines in their catalogue.

Roland CR-8000.

Microprocessors

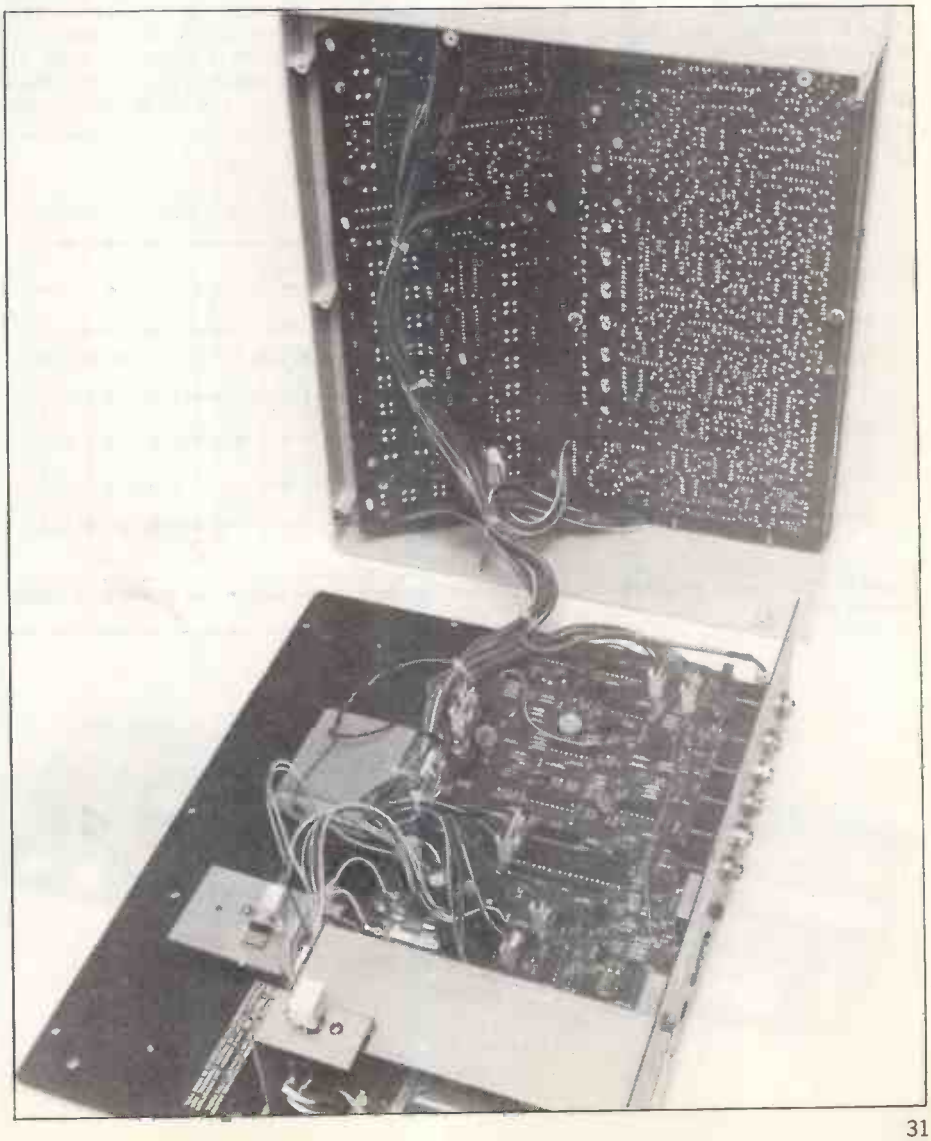
Undeniably, the advances in digital technology led to the total transformation of the rhythm unit's design. If we forget about the voice generation circuitry (for the moment), it is clearly the case that a rhythm unit centres around a control device that provides trigger pulses at exact positions in order to assemble a rhythm pattern or track. Early rhythm machines had very simple ROM — like arrangements generating basic patterns which just cycled round. Now, with the processor controlled units far more complex paralleled pulse trains can be set up — and what's more, they can be user defined, i.e. the units are programmable.

Needless to say, these new Roland machines are processor controlled and both offer programmable facilities.

The CR 8000 at £399, is big brother to the CR 5000 (£299), so let's look first at the 8000, then examine the differences.

The CompuRhythm CR-8000 Micro Computer Controlled Rhythm Machine, to give it its full title, comes packaged in a comparatively small unit. The casework is made from high impact white plastic (injection moulded) with an angled front panel. The controls used consist of rotary knobs (knurled and of various sizes), rotary switches, and push button switches with LED indicators — all of high quality construction. So to look at, and to operate, a smart well designed and fairly intelligently laid out product.

In brief the CR 8000 offers 24 basic rhythm patterns (preprogrammed at the factory), seven preset Intro/Fills, as well as eight programmable rhythm locations, and



Internal view of CR 8000.

Roland CR 5000 and CR 8000 Rhythm Units

four programmable Intro/Fills. The basic rhythm patterns are selected by an 8 x 3 matrix — 8 rhythm buttons, and three bank selector buttons. It is possible to combine two presets in any one bank together for a more complex pattern. There are eight programmable location buttons which can also be combined with one of the preset rhythms if required. The preset patterns include all the old favourites — Waltz, Swing (2), Slow Rock, Tango, Enka, Habanera (?), Rock (6 different ones), Disco, Foxtrot, 8 Latins, and an unusual one marked BD-4, which gives a straight 4/4 Bass Drum beat — yup! that's 24 in all.

In addition to these preset and programmable rhythms, Roland have come up with a new section known as the Arranger. It's really very simple; there are a series of eight push buttons that will either modify or introduce a preset instrumental pattern to the basic or programmed rhythm selected. Seven of these buttons will modify with a Cymbal-4 (a 4-beat cymbal), Cymbal-8, High Hat-4, High Hat-16, Open High Hat (an 8-beat off the beat), a Hand Clap, and a Conga (a mixture pattern of low, mid and high congas). For those that are counting, the eighth button, marked Shuffle, can be used to transform most preset patterns to a Shuffle beat. So this Arranger section is a handy little feature.

I soon found that by combining the BD-4 preset with the Arranger's Hand Clap that it was possible to produce that awful rhythm track that accompanies those ghastly compilation singles that seem to have infiltrated the music charts recently (though I shouldn't let my musical preferences creep in here).

The Intro/Fill Section is indeed a useful tool, it can be used both manually and automatically to provide an introduction pattern or to break up the cycling basic pattern. If you have a unit that doesn't have any form of fill facility, then the overall effect can become very monotonous. With the CR 8000, it is possible, in manual mode to select how much of the fill you want, this is dependent on which part of the cycle the manual fill button is depressed. In automatic mode the complete fill rhythm comes in every 2, 4, 8, 12 or 16 bars.

Programming

As with all the rhythm patterns, there are two measures available, and each measure is divided up into 16 (or in the case of Waltz, Swing etc: 12) steps. For the programmable Intro/Fills, there is but one measure. To program a pattern is simplicity itself. The Program mode switch is moved from Play to Basic (or Fill In), and a percussion voice selected. Two buttons are then used to step through the 32, or 24 steps, one tells the unit to register a 'hit' for that step, the other indicates a rest. When one voice line is recorded, another instrument is selected and that line programmed. Any number of instrument tracks can be used, though for best effect I found it advisable to use just five or six, otherwise things become a bit cluttered. Figure 1 shows how a pattern can be programmed. I suppose that I should point out that there is a battery back up installed in the unit, so all the patterns are memorised when the unit is disconnected from the mains.

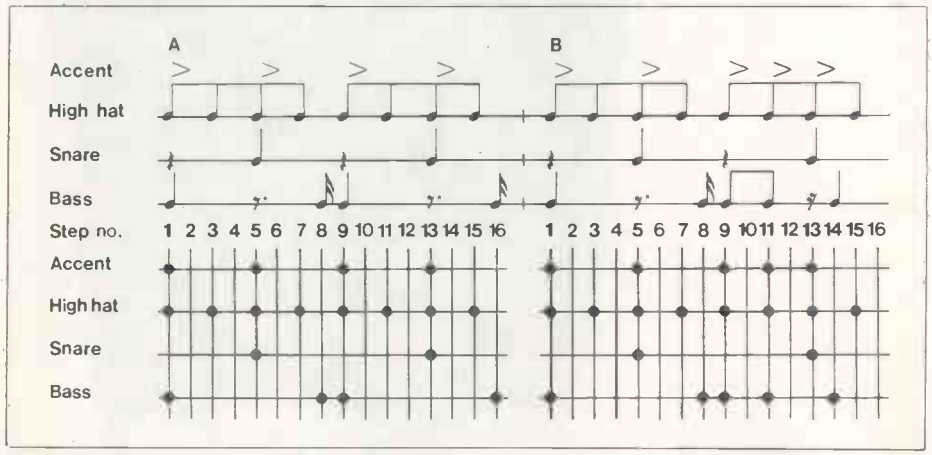


Figure 1. The 'Rock 5' Preset Rhythm broken down into steps — this pattern can be heard on E&MM Cassette No. 5.

The Analogue Voices

There are 14 different percussive voices on the analogue voice card of the CR 8000, and the quality of these simulations is excellent. Roland have produced a masterly Hand Clap voicing, as well as some excellent cymbal/hi-hat sounds using, as I understand it several ring modulation circuits (though unfortunately diagrams of these units' circuitry are as yet unavailable). Roland pioneered the Open-Closed Hi-Hat effect, which is so important when trying to simulate an acoustic kit. There are six independent voice volume controls (some voices share a single control) thus enabling the 'kit' to be balanced as desired. In addition there is an independent Accent control which can be used to emphasise certain beats in the bar (as programmed or preset).

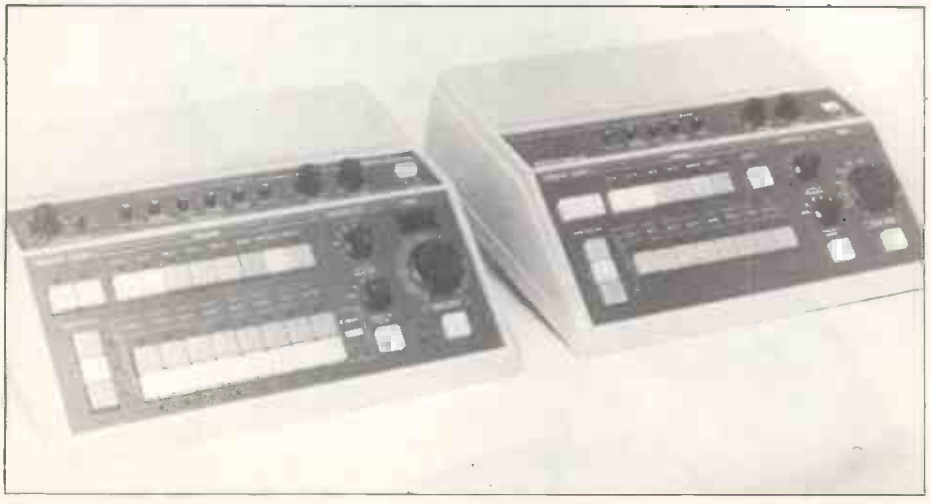
I should mention the extremely useful LED numeric readout included on this unit, which enables the number of beats per minute to be selected just by the turn of a knob.

On the rear panel are sockets providing: trigger outputs; the DIN interface connector common now to many Roland products, and carrying Start/Stop, and Clock information; and surprisingly, just a single mono audio output. I would have liked to have seen either a stereo output, or separate output jacks for certain percussive voices.

The CR 5000, which is a hundred pounds cheaper, doesn't offer any programmable features or an LED tempo readout, otherwise with the omission of the Hand Clap voicing, it is similar to the CR 8000.

It goes without saying that these units are beautifully made, both internally and externally, and that Roland will undoubtedly do well with them, though whether they can match the success of the earlier CR 78, only time will tell.

Dave Crombie **E&MM**



The Roland CR 8000 and CR 5000 rhythm units.

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Vox AC30

If I were to ask for anyone not familiar with the name (or memory) of a Vox AC30 to raise their hands, not many metacarpi would grace the sky! Many modern musicians probably remember cutting their teeth on a "Vox box", stacked up on beer crates, between the inevitable piano tuned to concert pitch and a juke box — good old days!

I was surprised when asked to review a Vox amplifier; I was expecting something totally different, up to the point of unpacking. I believe they say "surprises always come in great heavy packages", so here goes.

Cabinet

The 27" x 20" x 10" cabinet was neatly hidden beneath a black plastic cover with three cut-outs for the handles. Removing the cover showed these carry handles to be of a heavy-duty suitcase type mounted on top of the cabinet; one at each end and one in the centre.

Black grained, cloth backed plastic material covers the ¾" chip board and plywood construction. Edge facings and corners are radiused, but the eight plastic corner cups are destined for an early retirement. Metal fittings would be stronger. The front plywood speaker baffle board is fitted to an internal one inch square wooden frame work. Two sides are doubly secured to the top and bottom panels using four large corner wedges; very strong, and necessary for taking the weight when carrying. A double panel open back construction allows good airflow, but does nothing for standing waves. Of course, wires and attachments can be neatly stowed away inside without hassle, along with the drummer's broken sticks and empty cigarette packets.

Around the front, a large gold finished plastic Vox motif cheers things up a bit, along with a gold strip separating the baffle covering from the traditional diamond pattern speaker cloth. Completing the aesthetics is the inevitable white edge trim. Three recessed plastic ventilation grilles and a lengthy control panel complete the cabinet top, and the 70lb baby stands proudly on four rubber feet. Perhaps castors would have been better, instead of feet, to prolong an active spine.

The overall visual impression one receives is of a clean, straitlaced, nononsense, get down to business amplifier and indeed, that's just what the AC30 is.

Controls

Recessed in the back of the cabinet top lurks a control panel sporting an array of sockets and pointer knobs. The panel is finished in RAF grey with trim and legend in gold. Musicians are obviously intended to stand behind the amplifier when reading the control descriptions. As most of us would perform in front of the stage, with cabinets stacked behind, a good memory of control positions is essential, if twisted necks and injured drummers are to be avoided.

Looking at the controls (from behind) from left to right; we have two vibrato/tremolo channel input sockets, two normal channel input sockets and two brilliant channel sockets.

All input jacks are standard 0.25 inch fitting. The outer three sockets are high impedance inputs (not indicated!) rating 250k; while the inner three sockets are of lower impedance, rating 68k, and of lower sensitivity.

The first two rotary controls are vibrato/tremolo speed and effect select. Three volume controls follow, one for each input channel, and tone correction is provided for with treble, bass, and separate treble cut

View of the control panel from behind the amplifier.

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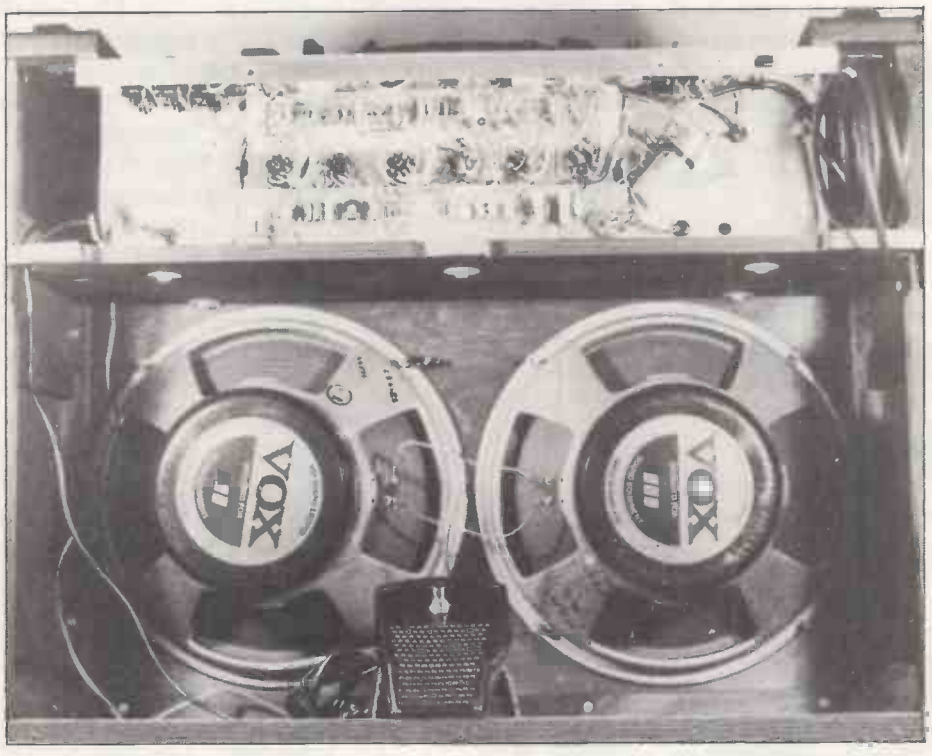

View of the back with covers removed.

controls. A chrome toggle on/off switch controls the volts, a red LED serves to indicate switch on, while a panel mounted 3.15A fuse monitors continued good behaviour.

After removing the rear cabinet covers I discovered the 220/240V voltage selector switch, mounted on the chassis beneath the control panel. A small recess had been made in the top back cover, into which the switch slider fitted. Finally, control of the effects was via a remote footswitch, complete with eight feet of connecting cable, and wired directly to the amplifier.

Visually, the control panel appears drab and somewhat austere, probably due to the black pointer knobs and dark colours used.

Circuitry

The AC30 has an all valve line-up using such stalwarts as five ECC83s, one ECC82 and four EL84s. Obviously one way to achieve true "valve sound". All valves, except for the EL84s which are retained by spring clips, are fitted with screening cans. HT rectification is by four silicon diodes and large 450V reservoir capacitors. Valve bases are wired to two small PCBs holding biasing and coupling components. A massive output transformer couples the amplifier to two eight ohm speakers connected in series. I must admit, they look very much like Group range Fanes complete with VSL labels glued on.

Vibrato and tremolo are the only effects built in. Tremolo (amplitude modulation) has preset depth as has the vibrato circuitry. Modulation rate (speed) is variable from four to twelve cycles (4Hz to 12Hz) but I would prefer a slower rate (1Hz) for a chorus quality. A rotary switch selects either effect (with a loud plop).

The effect foot switch cable along with the speaker wires are longer than required, to allow removal of the substantial chassis without disconnecting everything. The chassis bolts on to a 10mm plywood base and slides into place from the rear of the cabinet. Two wooden wedges support the chassis at each end, and tighten up to hold everything in place. Access and removal for servicing etc is simple and fast; often a problem in some units, but not here.

Test Results

Power output: 33W RMS into 16R
Distortion: 5% THD @ 33W, 1kHz
1.5% @ 18W (-3dB), 1kHz
Input sensitivity for rated output:
(Normal and vibrato channels)
High = 15mV, Low = 30mV
(Brilliant channel)
High = 10mV, Low = 20mV
Power bandwidth: 15Hz to 12kHz (-3dB)
(Brilliant channel): 400Hz to 15kHz (-3dB)
Tone controls —
Treble: +14dB @ 10kHz
(brilliant channel only)
Bass: +10dB @ 100Hz
(brilliant channel only)
Cut: -3dB @ 1kHz
-23dB @ 10kHz
Input overload margin: +16dB (100mV)
on normal input.
Hum and noise: -45dB, volume at maximum.
Vibrato/tremolo speed: 4Hz to 12Hz.

The Sound

Plug in, switch on and . . . where's the noise? Being spoilt with modern "instant" technology, I forgot that valves prefer a gradual start to the day. Time for a quick coffee and tune up the old guitar. The statutory ten minutes passed and all was ready, judging by the quantities of hiss, hum and heat in the room. Switching the tremolo off, along with turning back volume and treble controls, removed much of the problem.

First I plugged in to the vibrato/tremolo channel, and played a few bars with tremolo effect on. The going is pretty heavy without control of depth and I developed a feeling of motion sickness, but nevertheless, the effect works adequately. Switching to vibrato gave an effect similar to a weak tremolo, almost not there at all. Perhaps this particular sample needs a bit of tweaking, or an input signal rich in harmonics such as a synth or organ. So, not over excited by the effects department on this one. Incidentally, the bass and treble controls have no effect on this channel.

Changing inputs to the normal channel produced a richer sound with increased depth over the previous channel. Winding up the volume control produced a fantastically loud over-driven sound, and good smooth sustain without signal break-up, so often apparent in transistor units. (Back to the old valves versus transistors battle!) As before, tone controls were inoperative on this channel, but who needs them? Great, plenty of drive, a degree of top cut and filtering ideal for good rock and blues guitar work. This amplifier produces a sound output apparently closer to 100 watts than to 30 watts, and certainly had not lost any of its ancestor's performance.

Finally, I tried the brilliant channel. As the description implies, this one has better high frequency response, and control of bass and treble at last. Full treble boost also cut bass response here, but adequate control of range exists and both controls could be used very effectively, if not excessively. The top cut control could be adjusted from a flat response up to a point where everything above 700Hz disappeared, and was operative on all three input channels. So, there we have the Vox AC30. Ludicrously loud, for the stage heavy rocker, tantalisingly tonal for the MOR artiste and destined to keep its place (if not by weight) as a good performer. I wonder if Rose Morris will send me a free sample — Christmas spirit and all that?

Dave Goodman **E&MM**

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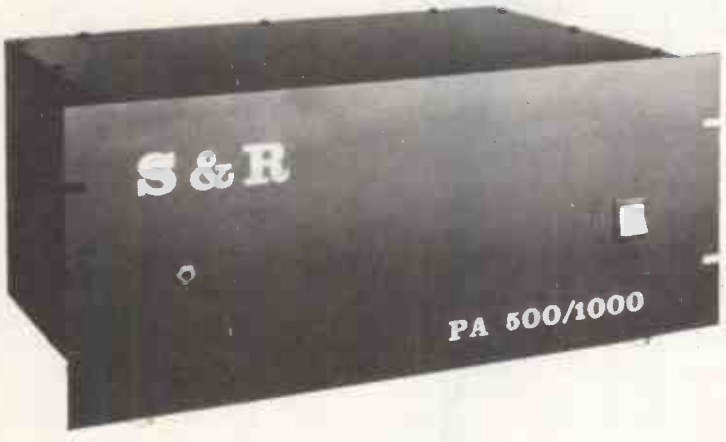

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SOUND ON STAGE

Ben Duncan

Microphones

As with speakers, microphones can be divided into two varieties — those with a flat, uncoloured response and those which sport a judiciously contoured frequency response to emphasise the character of a particular instrument. A microphone which 'sounds good' on the *original* musical instrument — the human voice — usually has a series of 3 to 8dB peaks in the 2·8kHz region, where the upper harmonics lie. This type of microphone is almost universally used, possibly for no good reasons apart from tradition and effective advertising. In the past, microphones with a flat response were very expensive or unsuitable for the rigours of stage use, and so too was the equalisation needed to make them sound anything but flat and lifeless.

Flat microphones have the advantage that their 'sound' and the maximum live sound level that can be attained with them is primarily governed by the versatility of the equalisation controls and the skill of whoever adjusts the knobs. In other words, using flat microphones spells *greater control*, assuming of course that the speaker system is flat. In the real world, however, microphones and speakers with a flat response and versatile EQ circuits aren't cheap, and we usually have to settle for a vocals microphone with a carefully placed response 'bump'. At least with this type of microphone, a 'tasty' vocals sound is available even without equalisation, assuming reasonably uncoloured speakers. The potential drawback of the traditional (i.e. coloured) vocals microphone is not so much the generalised bump in response in the upper vocals region, but rather the existence in the cheaper models of very sharp peaks coincident with this *presence* region, which rise well above the overall 'bump' in the response. Being very narrow (typically only a few hundreds of Hz wide), these peaks aren't particularly audible, but they can easily and surreptitiously incite premature acoustic feedback or howlround. If for instance the microphone has a narrow peak that is 3dB higher than the overall response peak, then the maximum sound level you can achieve will be *audibly halved*, relative to the limits set by the general presence peak. Of course, the general presence peak is also lowering the maximum level of your vocals (and even if you were using a flat microphone, you'd probably still add a presence peak with the EQ) can attain — say by another 6dB — but at least it's contributing to the colour of your voice! By comparison, the narrow peak is stealing half the potential loudness of your vocal delivery and giving nothing audible save ear-piercing howls in return.

Equalisation won't readily repair this hindrance, because its effect cannot readily be limited to the offending response peak; instead, it will remove the whole presence peak which eliminates the premature feedback but possibly at the expense of flat, lifeless vocals! This underlines the need to seek vocal microphones which are devoid of gross and precipitous peaks (as opposed to a generalised 'bump') in their response. Such deviations aren't particularly audible, and short of studying an unbiased frequency response plot for every prospective microphone, one can only choose according to the reasonable assumption that microphones which you have seen or you know are used at high levels on stage are practical tools.

As a general guide, a vocal microphone won't unduly restrict your performance calls for an investment of at least £40 unless you're lucky enough to find a second-hand microphone in good condition. A cheaper microphone *might* suit, but if it doesn't, then you have little choice but to buy another! If on the other hand you invest generously in your microphone, then you can at least be

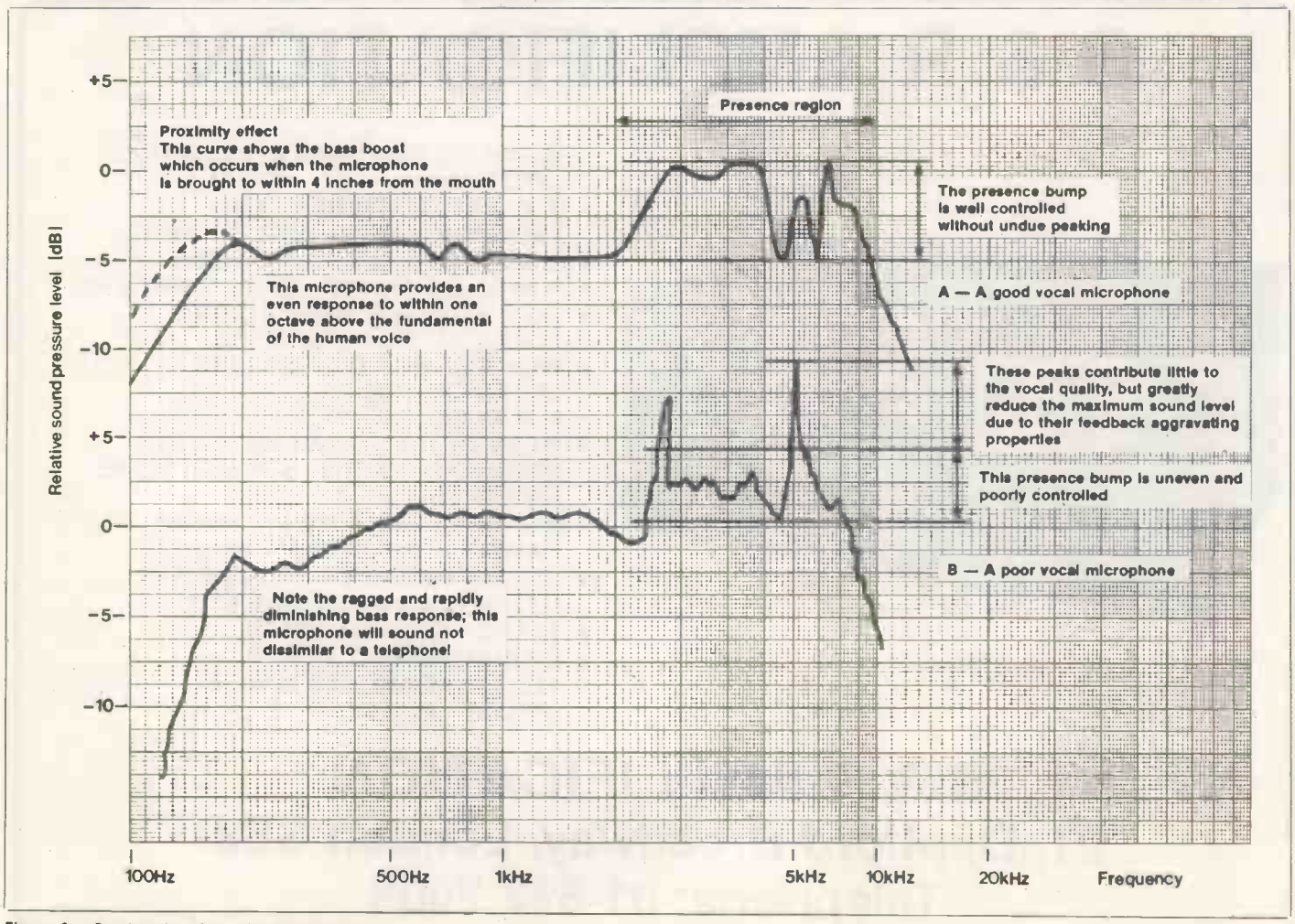


Figure 1. Good and bad vocal microphones.

sure that any lack of clarity or undue sensitivity to acoustic feedback is due primarily to shortcomings in your speaker system — or your voice!

At first glance, the directional properties of a microphone appear to be the crucial parameter that controls feedback. Ideally, we might look for a *unidirectional* microphone that only responds to sounds arriving head on, *viz* from the vocalist, whilst it ignores totally the amplified sound arriving from the rear. This would certainly obviate feedback problems, but lamentably such a microphone doesn't exist, and any *affordable* vocals microphone, regardless of whether it's (mis)described as 'directional', 'unidirectional' or 'hyper-directional' is at best merely biased to be some 10 to 20dB more sensitive over a limited range of frequencies to sound arriving from the front. In other words, directional microphones exhibit only a *generalised tendency* to be directional. Thus the 'anti-feedback' properties of the directional microphone are only a moderate aid — not a panacea, particularly when it's borne in mind that some of the amplified sound 'out-front' will bounce against the rear wall of the stage and enter the vocalist's microphone from the most sensitive position. Nonetheless, provided its limitations are heeded, the directional microphone is an invaluable tool on stage.

An important by-product of directional characteristics in microphones is their general tendency to emphasise the fundamentals of the voice — and other low frequency sounds — when the vocalist works from a short distance. This *proximity effect* increases exponentially from a distance of 6" to 8" and if the vocalist insists on working at zero distance, the vocals will be swamped entirely by muddy fundamentals and explosive breath sounds. A good vocals microphone will be compensated for this effect, by exhibiting bass cut beginning around 200Hz. In competition with the proximity effect, this compensation results in a roughly flat bass response at moderate distance (e.g. 8"). At closer distances, the proximity effect mildly overtakes the bass cut to provide a warm, intimate sound without undue susceptibility to pops and air blasting or outright muddiness — particularly if a windshield is fitted.

Although microphones designed to match high impedance inputs (circa 50k) are acceptable for stage vocals provided the cable lengths are short (< 4 metres), the majority of high quality microphones are designed to match low impedance inputs (200 to 1000 ohms). In addition, the sensitivity of these low impedance models is considerably lower. At the same time, your PA mixer or amplifier is likely to have inputs suited only to high impedance microphones. In an attempt to use a microphone designed for low impedance operation, the results — an abominable lack of sensitivity and excessive noise — are scarcely an encouragement to invest in a high quality mic. with its attendant low impedance!

This setback can be neatly overcome by investing in a microphone matching transformer, which will enable you to use your low impedance microphone as if it were a high impedance model, with the advantage of higher quality and the absence of cable length restrictions. And as most high quality microphones feature balanced terminations (3 wire), which don't suit the average musician's amplifier, the microphone transformer can also usefully feature balanced-to-unbalanced conversion; that is, to convert to conventional two wire operation (Figure 2). Best of all, when you graduate to using professional quality sound equipment, your microphone's performance will remain commensurate with such gear, and by unplugging the matching transformer your microphone will revert to its balanced, low impedance configuration and thus immediately suit your new requirements.

The above considerations apply principally to dynamic microphones. Capacitor microphones feature internal amplifiers, and whilst their output (or *source*) impedance may be low, their output voltage is generally 10 to 20dB (3 to 10 times) higher than the average low impedance dynamic microphone. Indeed, it's often equal to that of the cheap high impedance varieties. It's important to note that it's not an inherently

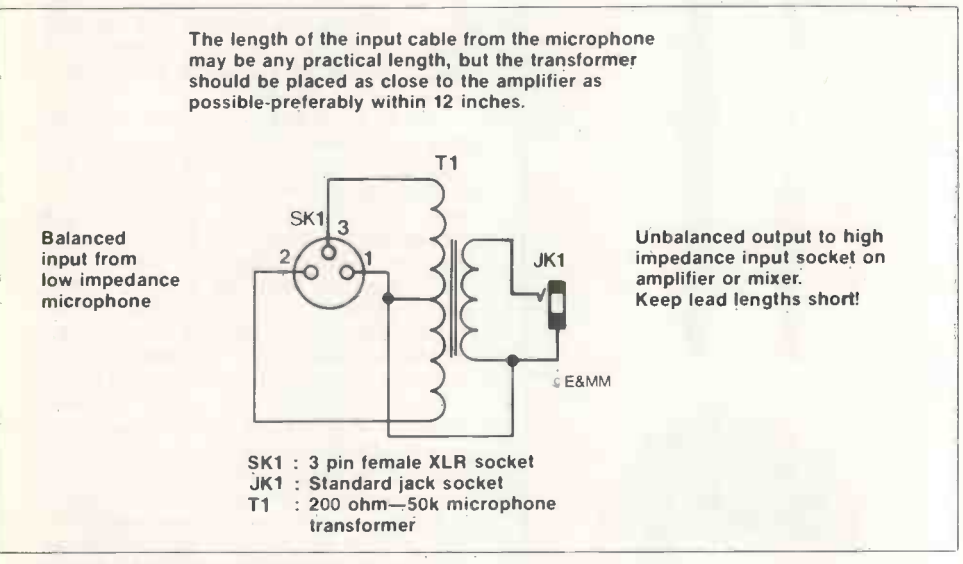


Figure 2. A microphone impedance transformer.

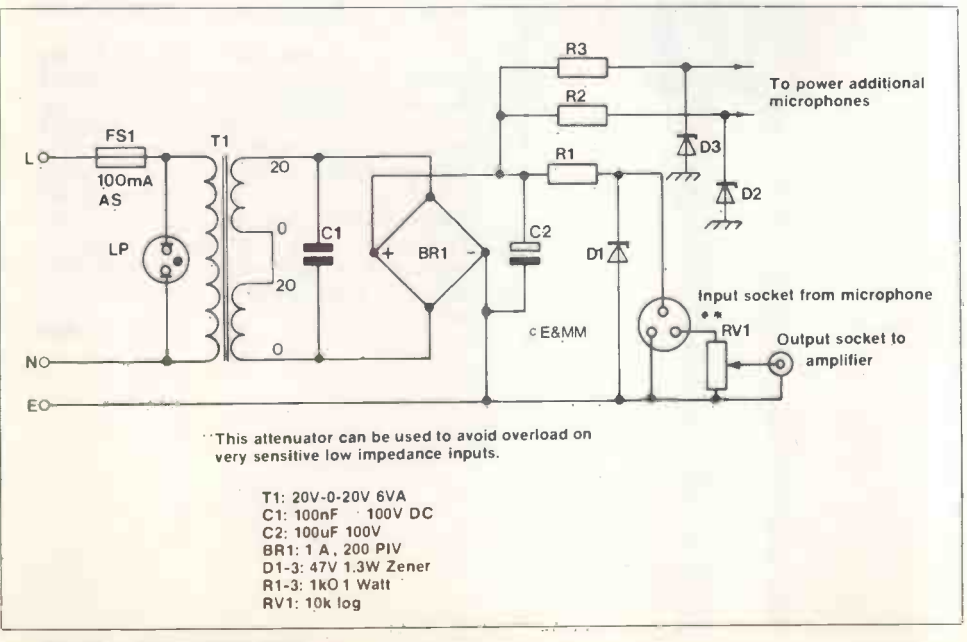
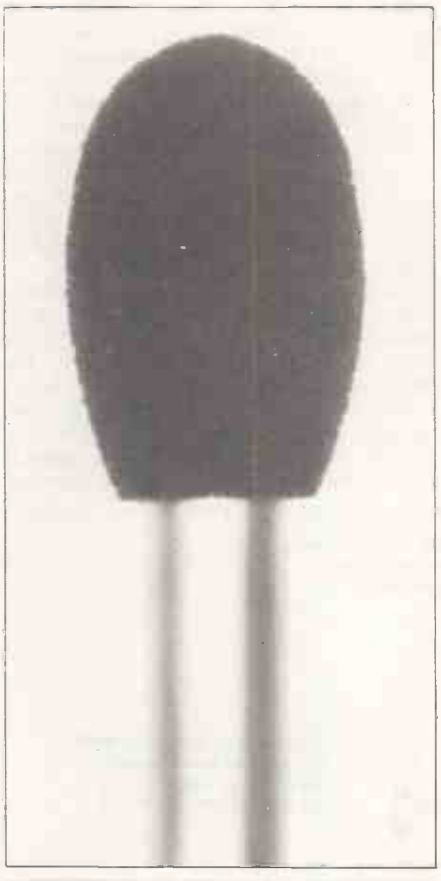


Figure 3. A power supply for Calrec 600 series microphones.

abusive practice to mate a low impedance microphone to a high impedance input; it's simply a noisy and unproductive practice in the context of the minute output of a low impedance dynamic microphone. By contrast, whilst the low source impedance of capacitor microphones is best suited to low impedance inputs for the sake of *nth* degree low noise, they often have sufficient output to mate happily and hisslessly with high impedance inputs. The rugged and affordable Calrec 654/656 vocally compensated capacitor microphones are perhaps the best examples of this species as regards vocals on stage; their high output level readily matches both high and low impedance inputs, and they're widely regarded as exhibiting sound quality that's equal to dynamic microphones costing many times the price. This is hardly surprising considering that the capacitor microphone family encompasses the pinnacle of finesse in microphone technology! The only drawback of capacitor microphones is the need to provide a supply to power the internal electronics; Figure 3 shows a DIY power supply designed to power a number of Calrec CM600 series microphones from a common stage box. A less arduous idiosyncrasy of capacitor microphones is their refreshingly 'crisp' sound, which stems from the presence peak being displaced upwards to the 10-15kHz region; a characteristic that particularly enhances the overtones of certain female vocalists!

Microphones in practice

Unless you aim to emulate Sid Vicious, it's unwise to copy willy-nilly the microphone technique displayed by many well known Rock vocalists. Too often they try to eat the microphone, with the simultaneous emission of blood-curdling 120 decibel screams! Few vocal microphones or PA systems can be expected to give sympathetic rendition under these circumstances. Yet vocalists often have good reason to shout into their microphone at zero distance: throughout their career, the acoustic feedback threshold has either been so low or the guitarist(s) have been so loud that an audible vocal level has been impossible without recourse to gross countermeasures. (Possible countermeasures against noisy guitarists and feedback prone PA's will be studied later). When, at the peak of their career they meet a well designed sound system, the bad microphone technique suddenly becomes unnecessary but nonetheless, hard to relinquish. Ideally, loud close-miking should be reserved for the very passionate and



aggressive effect its distorted texture conveys (e.g. Paul Weller, Paul D'Anno), whilst the more subtle varieties of close microphone technique can be used to convey laid-back sensuality or intimacy through the medium of the proximity effect (e.g. reggae, soul, funk and cabaret). These special requirements apart, a quality vocals microphone will give of its best if you maintain a reasonable distance — say 4" to 12". And bear in mind that your distance from the microphone can profoundly change the nature of your vocal sound through the PA, and the closer you approach the microphone, the more critical your positioning needs to be to obtain a consistent sound.

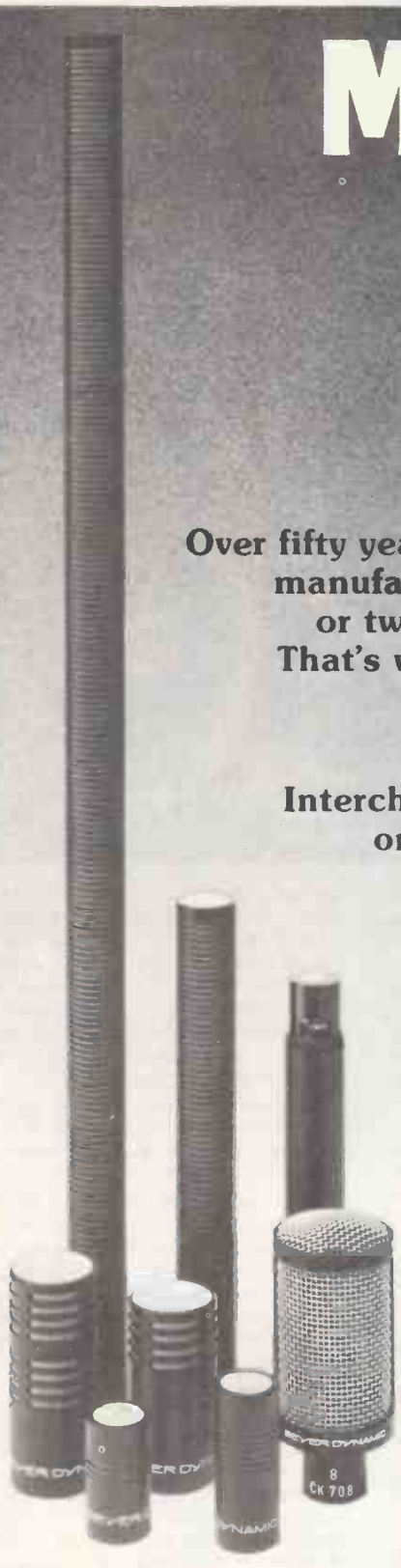
A common feature of many microphones is a series of slots along each side. In cheaper models, these are essentially decorative, but in high quality mics, these slots are crucial to the microphone's directional properties. Thus if they're obstructed by a carelessly placed hand, the resulting distortion of the directional pattern can readily precipitate howlround, so beware of clasping microphones!

For vocalists who leap around, considerable skill is needed not only to maintain the microphone at a reasonably constant distance, but also to avoid tripping over the mic lead — or worse still, boa- constrictoresque entanglement! With this style of performance in mind, together with the tendency of microphone leads to suffer continual entramplement, a tough *rubber* microphone cable is a sensible investment. In the context of raucous stage acts, connectors which feature effective strain relief are also worthy of consideration; if the cable is over-extended (e.g. vocalist falls off stage!), it's much better for the plug to be torn from the microphone or amplifier rather than the lead from the plug. In general, this means jack or XLR connectors — the latter preferably without latches for obvious reasons. Manufacturers who customarily fit DIN sockets to their microphones will usually provide the superior XLR termination for a nominal surcharge.

Finally, the false economy of buying cheap, feedback-prone microphones cannot be overemphasised. If you're short of money, to spend £25 on a scratched and battered ex-Rock concert PA or studio microphone in working condition is preferable to being enticed by a new and shining chrome-plated Oriental model. And bearing in mind the ease with which microphones disappear without trace, this item above everything else on stage benefits from insurance against theft.

E&MM

MICROPHONE FLEXIBILITY



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HOME ELECTRO-MUSICIAN

RECORDED ON CASSETTE NO. 5

With so much electronic music making taking place, E&MM looks with interest at musicians' home studio set-ups and invites possible contributions from readers.

I have been working in electronic music now for about three and a half years. It was while I was a student at Newcastle University that I was first introduced to a synthesiser (a VCS 3) at Spectro Arts Workshop. Since then I haven't looked back and have spent most of my spare time working on my compositions and continually improving my playing ability and repertoire of techniques. Indeed it is still a continuous source of satisfaction to discover new sounds and new techniques in electronic music. During the last two years I have been particularly busy being involved in concerts, workshops, courses and also in producing two cassette tapes of my work.

As a self taught musician working within electronic music under a limited budget I am well aware of the problems people face when trying to play and record their own material on fairly modest resources. However, there are ways of getting around such problems and of producing good quality recordings despite limited facilities. My basic strategy is to get several different sounds out of each instrument and to record several instruments simultaneously onto each track. Thus, I have found it possible to record quite complex pieces of music onto a single 4-track recorder and mix directly to stereo.

I usually start with the rhythm track by programming drum patterns into a Boss Dr-Rhythm drum machine which gives the main percussion sounds as well as acting as the master clock. This drum machine has programmable and semi-quaver trigger outputs which can be used simultaneously, to say, step a sequencer with the former and trigger a sound effect via the latter. Thus, a rhythm track could consist of:

a) Programmed drum sounds, these could be direct from the machine with only equalisation added or they could be flanged, giving a metallic sound, or ring-modulated against a high frequency sine wave giving wood-block type sounds etc., or perhaps a mixture of several sounds.
b) A sequence bass line, I use a Roland CSQ-100 which can store two sequences of 84 notes each — I often add echo to a sequence so that the repeats either fall on the beat or between the beats to give a syncopated effect. The sequence could also be used to 'chop up' the basic chords of the piece played on a string-synth. This can be achieved by putting the string sound through the external input of the synth being controlled by the sequencer and setting a short percussive envelope.
c) A sound effect triggered by the DBS output of the Dr-Rhythm, or perhaps a manually triggered sound.

These three elements can be mixed onto, say, two channels of a four-track recorder, two tracks being used to enable a stereo image to be preserved.

Next I would record the main chord work of the piece which usually consists of a string, brass, or organ sound. Again, one can get more out of a basic string-synth sound than is at first evident. For example, one could split the string sound into three using a splitter:

a) Straight sound, volume in mix controlled by a volume pedal.
b) Phased or flanged strings.
c) Treat the strings through the filter of a monophonic synth.

For example, use the envelope voltage to control the filter frequency and if the resonance (Q) of the filter is high, then every time the synth is manually triggered the timbre of the strings will be swept from bright to soft. Indeed, one could mix in at this point, for example, a bass line on the mono-synth.

These sounds could then be mixed onto the third track of the tape leaving the fourth track for a lead line on the mono-synth.

Now for the final mix. The two tracks containing the rhythm need only be played back as they have already been mixed to stereo. However, various echo, chorus or reverb treatments could be applied to the chords and lead line to give them more depth and they can be positioned in the stereo field. Thus, although only a four track tape has been used, if enough care has been taken, the finished stereo mix will be of such a quality as to sound as though it has been made on a much larger recorder.

The above procedure is very similar to the way in which the excerpt from 'Four Views', included in the E&MM Demonstration Cassette No. 5, was recorded.

Compositionally my pieces gel together via two separate approaches, producing a style particularly evident on my two cassettes, 'Images' and 'Elements of Chance'. Firstly the basic chords and melodies are composed on a string-synth. However, as the piece develops, new themes appear by improvising around the original themes. Secondly, the textures and timbres usually come about by experimentation and often new textures can affect the way a theme is played, or indeed, suggest new melodies. This rather 'organic' approach is often apparent in the fluid nature of my pieces, sustained textures often dominate and sudden changes are kept to a minimum, with slower, more gradual transitions being preferred.

Ian Boddy **E&MM**

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UNDERSTANDING ELECTRONICS

Robert Penfold

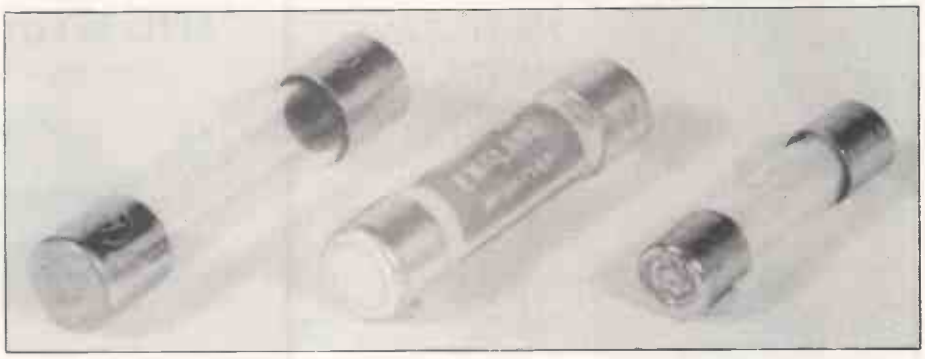
Fuses

Although fuses are probably the simplest of electronic components they still manage to cause a certain amount of confusion and misunderstanding, and it is probably a case of "familiarity breeds contempt". A fuse is simply a piece of (usually) fine wire which normally allows an electric current to flow, but it overheats and melts if an excessive current should flow through it breaking the circuit and cutting off the current.

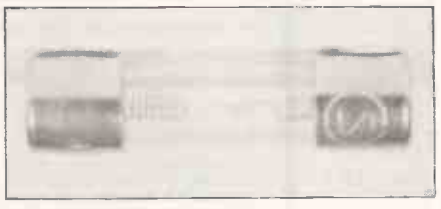
Fuses have a current rating in amps (A) or milliamps (mA). A milliamp is simply a subdivision of an amp, and is one thousandth of an amp. Confusion can arise because a lot of electrical and electronic equipment will have an information plate or handbook which states a power consumption of a certain number of watts, rather than a current consumption of the appropriate figure. Power takes into account both supply voltage and supply current, and it is simply the product of the two. In order to find the supply current it is merely necessary to divide the power in watts by the supply voltage. A 1000 watt electric fire operating on the 240 volt mains supply, for example, would have a current consumption of 1000 ÷ 240 = 4.17 amps. However, with (say) a 50 volt supply and a power consumption of 1000 watts there would be a current flow of 1000 ÷ 50 = 20 amps! Fuses must therefore have a rating in current and cannot be given a meaningful power rating unless supply voltage is also specified.

Although it is generally believed that the current rating of a fuse is the nominal current at which it will blow, it is, in fact, the highest nominal current that the fuse can withstand without blowing. In practice a fuse will normally take a current of about 40% to 90% more than its rated current indefinitely without being damaged. This means that, for instance, a fuse which is to operate at a normal maximum current of 1.2 amps could be a 1 amp type. In fact a 1 amp component would give better protection than a 1.5 amp type and should not be prone to blowing superfluously. However, it is probably best not to under-rate a fuse by more than about 25% as this could easily result in the fuse frequently blowing unnecessarily and becoming something of a nuisance.

It is undesirable for a fuse to have a rating very much greater than the nominal maximum current flow it will have to take, as this could conceivably result in a significant current overload occurring without the fuse blowing. In practice there may be no alternative to using a fuse having a rating perhaps 50% or more above the ideal figure simply because fuses are only available in a limited number of values and the required value may well fall between two of these. In practice, this is not of great importance because a serious fault will usually produce a current increase of several hundred per cent and will rapidly blow a fuse having a marginally high rating. This is just as well since fuses for mains plugs are only generally available in two current ratings; 3 amps (for loads of up to about 720 watts or so) and 13 amps (for equipment having a power rating of between about 720 watts and 3120 watts).



The three normal sizes of fuse.



An antisurge fuse.

Sizes And Types

There are just three normal fuse sizes, and these are 20mm, 1in and 1¼in. These sizes simply refer to the nominal length of the cartridge in which the fuse is housed. One inch types are only used in mains plugs, while 20mm and 1¼in types are fitted in items of equipment.

Both 20mm and 1¼in types are available as quickblow and antisurge types, but 1in fuses are only available as the quickblow type. A quickblow fuse is probably what most people would consider to be a 'normal' type, and as its name implies, is one which blows as rapidly as possible when an overload occurs. In electronic terms a quickblow fuse does not really live up to its name in many cases, and with an overload of around 100% it can actually take several seconds or even minutes for the fuse to finally blow! The time taken for the fuse to blow reduces very considerably as the overload margin is increased, and would typically be only around ten milliseconds (one hundredth of a second) with a 1000% overload. Even this may be too long to prevent expensive electronic components being damaged, and some pieces of electronic equipment, such as power supplies, normally have fast acting electronic overload protection rather than conventional fusing.

Antisurge fuses are used in circuits where in normal operation there are likely to be brief surges of current that are well in excess of the normal current flow. An antisurge fuse is deliberately made slow acting so that substantial overloads which only last a few tens of milliseconds do not blow the fuse. Overloads lasting longer than this will do so. The normal and brief surges are therefore allowed to pass without unnecessarily blowing the fuse.

If you examine an antisurge fuse having a glass cartridge you will notice that it does not have the usual straight filament, but instead it has the appearance of a spring with a straight section in the middle. This can be clearly seen in one of the photographs. Actually the fuse is formed by two spring-like pieces of metal which are joined at the straight central section, and it is this join that acts as the fuse. When an overload occurs the two 'springs' absorb heat from the central section and prevent the fuse from blowing. However, they soon heat up and become inefficient at taking heat from the central section which then overheats and blows. With a brief overload the current will drop back to an acceptable level before this occurs and, as required, the fuse will not blow.

Antisurge fuses are not used a great deal, and are primarily employed in power supply circuits which have a large smoothing capacitor that represents a virtual short circuit when the supply is switched on. However, after an initial heavy surge of current the capacitor is charged up and thereafter only a relatively small current flows. An antisurge fuse ignores the initial current surge, but acts fast enough to protect the mains transformer and (probably) the rectifier components as well if a prolonged overload occurs. **E&MM**

Fostex 250 4-track Recorder/Mixer

Most modern rock recording is based on the principle of multitracking. The principle itself is simple: multitracking means multiple tracking, whereby one can record on one or all tracks (usually from four to 32), with the facility to build up, alter and modify in section any or all of the separate tracks. Players can listen back to other tracks already recorded in synchronisation with the track they are recording — overdubbing. Once everyone is satisfied with the various performances on the multitrack tape, it can then be balanced into a stereo master tape recorder, with any changes to EQ and stereo position of the tracks (hence the 'pan-potted mono' label of many stereo mixes) made at this final stage. The result: a stereo master tape with all the benefits of the diversity and, if necessary, complexity of multitrack.

Multitrack tape machines started life as large, studio-bound objects — some of the earliest ones look decidedly clumsy, all metal casing and huge meters. But over the years, and especially the last ten, technology has aided the recording medium to bring multitrack facilities to smaller, more efficient and simpler machines. Teac, the large Japanese electronics company, have of course done much to bring multitrack to the musician — you'll have often heard players telling how they 'worked it out at home first on the Teac'. The company's 4-track ¼in reel-to-reel tape recorders have become industry standards, and very good results can be obtained with them.

And so we get to Fostex. Also a Japanese company, it has been boosted recently by the addition to its ranks of several (surprise surprise) ex-Teac engineers who wanted to do more with the multitrack medium. As Fostex say in one of their publicity leaflets, their 'recording equipment (is) built with the understanding that music today is conceived, composed, developed, practiced and realised on multitrack recorders. Four and eight tracks are as vital and natural today as ink and paper were to Bach'. You may reject that as advertising blurb, but it does at least show that their hearts are in the right place down in Akishima, Tokyo.

The new, first range of Fostex equipment includes the subject of this piece, the 250 Multitracker, or Recorder/Mixer Model. It's described as a 'self-contained, portable recording studio', and uses cassette tapes as its recording media. This idea was originally formulated by (you guessed) Teac, with their 144 Portastudio. While there are differences between the 250 and the 144 (and many similarities!), the 250 does have the benefit of nearly two years more technological development, and is generally easier to use. And it's about £100 more expensive. But this review is not a comparison of the two — we're looking at the new Fostex. But is it worth a whole £100 more?

So do you use the 250? Well, in the time that I had to work with it I concentrated on its home-demo facility, which does seem to be its primary *raison d'être*. You can build up complete songs or pieces of music in the comfort of your own front room/garage/rehearsal room/patio, should you so desire — its uses in this context are endless and limited only by the operator's imagination and creativity (and, admittedly, four tracks). It is quite conceivable that the 250 could be used to record certain types of music for short-run record releases; Teac machines have certainly been used for this sort of application.

The 250's control layout seems sensible, uncluttered, clear and easy to work with and follow. Bottom right is the cassette section — a flap raises to reveal a standard-looking cassette transport, and below this are the expected associated controls: Rewind, Fast Forward, Record, Stop and Play; along with a Zero Return switch which will fast wind the cassette to a pre-set zero — handy for returning to the start of a take or the start of a piece. The four-figure index is of the digital read-out type, which is actually usefully clear and easy to read. Below it are the Record buttons for the four tracks which, like the Record button, have associated red LEDs which flash when ready and stay lit when recording is in progress. The last control in this section is a Pitch knob, nominally set at 0, but allowing the home recordist to slow down or speed up the tape by up to 10% if necessary. The cassette tape itself is helped along at 3¾in/s — twice normal cassette speed — and uses the new Dolby C noise reduction system, which (despite some moans from the hi-fi press) seems to work as well as any. For those violently opposed to noise reduction systems, there is a switch hidden away in the innards of the Fostex that allows one to by-pass the Dolby, but really some sort of noise reduction is needed with a machine like this — otherwise, the limitations make the machine virtually impractical for the multitracking it's intended to carry out.

The rest of the machine is occupied by the mixer. A simple and ergonomically obvious choice has been made by Fostex to put the input socket (large jack) for each channel of the mixer at the front of the unit, so that the operator can see exactly what's plugged in and can change things around easily. Each channel's controls are identical: moving up vertically from the input socket we get the channel fader, then a Line/mic trim knob, and then a Line/mic or Tape status switch. These three combine either to feed signal (from a mic, electric or electronic instrument) into the 250, or to feed a signal already on tape into the mixer section for mixdown or monitoring. We'll see how this works later.

Above the input section are two EQ controls for high and low frequencies, set at 4kHz and 300Hz. These are adequate for most uses. Above these (labelled EQUAL on the mixer) is the Pan section, consisting of a pan rotary and a 4-CHAN BUSS switch. In recording mode, the operator combines the two controls to route the channel input signal to one of the four tape tracks; in mixdown mode, they're used to place the recorded tape track in the stereo picture on the master tape.

Moving up, we then come to the AUX BUSS knob, which controls the level of a signal that can be sent to external processing equipment, should this be necessary. Above this knob is the MON MIX rotary, which controls the level of a mono mix which you can use for musicians' monitors if you have the band round to play with your new toy, or it controls the level sent to your headphones in one-person recording sessions. There are in fact two headphone jacks on the front panel — the overall level and source fed to your cans is controlled by the headphone rotary

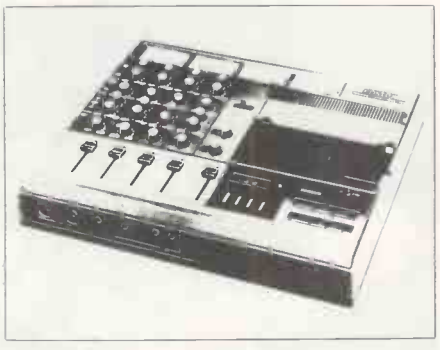
Fostex 250 4-track Recorder/Mixer

above the master fader, to the right of the four channel faders.

So that's what you get on each channel. Along the top of the machine are four large VU meters — unfortunately not angled towards the operator which would have been useful. Some people will have wished for PPMs, but the VUs appear to do the job required quite competently, although readings can be a little erratic on some programmes. The peak LEDs on the VUs are useful in this context — I often found myself on recording paying more attention to the LEDs than to the needles. A meter switch, above the headphone level control just mentioned, selects RECORDER or MIXER — on RECORDER, the four meters show record and playback levels; on MIXER, meters 1 and 2 show the Line Out signal monitored when mixing down to stereo.

There is a comprehensive selection of sockets on the back; as well as the pair of Line Outs just mentioned (used to connect to the stereo mastering machine, reel-to-reel or cassette) there are (all phono sockets): Tape Outs 1 to 4, with tape track 1 coming out on Tape Out 1, and so on; Aux In 1 and 2 bring a stereo signal into channels 1 and 2 via a control marked RCV1-2, below the meter switch on the middle section of the unit; Aux Send carries a mono mix determined by the AUX BUSS control on each channel; MON MIX carries a mono mix determined by the MON MIX control on each channel; Direct Out 1 to 4, with channel EQ 1 coming out on Direct Out 1, and so on; Record In 1 to 4, with Record In 1 applying signal to tape track 1, and so on; and Punch In/Out, taking the optional Remote Footswitch unit that allows drop-ins to be performed and activated by one person — hands playing, feet punching.

I recorded a number of pieces on the Fostex and got some very pleasing results. The only machine problem I encountered was the sudden break-up of sound on channel/track 3, as I was about to mix a piece. It took me about an hour to track down the fault to channel 3's EQ section — after some fiddling, the sound returned to normal. One suspects dodgy contacts, so watch out.



Other than this I had a smooth time, apart from some operator/machine interface problems (jargon for my stupidity). As I mentioned at the start, I concentrated on the home-demo aspect of the machine — but the 250 is, of course, suited to other applications. The fact that you can record on all four tracks simultaneously if you want to (on the Portastudio, remember, you can record on a maximum of two of the four tracks at any one time), means that the 250 is useful for taping gigs and other live performances, as well as for storing ideas from rehearsals, with the option of adding to them later, making the recorder a handy notebook for developing musical arrangements. Of course, an additional mixer with more input channels would be useful for submixing drums, say, in a fair-sized band. Fostex claim that this four-at-once facility makes the 250 well suited to Audio-Visual use too, using one track for a sync pulse to lock soundtrack and picture.

But back to my front room and a pile of instruments surrounding the Fostex. As I worked with the machine, it became clear that it is very well designed and laid out. The apparent intricacies of the mixer soon dissolved, and the dexterity required to hit the right combination of Record and Tape transport controls became more natural as I spent time with the 250. As with most machines, familiarity breeds ease of use. All manner of combinations of basic track-laying, bounces (which can be fiddled to include a new instrument as well as the tracks being combined), drop-ins, other inputs, signal processing and mixdown juggling can be used, re-used, improved upon, expanded and experimented with.

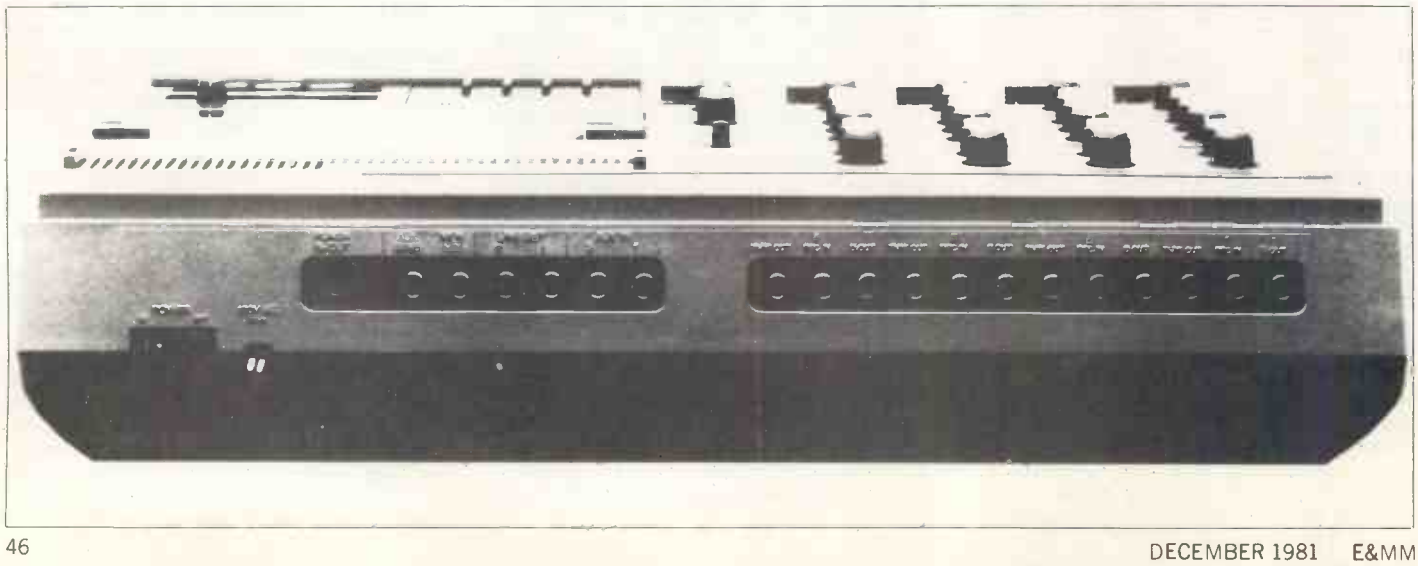
The Fostex is the sort of machine that would improve with continued use; my initial fumblings have certainly made me want to push the machine further to find out all its possibilities — a long job! One none-too-small item which must be mentioned: the owner's manual (instruction book) is excellent, and reads as though it was actually written in the UK, and not translated from the Japanese as so many have been to end up with incomprehensible streams of Eastern consciousness that have you dangling from the chandelier with a jack lead in one hand and a mains lead in the other. No — Fostex have got the instruction book just right. Useful information is clearly presented without condescension.

Lastly, a few notes on tape: the 250 is set up to take gamma-ferric oxide high bias 70u sec tapes (known usually as Group 2 or Type II), like TDK-SA, Maxell UDXL-II, Ampex Grand Master II, Memorex High Bias, and so on. I stuck with SAs and had no problems. The recommended C60 and C90 sizes will give you 15 mins and 22½ mins playing time each side respectively.

So, to come back to my earlier question: is the 250 worth £100 or so on top of the Teac Portastudio? If you need to make this decision, make sure you get long demos of both machines before making up your mind. My own view is that, well, if it was £50 more . . . But you have to decide for yourself — you're the expert on your music. Certainly the Fostex 250 4-track Recorder/Mixer is a machine that furthers the cause of Musicians' Multitrack; its ergonomic good sense, its adaptability and its plain usefulness make it a very interesting proposition for any earnest musician or band.

Tony Bacon **E&MM**

Recommended retail price is £618.60 (ex VAT). Further information from the UK distributor, Bandive Ltd, 8 East Barnet Road, New Barnet, Herts EN4 8RW. Tel: (01) 440 9304; Telex: 25769.



Fostex® Personal Multitrack

Bandive are proud to represent Fostex Creative Products in Britain. Everywhere, music is being created with multitrack. It's as essential today as pen and paper were to Bach. A new generation of multitrack has been designed, refined and engineered for the creative musician. Recording equipment that's easy to own and use. Read on and discover the new concepts and technology that have made Personal Multitrack possible.

Ideas are easy, it's another thing turning them into reality

If anyone is 'father of personal multitrack', Yoshiharu Abe, native of Tokyo, deserves the title.

Graduating from college in the early fifties, he joined the newly formed TEAC corporation. His technical ability and innovation quickly raised him to director status. An American marketing man opened Abe's eyes to the revolution that was about to happen in recorded music. Rapid modifications to a quadrophonic recorder were made, and the legendary 3340 recorder was born. It heralded a new generation of equipment, four channel multitrack saw the formation of TASCAM, a division of TEAC providing studio hardware for musicians.

Exciting new products were created, breaking new ground with eight tracks on half inch and lately the Portastudio, four tracks on cassette. Half the battle and success was gaining the approval of boards of directors and the acceptance of the recording industry. Abe's innovation and determination are two qualities that have made these real world products possible for musicians. They have shattered preconceptions of what you must have, they provide what you need. By the late seventies, for various reasons, relationships at TEAC had changed. Abe no longer had the possibility to develop his ideas. When he had made his decision to leave, twenty of his key staff followed. The engineers who had been instrumental in creating the world's first range of affordable multitrack. They joined the Fostex Corporation where funds and freedom were provided to develop creative products for the future. In the year that followed, a massive investment was made, both in time and sums reaching nine figures.

The result is this next generation of recording products for musicians. Personal Multitrack. Recorders, mixers and effects you can use to expand your music. And this is only the beginning.

In 1981 Abe is keeping that multitrack promise.

A new recorder will have a dramatic effect on the recording industry

It's revolutionary. Inside this compact recorder is the most advanced technology ever to put eight track affordably onto tape and into the hands of every creative musician. There's no more limit to personal creative possibilities. Mated with the unique 350 in line console, you can add a two track and it still costs less than eight tracks on half inch. And the technology incorporated, challenges the state of the art with the new improvements in quality.

The time has come

The breakthrough comes in the design of a recording head, that puts eight tracks onto quarter inch tape. It achieves a remarkable 45dB crosstalk figure and is specially contoured to extend frequency response and reduce low frequency head bumps. The technology is exclusive to Fostex, and it has brought down tape costs by a factor of two.

Coincidentally, Dolby Laboratories launch their 'C' system this year. Praising reports indicate a further breakthrough in noise reduction technique. The circuitry has been incorporated to provide a dramatic 73dB signal to noise ratio. As you will discover, a new approach is offering less noise with no side effects, plus some remarkable side benefits that ensure cleaner recorded sound.

Operator functions

The entire machine reflects much careful thought, not just in the way it's made but also towards the user. Operation could not be simpler. Automatic sel-sync, individual track monitoring, a unique group select function for four buss mixers and accessible electronics are just some of the advanced features. The transport features remote punch in, return to zero, full motion remote, cool running, in fact everything that adds up to fast convenient operation.

True innovation

The A8 frees up the musician to record eight tracks quickly anywhere. The machine is lighter, more compact and easier to use and own. The standards for creative recording are about to change again. If you have planned for four, you can now buy eight. If you need more convincing, just arrange for a demonstration and hear it for yourself.

FOSTEX

The most ingenious, compact mixer ever made

New concepts in mixers are hard to find, it took an enthusiastic company like Fostex to come up with a console with fresh new ideas. Featured in this compact unit are facilities often admired but hardly expected.

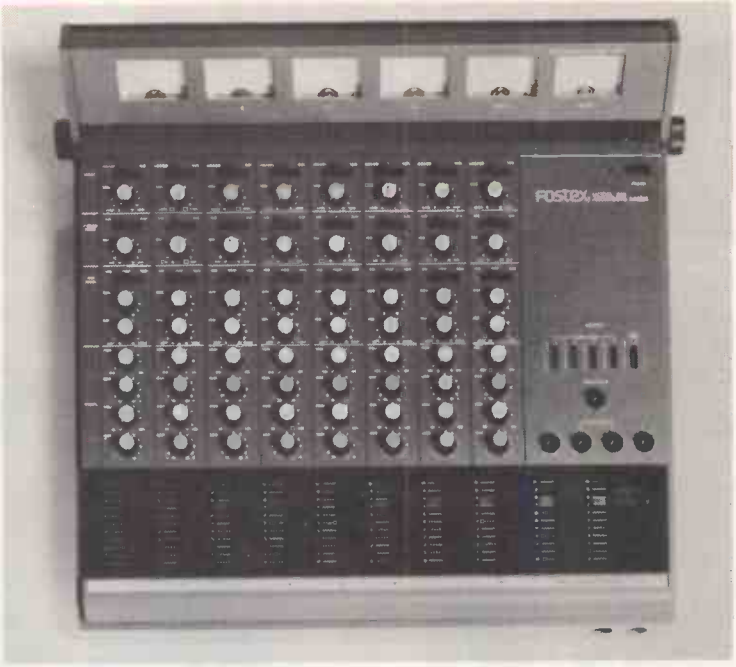
It has six busses, but it's designed to work eight tracks. Efficiently and economically. It mates with the Fostex A8 recorder as the state of the art in Personal Multitrack. Like all Fostex products it's carefully designed and made.

Accommodating inputs

Wide gain trim is available at the front end of each channel. It caters for signals ranging from microphones and guitars, right through to line level sources. And as a security device, there's a red LED indicator just above each input fader that flashes when levels get too high.

Parametric Equalisation

Each channel has two band sweep equalisation. It's the step beyond the simple, broadband bass, treble and mid. It lets you separate and lift individual signals in a complex mix. You tune instinctively, selecting the richness of a bass guitar or the sizzle of a cymbal.



In line multitrack monitor

A concept from much bigger consoles. The actual monitor controls for the eight track monitoring mix are located within the input channels themselves. Ingeniously, when you switch for mixdown these same controls are used for providing a stereo echo send.

Unique Monitoring Matrix

Above the output faders and auxillary returns, are five pushbuttons. The first four connect the four main busses to the left and right monitor outputs, the last one changes over to the auxillary mix, giving instant comparison of playback or pre fade signals.

Patchers Delight

There are as many features on the back as there are on the front. Each input has an accessory send and receive socket so you can add compression, delay, etc right where the signal starts. There's also direct out and tape in so you get at signals at every stage. Plus separate access points for each of the six busses to connect echo effects or even an extra mixer.

For Production Work

There are also four independant RIAA pre-amplifiers built into the console. You can patch these freely into any channel for music or drama production. A convenient fader link device permits easy synchronised fades for stereo signals.

Optional meter bridge

A smart pod containing six illuminated Vu meters attaches at any convenient working angle to the back of the 350. You get precise visual monitoring of levels going out to your recorder as well as the echo, cue and monitor signals on the auxilliary busses.

Fostex have packed great versatility and value into the Model 350. What appears at first sight to be a simple eight by four turns out to be capable of fast eight track operation, complex production work and sophisticated PA performance. Check out the Model 350, and discover the ways it can help you.

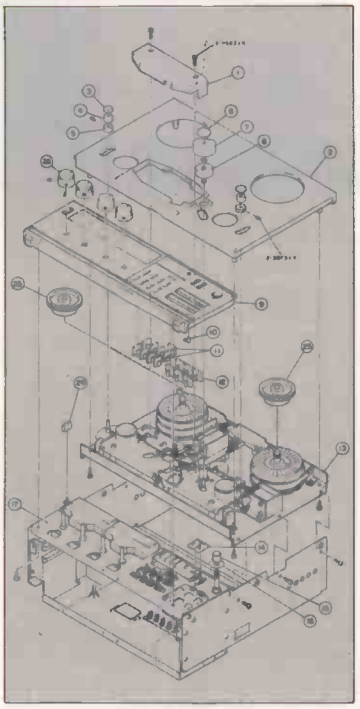
Your third hand

Work alone with multitrack and dropping in and out of record is an art you must master. Adding a lick or correcting a verse. There's always a problem trying to work a recorder and play music. Play guitar, and the only solution we have found is to hold a couple of pencils in your teeth to hit record and play at the same time! Both Fostex open reel and the Multitracker take a footswitch for punching in and out. Almost any footswitch from your guitar etc. The bottom line is, you can pay attention to your music, not the machine.

US Report

Fostex have formed their own marketing corporation in sunny California. The products were launched at the Los Angeles AES show in May and rapidly became the talk of the show. Seasoned engineers were seen coming out of the demo room, nodding their heads, smiling and muttering 'I don't believe it'. The press raved about it and sales reps queued up to sell it. There was a repeat performance at the music industries Namm show in June. It created excitement amongst musicians and dealers, as they recognised the implications that Personal Multitrack would have for musicians. Fostex had arrived.

Inside Fostex recorders, you will find as much innovation as on the surface



A New Transport

Fostex engineers know about the long hours and abuse that working recorders are subjected to. As a result the new transport is built for studio work, not just occasional domestic operation. It is not a converted hi-fi transport.

Designed entirely from scratch, mechanics have been rationalised to take advantage of new material and control technologies. Less parts mean less to go wrong. Everything in the design reduces your cost of ownership.

Cooler Running

Ask any electronics engineer, and you will discover that heat is electronics' arch enemy. That's why valve amps used to break down so often. The traditional, AC eddy current motors are big, heavy, need a large transformer and run hot. Fostex have replaced them with high efficiency, coreless DC types. As a result these new machines are smaller and lighter with less to go wrong than anything else available.

Editing Features

Above the headblock, there's a push lever that brings the lifters in during wind so you can find takes more easily. Heads are readily accessible for editing, with a pop up headshield that doesn't obstruct working. And during editing you can cut the pickup spool motor using the edit dump mode. These are features you will only find on a recorder designed for studio work.

Logic Control

Motion sensing, whereby tape handling is protected by the movement of the transport plays an important role in taking care of you master tapes. A microchip controls the entire machine logic. The motion pickup pulses a large digital counter that shows clearly where you are. And the return to zero function lets you get back there, quickly and accurately.

Full motion function remote is available for the transport including

the return to zero, speeding up repeat takes and dubs. And for all musicians who don't have three hands, a unique, footswitch operated punch-in and out remote facility features on all models.

Modular Electronics

All professional recorders require regular maintenance or alignment. It's the price they pay for working long, hard hours. All the Fostex Open reel machines feature fully modular audio electronics. All maintenance presets are accessible simply by removing the base plate from the machine. Silent, electronic switching results in transparent punch ins and click free operation.

If you get the chance, take a look at the mechanics inside the Fostex open reel product. What you'll find is a clear uncluttered layout that's obviously the result of innovative yet experienced engineering.

A look at some others

Study the features of other major manufacturers in recording equipment. You will find a range choice that seems to defeat its object. Study specs closely, and you will see how different equipment doing more or less the same thing will have figures that follow prices. Simul sync is a typical example. There is no technical and certainly very little price reason why simul sync performance should be any worse than playback. Yet look at the specs. You are in for a surprise.

Manual Labour

It shows the degree of meticulous detail that the Fostex team have gone to to prepare their products for a world market. Take the Multitracker for example. Three months before any product came off the production line we had received a printed, 70 page service manual for our engineers to study. It contains circuit descriptions, alignment procedures and lists every part with a computer stock number. We had learnt about every detail of the machine, before we even received the first sample. It has helped us prepare a competent service backup for the products.

The ultimate suitcase studio

You'll recognise the concept, in fact it's from the same team of engineers who created the original portable studio. New functions like full four track recording capability, footswitch punch in and the latest and smoothest noise reduction add up to a compact recording system that has no competition.

Separate, but together

The skillful packaging includes a full four track simul sync recorder, and a four in, five buss mixer. They are wired to work in harmony but you have the option to use them separately.

The recorder is based on a silent, solenoid transport, running at 3.75 ips, built to take the constant operation of creative use. Micro touch controls and motion sensing provide error free tape handling that also protects your master tapes. A large digital counter with return to zero facility speeds your creativity. There's pitch control and a unique head format that's compatible with the new breed of high speed cassette recorders, so you can freely play, record or overdub tapes made on stereo decks.

Utilising Dolby 'C' the record and playback electronics attains a dramatic 71dB signal to noise ratio. This is performance you'd expect from open reel.

Five Buss Mixer

For original recording, mikes or instruments plug in at the front. A trim control matches any signal level to the input. Peak and shelf equalisers give tight control over the tonal quality. Then there's a linear fader and pan control. A lever switch, that also serves as a useful cut control, directs the signal to the four buss outs. So you can feed the signals all to one track or all onto separate tracks for recording. At mixdown, or for pingponging tracks, another switch connects you directly to the outputs of the recorder. The fifth buss, for echo send with stereo return facilities is available at all times. Four large meters with peak indicators can be switched between mixer and recorder to keep an eye on levels. Five buss capability may seem like luxury, but they keep operation logical and provide added facilities for effects and live presentation.

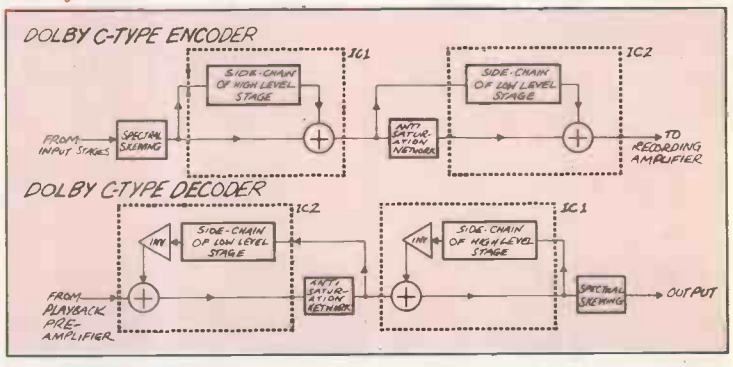
Monitoring, for two people

A single monitor level control combines two functions. Turn it anti-clockwise, from its centre detent and you listen to the monmix, an automatic function that lets you combine the signals you are recording with the ones already on tape. There's no complex switching, the feed to the four monmix controls is automatically selected between mixer out and tape sync, depending on which tracks you are recording on. Turn the monitor control clockwise and you hear only what the mixer is putting out. This checks your quality and stereo image, and is essential when mixer and recorder are used separately. As a final touch, the powerful headphone amp feeds two sockets on the front, so now you can listen with a friend.

The challenge is clear. The Multitracker combines open reel performance and versatility with a true multitrack mixer. Plug in a mike and cans, and you have a studio system to create on, or capture four tracks of live performance for future remix. In production of drama, AV or music, a wealth of new opportunities open up. Call in on a Fostex dealer and discover the remarkable Multitracker for yourself.

So what is Dolby C?

The principle of Dolby noise reduction is firmly established in recording. Low level, high frequencies are boosted on a sliding scale, and recorded on tape. Upon playback, these signals are detected and lowered to their original level. As a result, tape noise is also pushed down, providing quieter signal. Ten years ago, Dolby gave us ten decibels of noise reduction, now there's twenty.



Ten years of study

Dolby has resisted other systems of noise reduction. Companders such as DBX and High-Com all suffer from side effects. Though they provide magic numbers in the noise reduction stakes, because they affect the entire frequency band at both high and low levels, there are unpleasant side effects that include pumping, noise modulation and overshoot distortion. If you've ever tried to record jangling keys with one of these you'll know what we mean! The goal has been not only more but better sounding noise reduction, and the latest Dolby C system, achieves this. Essentially it's a pair of Dolby B processors in tandem and the result is a dramatic 20dB of noise reduction, free of any side effects.

There's something more

Dolby C does more than appears at first sight. There's an ingenious side benefit to the electronic circuitry. Tape recorder circuits boost high frequencies during recording. Its known as pre emphasis, and it helps keep noise down plus achieving a flat response on playback. The trouble is, it makes treble signals that much easier to overload. The Dolby C design takes this into account. It includes an anti saturation circuit which prevents this transient overload. What you get, is freedom from high frequency overload. A high end transparency that has to be heard.

A sonic improvement

Whilst Dolby C was designed with domestic recording in mind, something spectacular happens when it's used professionally to record live sounds. You can capture the full breadth of a musical performance with silence and no side effects. Drums are crisper and highs are cleaner, you probably won't believe your ears.

We urge you to hear the Fostex recorders and experience this for yourself.

There's a classic four track and a mastering two track, based on the new transport. They include the basic features, cool running, digital counter, full remote, two speeds, and both are smaller and lighter than anything else available. Individually, each has something special to offer.

The four track is the first step in open reel multitrack. Remote punch in and individual track monitoring coupled with full frequency sel-sync facility are facilities never before offered at this price. An optional Dolby C encode/decode package extends the dynamic range to over 80dB, more than adequate even when you perform the ten track bounce within the limits of second generation. For quality AV presentations, a full 44 minute programme can run without interruption or noise degradation, and no audible response loss at the lower speed of 7.5 ips. It's weight and size make it the ideal remote unit.

The two track machine is designed for critical mastering applications. Tape dump and easy head access make it ideal for editing purposes. And both tracks can be monitored, switched into record or operate in the sel sync mode, individually.

Expanded scale Vu meters and peak indicators let you keep a strict eye on signal levels, to get the maximum performance from your machine.

These recorders are alternatives to products already in the marketplace. We believe that their advanced technology and features deserve your consideration in their particular fields.

Prominent Pro-Audio Dealers are as enthusiastic about Fostex as we are. Here's who they are, and what they say.

Alan Cheetham
... 'the start of another home studio revolution'
Audio Services
25 South Meadway
High Lane
STOCKPORT, Cheshire

Ian Jones
... 'innovation and precision engineering are apparent throughout'
HHB Hire and Sales
Unit F, New Crescent Works
Nicoll Road
LONDON NW10 9AX

Tony Larking
... 'a great step forward in creative recording'
Don Larkin Audio Sales
50 Cheapside
LUTON, Beds

Neil Hassell
... 'the quality we expected, and much more'
REW Professional Audio
114/116 Charing Cross Road
LONDON WC2

Ian Downes
... 'Fostex will open new doors in broadcast and AV production'
Studio Equipment Services
The Studio Shop
100 Hamilton Road
LONDON NW11 9DY

Andrew Stirling
... 'this company is truly dedicated to the creative musician'
Turnkey
8 East Barnet Road
New Barnet
Herts EN4 8RW

These committed expert dealers carry stocks and demonstrate the Fostex product range. Go along, see and hear it all for yourself.

In this limited space we've told you what Fostex and Personal Multitrack is about. If you want to know more, there's a fourteen page booklet that tells it all. And in case you want to learn more about the principles and equipment used in recording a copy of 'Multitrack Facts' is also available free of charge from dealers. In case you have any difficulty in obtaining either of these, contact us at Bandive directly for copies.

Bandive Ltd.
8 East Barnet Road
New Barnet
Herts EN4 8RW

FOSTEX

FOSTEX®

Fostex, the name

Recording engineers will recognise the Fostex brand name. Until the creative recording division was created, it was the professional transducer division of the giant Japanese Foster Corporation. For years they have produced and developed a range of unique speakers, headphones and

FOSTEX®

microphones that challenge the esoteric brand leaders in professional audio. The integrity in design and performance all reflect in the Personal Multitrack range.

A word of warning to competitors

When it comes to time shift devices, you've no doubt heard it all. Phasors, phlangers, ADT, chorus and echo. They all work on the same time shift principle, but because delay is expensive each one is trimmed to perform just one or two functions at low cost. Good digital delay has been prohibitive to produce. That is, until now. It's easy to be blase about products. We'd like to say that here's the one that does it all the for the price you would expect to pay for a single function. But we won't.

Fostex is establishing Personal Multitrack and it will keep everyone involved busy for some time to come. This high technology delay is a sampling of processing products to come. We're underplaying the marketing, but it's available right now. We strongly urge you to hear what can be achieved.

Elka-Orla X-50

Previewed at Frankfurt earlier this year, the Elka-Orla X-50 portable organ is now just starting to appear in the music stores up and down the UK. We've managed to get hold of one of the first units to arrive in the country, and so we thought that we should 'take it apart'.

There has been a good deal of rekindled interest in single manual portable organs over the past two to three years. Especially with regard to recreating the old Hammond tone-wheel sound. As I expect you know, Hammond stopped producing tone-wheel organs in the sixties as a result of the very high costs involved in producing an electro-mechanical instrument. They've moved on to electronic and LSI instruments which serve the home organ market better. With the exception of the B3000, and the latest of their portables, Hammond seemed to have neglected the sound that they created and that became so fashionable.

The only portable organ that really seemed to come anywhere near the Hammond sound, up to five years ago, was the Crumar Organiser, which although suffering a lot from hum and noise, had a very nice sound to it. A couple of years ago Korg introduced a single manual instrument known as the CX-3, and at almost the same time, Roland came out with their VK-1 portable, both instruments using the nine drawbar system (see later) and with similar features designed, in essence, to recreate the tone-wheel sound.

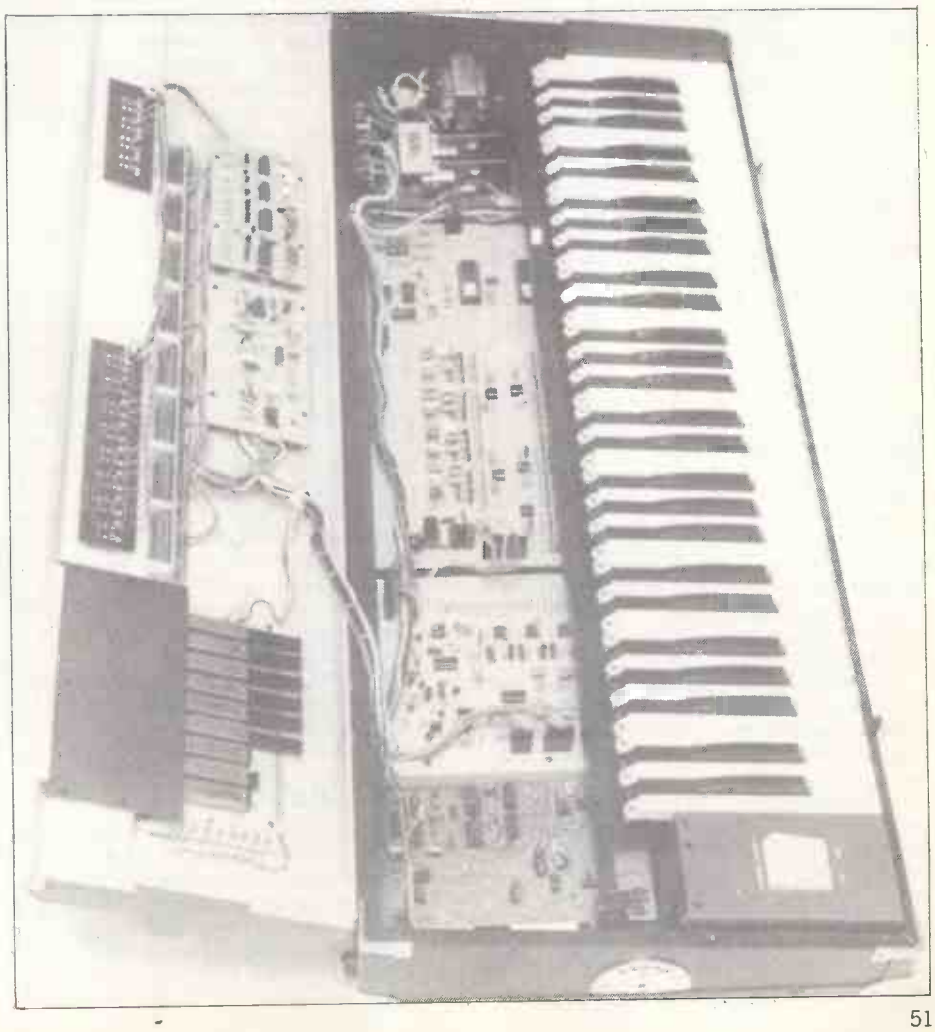
Now Elka have come out with a single manual portable, which offers much the same features to prevent the Japanese from having everything their own way. Have they succeeded? Read on and find out.

Why then, do so many manufacturers strive to recreate an 'old fashioned' sound, and why is this sound so popular? Well firstly, as in most aspects of music, a natural sound is more pleasing than an electronic one. Electronic organs, by their very nature do not produce natural sounds, but there is a difference to be realised between an electric organ and an electronic one. Many of you will, I'm sure, be familiar with this point. The Hammond tone-wheel instruments were the 'Rolls Royces' of the electric organs and they functioned by spinning a series of metallic wheels, shaped rather like a 50p piece, in front of a magnetic pick-up. There was a separate wheel for each tone — most Hammonds using 95 tones — and each wheel was set on a common shaft, so that just one motor was required for spinning all the wheels. The shape of each wheel was such that it generated a perfect sinewave signal in the pick up.

The beauty of the Hammond system relied on the fundamental principle of the superimposition of sine waves; which basically means that you can create any waveform by adding together sine waves of different frequencies and amplitudes. This is the principle on which most computer based systems (such as the Fairlight CMI) function. For each note of the Hammond organ there were nine harmonically related sinewaves which could be mixed together in varying amounts using drawbars; so with a nine drawbar system, each drawbar having nine different positions, it is possible (so I'm told, but I can't see how the figure was arrived at) to create 253 million different musical tones! It is clear now why the drawbar system lives on. Other characteristics of the tone-wheel sound will become clearer as we look more closely at the instrument in question, which we must now do.

The X-50 is a portable organ, so the manufacturers claim, meaning it should be relatively easy to move around, as well as being able to withstand the knocks and biffs it will undoubtedly receive if it is gigged for any period of time. I can report that it is portable measuring 40" x 15" x 6" when it is in its carrying case. The X-50 is actually built into its case, which is what I would call a road-case. That is, it isn't heavy duty enough to be called a flight case, but it still is rigid enough to be taken on the road to protect the instrument. A hinged lid sits over the top of the unit, and can be fully removed ready for action.

The control panel surfaces are rather interesting in terms of material and design. Surprisingly they are a moulded plastic, but which have been sprayed in a textured metallic grey paint. This gives the impression that the panels are in fact anodised aluminium or similar, and make the instrument 'feel' a lot more substantial. The X-50,



The Elka X-50 opened up.

Elka-Orla X-50

RECORDED ON CASSETTE NO. 5

Rear view X-50.

overall, seems to have something of a Gothic character about it, which I suppose is rather appropriate for an organ.

The X-50 has several different types of control mechanism. We have the nine drawbars, which can be seen quite clearly in the foreground of the internal photograph. These have a very positive action, and feel as if they would last for years. They are numbered, as were the original Hammonds, '1' through to '8', thus each has nine positions (the ninth being fully in). Situated just above the keyboard — for fast changes, are a series of momentary push switches each incorporating an LED indicator. The switches are fast and efficient to use, and ideally suited to their task, which involves the selection of drawbars or one of the seven presets, and for introducing one or more of the four harmonic percussion options. The X-50 has no rotary controls whatsoever, all the other adjustments, and parameter changes are made using laterally mounted slide switches positioned above the momentaries.

The X-50's keyboard is, by obligation, a 61 note (five octave) C to C type. Anything less just wouldn't be enough, and the Korg and Roland would leave the Elka standing. I must say that I liked the action of the keyboard. In a way it is similar to that of the Hammond, though a bit more plastic. The action is lightish, so glissando slides up and down the keyboard leave your fingers more or less intact. Internal examination revealed that the Elka uses single spring contacts and LSI switching.

Voicing

Well now, what about the sound of the X-50? My main complaint comes not so much with the sound of the instrument, but the balancing of the tones across the keyboard. For example, if I start with the 8' drawbar alone fully extended and play a simple scale of C up the keyboard, it is possible to hear the change in amplitude between the B of the proceeding octave, and the C of the next. Now we all know what is happening here don't we? No, well for those who haven't twigged I shall explain.

As with most electronic organs, the sinewaves are obtained by filtering square or sawtooth waveforms. If you pass a waveform through a low pass filter it will remove all the harmonics, and if the waveform is filtered heavily enough only the fundamental sinewave will be left. It is a relatively expensive business building filters for every tone, so they share filters, in this case one filter per octave of tones (12), which means that the higher notes are being more heavily filtered than the lower ones, consequently, they suffer a decrease in amplitude, so that when the next tone of the octave above is compared to the top tone of the lower octave there is a discrepancy in their amplitudes.

In the case of the X-50 the amplitudes vary by around 50%, but because of the logarithmic response to volume of the ear, this difference doesn't sound as bad as it sounds (if you get my drift). Anyway, the overall effect of this, especially if you have had your attention brought towards it, is somewhat distracting, especially if you are playing just single notes. I also felt that the upper octaves of the keyboard were less powerful than the lower ones. To my mind they should be given a larger amplitude. True there are separate treble and bass tone sliders, but the effect is not exactly the same. The actual purity of the harmonic drawbars themselves is not in question. They sounded good, and 'scope examination revealed them to be around 97% sinewaves, with the hint of extra harmonics in fact giving some extra body.

There are a series of eight push buttons associated with the voicing of the keyboard. One activates the drawbars, whilst the remaining seven proffer various preset combinations of the drawbars. After much frustration, I managed to work out that these presets were composed as follows:

Full Organ	888888888
Vox I	808080888
Vox II	558880000
Vox III	888000500
Theatre	808808008
Bright	800000448
Jazz	808000000

These are as close as I could determine the preset voicings. For those unfamiliar with the system, the numbers refer to the setting of each drawbar with the first number being the 16', the second 5⅓ and so on through the nine — 8', 4', 2⅔', 2', 1⅗', 1⅓', and 1'. So if you possess a drawbar organ you can try these settings out for yourselves.

The remaining four momentary switches are used to introduce harmonic percussion. Not many organs offer this many percussion footages. I found it rather nice to use the 5⅓' setting, the others being 4', 2⅔', and 2'. The decay rate and percussion volume can be adjusted by the sliders.

That then is the backbone of the organ, however there are several additional effects that serve to enhance the organ's sound, and to further simulate the old tone-wheel sound.

Extra features

Firstly there is a slider marked Noise Attack, which is more often known as key click. The origins, and desirability of such an effect are rather interesting to analyse. Originally manufacturers did everything in their power to eliminate the noise made by the bouncing of the key contacts when they 'made'. The Hammond Organs were initially amplified with their own custom system which had a bandwidth of only 6 kHz. Consequently much of the key noise was removed. When wider bandwidth amplification systems were used, this noise cut through loud and clear, but such was the music of the time that this clicking gave the sound an added percussive bite, and therefore became very popular. With the advent of transistor switching these clicks were eliminated, but to retain the old sound electronic click simulation circuits had to be included, and that's the reason for this feature, and I must say that Noise Attack certainly does add some guts to the sound of the organ. 'Noise Attack' summons up images of a futuristic sonic weapon confrontation — quite an apt description of certain bands' outputs.

Tube distortion is a similar phenomenon. Transistor amplifiers are too clean and pure to simulate the overdriven Leslie timbre, so Elka have to build in a distortion circuit to muddy things up. Unfortunately, they don't really seem to come too close to the mark with this one, tube distortion sounds more like a cheap fuzz box, than the 'warm' distortion of an overdriven valve amplifier.

Finally, we come to the rotary cabinet simulator. This consists of two switches (rockers) to the left of the keyboard — an ideal position for this effect which corresponds, to some extent, to the pitch bend or more strictly modulation performance controls of the synthesiser. The simulation is as good as any I've heard, with breaking and acceleration between the two speeds (fast and slow). A slider can adjust the relative rotation speeds as necessary.

On the rear panel is a master tune control, and an output line socket (jack) and a DIN connector for the opto swell pedal. A bit cheap having a DIN plug for this type of instrument, I thought. The swell pedal is a standard accessory, whereas the leg assembly (with carrying bag), is extra.

So, at £595.00, is the Elka-Orla X-50 a worthwhile investment? Well I must say I liked it a lot, despite some of the relatively minor criticisms I had of the instrument. It's well built, looks okay, nicely laid out, and above all sounds pretty good. As to whether it is better than the Korg CX-3, or Roland VK-1 and VK-09 is debatable. It is a bit more expensive now than its rivals, but otherwise there is little to choose between them, in particular between the X-50 and CX-3, which in terms of features are almost identical. Still, at least the organ lives on — I'm very pleased to say.

Dave Crombie **E&MM**

The X-50 is distributed by Elka-Orla (U.K.) Ltd, 3/5 Fourth Avenue, Bluebridge Industrial Estate, Halstead, Essex CO9 2SY.

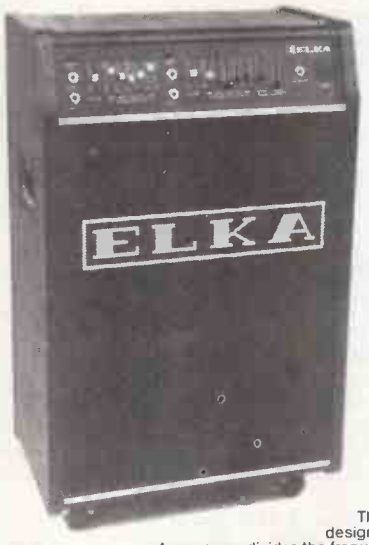
ALOT MORE SOUNDS FOR ALOT LESS POUNDS!

ELKATWIN 61

The sound generation for the polyphonic effects is accomplished by two identical sections, A and B, which are totally independent from each other, although obeying the same keyboard. A and B are completely polyphonic, (up to 49 notes each), thus imposing no restraint to sustained arpeggios, such as with Piano, Clavichord, Strings, etc.
Each of the two sections has 14 presets:
Organ 1, Organ 2, Organ 3, Strings 16, Strings 8, Full Strings, Accordion, Vibes, Guitar, Piano 16, Piano 8, Clavichord, Brass 1, Brass 2.
Each section or both may be sent to a built-in Symphonic Chorus circuit and/or a built-in electronic Tremolo/Chorale/Phasing system.
Phasing speed and depth are externally adjustable.
Each section or both can receive a glide effect, controlled by a foot switch. Each section has a separate sustain control. There is a balance control between A and B.
Section B has a fine detuning control to achieve far greater reallsm with almost all polyphonic effects. It also has an octave down/up selector and a swell pedal cancel switch (so that only section A may be controlled by the swell pedal, thus allowing a whole range of new, fascinating sound effects).
The Bass section is monophonic with left priority and a range of 1 or 2 octaves (c ÷ b). It includes Base Guitar, Tuba, Bass 16,' String Bass, and has independent volume, sustain and tone controls.
4 phone jack (¼") outputs: 1) General – 2) B – 3) Bass – 4) Elkatone (organ presets for tone cabinet).
When a plug is inserted into output 2 or 3, the corresponding channel is excluded from output 1.
When a plug is inserted into output 4, all organ presets are excluded from outputs 1 and 2.

X-50

9 drawbars: 16′ – 5⅓′ – 8′ – 4′ – 2⅔′ – 2′ – 1⅗′ – 1⅓′ – 1′.
7 presets: Full Organ, Vox I, Vox II, Vox III, Theatre, Bright, Jazz.
Percussion 5⅓′ – 4′ – 2⅔′ – 2′.
Percussion decay and volume controls.
Additional effects: Tube distortion, Noise attack, Rotary off/on, slow/fast (electronic, built-in).
External controls: Master volume, treble and bass tone (slider), Rotary speed adjustment (slider), Tuning (knob on the rear panel).



THE SIDEKICK 32

WALTZ, SWING WALTZ, TANGO, MARCH, MARCH 6/8, MEDIUM FOX, SWING FOX, ROCK 'N' BOOGIE, SLOW ROCK, BLUES ROCK, DISCO 1, DISCO 2, SAMBA, BOSSA NOVA, BEGUINE-RHUMBA, CHA CHA may be selected in either A or B, thus bringing the actual number of rhythms to 32. For each of them, a drummer's break is available by pressing a remote foot switch or a front panel push button.
A slide control is provided for balance. If you set it all the way up you hear only the cymbals, hi-hat, cabasa, brushes and a muffled bass drum. All the way down, instead, you hear the snare drum, tom-tom, rim shot, cow bell, bongos, conga and bass drum. On a middle setting you hear all instruments together.
OTHER CONTROLS
Volume, Tempo, Downbeat indicator, Upbeat indicator, Start/Stop toggle switch (front panel), Stop/Start remote foot switch, Break remote foot switch, Break push button (front panel), A/B Rhythm variation selector.

R.M. 140

The new Elka R.M. 140 is a compact, heavy-duty amplifier designed for general keyboard purposes.
A crossover divides the frequencies in 2 ranges: one is reproduced by a compression driver/horn tweeter, the other by a wide range woofer mounted in a bass-reflex enclosure.
Elka R.M. 140 features 2 separate input channels. Each of them has 2 input jacks (high and low sensitivity) and 6 slider controls: one for the volume and five for tone equalization, accurately centred at 60 Hz, 300 Hz, 1 Khz, 3.5 Khz, 12; Khz. Also, a reverb on/off switch.
The EFFECTS CHANNEL may be sent to a built-in electronic rotor/symphonic system, whose functions can be commuted through a quadruple remote foot switch with symphonic on/off, reverb on/off, rotor on/off and rotor slow/fast.
A master volume and a reverb slider control are located on the front panel, next to an 8 LED output level display and a headphone jack.
A main amp input jack and a pre-amp output jack are provided on the rear panel, together with a remote foot switch connection socket, a rotary speed adjustment knob and the mains on/off switch.

THE WORLD OF ELKA-ORLA

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Telephone: Halstead 5325.

Organ Talk

Ken Lenton-Smith

CHORD FORMATION

In the November edition, we looked at the question of re-arranging sheet music. Plenty of albums of light music for organ are available but, assuming that only a piano arrangement of a given number is published, it may be necessary to self-arrange that music for three staves. As it stands, a piano score is quite unsuitable for a sustained note instrument.

With a little practice, it will not be too difficult to make this re-arrangement at sight — as the music is read. The solo and pedal parts present no real problems but the accompaniment and harmony generally are not quite as simple and require considerable thought until more used to the system.

One finger chords and automatic pedal facilities certainly help in getting the beginner started but they tend to sound monotonous after a while. It is better to get to know something about the *structure* of chords and how to use them, taking advantage of the useful information provided in the line of Chord Symbols.

Chords

The study of Harmony and Counterpoint is a fairly laborious process. Public libraries have a number of books on this subject but they tend to be very dry reading and are probably more appropriate to music students than readers of E&MM. We are primarily interested in lighter types of music and chord formation in particular so musical purists will have to forgive my musical shortcuts. Even so, basic musical knowledge must be acquired along the way, which can only be to the good.

In order to form the *basic chords* upon which music is based it is necessary to know the intervals of the scale in any key signature — or the positions of the notes within the scales. Combining several known intervals will provide the required chord in *root* position, which can be inverted to suit the arrangement. The more complex chords encountered when reading Chord Symbols will for the most part be variations of the four basic chords to be described.

Intervals

An interval is the distance between two musical notes and is described by the inclusive number of letters from one to the other. For example, the interval from C to G is a fifth as five letters (CDEFG) are involved. Figure 1 shows the intervals of the scale of C major.

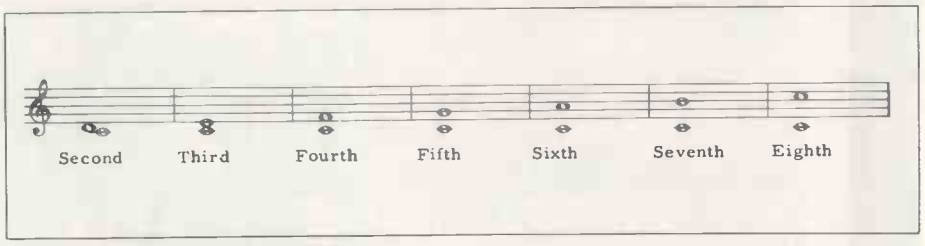


Figure 1. Intervals in the scale of C Major.

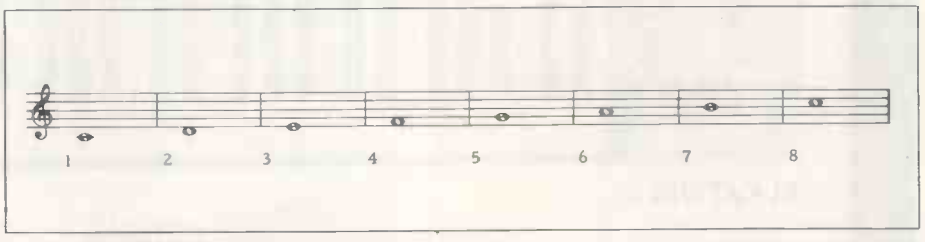


Figure 2. Positions of notes in C Major scale.

For our purpose, we are more concerned with knowing the *positions* of the notes of the diatonic scale so the same information appears in slightly different form in Figure 2.

The intervals can be increased by a semitone (augmenting) and can be flattened by a semitone when working out chords. The process of decreasing the interval will result in either diminished or minor intervals depending on whether the original interval was perfect or imperfect in the first place. This technicality need not concern us here: we will simply consider the interval as flattened, leaving the reader to consult 'Rudiments of Music' for a further explanation.

Diatonic Scales

The key signatures of fourteen Major Scales are shown in Figure 3. This may appear mind-boggling for a start (*seven* sharps!?) but there are only twelve to get used to if you accept that F#=G♭ and C#=D♭. Light music tends more towards flat keys than sharp keys so perhaps ambivalent black notes are best viewed as 'flats' in this context.

Knowing the sound of the ascending scale of C major, the player may be able to find and remember the other major scales without referring to Figure 3 continuously. The individual positions of the notes in keys other than C Major have not been shown but are counted upwards in exactly the same manner. In any case, it is better that the organist gets to know and remember these by experiment.

Chords

Knowing the positions of each note in the major scales, we can use a form of musical 'shorthand' to remind us how to form the basic chords. The numbers refer to the position of the note in the Major Scale: a ♭ sign indicates that the note is taken down by one semitone. Figure 4 shows root positions of the chords to be described.

Major Chord

1 3 5 (Chord Symbol: C)

The keynote, 3rd and 5th are used to form this chord (in any key, of course). It is good practice to try to recognise the sound of a particular type of chord: the Major Chord sounds bright and cheerful.

Minor Chord

1 3♭ 5 (Chord Symbol: Cm)

In this case, the keynote, minor 3rd and 5th are combined, giving a more melancholy impression.

Seventh Chord

1 3 5 7♭ (Chord Symbol: C7)

Strictly termed Dominant Seventh, this is the Major Chord with minor seventh added. It has an 'unfinished' sound, leaning towards the next chord which is normally a fourth higher. For example, C7 propels the

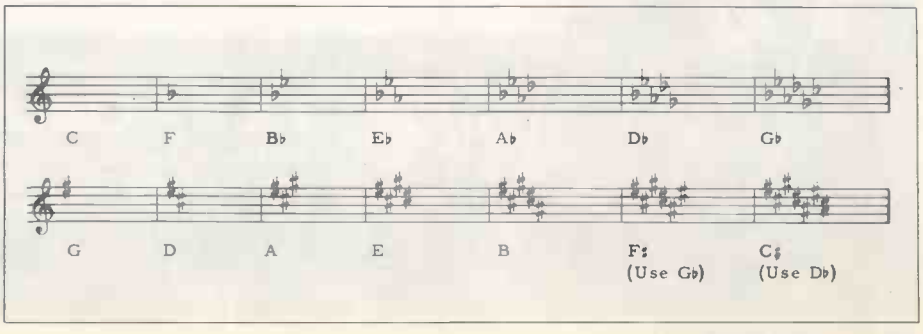


Figure 3. Key Signatures of Major scales.

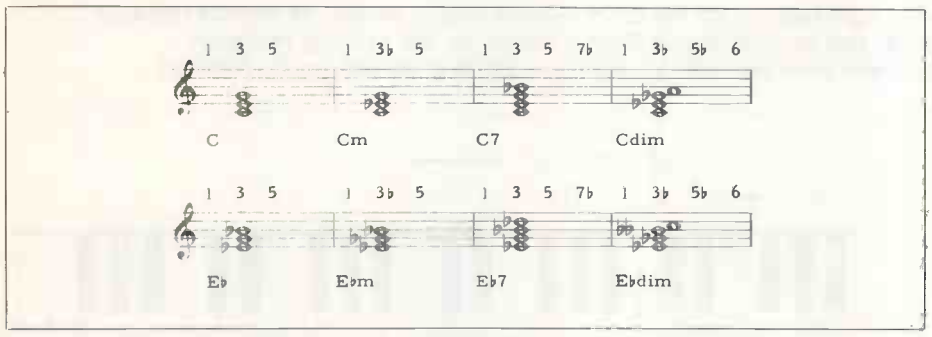


Figure 4. The four basic chords of C and E♭ in root position.

sequence into an F chord of some sort (major, minor or seventh).

Diminished

1 3♭ 5♭ 6 (Chord Symbol: Cdim or C°)

The Diminished Chord comprises keynote, minor third, diminished fifth and diminished seventh. Musically, the diminished seventh is strictly 7♭♭ but for the purpose of our shorthand we will call it the 6th.

This chord has a somewhat eerie sound (try a series in chromatically ascending order) but is easiest to remember as there are only three versions. If you experiment with it in each key you will find that you keep getting inversions of the same notes. For example, C, E♭, G♭ and A all share the same diminished chord.

Chord Symbols vary slightly according to the publisher of the music, those shown above being typical. For chords of 'X', they take the form:

X	X Major chord
Xm	X Minor chord
X7	X Seventh chord
Xdim or X°	X Diminished chord

Inversions

Counting up from the keynote, using Major Scales and 'shorthand' will have allowed us to form the 48 basic chords — all in the *root* position (that is, with the keynote at the bottom of the stack).

However, where the accompaniment manual is concerned, the root position chord may not be entirely suitable. A chord played at 8' pitch too low on the keyboard will sound muddy, whereas played too high it will tend to interfere with the melody line.

Any chord can be *inverted* by taking the keynote up an octave (i.e. moving it from the bottom to top of the chord) so that it occupies another area of the keyboard. If necessary, a second inversion can be made by repeating the process; in fact, the notes of the chord can be played in any order you wish.

My preference is to try to limit the part of the accompaniment keyboard used to the octave F — F either side of middle C (at 8' pitch) when re-arranging at sight. Later on the arrangement can be altered or embellished but this part of the keyboard seems to me to be the optimum and allows counter melodies to come through clearly.

Figure 5 shows the chords of Figure 4 inverted to suit the F — F octave. They should, of course, be written in the bass clef as accompaniment chords but the two illustrations are more easily compared by using the same clef.

This aspect is as important as finding the right notes in the first place so it is imperative to consider this point alongside the 'shorthand'. As the same chords crop up time after time, it doesn't take long to memorise a stock of them for a lifetime's use.

Although it would be quite feasible to publish a complete table of suggested inversions of the 48 chords that can be found by this method, I believe that it is far better to have to work them out initially as they are more likely to become part of the personal ROM that way!

There are a good few chords in addition to these but they are mainly extension or variations of the four chords examined so far: we will be examining some of these later in this series.

The harmonic structure of entertainment music frequently goes through a sequence

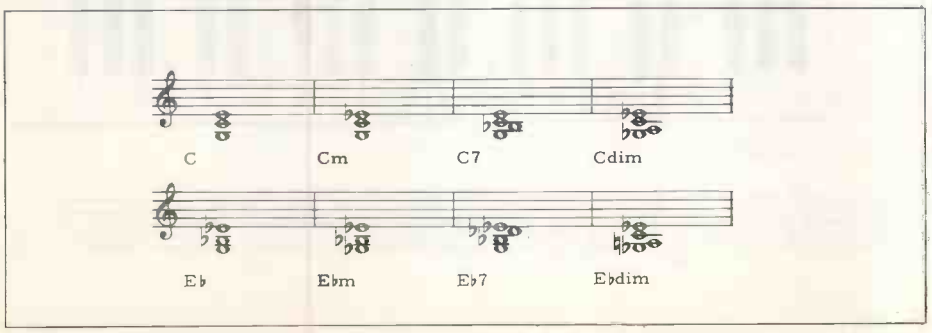


Figure 5. Inverted chords of Figure 4 — shown in treble clef for comparison.

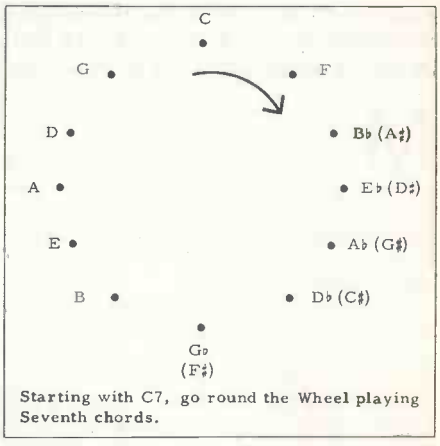


Figure 6. The Chord Wheel.

of chords which is often similar in the case of totally different melodies. The 'Chord Wheel' shown in Figure 6 illustrates how the Dominant Seventh chords lead into the next — always a fourth above.

The chord sequence of a given tune occasionally jumps over a few chords anticlockwise but then starts to drift back in the direction of the keynote chord. As an exercise, try going round the wheel clockwise by playing the succession of Seventh chords to prove how each modulates into the next.

Chromatic or totally unrelated chord sequences are also found in modern music which abrogate many of the rules of harmony but nevertheless sound attractive. The chords involved will often be among those seldom used normally — so beware! In this respect remember that the black notes all wear two hats — so that we take F# as being G♭ for the sake of simplicity.

Finally, perhaps I can suggest that the reader finds a piece of music with Chord Symbols and extracts the solo and pedal parts as proposed in the previous article. For the moment, the chords indicated can be played on the accompaniment manual in sustained form until we get round to methods of using them in rhythmic music in the next edition.

Footnote. *The legal column of the Financial Times a few weeks ago contained a letter from a reader who had bought an organ six months previously but had taken an interest in using the pedals only recently. He found the pedals were sticking and wondered if he could get a refund.*

The newspaper's legal experts advised the reader that the seller could contend that the instrument had developed the fault due to dampness or misuse. There's a moral here somewhere! Perhaps he should also take E&MM . . .

MAKING NOTES

This month we start a new workshop that goes right back to the basics of reading music. Written by Brenda Hayward, authoress of several music books including the very popular 'Organ Master' tutors, for the aspiring musician. Its direct approach is aimed at all our readers who have not had the chance to get to grips with music notation.

My 'Making Notes' articles are a challenge to many musicians who say, 'I can't get interested in or understand the boring subject of Music Theory'. I prefer to call my method of teaching *Musical Interpretation*, meaning: Simplicity in learning the principles devoted to creating and understanding music.

The term Musical Interpretation also represents a modern approach to a very ancient subject. As an alternative to the words 'Work, Practice' and 'I won't bother', think of the three P's: Pleasure, Playing and Perseverence, and psychologically the effect will be stimulating.

I must obviously start at the very beginning, so join me this month to see if I dispel some of the 'cobwebs' surrounding keyboard or manuals, reading the Treble and Bass stave and identifying the Bass Pedal notes.

The Keyboard or Manual is arranged in sequences of black and white notes. The white notes are named in a repetitive alphabetical sequence of 'A' to 'G'. Each note of 'C' is located to the left of two black notes and each note of 'F' is located to the left of three black notes.

The Black notes, which are 'Sharpened' or 'Flattened' white notes, each have two names for which the musical term is 'Enharmonic'. To SHARPEN a note is to *raise* or *higher* its pitch or sound and is indicated by the sign . To FLATTEN a note is to *lower* its pitch or sound and is indicated by the sign ♭. (See Figure 1.)

The easiest way of remembering is Sharps to the RIGHT and Flats to the LEFT of the keyboard. Not always easy I know, as the first problem can be finding the actual note which has to be sharpened or flattened!

When first studying a keyboard the task of trying to remember 44 notes, more or less, can seem impossible. The solution is to identify one section of the keyboard only, 'C' to 'C' which is then repeated up and down the keyboard. (See Figure 2.)

Unless you are one of the gifted people who can start to create music by hearing a melody and playing it, even with one finger, the time spent on learning to relate 'the dots' on manuscript (musical notation) to the keyboard is invaluable.

I will assume that you are familiar with a Treble Stave, headed by a Treble Clef 𝄞, which circles around the line of 'G' and is also known as the 'G' Clef. I understand that at one time the Treble Clef was written as a capital 'G'.

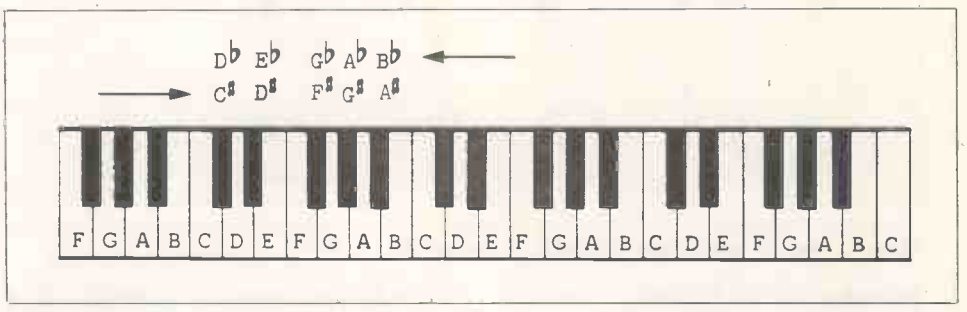


Figure 1.

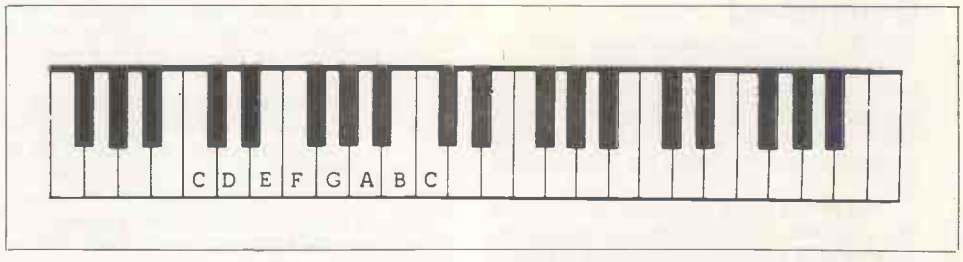


Figure 2.

The five lines, E - G - B - D - F and the four spaces, F - A - C - E combine to complete the Treble Stave, which most of us learnt at school with a 'jingle', such as 'Every Good Boy Deserves Favours' and the word 'FACE' to describe the four spaces. The notes on the Treble Stave are MELODY NOTES and are played with the right hand. I have included the notes of 'C' and 'D' in the following illustration. LEDGER LINES are used when notes to be played are too high or too low to be written on the stave. MIDDLE 'C' is written on the first Ledger Line below the stave and the note of 'D' occupies the first space below the stave. (See Figure 3.)

To simplify relating the 'dots' to the keyboard, I suggest that the lower note of 'E' is located first, as it is the starting lower line of the Treble Stave. By then playing every white note *to the right*, one after the other, the same sequence will occur as in the illustration: E - F - G - A - B - C - D - E - F.

Emphasis is normally placed upon locating the Middle 'C', which is fine if you need to know the correct sitting position for playing the Electronic Organ, Piano or the link between the Treble and Bass Staves, but when initially reading the 'dots' locate the 'E' note on the first line instead of the Middle 'C' note, which is sitting "somewhere in space", and proceed to play the sequence as described. Other electronic keyboards (synthesisers in particular) can often select their keyboard octave range by changing the pitch selector to 16', 8', 4' etc. Nevertheless, it is still best to assume a Middle 'C' at your keyboard centre for reading music.

A 'Notefinder' can be placed on the keyboard to simplify locating the 'dots'. This can be a great aid when first starting to play but it must be removed as soon as possible so that the bad habit of looking down at the keyboard is not established. Feel for the notes and judge their spacing after playing the sequence 'E' to 'F' in the previous

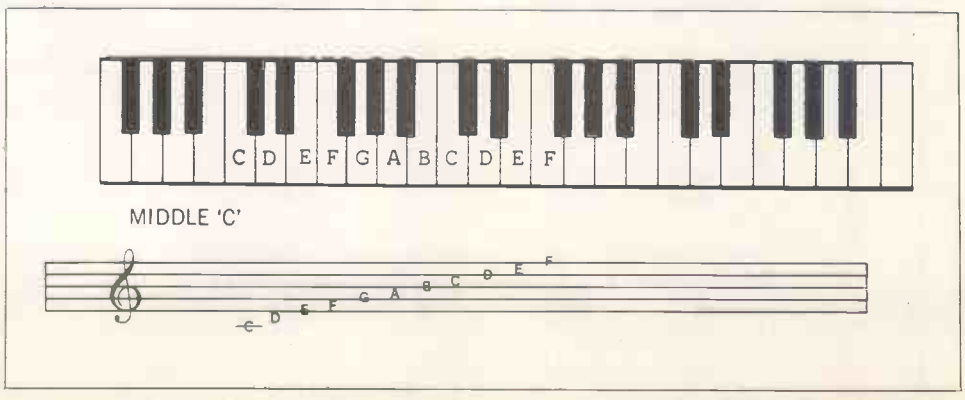


Figure 3. ▶

by Brenda Hayward

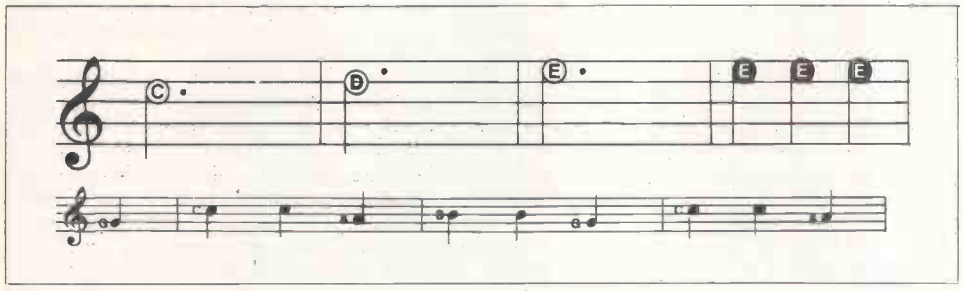


Figure 4.

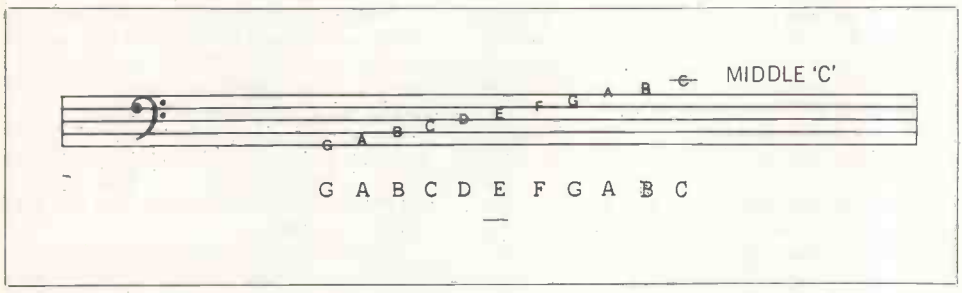


Figure 5.

illustration a few times. The odd wrong note will not only sound wrong but will also feel wrong.

Another aid when starting to play is the inclusion of note names in the manuscript, which are either placed inside large melody notes or are written beside them on the stave. (See Figure 4.)

The problem which can occur when relying for too long upon this method of reading the manuscript, is that the habit of *naming* a note each time it is played can detract from learning or feeling for the *position* of the note on the keyboard. However, both methods are acceptable for the starter musician.

In both the above illustrations the Treble Stave is divided by BAR LINES, to group the notes into the correct Time Value of the music. I will be explaining these in next month's article.

I will assume that you are also familiar with a Bass Stave, headed by a BASS CLEF 𝄢, which is also known as an 'F' Clef. The position of the two dots either side of the 'F' Line fixes its pitch or name. I understand this sign was originally written as a capital 'F'.

The five lines, named: G - B - D - F - A, and the four spaces: A - C - E - G combine to complete the Bass Stave. See Figure 5.

The note of Middle 'C' does not appear on the Bass Stave, but will be sitting on the first ledger line *above* it, as in the above illustration. The note of 'B' occupies the first *space* above the Bass Stave. The middle 'C' Note forms the link and joins the notes in an alphabetical sequence between the Treble and Bass Staves. See Figure 6.

Ledger Lines will also be used if the notes extend above the top line of the Treble Stave and below the bottom line of the Bass Stave. The note names will maintain their alphabetical sequence.

The notes written on the Bass Stave are normally played with the left hand and can include a Bass Note. On a two manual electronic organ, or synthesiser such as the Yamaha SK50D, the left hand notes could be grouped together and played as a 'Chord' and the Bass Note would be played on the Bass Pedal Board. (See Figure 7.)

The thirteen note Pedal Board often used on the home or portable electronic organ (and now appearing as an optional extra on some synthesisers) is identical to the section of the keyboard, 'C' to 'C' illustrated earlier in the article. The Bass Pedal notes are played with the toe of the left foot and the correct sitting position will ensure freedom of the left leg to move easily over the pedalboard. The pedal action has to become automatic as it is virtually impossible for the player to constantly look down at the pedal board, play the correct melody, the accompanying chords and read the manuscript at the same time. (See Figure 8.)

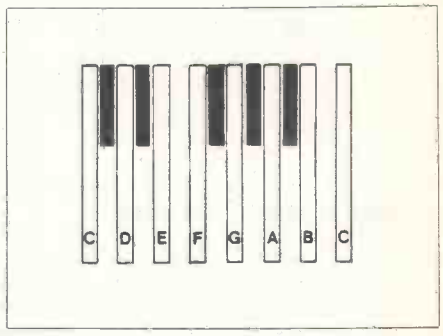


Figure 8.

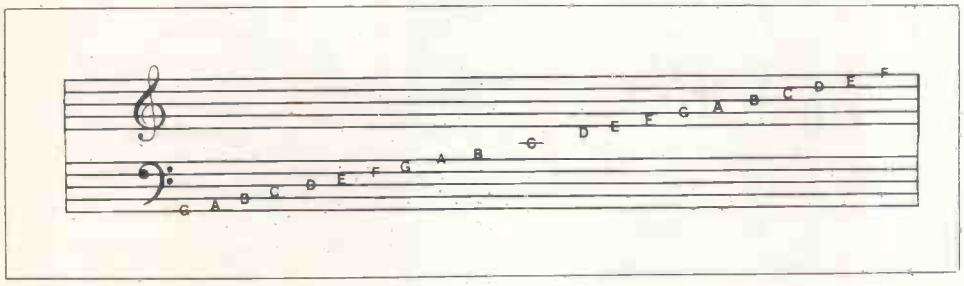
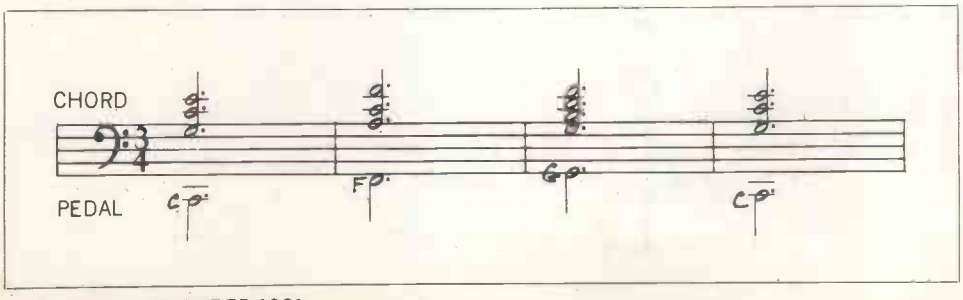


Figure 6.



◀ Figure 7.

Adhesive pedal labels naming the 'C', 'F' and 'G' pedal notes, which are normally the first to be played, are available as a starting aid. Again, the aim is to remove them as soon as possible!

I suggest using a manuscript book for 'Making Notes' of the snippets of information you have found useful. The act of physically writing helps to create a mental photograph which can be reviewed at will.

Join me next month for my article on Note Values, Timing, Time Signatures and Fingering — most important! **E&MM**

HI-FI

Jeff Macaulay

This month I thought I might investigate the different types of output stage employed in power amplifiers. This subject is one of some contention among informed audiophiles. Some hold that only the expensive and hot running class 'A' provides audio perfection and others, probably the majority, are quite happy with the ubiquitous class 'B' stage.

If you're not up in electronic theory you may wonder what all the fuss is about. To understand the problems involved we have to go back to basics. Figure 1 shows a single transistor with the emitter (e) connected to ground. The circuit to the positive rail is completed by R_L. Now any amplifier operates by using a small signal, the input, to modulate an external power source. The power source is the power supply to the equipment.

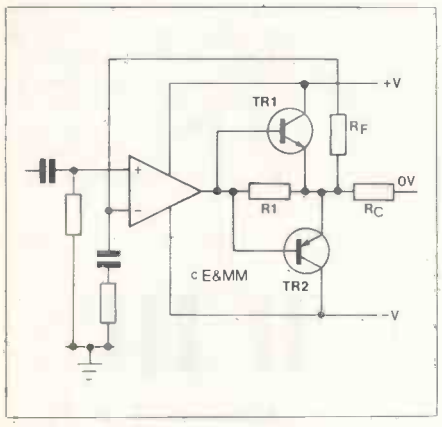


Figure 1. Single transistor amplifier.

It follows then that the laws of physics are not violated, you still don't get 'owt for nowt'. Looking at Figure 1 you will notice that the base is connected across a potentiometer so that adjusting it will alter the voltage at the base. Starting with the base at the negative supply rail, a multimeter will show no voltage drop across R_L. As the pot is adjusted to positively bias the transistor a point will be found where the voltage across R_L suddenly increases. If the pot is carefully adjusted until half the supply voltage appears across the load the base voltage will be found to be about 0.65V.

We now have a class 'A' amplifier. This may be defined as any amplifier in which current flows through the load at all points in the output signal's cycle. To illustrate this we need an oscilloscope and a signal generator. The signal is fed into the base via C1 and is thus superimposed upon the base voltage. In consequence when the signal goes positive the transistor is turned harder on so the voltage drop across R_L increases. When the signal goes negative the converse occurs. If the input signal is too large the output waveform, as observed on a scope, will be clipped. The resulting sound, if R_L were a speaker is the familiar fuzz sound beloved of guitarists.

The point though is that if the transistor is initially biased in class 'A' the output stage will reproduce an essentially perfect replica of the input at its output.

If we now carefully adjust the bias until the transistor is just conducting and observe the output we will get a half wave rectified signal. The transistor is said to be operating in class 'B'.

If we now take a PNP and NPN transistor and arrange them as shown in Figure 2 we can make an amplifier output that theoretically requires no bias at all but can reproduce the input signal. Both transistor bases receive the input signal simultaneously, R1 and R2 set the DC voltage at the output at half supply volts. RV1 sets the bias. The illustration shows the result of zero bias. Note the distortion at the zero crossing points of the waveform. This distortion, not unnaturally, is known as crossover distortion.

Crossover distortion is the main problem with this type of stage and is usually countered by applying a small bias voltage via RV1. The signal now looks okay on a scope. What we have just examined is the conventional amplifier output stage used in 99% of commercial amps. It's easy to see why; quiescent current need only be a few tens of mA to reduce the crossover. Further distortion reduction is obtained by the overall feed back loop.

The matter might well rest there if it were not for the problems inherent in transistor design. In particular thermal runaway. As a transistor heats up the amount of bias it requires for a given current to flow reduces. Power transistors particularly tend to get hot because of the power they dissipate. As they get hotter the more current will flow making them hotter still, so even more current flows. If this effect is unchecked the final result is the destruction of the devices.

The cure is to mount the transistors on a hefty heatsink and to make the bias voltage temperature sensitive. This usually means diodes or a transistor bolted onto the heatsink for thermal feedback.

As speakers become less efficient and amplifier power rises to cope the problems become more pressing. This leads us on to another form of output stage, the so called 'current dumper'.

Figure 3 shows this. Note that a high gain amp is used to feed the output pair which are used without bias. Notice the use of R1 which feeds from the amp to the output. The amp itself is designed to deliver an output current of 100mA. When an input signal is fed into the input, current flows into the load via R1. As this happens TR1 or TR2 is biased on providing the majority of the current to the load. However, in the idling mode neither TR1 or TR2 are conducting. They cannot, therefore, suffer from thermal runaway. Distortion is reduced by overall feedback. This technique is known as current dumping. The most well known application of this is the Quad 405 amplifier. **E&MM**

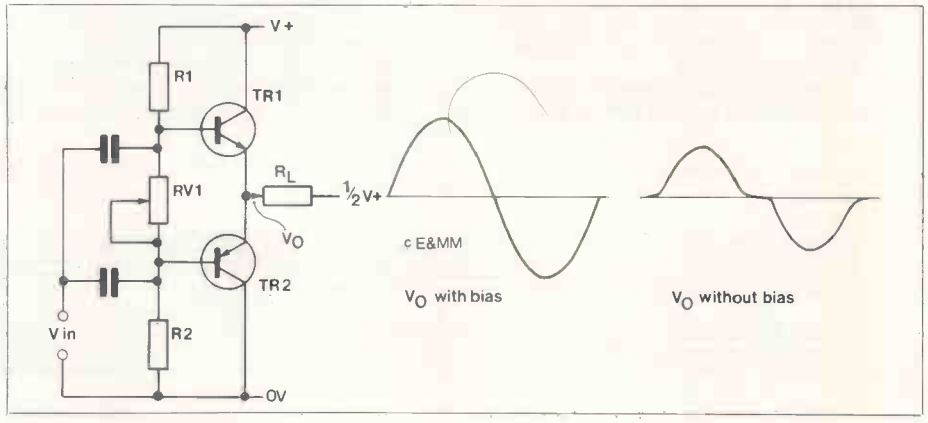


Figure 2. A two transistor amplifier.

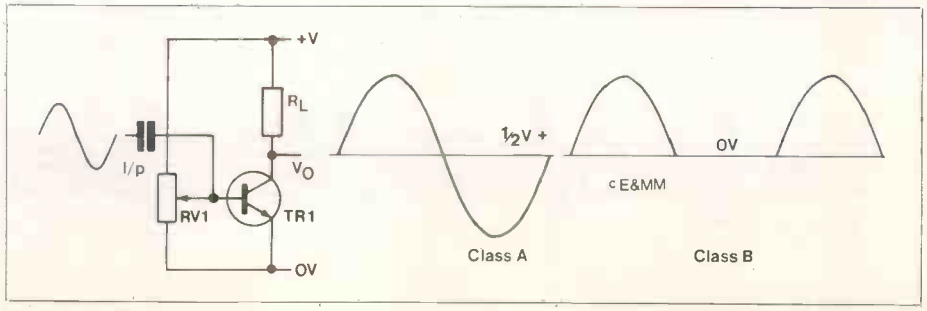
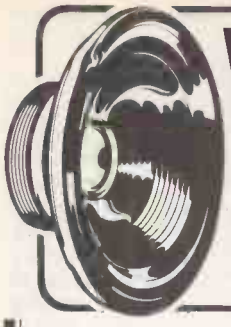


Figure 3. A current dump circuit.



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EMAS

Before starting my survey of electronic music studio members of 'EMAS' I want to draw reader's attention to the Society for the Promotion of New Music (SPNM). Many readers may not know of this society which was founded to promote living music, with an accent on Contemporary British Music. The SPNM receives scores in all contemporary genres, and a reading panel (of vast proportion) forwards work to the workshop rehearsals and performances, which are always recorded, taking place approximately monthly throughout the year.

Last year the SPNM invited 'EMAS' to help with a weekend of electro-acoustic music "Towards a Theatre of Sound" at St. John's, Smith Square, London. Two days of open workshops and a final concert were a success beyond the best hopes of the organisers — five hundred participants! All aspects of the gamut of electro-acoustics were covered: live electronic scores, with instrumental performances.

This was the first major outing for the 'EMAS Sound Equipment Pool', a sixteen channel playback system, purchased with the assistance of the Arts Council, for hire to concert organisations throughout Britain. The Pool differs from commercial concerns in that it is able to devote a lot of interest and give advice on the particular problems of the concert environment and works to be presented. One of the main reasons for EMAS foundation was the feeling that in total contrast to the Rock music scene, concert promoters in so-called 'Art' music (terrible phrase, but readers know what I mean!) knew next to nothing about the needs of presentation of electro-acoustic music.

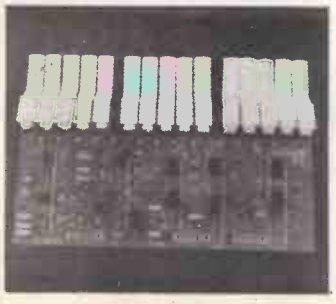
During September 10-13, EMAS once more entered into collaboration with the SPNM for the Composers Weekend. Leading British and foreign performers, Vinko Globokar (trombone), The Michael Nyman Band, Peter Lawson (piano), Alan Brett ('cello), Harry Spaarnay (bass clarinet), the Myrha Saxaphone Quartet, presented works written for them. In addition composers submitted scores for these instruments.

Both the SPNM and EMAS are open to all members of the public to join, both have student rates, both have increased membership and successful presentations in the midst of the recession currently hitting many forms of concert promotion. Write for details to: Hon. Sec. EMAS, 72 Hillside Road, London N15 6NB, and to the Administrator, SPNM, 10 Stratford Place, London W1N 9AE.

Simon Emmerson **E&MM**

NEW PRODUCTS

ORGAN EFFECTS KIT



Wersi now have a Special Effects Kit Pack 11 which will become the standard fitting on all models except the Cosmos. A modification kit for existing organs will be available and the price for the W1, 2 and 3 organs will be £129.

The main differences in the new kit are: a 'brass' effect which according to Wersi adds a realistic tone to trumpet, trombone and similar voices, and a 'wind' effect which adds a 'breathy' edge to voices like the flute and saxophone.

For further information contact Aura Sounds Ltd, 14/15 Royal Oak Centre, Brighton Road, Purley, Surrey. Tel: 01-668 9733.

TRAVELLING COMPUTER CLASSROOM

Acorn computers have built a mobile computer classroom. It is equipped with six microcomputer terminals which are serviced by an Econet network system. The latter enables fast and cost effective access to floppy disks file storage and to a printer. The classroom will enable teachers and pupils to familiarise themselves with the concepts and benefits of networked computing.

The classroom is available for use by any school or local education authority on a weekly basis. Schools can apply directly or via their education authority. The unit is completely self-contained merely requiring a mains supply within 100 yards. The first day of the week is an introduction for teachers, then the classroom is available for continued use by pupils and teachers.

Schools and education authorities wishing to be added to the itinerary should apply to: John Coll on Cambridge (0223) 311427.

For more information contact: John Jones, JJA, 20 Orange Street, London WC2. Tel. 01-930 1612.

Alpha Syntauri

A computer-based digital music synthesiser

The Alpha Syntauri is described as 'a keyboard-based digital playing and recording system with a micro-computer interface'. The first appearance of the system was at a Computer Music Festival held in Philadelphia in August last year, where it attracted considerable attention by virtue of the fact that its target market was the average musician rather than the tax-juggling member of a 'super group'.

The components needed for the primary system are the 61-note Alpha Syntauri keyboard with relevant software, a 48K Apple II Plus, a disc drive with 16-sector controller, a colour or monochrome monitor, and hardware oscillators. A multiway lead connects the music keyboard to a scanner interface card plugged into one of the expansion connectors on the Apple motherboard. The primary system is illustrated in Figure 1. The hardware oscillators are, in fact, old friends of ours, as they are derived from the two Mountain Hardware digital oscillator boards used in the Apple Music System reviewed in the May issue of E&MM. The 16 oscillators available from this system are individually programmed from a 256 byte waveform table, which assigns pitch and amplitude information over one period of the waveform to be produced by each oscillator. The oscillators receive a waveform update every 32 microseconds, which means that direct memory access to the waveform table has to occur every 2 microseconds.

This comparatively high sampling rate of 32kHz (20kHz is a norm for the majority of other systems) gives the system an excellent theoretical frequency response (up to 15.6kHz). The main Alpha Syntauri performance program, Alpha III, translates traditional analogue synthesiser control patterns into real-time control of the Mountain Hardware oscillators by using processing loops. The programs embedded in the process loop are written in 6502 assembly language to provide the necessary speed for the system. Two other languages, Applesoft BASIC and integer BASIC allow user-selection of parameters to control the processing cycles and setting-up of the initial process loops.

The Alpha Syntauri system.

Programming

The set-up program is basically to configure where the interface cards are in the Apple, and, once that's done, a master file can be loaded into RAM to prescribe instrument definitions according to a waveform table and set of envelope parameters. Using Alpha Syntauri's preset master file, Alpha, six banks of ten instruments are available on file, with one bank being loaded into RAM on power-up. Each of the ten instruments per bank can be immediately called-up by entering the number 1 to 10 on the Apple keyboard.

Envelope parameters preset in Alpha can also be reassigned to other instruments in the same way, which means that from the beginning each bank can provide a hundred variations using their simple command language. The decay and release times of the software ADSRs are varied when the sustain pedal is depressed and the degree of variation is selected by an appropriate key entry. Of the six banks in Alpha, four actually turned out to consist of the same presets, which suggests that Syntauri still have some way to go in constructing a decent library of presets. However, the ease of calling-up presets, whether they are Syntauri's or your own stored on disc, means that real-time playing is a cinch on stage. Further user-control is derived from the velocity-sensitive Alpha Syntauri keyboard. Two sets of key contacts are used in the keyboard, and, typically, the attack rate and volume are inversely proportional to the time between contact closures. The actual changes to attack rate and volume are handled by a look-up table which is loaded automatically by the Alpha III software into a specific memory location. Flexibility in the velocity-sensing results can be further achieved through reworking the look-up table from which the velocity-sensing results are ultimately derived. In addition, being a general design, the parameters of the envelope which are affected by the velocity-sensing process may be altered from the attack rate/target volume to, for instance, the attack target volume/decay rate.

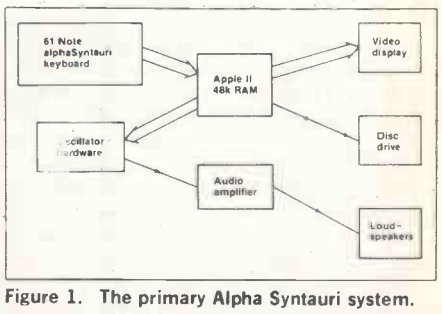


Figure 1. The primary Alpha Syntauri system.

The main process loop contains what is called an unconditional JSR (jump to a user-written subroutine). This allows any user familiar with 6502 assembly language to devise his/her own special effects and controls which are then assessed during the process cycle. An example of a JSR might be to process the note information through a table for frequency modulation of the sound. The current Alpha III program utilises this modification, and provides frequency modulation by any of 253 possible knob-selectable complex waveforms which result from sequences of logical ANDs between the knob-defined 'FM mask' (a value entered from the Apple game paddles which defines the modulation signal) and the changing envelope as updated by the envelope routine for the instrument currently selected. As a result, this gives different timbres and effects for different envelope presets too,

and adds further variations to user-selected presets from the master file. The impression gained so far from the system is that Syntauri have elected to make the interaction with the user as straightforward as possible, and a near approximation to the knob-selected options offered by analogue systems.

This somewhat unorthodox approach to digital synthesis is probably due to the role played by the composer and synthesist Laurie Spiegel in the development of the Alpha Syntauri system. She feels that the feedback loop present in analogue synthesisers (move this knob to get a different sound, i.e., instant response) is a necessity not really present in digital synthesis. The Alpha Syntauri goes a long way towards providing this feedback by means of a bar graph representation of the frequency content of whatever is being entered on the Alpha Syntauri keyboard. The five octave range of the keyboard is displayed along the x-axis of the VDU, and each division of the octave is allocated a different colour. The amplitude of each note is displayed on the y-axis and indicates envelope shapes as well as reiterated cycles and looped ADSRs. The potential in this as a teaching aid is terrific, but its use as a serious means of feedback is only really possible once you've convinced yourself that you're not looking at Liberace's 'dancing fountains'!

Configuration

The Alpha Syntauri is actually configured as an octophonic system, with two Mountain Hardware oscillators for each note. Each of these is programmed by a waveform table, but the waveforms are separated by 0.5Hz to get a chorus effect. In software it's also possible to program an alternative Leslie-type effect. One oscillator is programmed with a standard ADSR envelope, whilst the other is used as a percussive waveform generator and produces what Syntauri call a 'PFSF' envelope. The percussive waveform is constructed to give the hammer action to a keyboard or the blowing sound to a flute.

This second waveform gives some splendid sounds on presets like RMI electric piano, pipe organ or vibes (you can hear examples on demo tape 4), but applying the same PFSF envelope to instruments that don't characteristically produce a percussive envelope (such as their preset 'strings') doesn't seem a particularly clever way of selling your product. Considering how good strings and brass sounds are from polysynths, ranging from the Poly-Moog to the Prophet 5, more effort should have been put into creating realistic presets — that's if Syntauri really feel that it is important to go along with the convention of trying to imitate conventional instruments.

These criticisms are no great thing, though, for the Alpha III program also enables the user to synthesise waveforms. These can be constructed from sinewaves, as in the case of the Apple Music System, but also with sawtooth, square and triangle waveforms, all of which can be applied to the construction of any number of harmonics as well as the fundamental pitch. It has to be

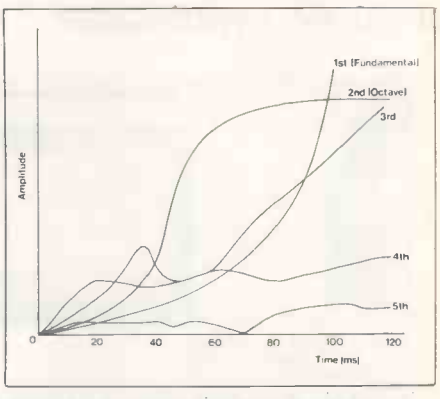


Figure 2. Harmonic envelopes of a violin note A440.

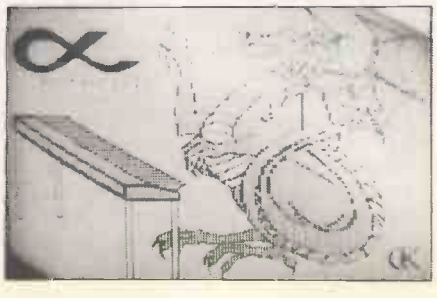
said at the outset that the Alpha III waveform program has the same limitation as that in the Music Player program of the Apple Music System, and that's that all harmonics have the same amplitude envelope. Looking at Figure 2, it's quickly apparent that any attempt to synthesise a realistic violin sound from the first five harmonics is only possible if some variation can be made between the envelopes of the upper harmonics and those of the fundamental and octave.

Apart from programming waveform tables via additive synthesis, it's also possible to go half-way through additive synthesis and then start subtractive synthesis by specifying a negative number to lower the weighting given to a particular harmonic. Again, this subtractive element of the Alpha Syntauri reflects Laurie Spiegel's belief in subtractive synthesis as being more natural to musicians than additive synthesis.

VDU Synthesis

Waveform synthesis is also assisted by an analysis program built into Alpha III. This displays the effect of an added harmonic on the overall waveform by updating the display of the waveform in a slow scan across the VDU screen. Though the Apple doesn't have the computing power of the Fairlight CMI, paradoxically the slow sweep resulting from this limitation permits the process of additive synthesis to be shown much more clearly than the over-complex if, undeniably, pretty 3-D waveform plot displayed by the Fairlight.

With the present software version of Alpha III, the analysis program also allows any waveform stored on disc to be separated into its harmonic components, a digital filter algorithm being executed for each of the first twenty harmonics, and their relative amplitudes displayed on screen. It doesn't take much imagination to see that this program could be adapted to analysis and reconstruction of real sounds input via an A/D converter, though to make any real sense of this Syntauri would need to add a routine for prescribing individual harmonic envelopes.



Conclusions

As you'll have realised now, Syntauri have paid a great deal of attention towards developing a system which is really dynamic, and this also includes a portamento pedal that glides between notes according to values entered in software. Since Alpha Syntauri is at an early stage of its development, and bearing in mind the very reasonable price of the software, it's hardly surprising that there are some areas of the system needing a lot more work. This includes the current facilities for 'recording' music on disc. At the moment, you're limited to putting all your eggs in one basket, so to speak, as all eight possible parts have to be written on to disc at the same time, i.e., it's akin to recording any polyphonic keyboard on 2-track tape.

Mind you, whilst playing back the notes file it's possible to transpose the keyboard over six or more octaves, change the tuning from well-tempered to International or Just, play along with the pre-recorded piece, vary playback speed between half and double the original, and select a continuous repeat (echo) of any section of it. All this is pretty impressive, but it would be rather cool to add what the Apple Music System provides, and that's to enter one part at a time, but in real time from the Alpha Syntauri keyboard, i.e., using the system as a 8-track sequencer. Also, bearing in mind that the Apple Music System has something approaching a music composition language entered from the Apple keyboard, it is perhaps surprising that the Alpha Syntauri doesn't have the facility to use the music files created by the Music Editor in the former system as the source of notes for the Alpha III program.

The approximate UK price of the Alpha Syntauri keyboard and software is £750, and distribution is being handled by Personal Computers Ltd, 194-200 Bishopsgate, London EC2M 4NR. Anyone interested in knowing more about this excellent system should contact John Hopprich at PCL, on 01-626 8121.

If what I've been looking at represents the primary Alpha Syntauri system, then the quaternary system should really be something!

Dr David Ellis **E&MM**

DIGITAL MUSIC—

The Sensational Alpha Syntauri

Technical Specification

Keyboard: 61 note touch sensitive, response under software control.

Frequency Range: 30 Hz to 13 Khz.

Transposition: Real time keyboard transposition in semi-tones.

Voicing: 8 voice polyphonic:
— 2 oscillators per voice ~ offset variable to one octave maximum.
— 2 waveforms per voice ~ use additive/substractive synthesis to create waveforms from pure sine or complex composite waveforms from ⊓⊔, ⩘, ⩙.
— 2 four-stage envelopes per voice.

Instrument Banks: Instrument banks of 10 instruments each, any number of banks may be created.

Footpedals: Sustain and portamento.

Real Time Recording: Over 2000 notes a session. These can be named and stored. They can be continually sequenced, played back between 50% and 200% of original playing speed. The keyboard can be played while sequence is playing.

Microtones: Choose your scale: up to 61 equally tempered tones per octave.

Vibrato: Vibrato with software L.F.O., control of rate, depth, and waveform.

Pitch Sweep: Sweep up into "aliasing" for special effects.

Timbre Scan: Sequence through 20 waveforms and control rate and pitch.

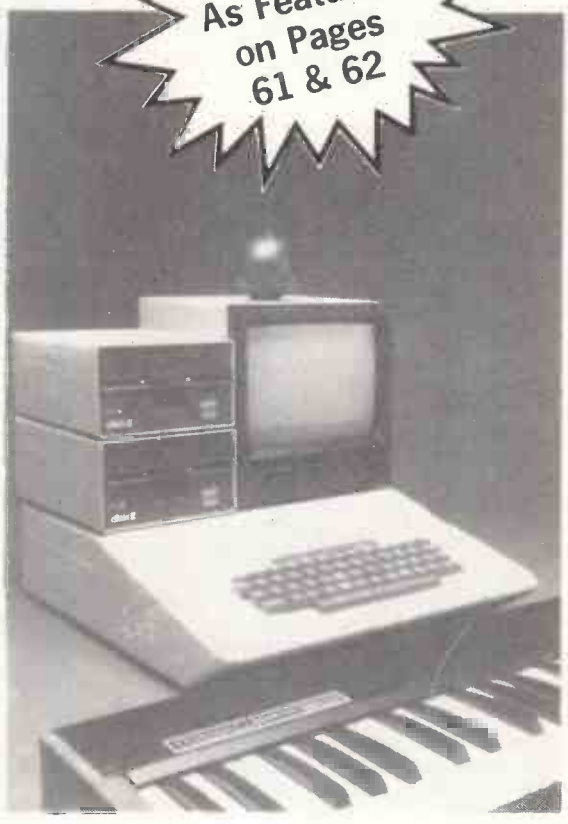
Pitchbend: Dynamically vary the pitch of the instrument.

Wave III: Specify harmonics or overtone series and tune by adding and subtracting harmonics — these waveforms produce the instrument voicings.

Analyzer III: Analysis of stored waveforms using a digital filter algorithm, and display of waveform graphically plus list of the relative amplitude of each harmonic.

Colour Display: Each 12 tone octave has its own row; each note has an individual display — one coloured rectangle per note produces a visual display of your music.

As Featured on Pages 61 & 62



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MH Oscillator Board	351.00

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E&MM/12

WORKING WITH VIDEO

Andy Emmerson

I had an amazing shock recently. I was thinning out a vast pile of old video magazines going right back to the first issue of "TV & Home Video" dated Winter 78/79. Ah, those were pioneering days for home video! What caused the shock though, was the prices of video recorders. Let me explain . . .

Looking at a Comet advertisement of November 1978, the Ferguson Videostar cost a giveaway £699.90 while the identical machine in Akai VS-9300 guise cost £709.90. The bargain was a Phillips 1700 for £624.90 while the Grundig SVR cost £759.90. Now, Comet are competitive where prices are concerned but those look pretty frightening compared with today's prices, and that's despite inflation! Of the machines mentioned only the Ferguson Videostar is still sold (now the 3V22) and the average discount price is around £475 — that's a price drop of nearly a third in just three years.

Of course anyone setting out to buy a budget recorder has a much wider choice now than he did three years ago. Demand for home video has increased and so has the competition for your custom. Most video recorders in the budget £450 to £500 range have better styling and far more features than those early models, though if cash is really tight you can pick up those old ones secondhand for £300 or so. In case you've been holding back buying — or are considering a replacement — here is a rundown of some of the most eligible machines.

All these machines share the basic features of a video recorder — they record and play back programmes recorded from BBC and ITV or from an auxiliary source such as a home video camera or even another video recorder. They can all record in timer mode (controlled by a built-in time clock) up to seven, ten or fourteen days after when you set them. Remote control is available on most machines — sometimes it's only a pause control for crude editing of commercial breaks, in other cases it's more comprehensive but it's nearly always wired rather than infra-red. A basic tape memory switch, allowing you to rewind to a preset point, is normally fitted. Other user features are noted here.

The five models I have taken as representative of the new wave are the GEC V4000H, the Hitachi VT-8000, JVC's HR-7200EK, Panasonic's NV-2000, the SL-C5 from Sony and the PVC-700 by Nippon Electric. The last two are Beta format machines and we'll look at them first.

Sony's SL-C5 (or C5 for short) is a real bargain at £450 (all prices quoted are average retail). Special user features include still frame and rapid picture search (both in monochrome only). Picture search (also known as cue and review or shuttle search) enables you to watch the action at many times the normal speed to rapidly locate the start of a programme in the middle of a tape or to skip the commercials on replay! It is marvellous for folk like me who forget to log counter settings. The timer works over seven days and audio dub is available. A corded remote control is available as an optional extra. Soft touch switches are fitted as on virtually all new machines and the general styling is unconventional — rather like a Citroen car. You'd probably get used to it!

Panasonic NV-2000 home video cassette recorder.

A machine with the same internal electronics and mechanics but a totally different styling is the PVC-700 from NEC (Nippon Electric Company). Features are not quite the same as the Sony C5 — for instance the picture search is in colour and the remote control handles just pause and picture search. It is less widely distributed than the Sony equivalent and at £500 its higher price and unknown name won't help sales — though shortages of the Sony C5 will! Both the Sony and NEC are Beta machines — the others are VHS format.

Just as the C5 and PVC-700 are similar internally, so are the GEC V4000H and the Hitachi VT-8000. Both sell for £500 and feature still frame, picture search, frame advance, auto rewind, counter memory and a ten day timer. The only real difference is in the styling and the wired remote control units. On the GEC this controls all functions, on the Hitachi only pause and frame advance (slow motion). Since the price is the same this makes the GEC the better buy.

JVC's HR-7200EK is the newest of all the machines. Price is around £500 and special features include forward and reverse picture search with (noisy) colour, ten day timer, counter search and not much else. There is a corded remote control unit (with all functions) supplied with it.

The final machine is the NV-2000 from National Panasonic. The timer works up to fourteen days in advance and other user facilities include forward visual search, slow motion, moisture indicator and a precision edit system with minimal picture break-up. Price is around £500. If pressed to make a choice this is without doubt the one I would go for. For anyone interested in the creative side of video the clean edit function is essential and the diecast alloy chassis of this machine helps it earn its excellent reputation for above average sound quality and stability. The other features are useful and well chosen but the two points I first mentioned are the most important to me. The picture quality is also above average, which does help too.

Despite this we have not yet seen the ultimate video recorder. Several other manufacturers have indicated their intention to make home video recorders and the increased competition can only serve to stimulate development of improved machines. There is a very good chance that the VHS manufacturers will announce a long play option within a year or two, and Sony may follow suit too. This will record and play back at half speed, enabling you to get eight hours programming on to a four hour tape, something currently possible only with the VCC system from Philips and Grundig. I also predict stereo playback will be with us soon, enabling you to play the sound of music programmes through your hi-fi system. If, together with all this, prices of machines fall as they have done over the last three years, well . . . **E&MM**

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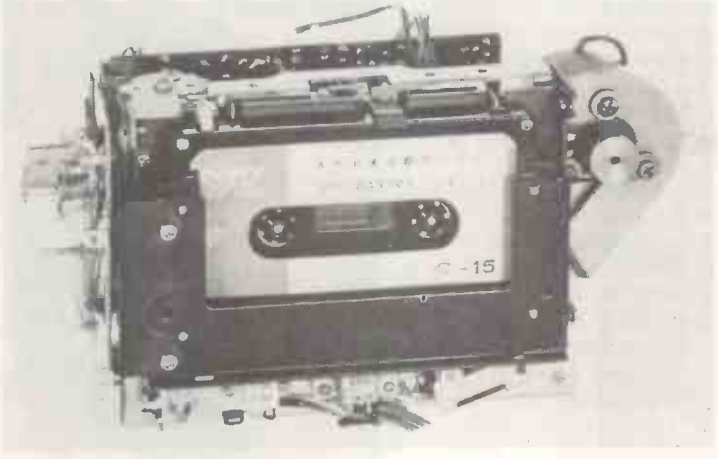
The system is very high quality and the signal to noise ratio is extremely good.



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ORCHESTRAL MANOEUVRES IN THE DARK

"Being fairly incompetent musicians means that we can't do the normal things that a musician would."

Andy McCluskey of Orchestral Manoeuvres In The Dark makes it quite clear that he and Paul Humphreys, although they are among the most innovative electronic musicians in the country are not interested in doing things by the book. "Synthesisers should be a means to an end. If we wanted to, we could spend £10,000 on the Fairlight CMI which would record and analyse acoustic sounds, then reproduce them for us from its VDU analysis, but it doesn't interest us. We'd rather do it our way."

Doing it their way has, so far, proved musically fascinating and financially rewarding. Orchestral Manoeuvres is simply the most enduring line up, so far, of all the bands Andy and Paul have been involved in since they formed the Neu and Can influenced VCL XI when they were sixteen. That was followed by Hitlerz Underpantz and The Id. All of these bands had experimental leanings, but when The Id and our two heroes parted company in 1978, the decision was made to team their talents with those of Winston.

Winston was a tape recorder, who took the place of other musicians via tapes made by Paul and Andy prior to their gigs. So it was that OMD came into being with a gig at Eric's on 12 October 1978 in Liverpool. Merseyside is their home, and local landscapes infiltrate their lyrics frequently. "We were too young to be influenced by The Beatles, and I particularly don't like them," says Andy. "We listened to Eno, Kraftwerk, Can, but we had no idea that anybody else in England was doing the same thing until 1979 when Numan and Cabaret Voltaire suddenly appeared."

Gary Numan invited them to join his tour in September of that year and, very astutely, they used the money they earned to build their own 16 track studio in Liverpool. What they lack in traditional musical values is made up for by sheer hard work. "We're compulsive workers. We spend whole days in the studio and we've found it a great asset to us. We can spend a week in the studio and it costs us nothing, whereas most bands pay a fortune to get studio time exactly when they want it."

OMD are continually self-critical, but it is clear that most of their criticisms are unfounded. They claim to be disorganised but, in fact, "The studio also houses a rehearsal room, control room and office, so if we get bored we can do some office work." That kind of organised work pattern could improve many bands attitudes and their output. "We engineer ourselves, which accounts for the poor quality of our sound," says Paul, but on their new album Architecture and Morality (Dindisc), several of the tracks were completely recorded in their own studio and simply mixed elsewhere. "We didn't like the clean, clinical sound you get in most big studios. Our mixing desk is really battered and has a lot of channel distortion which gives a wonderful, graunchy edge to our sound."

Where most bands spend years trying to eliminate distortion, OMD are taking pains to introduce it *creatively* into their work. "Electronic music often sounds too clinical because synthesisers are usually D.I'd (direct input) into mixing desks, so because there's no microphone involved you don't get the speaker distortion or the amp

distortion. We sometimes mike things up to restore that. We also have an ambient room down at The Manor studio where we mike things up at a distance and get a big, boomy sound."

What this ingenuity and lateral thinking proves is that you don't have to be a world class musician to produce unusual sounds or thought-provoking music. On the new album, OMD have been experimenting with electronic reproduction of vocal and acoustic sounds but typically, they even tackle that in their own way. "Our instrument of the week is our second-hand Mellotron, but we don't use it to sound like the Moody Blues. We don't put any echo on it and we use a sharply defined cut and thrust sound, big blocks of it. We build up whole choirs through multiple tape loops, and because some of them don't go round at quite the right speed, they shimmer and shift in ways that a real choir never could."

There was a certain irony in the fact that the 1976 punk explosion involved much sneering at the synthesiser. "In one sense," Paul points out, "they're the ideal punk instrument. If you take the punk ethic as being 'get up there and do it without being a musician', then the synthesiser allows you to make wonderful sounds with one finger and very little ability."

The hoary old chestnut - could the synthesiser eventually replace the guitar - puts Andy in two minds. "I don't know. They're in vogue at the moment, they're also cheaper and more accessible than ever but I think that what's really taking over is studio technology in general. Flangers, aural exciters, DDLs and space echoes, all that stuff."

When the synthesiser was first introduced onto the market, back in the sixties when people still couldn't pronounce Moog properly, it was seen as an instrument capable of reproducing any sound the musician might imagine, but in practice every synthesiser has its own unique sound, which to some extent explains why so many electronic bands sound alike. "There are getting to be synthesiser cliches or if you want to sound like Gary Numan you buy a Polymoog," explains Paul.

"A lot of Ultravox's sound depends on the ARP Odyssey," says Andy, taking up the theme. "And a lot of ours is Korg with a Prophet string sound. The real reason why people sound the same is that they don't use the instrument properly. They don't explore the potential, which is dreadful, because the synthesiser has more potential than any other instrument."

For Orchestral Manoeuvres, ideas are as important as technique, if not more so. In common with classical music composers, they can see ways to incorporate abstract ideas into their music. For example, "On the latest album, 'The New Stone Age', was an attempt to make primitive synthesiser music." To Andy, primitive synthesiser music doesn't mean George Crumb or Morton Subotnik. "No, it relates to my love of archaeology. The first thing I ever wanted to be was an archaeologist, so I wanted to bring that into the music. It seemed quite feasible to us, but we failed miserably."

I was lucky enough to hear the track he referred to, and if that's his idea of failure, I can't wait to hear it when they finally get it right. "What we ended up with here is choral and religious synthesiser music, because lately we've been listening to a lot of Gregorian chants, Debussy and various requiems. But we're still working on the 'Stone Age'."

"I suppose we have basically, a non-musical sound. Recently we were trying to work out some rather complicated chords which were too difficult for Paul to play so he did octaves, which gave it a very strange sound. In the studio we have our keyboards set up back to back and we search out the harmonies we want without looking at each other until we find what we want. I suppose it is unusual but if you compare our work with a lot of the stuff done by technically first class performers who know about all the latest hardware, it's our stuff that has a different edge to it."

Orchestral Manoeuvres In The Dark is a group you can only judge on results. Despite their insistence that they can't play, their music is more melodic than most and that's what counts. It's hardly surprising that they can spot a good tune when they hear one because Andy points out that, as well as Kraftwerk, Can and the other Germans, they have some less predictable tastes. "Nat King Cole is just about my all time favourite singer, and if we ever get near a juke box with Sinatra or Glenn Miller on it, Paul invariably puts it on. Their stuff has become standard, it is revered almost as antiques. In terms of our melodies I'd like to think we could be like that. Good melodies should last forever."

You better believe it. Apart from the new album, just released, Orchestral Manoeuvres are currently touring the UK, so you've no excuse to miss out.

Johnny Black **E&MM**

Electro-Voice PL95 and PL91A

I have more than a sneaking regard for Electro-Voice microphones since first using a pair during multi-mic comparisons recently. These two USA-made moving coil vocal mics are from an extensive catalogue — there must be over 50 in the range, one way and another, with prices ranging from around £40 to £300 if you ignore the specialist 'gun' mics.

There are basically three ranges of moving coil mics in the EV catalogue. These are categorised as Professional Dynamic with the ubiquitous RE20 and other RE suffix models, General Purpose Dynamic and Proline ranges. This latter range, all with the PL suffix, are handled by Rosetti Ltd for music shop distribution.

The mics in this report are the PL95 (although listed in the price list as the PL95A) and the PL91A. The former is the equivalent of the 671A in the General Purpose Dynamic range whilst the latter is equivalent to the DS35 in the Professional Dynamic range!

General Points

Both have the fine Cannon connector fitting — male type on the mic following the convention of the pins pointing in the direction of the signal. Balanced floating connections are provided, but of course either balanced or unbalanced inputs at the pre-amp can be used. Zippered soft vinyl pouches are supplied as are Cannon connector fitted leads. Both mics have descriptive leaflets giving all the basic information needed. Another common physical aspect is the built-in anti-pop foam under the mesh grille.

In Electro-Voice parlance these are Single D cardioid designs, giving the usual cardioid proximity effect where the bass rises with close work. There are also Variable D cardioids in the EV range and these do offer a degree of reduction in the proximity effect. Being Cardioid as opposed to Super Cardioid (or Hypercardioid) the two mics looked at here have their response null at 180°.

Nowadays there is no problem in the impedance 'matching' of mics to their pre-amps. Most manufacturers produce mics between 150 and 600 ohms source impedances. They should not, however, 'see' these impedances when connected to the mic pre-amp — some five times or more is the usual situation. The only really important thing is that the source be low enough to avoid cable capacitance effects at high frequencies.

One physical difference in the microphones is the provision on the PL91A of an on/off switch which short-circuits the balanced feed. A novel screwdriver locking facility is also provided.

Electro-Voice PL95.

Test Conditions

I find it necessary to relate any product under evaluation to others one is already familiar with. So four mics were lined up for comparison. As I often have used an AKG D202 for vocals in my recordings, one of these was brought in. That's a double moving coil unit. Also to hand was a vocal 'proper' capacitor mic, the Calrec CM656D. Both are cardioids — the former not being specifically for vocals though. The channel presets of the custom built mixing desk were adjusted to give similar levels from all the mics. A Revox B77 at 15 IPS was used to record the sequences via Dolby A noise reduction.

Electro-Voice PL91A

I do not think that it is possible to be anything but delighted with the performance of the mic (and its brother)! Just the right amount of presence lift compared to a 'flat' response mic and a lighter bass at 2ft plus, giving a fine vocal sound. It's not an exaggerated sound — in fact still very natural. An opportunity arose to add some vocals to an already laid down backing track. This proved the need for a special vocal mic as there was a lot more ease in "cutting through" the backing, but definitely not harshly. I have always been wary of super boosted vocal mics. A very natural tailoring, and in comparison with the other two in the line up, showed the need to reduce the low frequency response on the PL91A a little.

Going closer to the PL91A thickened the lower frequencies as would be expected from the proximity effect. Interestingly, all the tests and comparisons seemed to bear out the supplied descriptive leaflet. One aspect of the PL91A which was striking was its 180° rejection. It sounded greater than the others and interestingly the single frequency curve in the leaflet shows a right royal 180° rejection!

Handling noises are relative to the abuse a soloist is giving a mic and to the level of the sound input. Also a sharp bass cut below some 60Hz might be employed in the mixer in practice. All this would reduce the effect of the handling noises which I feel are higher than I would have expected and also higher than the two 'reference' mics.

Electro-Voice PL91A. ▶

Electro-Voice PL95A

Now all the same things could be written about this model. In fact, one wonders why there are so many different vocal mics in the EV ranges. No doubt subtle differences would become apparent with extensive use, but they would be subtle. Possibly a particular singer's voice just suiting a nuance of one mic more than another. Again a fine vocal sound.

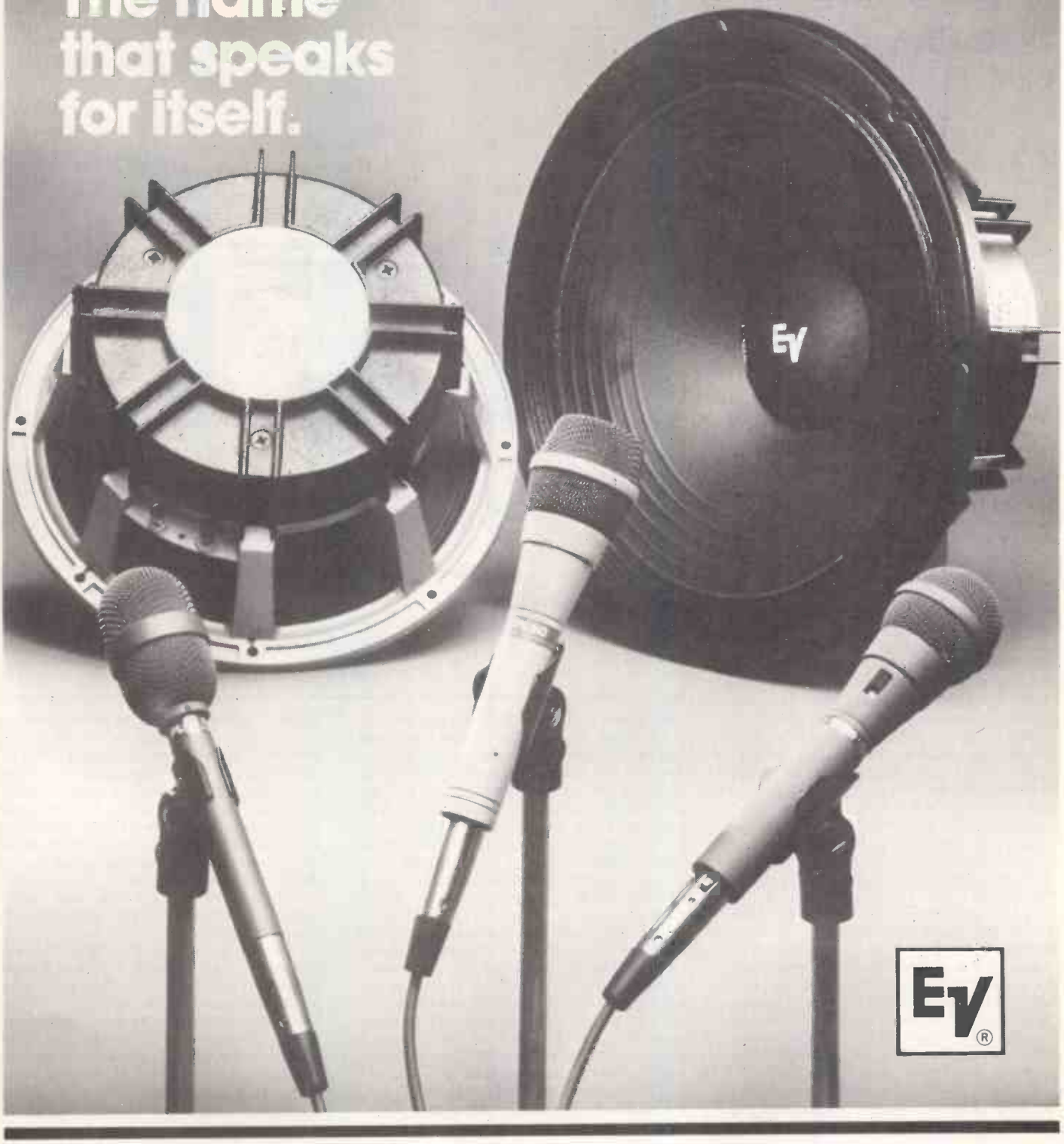
Slightly more expensive than its brother, but both bring out the point I cannot overstress. Buy the best microphone you can as there is really no short cut to quality in terms of price. Both mics verified this. A casual listener said 'those mics sound good 'uns'. And so they should, averaging around £85 incl. VAT. Some people might buck at paying £85 for a mic but cheerfully use a recorder costing £800 (if an open reel), and loudspeakers at over £300 a pair if they want reliable 'professional' standards. Decent mics go on and on and these two EVs will undoubtedly do so — thoroughly recommended.

Mike Skeet **E&MM**

Electro-Voice microphones are distributed by Rosetti Ltd, 138-140 Old Street, London EC1V 9BL.

Electro-Voice

The name that speaks for itself.



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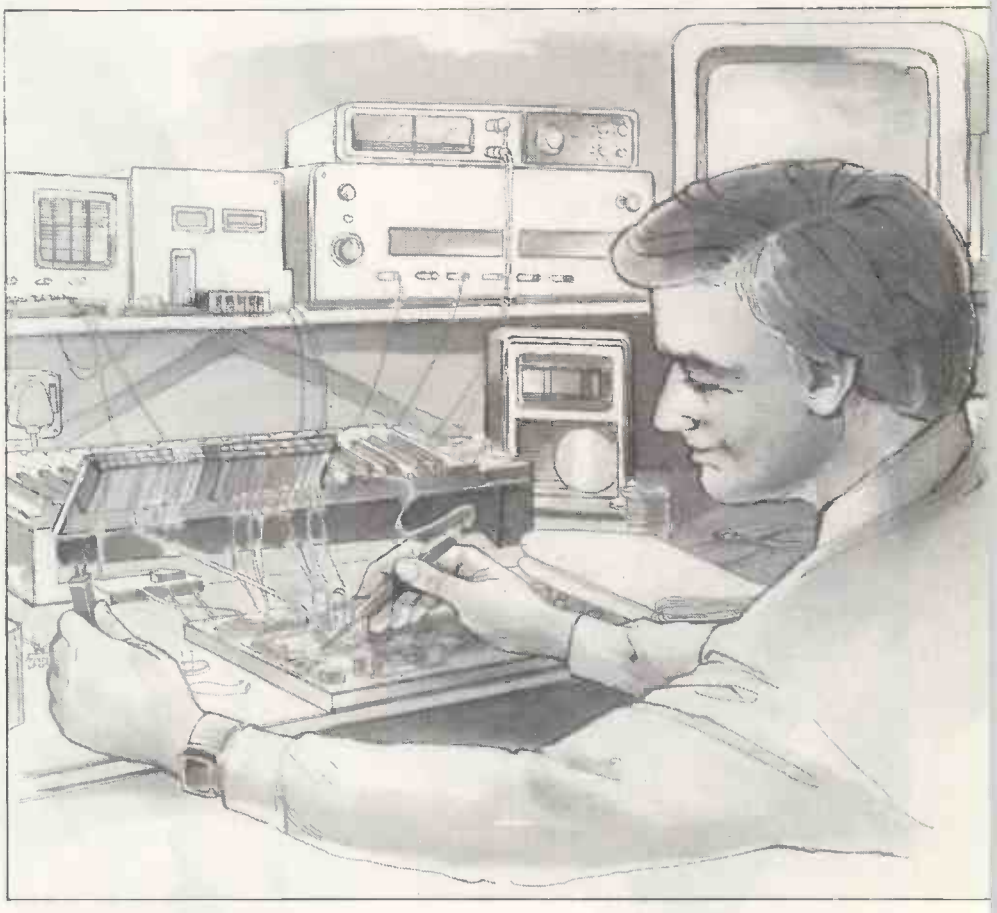
ELECTRO-MUSIC ENGINEER

Charles Blakey

Application of the CEM 3310



As readers will have observed this new column is a development of our ICs for Electro-Music and will continue to examine ICs of specific interest for electronic music applications as well as other equipment and components for the electronic engineer working with music designs. For this article the format is changed from a simplified data sheet type of approach to one which will provide a specific practical application or some design ideas for the CEM 3310 Voltage Controlled Envelope Generator, from Curtis Electromusic Specialities, which was briefly described in the April 1981 issue of E&MM.

The features of this IC which the writer finds most intriguing is its voltage control capability, that is, the time constants of attack, decay and release as well as the sustain level are proportional to the voltage applied at the appropriate pins of the IC. This makes it easy to configure the device such that a proportion of the keyboard control voltage may be summed with one, or more, of the A, D, S and R inputs and so vary the envelope in relation to the note played. For example, if we add a proportion of a positive keyboard control voltage to the negative voltage used to vary the attack time then the result will be a faster attack time the higher the note played. Another alternative is to return a proportion of the ICs output, with or without inversion, to the control pins and obtain a virtually unlimited variety of envelope contours. Thus instead of the usual curved (exponential) shapes of the envelope contour one may obtain, say, an attack response which is concave, linear, S-shaped and so on. Since the sound contour from a synthesiser is governed by the envelope shape then the ability to depart from the conventional ADSR envelope is well worth exploring for both imitative and creative synthesis.

The main difficulty with using the feedback technique for obtaining unusual envelope shapes is the time required to establish the required conditions, especially in a polyphonic synthesiser. The next best thing is to have switch selection of various proportions of feedback to produce contours of specified shape. Doug Curtis, the president of Curtis Electromusic Specialities, has recently described such a circuit. What caught our attention, however, was another of his designs which, with a few add-ons and component changes, I have configured into a complete circuit. The design has three operating modes. The first is called NORMAL and is the conventional ADSR envelope which is familiar to readers. Second, is an AUTOMATIC mode in which a short gate pulse will cycle the envelope shaper through a complete ADR envelope. Such an envelope is illustrated in Figure 1 and it can be seen that by adjustment of the time constants it can be made to approximate the ADSR envelope.

We have found that this mode allows the envelope shaper to be interfaced with some of the programmable sound generators which usually only produce a short pulse when a new note is played. Also when gated from an LFO, or other non-keyboard trigger generators, it provides a more useful envelope than the usual AD type obtained from conventional shapers.

Furthermore, as Doug Curtis points out, the mode is useful for long attack times since the player can get on with something else while the envelope cycles through its phases. The third mode is called DAMPED and allows a closer approximation to the piano envelope. The envelope type is ADRR, as shown in Figure 2, and for a piano type sound one requires a fast attack followed by a brief decay then a long release and finally a very short release corresponding to the damper rejoining the string. In this latter mode the release of the key, which terminates the gate signal, simulates the damper action.

The complete circuit for this envelope shaper is shown in Figure 3. RV1, 3, 4 and 5 and associated resistive dividers are used to adjust the sustain level (from 0 to 100% of peak attack level) and the time constants for attack, decay and release. The time constants are also governed by C9 plus the feedback components RV6 (for matching units in a polyphonic system) and R15. With the components shown the A, D and R time

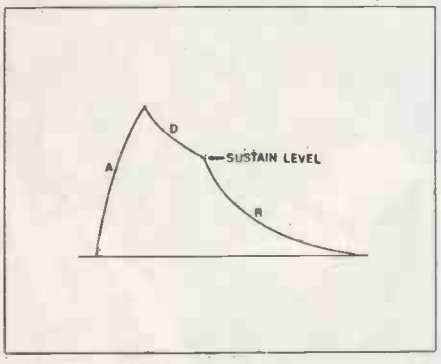


Figure 1. 'Automatic' envelope.

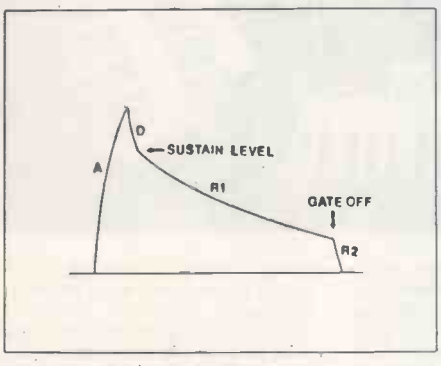


Figure 2. 'Damped' envelope.

values may typically be varied from two milliseconds to twenty seconds. IC3 is solely to convert the +5V output from the CEM 3310 to a +10V output and so may be by-passed, or omitted, if +5V is suitable for a particular application.

The unusual part of the circuit is built around IC1, TR1 and TR2. In the NORMAL mode a gate pulse, in the range of approximately +3 to +15V, will simply switch the output of IC1A high and this output is connected to the gate pin (pin 4) of the CEM 3310. A simultaneous trigger pulse will also be generated and applied to pin 5. It was noted in the article on this device that both a gate and a trigger pulse is necessary in order to generate an ADSR envelope but the trigger pulse is readily obtained by differentiating the gate pulse. If an independent trigger pulse is also available then this may be applied to the TRIGGER input, C5, while the gate is high and so initiate a new attack cycle for generation of multiple peak envelopes.

In the AUTOMATIC mode IC1A will again go high and produce the required gate and trigger pulses. Note, however, that IC1A is acting as a set-reset flip-flop and in this mode the length of the gate pulse at the input, S1, is of no consequence and is solely used to switch IC1A high. The envelope then progresses through the attack and decay phases and when the latter is within about 100mV of the sustain level, as determined by R10 and R11 connected to IC1B, the output of IC1B goes high which will then reset IC1A low and cause the envelope to go into its release phase. In other words when IC1A goes low as the decay matches the sustain level then as far as the CEM 3310 is concerned the action is the same as when the normal manual gate is removed.

When S1 is switched to the DAMPED mode then the gate pulse is applied to the base of TR1, switching it on and producing a positive pulse to IC1A which, as before, initiates the envelope. Again in this mode an independent trigger may be applied, if required. With IC1A high the cycle will normally follow the same procedure as the automatic mode and it will be reset low by IC1B when the decay more or less matches the sustain level which has been manually set by RV1. When the gate pulse at S1 is removed, however, TR2 will be turned on and since its emitter is connected to the release input of the CEM 3310 it will thus short this input causing the release (denoted by R2 in Figure 2) to go to zero in several milliseconds.

The circuit also includes a manual gating facility which is disabled when the unit is operated from other sources.

It is hoped that the above focuses more attention on the rather neglected 'sound contour' and stirs some interest in utilising dynamic control of contour. **E&MM**

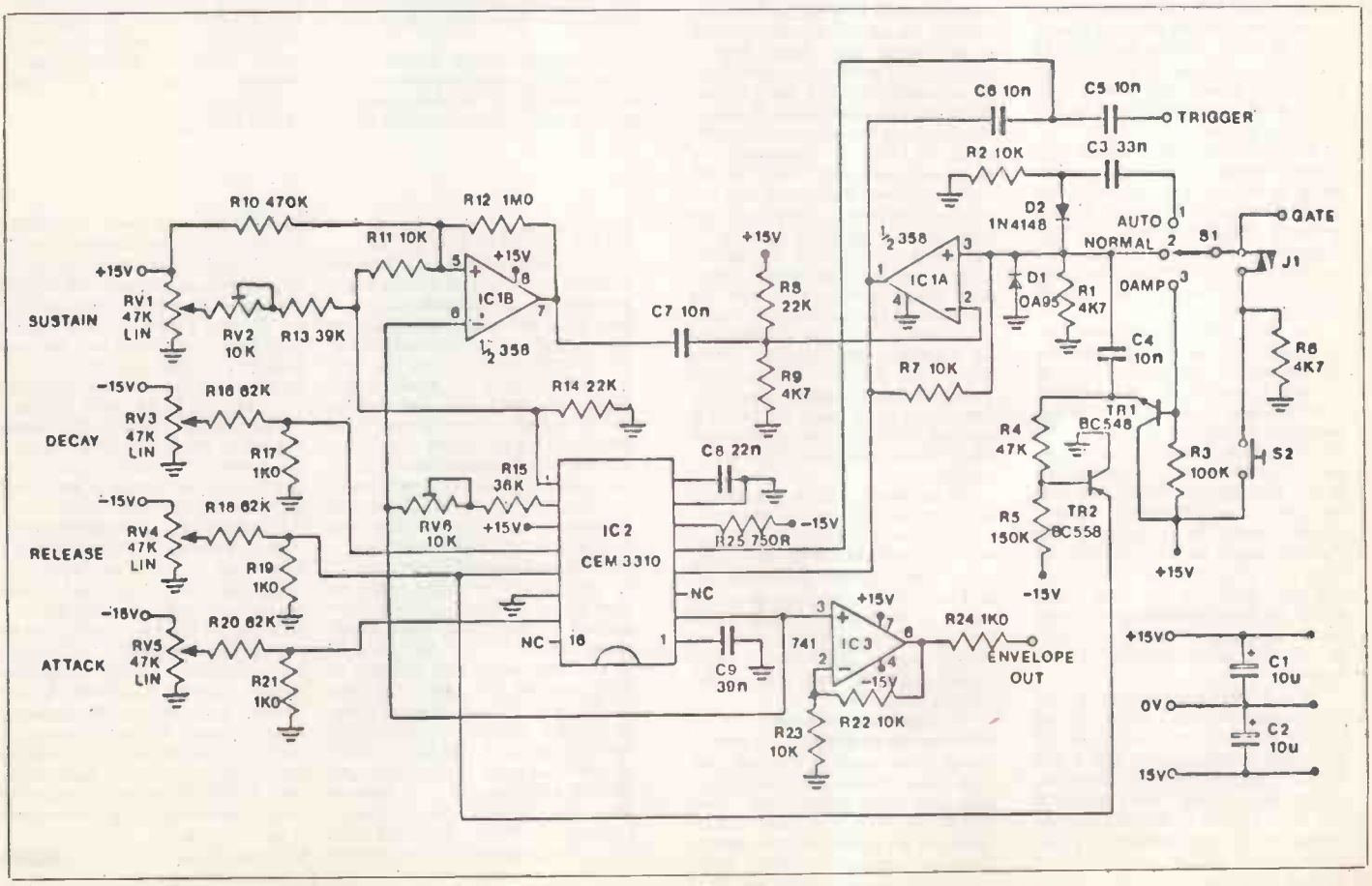


Figure 3. Circuit diagram of the three mode envelope shapes.

RECORD REVIEWS

Logic
by Logic System
EMI

Musicians have in the past twenty years become infinitely more scientifically minded and the potentialities of the computer have fascinated our more far-out composers. There has, however, been no clear agreement as to how to exploit this remarkable and potentially revolutionary tool.

Computers have been used to originate musical material and to organise it. However, this approach is less popular than the approach used here by Hideki Matsutahe. Matsutahe, the computer programmer with the Yellow Magic Orchestra, has used computers to control tempo, timbre, rate and shape of attack and decay, register and so on, in the same way as the *traditional* composer does with his or her score.

The results are presented on his debut album for EMI entitled 'Logic'. Together with electric guitarist Kenji Omura and Hiroki Tamahi, electric violin, they form Logic System. The tunes on this album were composed by Ryo Kawakami and their simplicity together with the excellent production afforded by Hideki and his collection of electronics results in a truly excellent album.

After a short introduction the album kicks off with the longest of the tracks, albeit at four minutes fifty seconds it is hardly self indulgent. Entitled 'Unit', it features vocals sung in French by an uncredited female. It has a nice relaxed almost reggae feel to it, and a very memorable hook.

'Domino Dance' which follows is one of five tracks which are exactly four minutes fifteen seconds long. Maybe four minutes fifteen seconds is the optimum length of time for this sort of music? It has a driving beat and is reminiscent of the works of 'Space' — i.e. Magic Fly, Tender Force etc. As this track is released as a single c/w with 'Unit', it will undoubtedly soon crop up in the Futurist Charts, such is its dance appeal.

'Convulsion of Nature' weighs in at three minutes and evokes a rather eerie quality, almost contemporary horror film music. 'XY', which follows, reminds one of the work of fellow Japanese composer Tomita. The piece is spoiled to some degree by the inclusion of some rather banal 'Vocoded' vocals.

The first track of side two, 'Talk Back', appears on the EMI sampler 'Terpsichore'; although adding strength to that album it is somewhat overshadowed here. A definite Yellow Magic Orchestra feel is apparent on 'Clash' with its percussive nature, as well as some excellent synthesised brass. The 'Lighted Match' sound at the beginning of 'Person to Person' reminds one of 'Being Boiled' by the Human League, although its plodding bass line gives it a rather ominous feel. On then to the title track 'Logic' which is a bouncy little number that is also somewhat derivative, being similar in rhythm to Landscape's 'Einstein A-go-go'.

This is undoubtedly an excellent, if somewhat derivative album, whose quality of production and variety of electronic sounds ensure that it will appeal to both listener and dancer. As Hideki says on the sleeve notes: 'If you do not listen to this album, you cannot enjoy the essence of computer music'. Ah! So!

Derek Pierce

Logic System.

O Superman/ Walking The Dog
by Laurie Anderson
Warner Bros K17870 (single)

Laurie Anderson is a performance artist from New York. Her vocoder is a VP330 from Roland, her harmoniser an H949 from Eventide. Laurie's vocodered and harmonised vocals, along with Roma Baron's keyboards (Farfisa organ and Casio preset keyboard) and Perry Hoberman's flute and sax, make 'O Superman' perhaps the most surprising hit single of 1981 — especially for Anderson. She's said to find recording a relatively frightening and unfamiliar medium to work in — her stock in trade since the early 1970s has been multi-media live performance, incorporating visual projections which shift in time with her vocoder and backing tapes. 'O Superman' itself, for example, is taken from an extensive work called 'United States I-IV', the four parts subtitled Transport, Politics, Money and Love. The whole thing takes six hours to perform — she'll probably be presenting it in New York towards the end of the year.

In her teens, Laurie was almost won over by the violin — she could have become a virtuoso if she'd stuck with it — and she's since composed music for chamber ensemble and orchestra. Her violin pops up on the b-side of 'Superman', 'Walking The Dog', another fascinating concoction, mixing drums, Dolly Parton, vocodered dog and that old faithful, 'various instruments'.

'O Superman' reminded me on first hearing of some of the work of Philip Glass, another talented, New York-based musician who favours extended, three-dimensional shows (his 'Einstein On The Beach' opera lasts four and a half hours in performance). Superficially, Glass' music has the repetitive quality of that of Steve Reich or Terry Riley, which Anderson echoes in her opening 'uh-uh-uh-uh' and the mesmeric effect of much of the following vocodered verses. But 'Superman' (nearly eight and a half minutes long) inevitably defies comparison and, with its hypnotic chant-like air and cryptic lyrics, is wholly her own both in style and form.

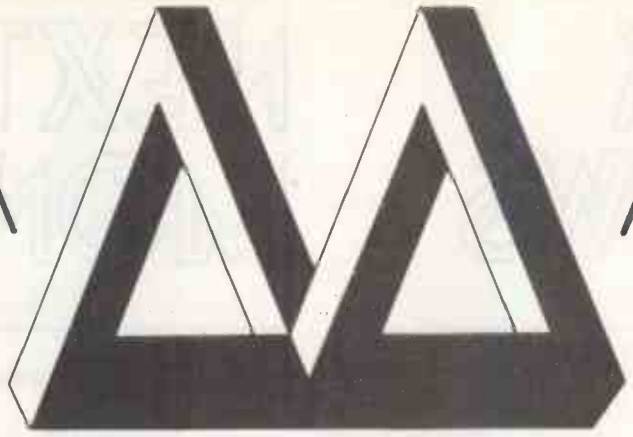
Keyboardist Roma Baron engineered and co-produced the record with Anderson at an anonymous-sounding NYC location called The Lobby, which is presumably the studio that Laurie's in the process of building in Manhattan. Predictably, major record companies are beginning to show interest — Warner Bros only got hold of 'Superman' in the UK after Rough Trade had been bringing in the One Ten Records US release on import. Then the rush began, and radios across the land were chanting 'uh-uh-uh-uh' in A flat unison. I wonder if vocoder sales have increased?

Tony Bacon

ELECTRO RECORD

. . . Radio Caroline to use the most powerful transmitter in Europe to give greater exposure to electro-music . . . tired look about Sky label releases these days — sub-standard Cluster and Phantomband joined by their regulars Ramses — Adelbert Von Deyen sounding like bad Barclay James Harvest — only Mythos/Plank offer hope for the future — and also yet another Roedelius (does his contract really say six albums each year?) . . . Klaus Schulze's IC shows that musicians aren't necessarily the best people to run an A&R department — new releases include another dreadful Lorry LP . . . passable new wave New York Avis Davis . . . of greater interest are albums by Clara Mondshine; Klaus Kruger; the third by Robert Schroeder and another by Klaus Schulze: Trancefer . . . UK sales on Brain/I.C reflect losses of popularity of K.S. Friends of electro-music seem in retreat in the major music papers these days . . . champion John Gill now with Time Out . . . so who will wave the banner? Holger Czukay's follow-up to Movies expected from EMI . . . reappearance of Canaxis Von Spoon in the New Year . . . but where will the doughty Ms. Schmidt find the master tapes? Also from Spoon an album by Michael Karoli and the first time issue of new Can material from the Mooney period . . . was Initial's Karel Beer really happy with Bernard Szagner's Superficial Musics? . . . sounds to us like reversed out-takes . . . Fanzines agog with Richard Pinhas' live gig in Paris in April will be pleased to know next LP will feature same line-up . . . discussions at advanced stage on February/March live gig in London for Monsieur Pinhas . . . Pulse's Dave Lawrence upset at some wonky pressings of Didier Bocquet's Sequences . . . mine was wonky too . . . but the music! At long last US now has the fine Palace of Lights label . . . stirling work done on distribution by Making Waves in 1981 . . . by Lotus in mail order field . . . interesting newcomers, Miracle Mail Order launch with this magazine . . . US repository of good items Archie Patterson at Eurock is now freelance and seeking your custom . . . over the next months read E&MM for an ever expanding service of information and all aspects of electro-music.

Matthew Gavin **E&MM**



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BOOK REVIEWS

Home Recording for Musicians
by Craig Anderton
Published by Guitar Player Books (Music Sales Corporation)
Price $9.95

To the solo home recording musician the title of this book must be irresistible. Craig Anderton is well known for his articles in American publications. Although the book is distributed by Music Sales, I have tried unsuccessfully to obtain it from a British supplier. I finally bought it direct from America from Polyphony (PAiA).

So, what is so special about this book? Well, as Craig says in his preface: "There are many excellent books on recording written by engineers; this one is written by a musician for musicians." And that about sums it up. So much of the information has been worked out by Craig from practical experience as he struggled, like many of us, with the problems of recording in a garage, an attic or a corner of a room.

The first chapter covers the basics of sound and contains the 'hardest stuff' to get it out of the way. It explains basic theory, often simplified but sufficiently accurate and comprehensible to form a working knowledge for your recording. This chapter also gives details of various makes of 4-track recorders which is, unfortunately, a little out of date (the book was written in 1978) but the points to look for when buying a recorder are still relevant.

Chapter 2 is called, "Creating the Home Studio Environment" and gives suggestions on how to lay out a studio in places ranging from a room to a closet.

Chapter 3 describes the console, what facilities you may need and the various ways you can arrange and route the signal path. It also mentions various signal processing devices.

Chapter 4 discusses microphones including the problems of impedance matching — *now* I understand it — and different microphone types.

Chapter 5 is probably the one you will refer to the most. It discusses recording techniques. Even such instructions as "clean your machine" are highly relevant. This chapter leads you through every aspect of recording in minute steps. Tips are given on microphone technique (it's amazing how many singers are unaware of microphone procedure in a studio), arranging baffles, bouncing tracks, creating special effects with tape and mixer and noise reduction techniques.

Chapter 6 is about mixing, of which a book could be written, but Craig covers most aspects and situations the home recordist is likely to encounter quite succinctly.

Chapter 7 gives suggestions about maintenance including de-magnetising and cleaning the heads.

The whole book is extremely easy to read, written as it is in Craig's easy-going softly humourous style and it is well illustrated. Craig's interest and enthusiasm for the subject is obvious; he has written the sort of book he probably wished he had when he began recording.

The last chapter is devoted to the design and construction of a mixer which may be of interest to avid constructors but the strength and interest of the book lies in the details on recording. A record is supplied with the book which demonstrates aurally ways of altering and spicing-up a recording.

For anyone with a 4-track recorder and or doing home recording of any kind this book is so full of information, tips, hints and suggestions that there can be few better ways to invest a few pounds.

Make the effort to get a copy.
Ian Waugh

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MICROMUSIC
Make music with the ZX81

RECORDED ON CASSETTE NO 5

The Sinclair ZX81 is the cheapest BASIC microcomputer currently available, and many of our readers will no doubt own one. For the would-be computer musician, the machine has disadvantages, however. There is no sound generator or BASIC music statement, as on the Sharp MZ-80K; nor is there provision for an input/output port, or any statements for the use of a port. To cap it all, machine code programming has to be done via PEEK, POKE and USR, since there is no machine code monitor. Despite these objections, a little bit of work can yield quite amazing results, and the effort is well worth it; especially bearing in mind the cost of the computer, even including the 16K RAM pack which is necessary to obtain a decent amount of music storage. Before we can start thinking about I/O ports and driving synthesisers, however, there's something more basic to get to grips with.

Machine Code Programming

Even if the ZX81 did have IN and OUT statements, all but the simplest sequencer programs would need to be in machine code for speed reasons: ZX81 BASIC simply isn't fast enough to haul vast quantities of data out of memory and feed it out, especially *presto*.

This article won't attempt to teach either ZX81 BASIC or Z80 machine code programming, since the ZX81 manual deals admirably with the former, and this magazine's Using Microprocessors series has dealt equally admirably with the latter; a reasonable knowledge of bothwill be assumed from now on.

Chapter 26 in the ZX81 manual gives three methods of entering machine code; the only one which I use is the REM statement, which has the advantages of (a) not moving about in the memory, provided it's always the first line in the program, and (b) it's saved on tape along with the rest of the program.

To elaborate on this, we'll jump in at the deep end. Enter this one line program:

```
1 REM TAN
```

Note that I've used Sinclair's convention of printing single key keywords, functions, etc., in bold type. These should be entered with the appropriate key, and not spelt out letter by letter. Now enter the following as a command, not another program line:

```
PRINT USR 16514
```

The answer will come up 16514. What's happened? Refer to the diagram at the bottom of page 171 in the ZX81 manual, which shows how a program line is stored. The first memory address to be occupied by the BASIC program is 16509 (in decimal): this is the line number of the first statement, which in fact always takes two bytes, i.e. locations 16509 and 16510. The 'length of text' bytes are at 16511 and 16512, and the words **REM** and **TAN** take one byte each, at 16513 and 16514 respectively. Our **USR** command called a machine code subroutine at 16514 - so for some reason it thinks the word **TAN** is a machine code program! Why?

The answer to this riddle lies in Appendix A, which lists the character set and several other useful things. Look up **TAN**, which is character code 201, and you will see that in hex this is C9 - the Z80 command 'RET' or 'return from subroutine', the shortest machine code segment you can write on the ZX81. All the program did, then, was to go to a machine code subroutine which told it to return to BASIC straight away; which it did, printing the value of the BC register pair which stayed unchanged at 16514. To convince yourself of this strange effect change your one line program to this:

```
1 REM AGENT
```

and enter the command

```
POKE 16514,201
```

Now look at your program again and it will have changed to:

```
1 REM TAN GENT
```

and if you try **PRINT USR** 16514 again you'll get the same answer. This gives us the simplest way of entering a machine code subroutine; without altering the BASIC program, enter the following series of commands:

```
POKE 16514,1
POKE 16515,0
POKE 16516,0
POKE 16517,201
```

This time the answer will come up 0. Decipher this new program using that handy character list, and in hex it should be:

```
01,00,00,C9
```

which in Z80 assembler language is:

```
LD BC,0000
RET
```

In other words, the program loads the BC register pair with zero, then returns to BASIC with this value. To avoid having to enter long sequences of **POKE**s to load every machine code program, try this simple program:

```
 1 REM .....
10 LET A = 16514
20 SCROLL
30 PRINT A
40 INPUT D
```

```
 50 IF D< 256 THEN GOTO 80
 60 LET A = D
 70 GOTO 20
 80 POKE A,D
 90 PRINT D
100 LET A = A+1
110 GOTO 20
```

The program starts at address 16514 and **POKE**s the decimal value you give it into that address; then it steps onto 16515 and so on. If you want to skip on (or back) to a different address, enter the address first. As long as the number is greater than 255, the program will assume it's an address. To stop simply enter **STOP**. The **REM** statement, line 1, can contain any characters you like as long as there are enough to accommodate the program you want to enter; otherwise you'll start overwriting the rest of the BASIC program and the system will crash.

A Machine Code Monitor

Many of you will want to write more intricate 'machine code monitors', and this is quite possible, although a simple program has advantages - it's easy to erase in order to superimpose another BASIC program which will make use of the machine code you've just written.

For people who are used to hex code, a simple refinement is possible, as in the next program:

```
  1 REM ..... (etc.)
 10 LET A = 16514
 20 SCROLL
 30 PRINT A,
 40 INPUT D$
 50 IF LEN D$ = 2 THEN GOTO 80
 60 LET A = VAL D$
 70 GOTO 20
 80 POKE A, (16* (CODE D$(1)-28) +
    (CODE D$(2)-28)
 90 PRINT D$
100 LET A = A+1
110 GOTO 20
```

This one accepts a two digit hex number - each digit must be between 0 and F inclusive. A 'change of address' request is detected if the input string is more (or less) than two digits - addresses are still entered in decimal. To finish entering, type **RUBOUT** then **STOP**.

The Keyboard

Future programs will give machine code listings in hex code, along with Z80 assembler mnemonics. As an example, here is a routine which is vital in any machine code that loops round and round until you want it to stop. The program looks at the BREAK (SPACE) key and returns to BASIC if it is pressed. For the purpose of illustration, this routine simply loops back on itself; it would normally be incorporated as a segment of a longer loop, and the last instruction would be elsewhere in the program.

Address	Opcode	Hex
16514	LD BC 7FFE	01 FE 7F
16517	IN A,(C)	ED 78
16519	RRA	1F
16520	RET NC	D0
16521	JR 16514	18 F7

At this point we need to examine the ZX81 hardware in a little more detail than the manual goes into. Figure 1 illustrates the keyboard matrix, which is arranged 5 x 8 internally although the actual board is 4 x 10. To address the space key, therefore, line A15 needs to be at a low level while A8-A14 remain high. Here we (and Sinclair) make use of a peculiarity of the Z80's port addressing system - or is it perhaps deliberate? When using indirect port addressing, register C is placed on the lower half of the address bus, representing the actual port address; meanwhile, register B appears on the upper half (A8 to A15) of the bus. So, if the port address to read the keyboard is FE, and 7F needs to appear on the upper half of the address bus (A15 low, remember) then a single LD BC instruction can set up both these conditions. The instruction IN A,(C) then reads the port FE into the accumulator. Since we only want to examine bit 0, 'rotate right accumulator' (RRA) will place this bit in the carry flag, where a conditional return may be done. Remember we're looking for a zero to indicate the key being pressed, so the return is performed if there is no carry (RET NC).

ZX81 Hardware

A word about port addressing: the ZX81 doesn't use a decoder for its input/output instructions; ports are addressed by the address bus directly. For example, the keyboard port is addressed by $\overline{IORQ}$, $\overline{RD}$ and A0 being low simultaneously; so FE is obviously not the only address that could be used in this instance, any address which has A0 low will do. Similarly, A1 low is used by an internal port, and A2 low will address the printer. Any additional ports, then, should have addresses in which A0,A1 and A2 are high.

The rest of the hardware is fairly transparent, and it is possible to run a machine code program while **SLOW** mode is operating; but remember that it will be interrupted 50 times a second, so any programs with critical timing in them should be run in **FAST** mode.

The interrupt lines, $\overline{INT}$ and $\overline{NMI}$, are both connected internally and so should not be used - even though they are available via the edge connector - unless tracks are cut inside the computer; not recommended procedure!

The last point concerns chapter 26's warnings about 'HALT' instructions; whilst it is true that the BASIC interpreter will translate these as a new line - and this applies to 76(hex) as data also - all that will happen is that the listing of your **REM** statement will look a bit peculiar. Any data or op code may be used without problems.

These articles are headed 'Micromusic' and so far, it's been all micro and no music. This will be rectified in the next article, where we shall explore interfacing, with particular reference to the driving of synthesisers.

It is not intended to present programs in which the ZX81 generates the sound itself; through the cassette port, say. We feel that the musical uses of a monophonic square wave are strictly limited, and yet such programs require a fair amount of programming effort which is not really worthwhile.

We have published similar programs in the past, however; if you would like to see one for the ZX81, please let us know and we will try to fit one in a future article.

Peter Maydew **E&MM**

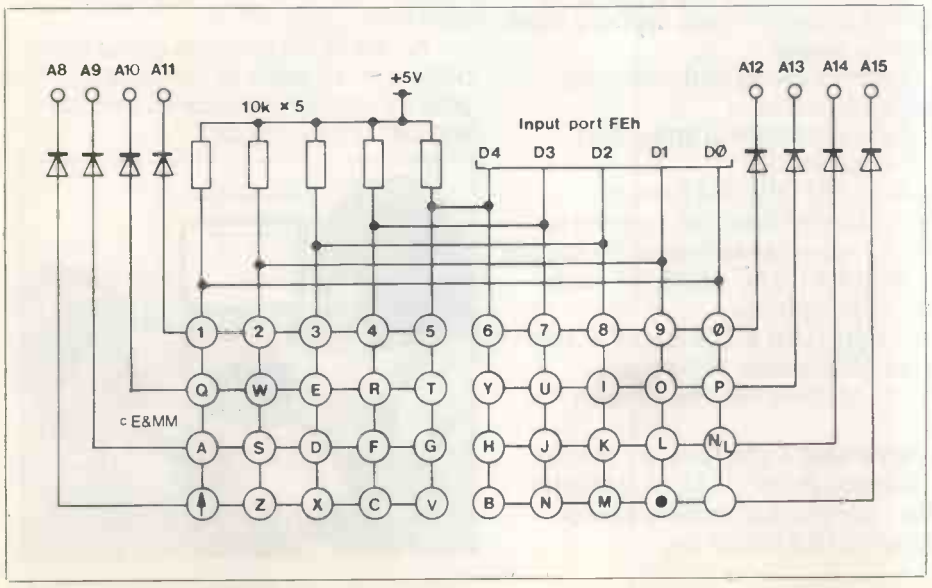

Figure 1. ZX81 keyboard matrix.

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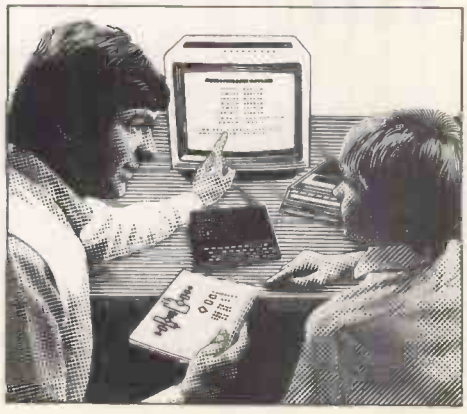
Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



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America

Tim Schneckloth

As the synthesiser has grown in popularity over the past decade or so (where did that decade go, anyway?), some unenlightened types have continued to sneer at the instrument, calling it a fad or gimmick. Well, the number of such ungenerous nay-sayers has been decreasing regularly, and it might be worth asking why.

One reason, I think, is simply the fact that, by and large, synthesisers are being built with more care and craftsmanship these days (in the US, at least). Smaller companies are turning out synthesisers that look and feel like real, "legitimate" musical instruments — with good keyboard action and touch, solid reliability and classic appearance.

The industry may not have come up with its equivalent to the Stradivarius yet, but some companies are trying their best. Kinetic Music Systems Corp., for instance, has come up with The Prism, a digital polyphonic programmable synthesiser that seems both innovative and classic.

The basic instrument is equipped with 24 voices, expandable to 40. The unit's live performance centre gives immediate access to all pre-programmed and user created ensembles. Each time an ensemble is recalled, all eight instrument sounds come in with their own waveforms and a device configuration as well. Instruments within an ensemble can be switched on or off individually by the performer as he plays. The instrument features six synthesis modes — two modes each of wave shaping, wave blending and frequency modulation. Mono, stereo or full quad sound can be altered during performance. Optional five-octave keyboards and one-octave pedal boards are available.

Craftsmanship is also obvious in a new mixing board from a smaller New England manufacturer: Audy Instruments, Inc. The Audy Monitor Mixing Console is a 16-channel unit for on-stage monitor mixing, sound reinforcement and recording applications. It has 16 inputs (stackable to 32) with separate output mixes that permit control of up to six independent monitor sends. Using high speed, low noise IC op-amp technology, it minimises transient and slewing-induced intermodulation distortion. A dual LED system assures proper adjustments of input attenuation switches and maintains 25dB of headroom throughout for clean sound.

Standard features include: Penny and Giles faders and sealed conductive plastic rotaries; input and output channel patching; EQ in/out switch for each input mix control; individual channel muting; talkback; six auxiliary inputs; headphone monitoring with solo priority system; high resolution, 20-segment LED bargraph meters; phantom power; work lamp socket; and flight case. Its suggested retail price is $6995.

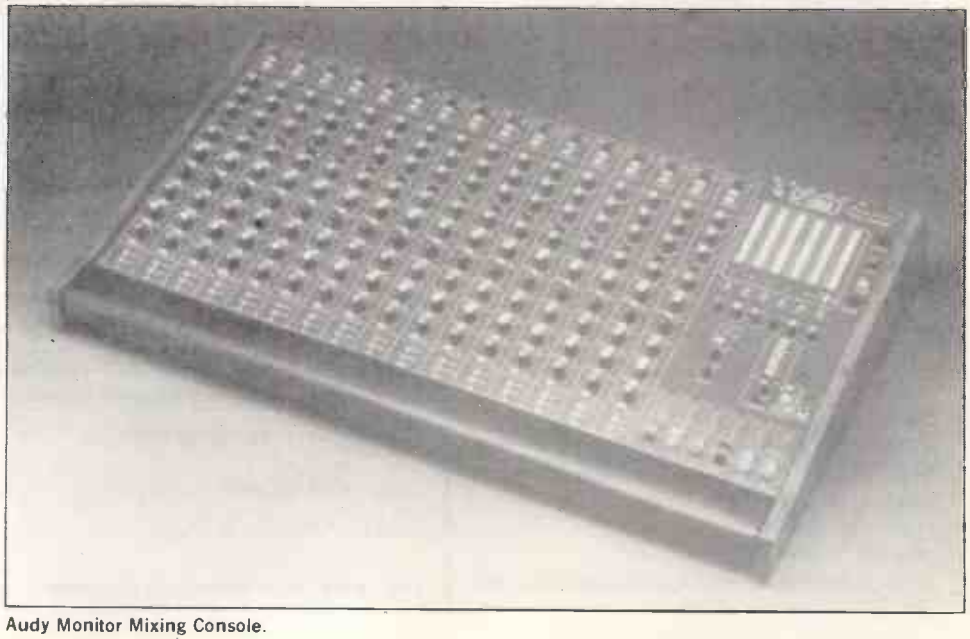
Also new on the New England sound reinforcement front is the EAW Model FR-100 from Eastern Acoustic Works, Inc. This speaker is intended to meet the demand for a portable full-range round reinforcement system. It's useful for bands, clubs etc.

It includes a 52mm phenolic dome high/mid driver that delivers essentially solid angle response. Off-axis response dips less than 3dB at 45 degrees and less than 6dB at 90 degrees. A true constant-impedance L-pad high/mid level control allows adjustment from "off" to +4dB.

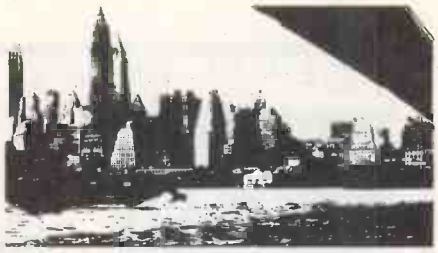
The woofer has a rugged cast aluminium

Electro-Harmonix Graphic Fuzz.

Prism synthesiser.



Audy Monitor Mixing Console.



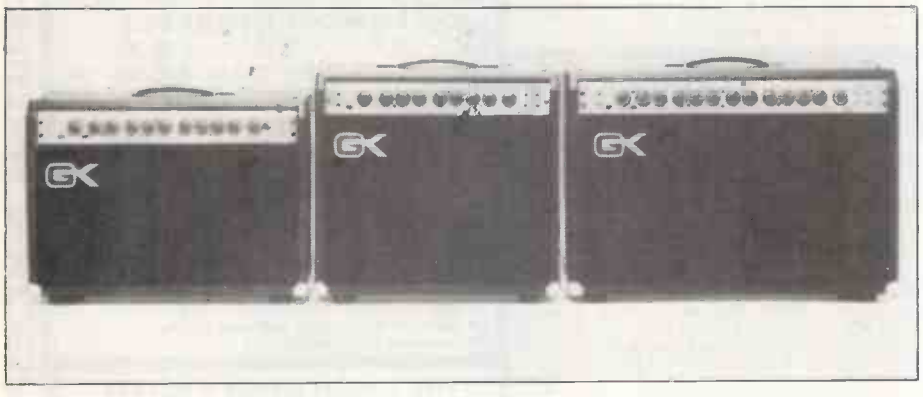
frame and vented pole piece magnetic design with a 70mm voice coil driving a 300mm cone to provide flat frequency response to below 50Hz. In the 2,500Hz crossover region, a third-order network with 18dB/octave slope is used. Two precision air core inductors team with five per cent tolerance resistors and capacitors to assure freedom from response anomalies at the crossover frequency.

The unit is conservatively rated at 100 watts power handling on sine wave signals and 200 watts on music programmes. Its high efficiency of 95dB per watt at one meter allows a practical output of 118 SPL without overstressing the drivers.

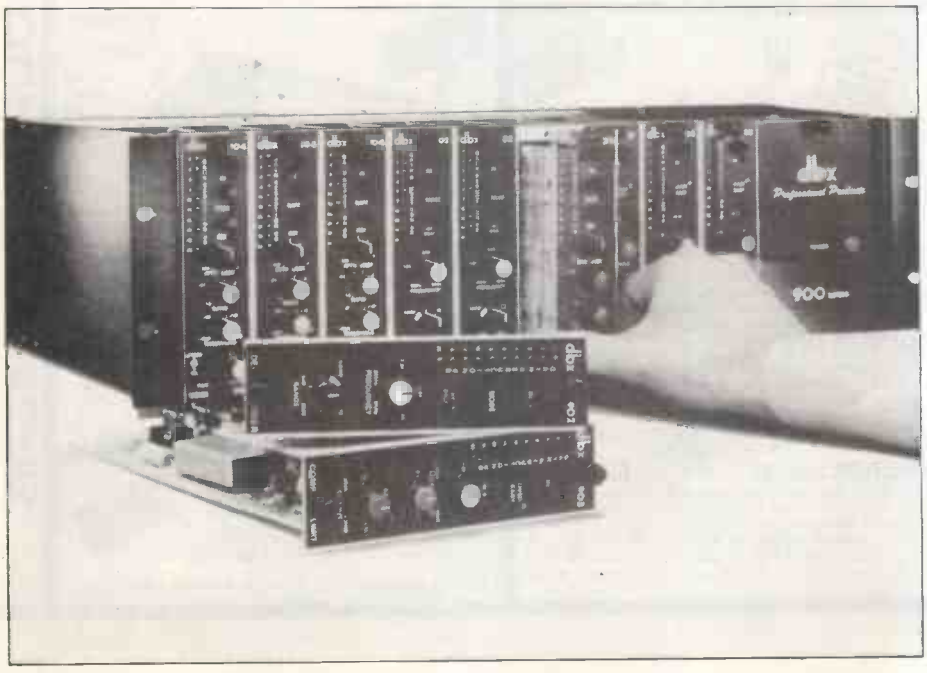
Moving on to New York City, we note that Electro-Harmonix, a firm whose marketing talent is undeniable, has come out with another new fuzzbox. This one's called the Graphic Fuzz, and it features a built-in six-band graphic equaliser. It also has special low-noise/low-hum circuitry, status indicator light and a Dynamic Response Control. The equaliser, which can be used with or without fuzz, features a full ±15dB cut or boost, providing a wide range of tonal colours. A silent electronic footswitch eliminates switching "pops".

On the other coast — Campbell, California, to be exact — a company called Gallien-Krueger has some new amplifiers on the market: the 210LC, 112LC and 212LC. All three are "limiting" amplifiers, allowing the musician to emphasise some singularly warm sounding harmonics.

All three feature channel switching from a clean to an overdriven channel that has three volume controls in series for smooth sustain. Four bands of active EQ plus tone controls allow variations in tone through an easy-to-use format. The amps also include an effects loop, direct out, and headphone jack. All three are rated at 85 watts into eight ohms. Suggested retail prices are: $699 for the 112LC (one 12-inch speaker), $729 for the 210LC (2 10-inch speakers) and $899 for the 212LC (2 12-inch speakers).



Gallien-Krueger amplifiers.



dbx 900 series.

Also from California come new pick-ups for stringed instruments. They're made by Barcus-Berry, a company that pioneered the amplification of strings, bringing many traditional instruments into the 20th Century.

Barcus-Berry's new models are the #1420 (for violin/viola) and #1424 (for cello/bass). Both are designed for quick and easy attachment to the instrument bridge. According to the company, the units won't damp or mute the normal acoustic sound of the instruments, and they can be used with any type of gut, metal or nylon core strings.

Because the pickups' output signal is of relatively high amplitude, they can be connected directly to practically any musical instrument amplifier or PA system without pre-amplification. They can also be correctly matched to the mic input of any professional audio console by means of a Barcus-Berry "Studio Preamp" or any suitable direct box which can provide the requisite minimum load impedance.

Also new from Barcus-Berry is "The Insider", a flat-top acoustic guitar transducer with a wide dynamic range and transient response. According to Barcus-Berry, the transducer's output level is comparable to that of magnetic pickups, thus eliminating the need for preamping for signal gain. The transducer itself is mounted beneath the bridge of the guitar, while the output jack can either be located in the end pin hole or, as an option, clamped to the rim of the soundhole. The latter method makes modification of the instrument totally unnecessary.

And finally, from the innovative dbx, Inc., we have two additions to the company's 900 Series. These latest entries are noise reduction modules: the Model 941 (2-channel encode module) and 942 (2-channel decode module) will provide up to 16 channels of Type II noise reduction for broadcast applications in a rackmount unit measuring 5¼ inches high. Both modules feature active balanced inputs and +24dBm output drive capability. In addition, the 942 provides switch selectable dbx disc decoding. **E&MM**

Manufacturers and companies mentioned:
Kinetic Music Systems Corp., 11 Maryknoll Drive, Lockport, IL 60441
Audy Instruments, Inc., 35 Congress Street, Salem, MA 01970
Eastern Acoustic Works, 59 Fountain Street, Box 111, South Framingham, MA 01701
Electro-Harmonix, 27 W. 23rd Street, New York, NY 10010
Gallien-Krueger, Inc., 502-F Vandell Way, Campbell, CA 95008
Barcus-Berry, Inc., 5381 Production Drive, Huntington Beach, CA 92649
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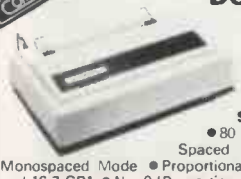

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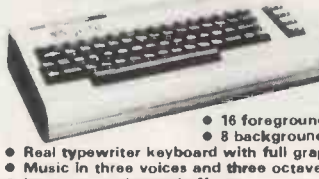

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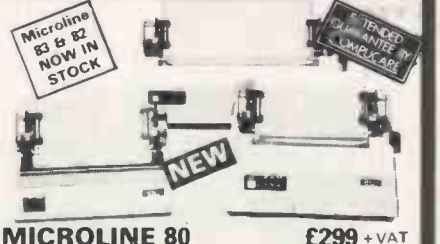

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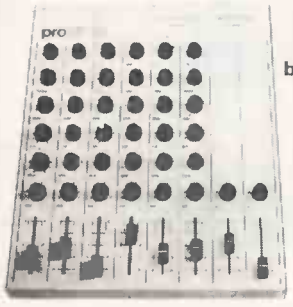

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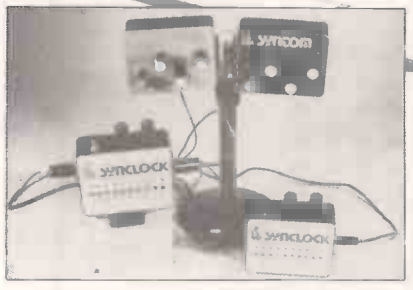

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Units for generating drum rhythms have been around for many years. They first started to become popular when home electronic organs incorporated them in their accompaniment sections. The early rhythm unit produced typical dance rhythms such as Rock, Bossa Nova, Swing and Waltz, with sounds that could not really be called typical of a drum kit. Over the years the sounds have been improved considerably as knowledge of synthesis has widened and now the rhythms themselves have come into a period of change. The musician is no longer satisfied with a choice of preset rhythms, he wants to plan out his own rhythms to try and break the monotony of the drum machine. Enter the programmable rhythm units; now it is possible to create your own drum rhythms and set up your own drum sounds.

There are many different analogue and digital sequencers now available which are used to set up a pattern of electronic information for controlling one or more parameters on a synthesiser. Because they generally supply and control voltages as well as a trigger output, the sequencer is more obviously applied to synthesiser pitch and EG control to produce repeated note patterns, bass lines and special rhythmic effects. The sequencer can control a synthesiser without the use of a keyboard and thus enables complex patterns to be sounding whilst the performer plays his instruments.

Many well known soloists and groups have based their compositions on the use of sequencers, including Tangerine Dream, Kraftwerk, Klaus Schulze, Jean Michel-Jarre and Logic System. Even though sophisticated micro-memory sequencers, such as the Roland CSQ-600 computer controlled digital sequencer can be regarded as state-of-the-art systems, often the most convenient sequencer is simply one that can count just a few bars of the chosen time signature to provide live performance control of each pulse within the bar.

So using the Synclock as the music proceeds, the player manipulates the switches and makes subtle changes to the rhythmic control of percussive and melodic sounds. No bar need sound the same and because speed can be set over a very wide range, the sequence can be running faster than it's physically possible to play.

Since the Synclock PCB board with its components measures only a few inches and is very cheap to construct, it should enable any electro-musician to experiment with this fascinating and important part of music-making.

The E&MM Synclock is a compact and uniquely expandable control sequencer which can be used to trigger the Syntom and Synwave, as well as most synthesisers and other sound generators, to give new and exciting rhythms and sounds. When used with the Syntom or Synwave, the internal triggers of these devices still operate allowing an even larger scope for filling

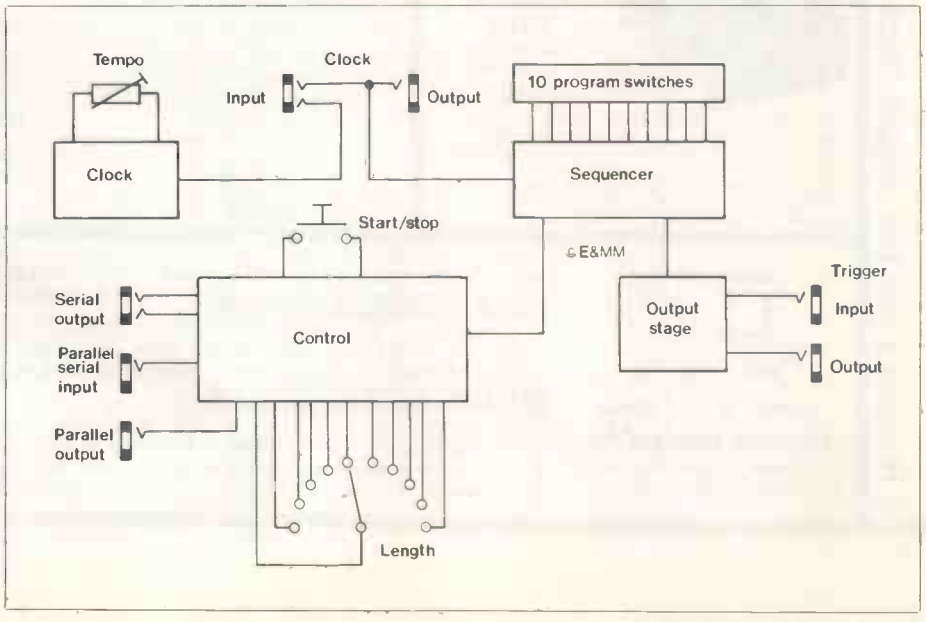

Figure 1. Block diagram of the Synclock.

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EF6850	1.70
EF6862	6.91
EF6871-A1T	18.70
EF6880	1.07
EF6887	0.80
EF68488	9.11
EF6875	4.18
6502 FAMILY	
SYP6502	4.95
SYP6520	3.15
SYP6522	4.95
SYP6532	7.95
8080 FAMILY	
8085A	5.50
8212	1.70
8216	1.70
8224	2.45
8228	3.95
8251	3.95
8253	7.95
8255	3.95
CMOS 4000 'B' SERIES	
4000	0.12
4001	0.13
4002	0.13
4006	0.60
4007	0.17
4008	0.55
4009	0.28
4010	0.28
4011	0.14
4012	0.17
4013	0.33
4014	0.58
4015	0.58
4016	0.28
4017	0.45
4018	0.58
4019	0.29
4020	0.58
4021	0.60
4022	0.62
4023	0.17
4024	0.38
4025	0.16
4026	0.99
4027	0.30
4028	0.55
4031	1.65
4033	1.60
4034	1.55
4035	0.72
4040	0.57
4041	0.69
4042	0.54
4043	0.59
4044	0.64
4045	1.65
4046	0.68
4047	0.68
4048	0.54
4049	0.30
4050	0.30
4051	0.59
4052	0.68
4053	0.59
4054	1.20
4055	1.20
4060	0.89
4063	0.95
4066	0.34
4068	0.17
4069	0.17
4070	0.19
4071	0.19
4072	0.19
4073	0.19
4075	0.17
4076	0.60
4077	0.22
4078	0.24
4081	0.14
4082	0.19
4085	0.63
4086	0.69
4093	0.39
4502	0.69
4507	0.39
4508	1.90
4510	0.60
4511	0.49
4512	0.60
4514	1.49
4515	1.49
4516	0.75
4518	0.40
4519	0.28
4520	0.69
4521	1.49
4522	1.20
4526	0.70
4527	0.89
4528	0.70
4532	0.89
4541	1.39
4543	0.99
4553	2.90
4555	0.49
4556	0.54
4585	0.98
LOW POWER SCHOTTKY TTL ICs – 74LS SERIES	
74LS00	0.11
74LS01	0.11
74LS02	0.12
74LS03	0.12
74LS04	0.13
74LS05	0.13
74LS08	0.13
74LS09	0.13
74LS10	0.13
74LS11	0.14
74LS12	0.15
74LS13	0.22
74LS14	0.44
74LS15	0.13
74LS20	0.12
74LS21	0.14
74LS22	0.14
74LS26	0.18
74LS27	0.14
74LS28	0.19
74LS30	0.12
74LS32	0.14
74LS33	0.18
74LS37	0.18
74LS38	0.16
74LS40	0.13
74LS42	0.34
74LS47	0.39
74LS48	0.60
74LS49	0.59
74LS51	0.14
74LS54	0.15
74LS55	0.15
74LS73	0.20
74LS74	0.17
74LS75	0.28
74LS76	0.20
74LS78	0.24
74LS83	0.50
74LS85	0.70
74LS86	0.17
74LS90	0.30
74LS91	0.80
74LS92	0.35
74LS93	0.34
74LS95	0.44
74LS109	0.25
74LS112	0.25
74LS113	0.25
74LS114	0.25
74LS122	0.39
74LS123	0.55
74LS124	1.00
74LS125	0.28
74LS126	0.28
74LS132	0.45
74LS136	0.28
74LS138	0.34
74LS139	0.37
74LS145	0.75
74LS148	0.90
74LS151	0.34
74LS153	0.35
74LS155	0.39
74LS156	0.38
74LS157	0.34
74LS158	0.36
74LS160	0.39
74LS161	0.39
74LS162	0.39
74LS163	0.39
74LS164	0.47
74LS165	0.99
74LS166	0.84
74LS173	0.70
74LS174	0.54
74LS175	0.54
74LS181	1.30
74LS190	0.55
74LS191	0.55
74LS192	0.69
74LS193	0.59
74LS194	0.39
74LS195	0.39
74LS196	0.58
74LS197	0.65
74LS221	0.60
74LS240	0.89
74LS241	0.89
74LS242	0.79
74LS243	0.79
74LS244	0.79
74LS245	0.89
74LS247	1.34
74LS248	1.00
74LS249	0.68
74LS251	0.39
74LS253	0.39
74LS257	0.44
74LS258	0.38
74LS259	0.38
74LS261	1.90
74LS266	0.23
74LS273	0.90
74LS279	0.34
74LS283	0.44
74LS290	0.56
74LS293	0.45
74LS365	0.34
74LS366	0.34
74LS367	0.34
74LS368	0.34
74LS373	0.74
74LS374	0.74
74LS375	0.47
74LS377	0.89
74LS378	0.69
74LS379	0.64
74LS386	0.28
74LS390	0.59
74LS393	0.59
LOW PROFILE DIL SOCKETS	
Number of Pins:	
8	0.07
14	0.09
16	0.09
18	0.15
20	0.17
22	0.21
24	0.23
28	0.25
40	0.29
CRYSTALS	
1 Mhz	3.00
1.8432 Mhz	2.50
4 Mhz	1.85

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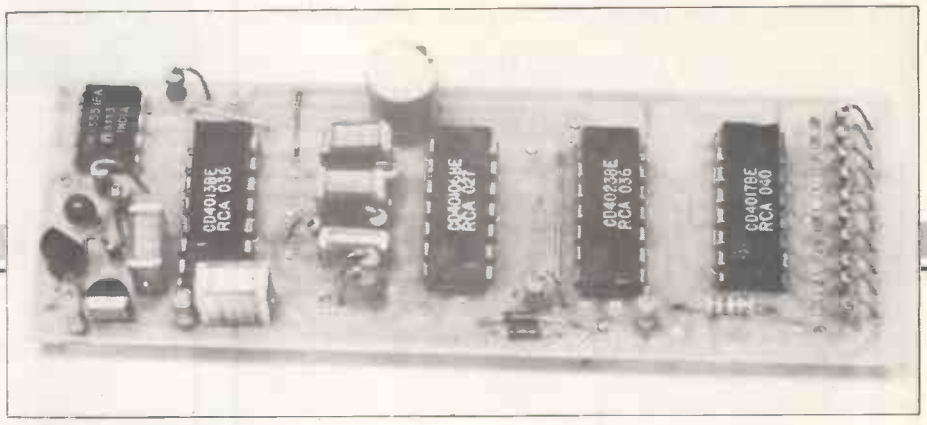


Completed circuit board.

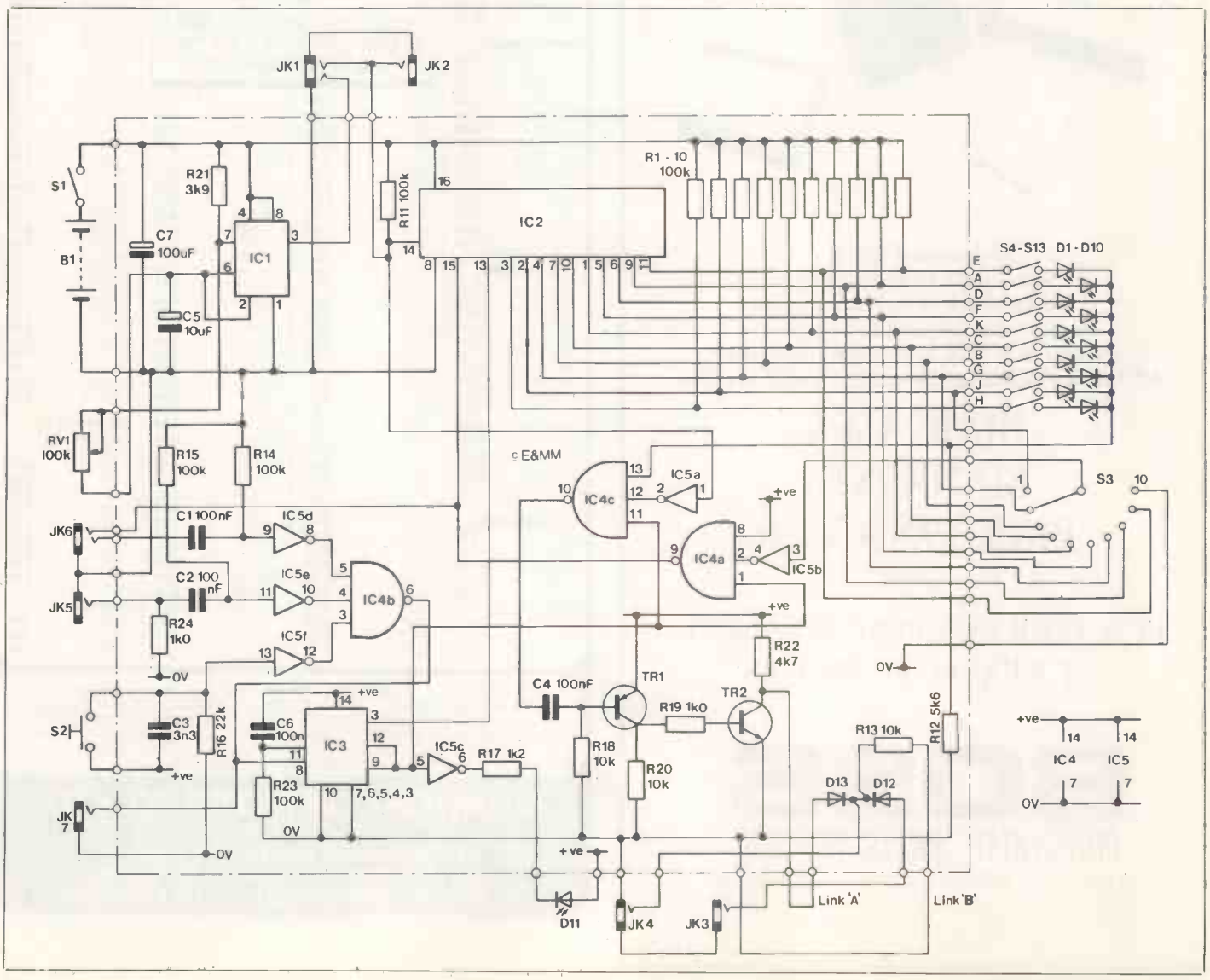
in further rhythms by hitting the box.

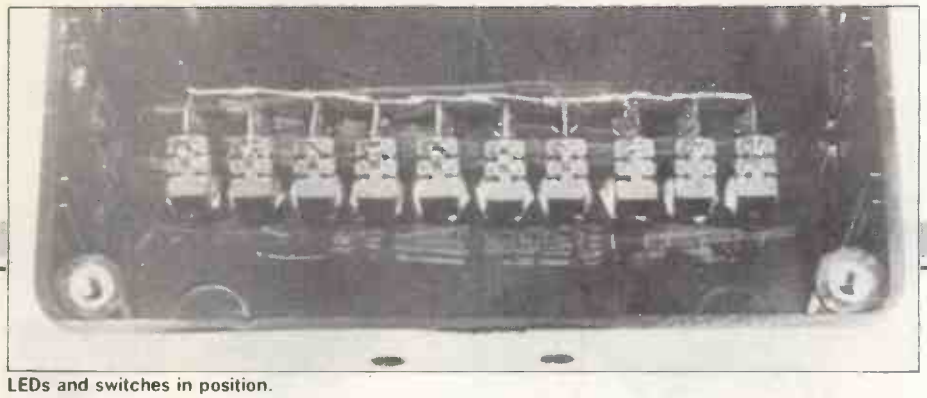
The Synclock has a sequence length variable between 1 and 10 beats and this is of course expandable with further Synclocks. This system allows any number of beats in any time signature to be programmed. There are only a minimum number of controls for ease of use and setting up. The three controls on the top of the unit are: Stop/Start, Sequence Length, and On-Off/Tempo with the programming switches and indicators on the front panel. The sockets for interfacing and control are mounted on the side of the box and finally the clamp is mounted on the bottom if required. All the components except the LEDs and controls are mounted on a PCB and everything fits into the same size box as the Syntom and Synwave.

The Circuitry

The block diagram of the Synclock is shown in Figure 1. As can be seen, there are four blocks: the Clock, Sequencer, Control and Output stage. The Synclock design is based around the popular 4017 (Decade counter divider with ten decoded outputs) and 555 (Timer). The CMOS version of the 555 has been used to keep current consumption as low as possible. The circuit diagram of the Synclock is shown in Figure 2. The timer (IC1) is used in its astable mode to generate the clock signal for driving the 4017 (IC2) the rate being controlled by RV1. The 'clock in' and 'clock out' jack sockets have been included to enable another unit to drive or be driven by the Synclock. The clock signal is also used to gate the output through IC4c. The outputs of IC2 are pulled high by resistors R1-R10 and fed to the ten programming switches (S4-S13) and the sequence length switch (S3), the other side of the programming switches being connected to the anodes of the ten miniature LEDs. The cathodes of the LEDs are all commoned together

Figure 2. The circuit diagram of the Synclock.



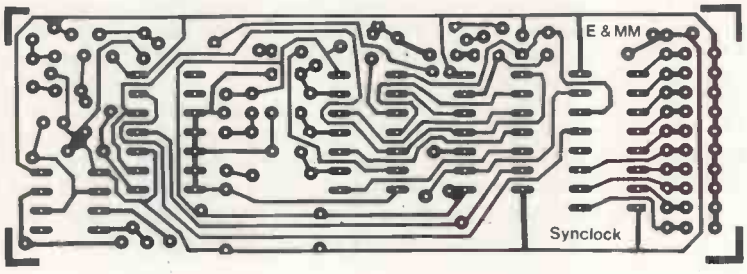


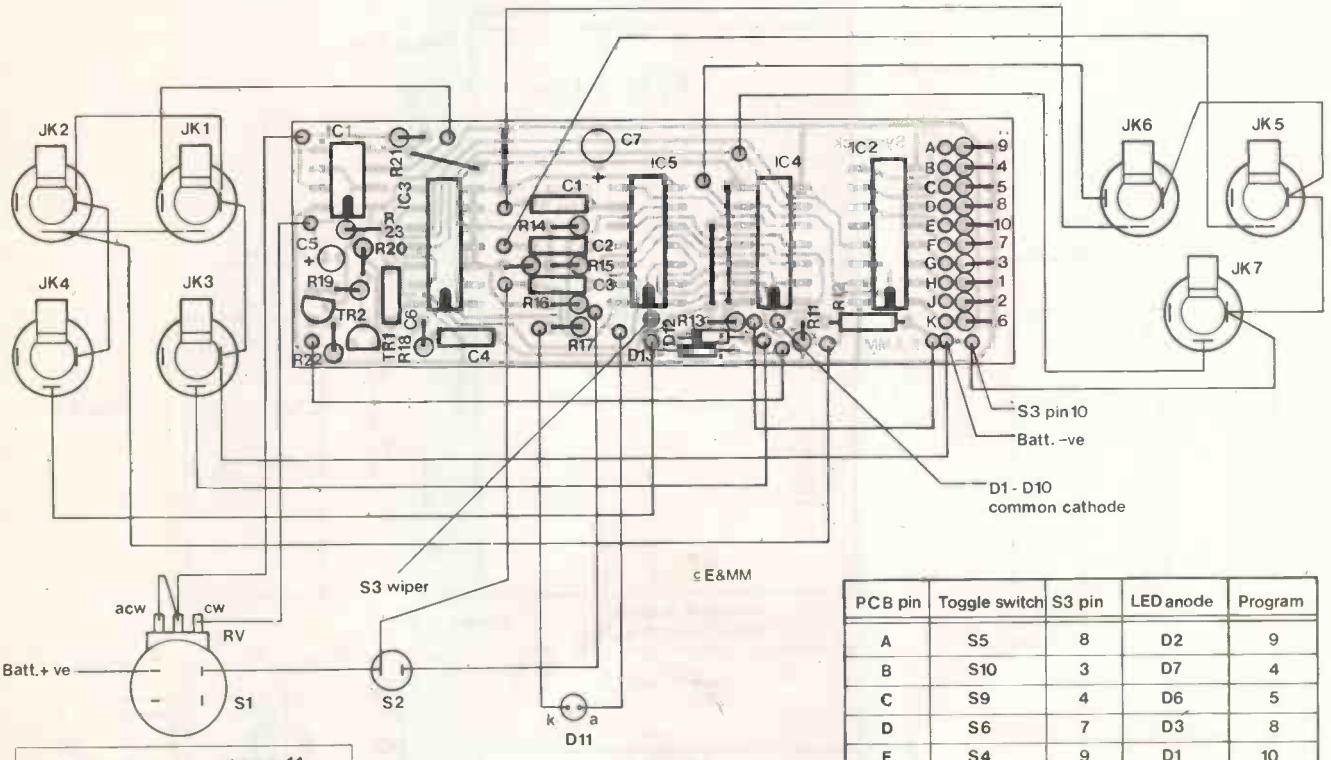
LEDs and switches in position.

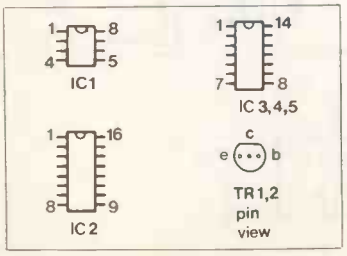
and taken to ground via R12 to form a ten input diode 'OR' gate. The intensity of the LEDs can be adjusted if required by changing the value of R12, the lower the value the brighter the LEDs, but remember that battery life will be shortened. The output of the 'OR' gate is then fed to IC4c. The other input to IC4c (pin 11) comes from the control circuitry to ensure no output occurs when the sequencer is stopped. IC4c then feeds into the output stage consisting of TR1 and TR2, and then to another diode 'OR' gate to combine the signal with any other trigger information being used.

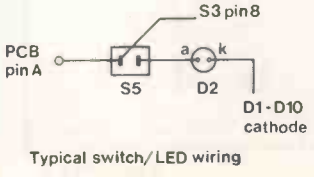
The most complex part of the Synclock is the control circuitry. The complexity arises due to the need for expansion of the system both serially and in parallel. ICs 3, 4 and 5 are all used in this section and the heart of the circuit is IC3a, a D type flip flop which is connected so that each clock pulse on pin 11 causes the outputs (pins 12 and 13) to change. R23 and C6 are used to provide a power-up reset to ensure the unit is not running when you switch on. The stop/start switch is debounced and fed into IC5f, a Schmitt inverting buffer, and then to IC4b. The control input is differentiated, then inverted by

Figure 3. PCB track, component layout and wiring details.









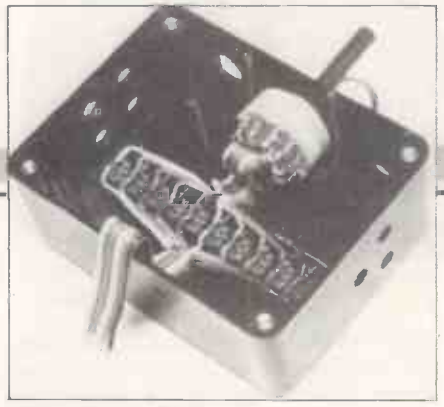
Typical switch/LED wiring

PCB pin	Toggle switch	S3 pin	LED anode	Program
A	S5	8	D2	9
B	S10	3	D7	4
C	S9	4	D6	5
D	S6	7	D3	8
E	S4	9	D1	10
F	S7	6	D4	7
G	S11	2	D8	3
H	S13	-	D10	1
J	S12	1	D9	2
K	S8	5	D5	6

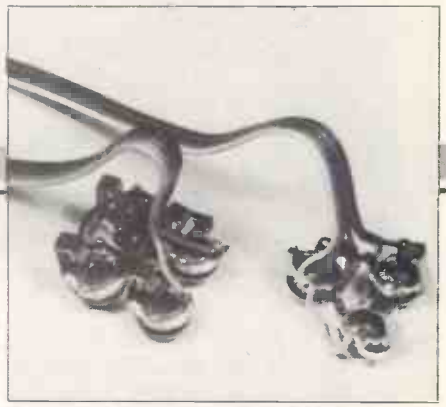
IC5e and fed into IC4b. The other input to IC4b comes from the serial output via the jack socket switch through a differentiator and an inverter (IC5d). The stop/start LED is driven by IC5a from the flip flop $\overline{Q}$ output. S3, IC5b and IC4a are used to control the sequence length by resetting IC2 at the appropriate point.

Construction

The Synclock is housed in a plastic box (Maplin type MB2) which is the same as that used for the Syntom and Synwave, and a reasonable amount of care is required to fit all the components into the box. If you have only a limited experience in the construction of compact projects you will probably find it easier to use a larger box. Construction can begin with the assembly of the PCB (see Figure 3). The veropins should be fitted first and these are pushed in from the component side of the board. The four wire links can then be soldered in place.



LEDs, switches and S3 wired up.



Jack socket wiring before fitting into case.

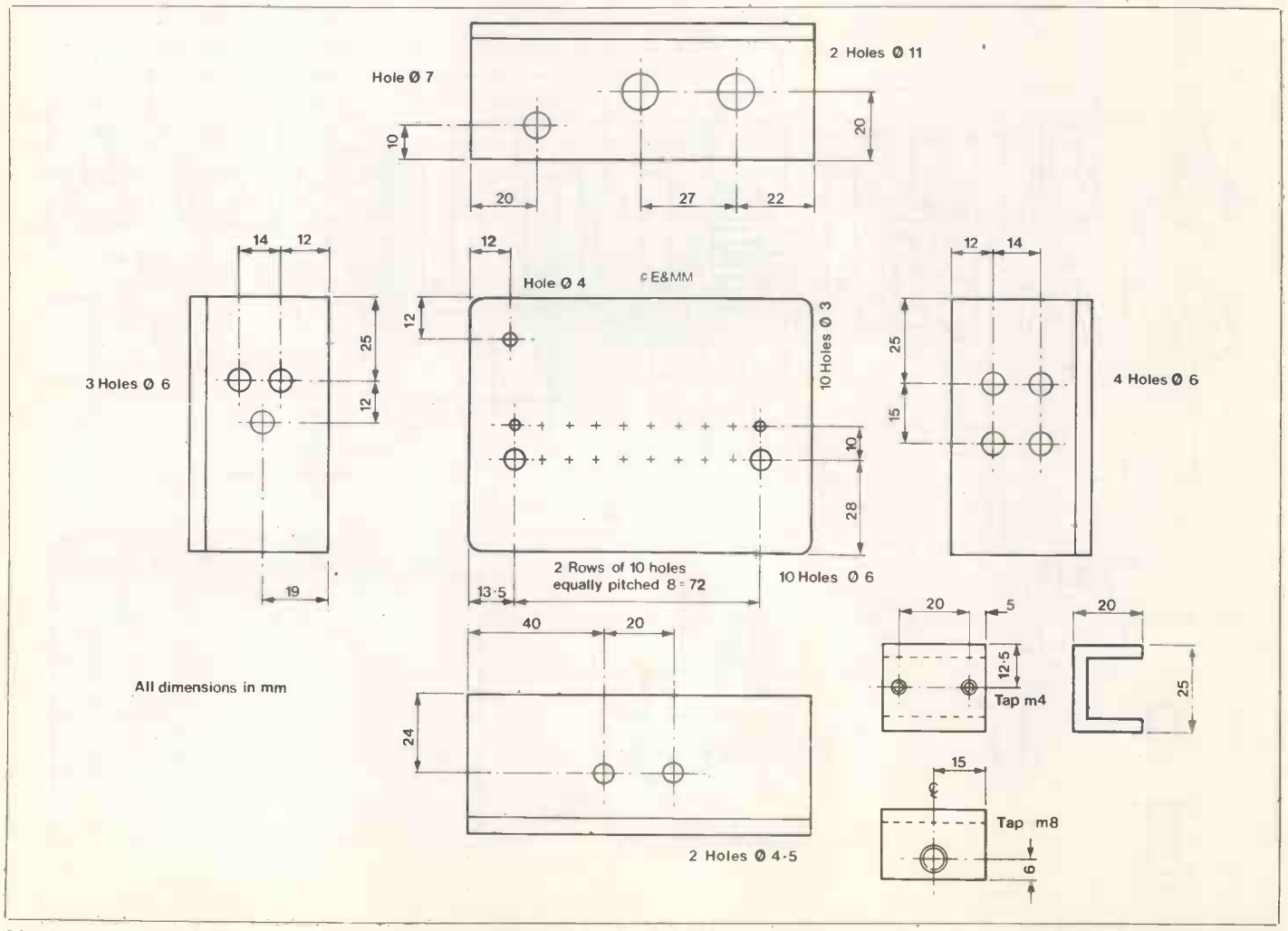
Next fit the resistors and capacitors in place, remembering to get the micro resistors in the correct positions and the polarities of C5 and C7 correct. The diodes and transistors can then be soldered in place on the PCB. The PCB assembly can then be completed with the insertion of the ICs. The prototype unit was not fitted with IC sockets as the space on the PCB is very limited, but sockets can be used if there is sufficient room in the case used.

All the ICs are CMOS and require a certain amount of care when being handled - use a low leakage soldering iron and avoid physical contact with the IC pins if possible. The ICs should be left in their protective packing until you are ready to insert them.

The board is now complete and can be put to one side while the box is assembled. Figure 4 shows details of the box and the drilling should be as accurate as possible to ensure all the components will fit into the box. When the drilling has been completed you will need to cut away some of the ribs of the box to ensure that all the components will seat properly - this can be done with a sharp knife.

The ten miniature LEDs can then be pushed into place with the anodes towards the switches (see Photograph) and should not be glued in place until the unit has been tested. Next fit the ten ultra-min. toggle switches in place (due

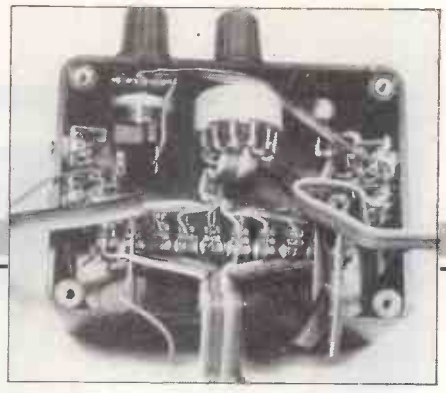
Figure 4. Case and bracket construction.



to the closeness of the switches the washers supplied with the switches cannot be used). Now connect the anodes of LEDs 1 to 10 to the nearest contact of switches 1 to 10 respectively and connect the cathodes of the LEDs together. Cut a 4 inch and a 5 inch length of 10 way ribbon cable and then cut and wire one end of each wire to the programming switches (Photo 3). Make use of the wire colour coding, with programming switch 1 connected to the black wire and switch 10 to the white wire. Next take the other end of the 4 inch length of ribbon cable, cut the black wire off an inch from the end and then strip and tin the ends of the remaining 9 wires. Then solder wire 1 (brown) to S3 pin 1, wire 2 (red) to S3 pin 2 etc. Cut a 5 inch length of two way ribbon cable, strip and tin one end of each wire and connect one wire to S3 pin 10 and the other to the wiper of the switch. Next fit and wire up S2, D11, RV1 and S1 with suitable lengths of ribbon cable leaving the end that connects to the PCB floating for the moment.

The jack sockets should now be wired up - this has to be done outside the box. The first thing to do is to change JK6 from a 'break' contact type to a 'make'-contact type. This can quite easily be achieved by bending the outer contact to the other side of the spring contact with a pair of pliers (see Figure 5). Cut one 5 and one 6 inch length of 5 way ribbon cable and use the 6 inch length to wire JK1, 2, 3 and 4 as shown in the wiring diagram and the other piece to wire JK5, 6 and 7 (Photo 4). The two groups of sockets can then be mounted in the box and the positive of the battery connector soldered to S1.

All the components in the box should now be connected up (Photo 5) and the connections to the board can be made. If you wish to fit a clamp to the unit (for a drum rim) this should be fitted prior to connecting the PCB. There are two wire links (A and B) to be made on the back of the PCB first, then



Completed off board component wiring.

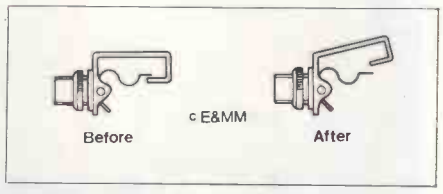


Figure 5. Jack socket modification.

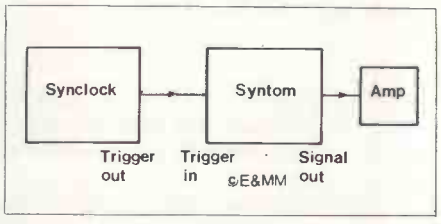


Figure 6. The Synclock driving a Syntom.

the board can be wired as indicated in the wiring diagram (Figure 3). The PCB can then be slotted into the box and the battery connected (Photo 6).

Testing

Set the sequence length to 10 and the ten programming switches down, then switch the unit on. LED number 1 should be on and all the others should be off. If all is correct then press the

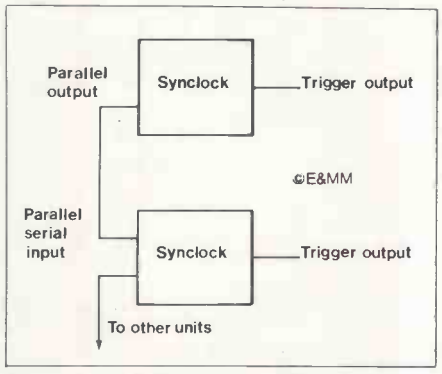


Figure 7. Parallel connection of Synclocks.

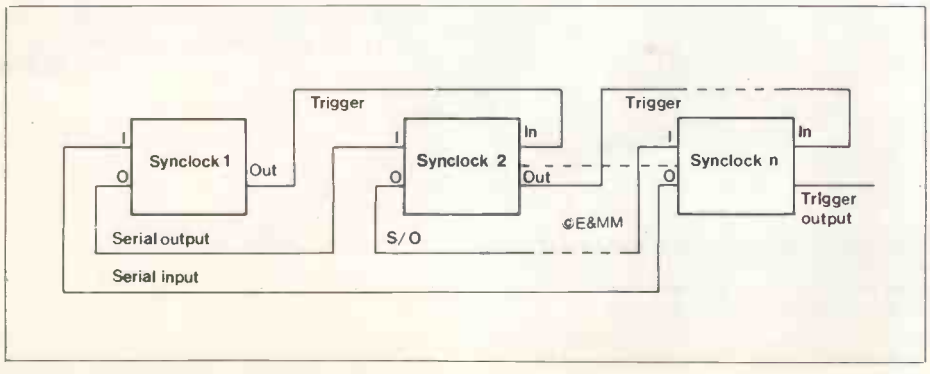


Figure 9. Synclocks connected for long serial sequence.

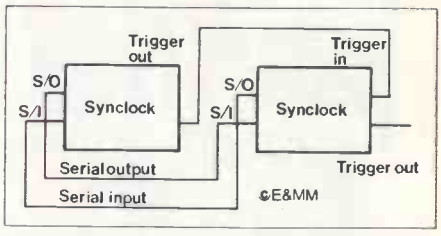


Figure 8. Serial connection of Synclocks.

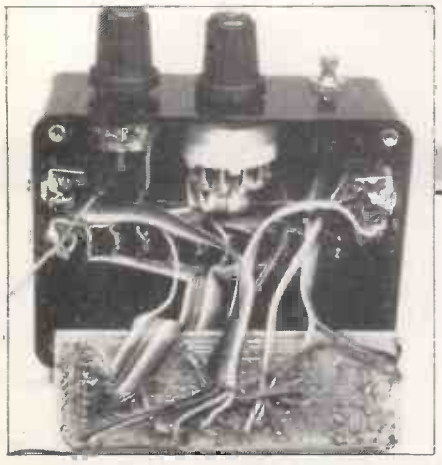
stop/start button. The start LED should now be lit and the program LEDs should light sequentially. Next, check the sequence length switch operates, the tempo control alters the clocking rate and that the stop/start button will also stop the sequencer and reset the unit so that LED number 1 is on.

If the Synclock has functioned correctly up to now, you can connect the trigger to your Syntom or Synwave trigger input (see Figure 6). Start the Synclock and the Syntom or Synwave should now trigger once on every step. Check all the programming switches are operating by changing the rhythm pattern. The other input and output sockets are best tested with another Synclock unit.

Using your Synclock

It is very easy to learn the best ways of controlling the Synclock and together with the Syntom and/or Synwave the variations on rhythms and sounds give you endless possibilities. There are only a few points to note when using one Synclock: the clock input required is a 9V square wave, the clock output is a 9V square wave the frequency of which is set by the tempo control and the trigger output is an 8V pulse.

The potential of the system really comes to light when two or more Synclocks are available. The wide combination of interconnections and control settings give unlimited scope. Two of the many possibilities are shown in Figures 7 and 8. The parallel connection allows one Synclock to start and stop all the other Synclocks simultaneously and each Synclock can be used to trigger a different sound with its programmed rhythm. The units can all



Synclock with wiring completed and PCB inserted in case.

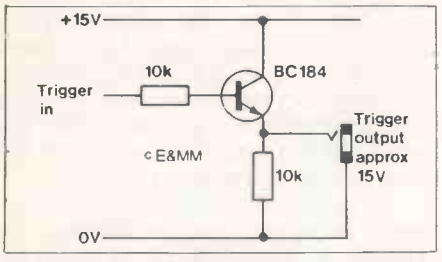


Figure 10. Output stage modification.

Edgar Froese of Tangerine Dream looks with interest at the Synclock.

be run from one clock control using the clock in and out jack sockets or they can be controlled with their own tempo pots.

Figure 8 shows how to connect two Synclocks so that a sequence of up to 18 beats can be used. Note the maximum of 18 (and not 20) is due to the fact that the tenth beats have a different reset mechanism. The first Synclock can be used to control the system and the clock signals can again be commoned if required. If a long sequence (more than 10) is being used for one sound generator then the trigger signals need to be combined and this is simply a matter of connecting the output of one to the input of the next. In the serial mode the Stop/Start button will only stop the sequence if it is operated on the unit in which the sequence is running.

Figure 9 shows how a long serial chain may be set up and the legend for the front panel is shown full size in Figure 10 to enable you to give a professional finish to your project.

PARTS LIST FOR SYNCLOCK

Resistors — all 5% ⅓W carbon unless specified			
R1-R10	100k ⅓W	10 off	(W100K)
R11,13,15,16,23	100k	5 off	(M100K)
R12	5k6		(M5K6)
R18,20	10k	2 off	(M10K)
R14	22k		(M22K)
R17	1k2		(M1K2)
R19,24	1k0	2 off	(M1K0)
R21	3k9		(M3K9)
R22	4k7		(M4K7)
RV1	100k lin pot with switch		(FW45Y)
Capacitors			
C1	3n3 carbonate		(WW25C)
C2,3,4,6	100n carbonate	4 off	(WW41H)
C5	10u 16V tantalum		(WW68Y)
C7	100u 10V PC electrolytic		(FF10L)
Semiconductors			
IC1	7555		(YH63T)
IC2	4017		(QX09K)
IC3	4013		(QX07K)
IC4	4023		(QX12N)
IC5	40106		(QW64U)
TR1	BC214		(QB62S)
TR2	BC184		(QB57M)
D1-D10	LED min red	10 off	(WL32K)
D11	LED red		(WL27E)
D12,13	1N4148	2 off	(QL80B)
Miscellaneous			
S1	see RV1		
S2	Push button switch HQ		(YR67X)
S3	Rotary switch 1 pole 12 way		
S4-S13	SPST ultra min toggle	10 off	(FH97F)
JK1-JK7	3.5mm open jack socket	7 off	(HF82D)
	Case plastic box type MB2		(LH21X)
	PCB		(GA54J)
	Battery clip PP3		(HF28F)
	LC collet knob	2 off	(YG40T)
	Collet knob cap black	2 off	(QY00A)
	10 way ribbon cable	1m	(XR06G)
	Front panel		(XX44X)

All the parts for the Synclock are available in a kit from Maplin Electronic Supplies Ltd, PO Box 3, Rayleigh, Essex SS6 8LR, order number LW55K, price £19.75. Also available separately are the lettered, brushed aluminium stick-on front panel: order number XX44X, price £1.50; and the PCB: order number GA54J, price £1.65. Prices are inclusive of VAT & p&p.

Extending the use of the Synclock

The ratio of R22 to R13 determines the amplitude of the output pulse. The amplitude can be increased by reducing the value of R22 and increasing R13 - remember, however, that the effective resistance of R13 is the parallel combination of R13 and the input stage being driven.

The Synclock can be used to drive commercial equipment but a few modifications may be needed. The industry standard for trigger signals is +15V and for this the Synclock really needs an additional output stage. This can consist of a single transistor buffer as shown in Figure 11. The +15V supply is needed as it is impossible to obtain a +15V trigger pulse from a 9V supply.

The length of the trigger pulse in the Synclock is set to approximately 1ms by R18 and C4. The pulse length can be increased by increasing the value of R18 (or C4). Some interesting effects at higher clock rates have been found when using the Synclock with the Syntom, by lengthening the pulse to about 5ms - due to the Syntom trigger circuitry the pitch will vary automatically!

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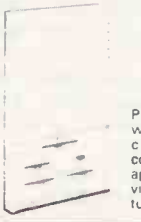

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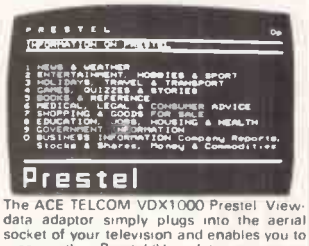

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Subroutines

Often it is required to perform the same series of operations at different points in a BASIC program. This can be achieved by writing the statements as a subroutine within the main program. When the statements are to be executed the subroutine is referenced (or 'called') by the main program. After the statements of the subroutine have been executed, control is automatically directed back to the main program statement that immediately follows the call to the subroutine.

The GOSUB and RETURN Statements

The GOSUB statement transfers control of the program to a subroutine and the RETURN statement returns control from that subroutine back to normal program execution.

The general form of the GOSUB statement is:

GOSUB line number

where the line number is the first line of the subroutine. The first line of a subroutine can be any legal BASIC statement including the REM statement. It is good programming practice to make the first line of a subroutine a REM statement followed by a comment which outlines the function of the subroutine.

The last statement of any subroutine must be a RETURN statement. The RETURN statement causes control to transfer back to the main program line following the GOSUB statement. The RETURN statement is not followed by a line number — when the subroutine is entered the computer 'remembers' the line which called the subroutine. The RETURN statement instructs the computer to use this value to return to the statement after the GOSUB.

The use of the GOSUB and RETURN statements to implement a subroutine is best illustrated by considering a BASIC program:

```
10 REM PROGRAM — SORT LISTS OF NUMBERS
15 DIM X(10)
20 PRINT"INITIAL LIST 1"
30 FOR I=1 TO 10
40 READ X(I)
50 PRINT X(I);
60 NEXT I
70 REM CALL SUBROUTINE — SORT LIST ONE
80 GOSUB 600
90 REM NOW READ SECOND LIST OF NUMBERS
100 PRINT:PRINT"INITIAL LIST 2"
110 FOR I=1 TO 10
120 READ X(I)
130 PRINT X(I);
140 NEXT I
150 REM CALL SUBROUTINE- SORT LIST TWO
160 GOSUB 600
170 REM NEXT TWO LINES ARE DATA
180 DATA -10,6,3,50,-7,0,41,32,9,15
190 DATA 18,-4,-50,61,11,18,22,-1,99,6
200 END
600 REM SUBROUTINE-SORT LIST IN ARRAY X
610 FOR I=1 TO 9
620 FOR J=I+1 TO 10
630 IF X(I)>X(J)THEN LET T=X(I):LET X(I)=X(J):LET X(J)=T
640 NEXT J
650 NEXT I
660 PRINT:PRINT"SORTED LIST"
670 FOR I=1 TO 10
680 PRINT X(I);
690 NEXT I
700 RETURN
```

In this example, the subroutine begins at line 600 and ends with a RETURN statement at line 700. The subroutine uses a simple sort algorithm to sort the numbers stored in the array named X. It then prints the list of sorted numbers before returning control back to the main program.

The program is composed of the following lines:

Line 10 — The REM statement 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.

Lines 30, 40, 50 and 60 — The FOR statement initialises the variable I to one and sets the limit of the loop to ten, its corresponding NEXT statement is on line 60. Each time the loop is executed the READ statement on line 40 takes a number from the DATA statement in line 180 and assigns it to the array named X in the position specified by the subscript (the subscript is the variable I within the parentheses after the array name). The PRINT statement on line 50 outputs the number to the terminal. The semicolon after the array element directs the computer to print each number on the same line. When the loop has been executed ten times, program control proceeds to line 70. The array X now contains the ten numbers specified as data in line 180.

Line 80 — The GOSUB statement directs the program control to the subroutine beginning at line 600. The statements of the subroutine are now executed until the RETURN statement on line 700 is encountered. This RETURN statement directs the control back to the main program line following the GOSUB statement (line 90).

Lines 100, 120, 130 and 140 — These statements are the same as lines 30-60 and read into the array X the next ten numbers from the data in line 190. (These statements could also have been written as another subroutine. The main program would then consist of four subroutine calls — first a call to a subroutine to read the numbers into the array and then a call to the subroutine to sort the numbers. Then these two subroutines would be called again to repeat the process for the next set of data.)

Line 160 — The GOSUB statement accesses the same subroutine on line 600 as referenced by line 80. However, when the RETURN statement of the subroutine is executed this time, control shifts to line 170 because the GOSUB at line 160 was the last statement in the main program to be executed.

Lines 180 and 190 — These DATA statements contain the values that are provided for the READ statement.

Line 200 — The END statement signifies the finish of the main program. The statements after the END statement are those of the subroutine which sorts the array.

Line 600 — This is the first statement of the subroutine. Note that it is a REM statement followed by a comment which explains the function of the subroutine. It is given a high line number to make it easier to distinguish between subroutine statements and those of the main program.

Lines 610, 620, 630, 640 and 650 — These statements perform the sort operation on the array X. The IF THEN statement on line 630 compares adjacent array elements. If the first element is greater in magnitude than the second, the elements are exchanged. In order to perform this exchange the original value of the first element is stored in the variable T. The value of the second element is then put into the first element. Now the original value of the first element remembered in T, is assigned to the second element. If the comparison is false the exchange is not performed.

The FOR loop initialised on line 630 is between the FOR and the NEXT statements of the loop initialised on line 620. This is a 'nested loop'. The loop index variables I and J are used as subscripts to reference the elements of the array X. Initially I is one and J is initialised to two (I + 1). Thus the first element of the array is compared with the second by the IF statement on line 630 and exchanged if it is greater in magnitude. Now line 640 increments J by one to three and the first element of the array, which may have originally been the second element depending on the result of the first comparison, is compared with the third element and exchanged if necessary. This continues until J reaches ten at which point the first position in the array contains the smallest number of the list. Now I is incremented to two and J is initialised at three. The second element of the array is compared with the third and exchanged if greater in magnitude. This comparison and exchange process continues for each element in the array. When I reaches nine the elements of the array have all been compared with each other and arranged into ascending numeric order.

Line 660 — This starts a new line and outputs a message to the terminal.

Lines 670, 680 and 690 — The FOR loop index I is used to reference each element of the array which is printed by the PRINT statement on line 680. This is similar to lines 30-60 except that new data is not read in.

Line 700 — The RETURN statement redirects the program control back to the statement in the main program immediately following the GOSUB statement which called the subroutine.

When the program is run the output to the terminal will be:

```
INITIAL LIST 1
-10 6 3 50 -7 0 41 32 9 15
SORTED LIST
-10 -7 0 3 6 9 15 32 41 50
INITIAL LIST 2
18 -4 -50 61 11 18 22 -1 99 6
SORTED LIST
-50 -4 -1 6 11 18 18 22 61 99
```

The use of subroutines enables programs to be constructed in a modular way. This makes testing and de-bugging easier, since each subroutine can be individually tested using a test program, before it is combined with the main program.

Nested Subroutines

A 'nested subroutine' call is a call to a subroutine from within a subroutine. Subroutines can be nested to several levels (the limit on the level of nesting is dependent on the version of BASIC being used). Each GOSUB must have a corresponding RETURN statement. The following simple program illustrates how subroutines can be nested:

```
 10 REM NESTED SUBROUTINES
 20 GOSUB 200
 30 PRINT "LINE 30"
 40 END
200 PRINT "SUBROUTINE 1"
210 GOSUB 500
220 RETURN
500 PRINT "SUBROUTINE 2"
510 GOSUB 800
520 RETURN
800 PRINT "SUBROUTINE 3"
810 RETURN
```

The GOSUB statement on line 20 calls the subroutine starting at line 200, line 210 prints out the message identifying the subroutine and then the GOSUB on line 210 calls the second subroutine. This subroutine prints a message and then calls the third subroutine. The RETURN statement on line 810 directs the program to line 520, the statement immediately following the GOSUB which called the third subroutine. Line 520 is a RETURN statement which directs program control back to line 220 which in turn directs control back to line 30 of the main program. The output when the program is run would be:

```
SUBROUTINE 1
SUBROUTINE 2
SUBROUTINE 3
LINE 30
```

The ON GOSUB Statement

The ON GOSUB statement is similar to the ON GOTO statement described previously, in that it is used to implement a semi-conditional branch. The ON GOSUB statement has the general form:

Line number ON variable or equation GOSUB list of line numbers

For example, 10 ON X GOSUB 600, 800, 1000

Based on the integer value of the variable X, the program branches to one of the list of alternative subroutines. The selection is made in numeric order. So, for the above example:

if X is 1 — the program branches to the subroutine at line 600
if X is 2 — the program branches to the subroutine at line 800
if X is 3 — the program branches to the subroutine at line 1000

When the RETURN statement of the subroutine which is referenced is reached, the program control is directed back to the statement in the main program which immediately follows the ON GOSUB statement.

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 the variable or equation 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. **E&MM**

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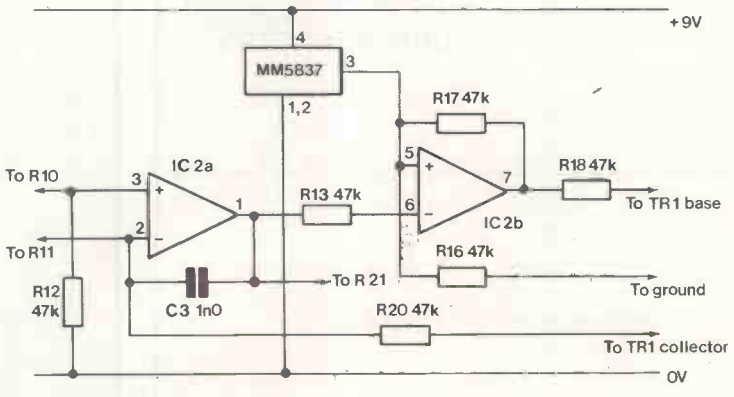

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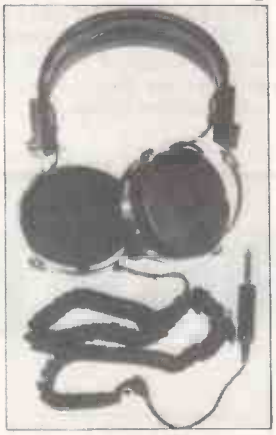

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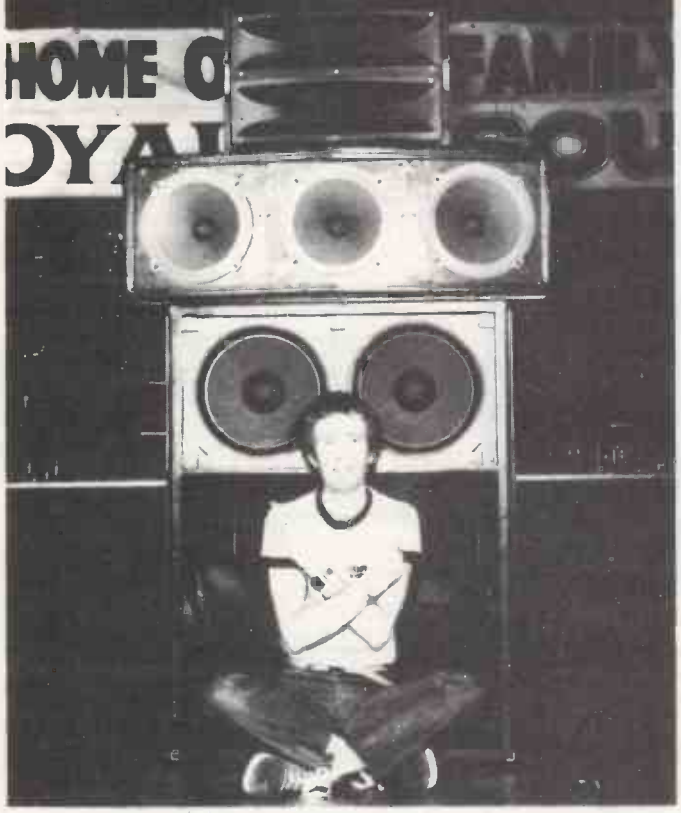

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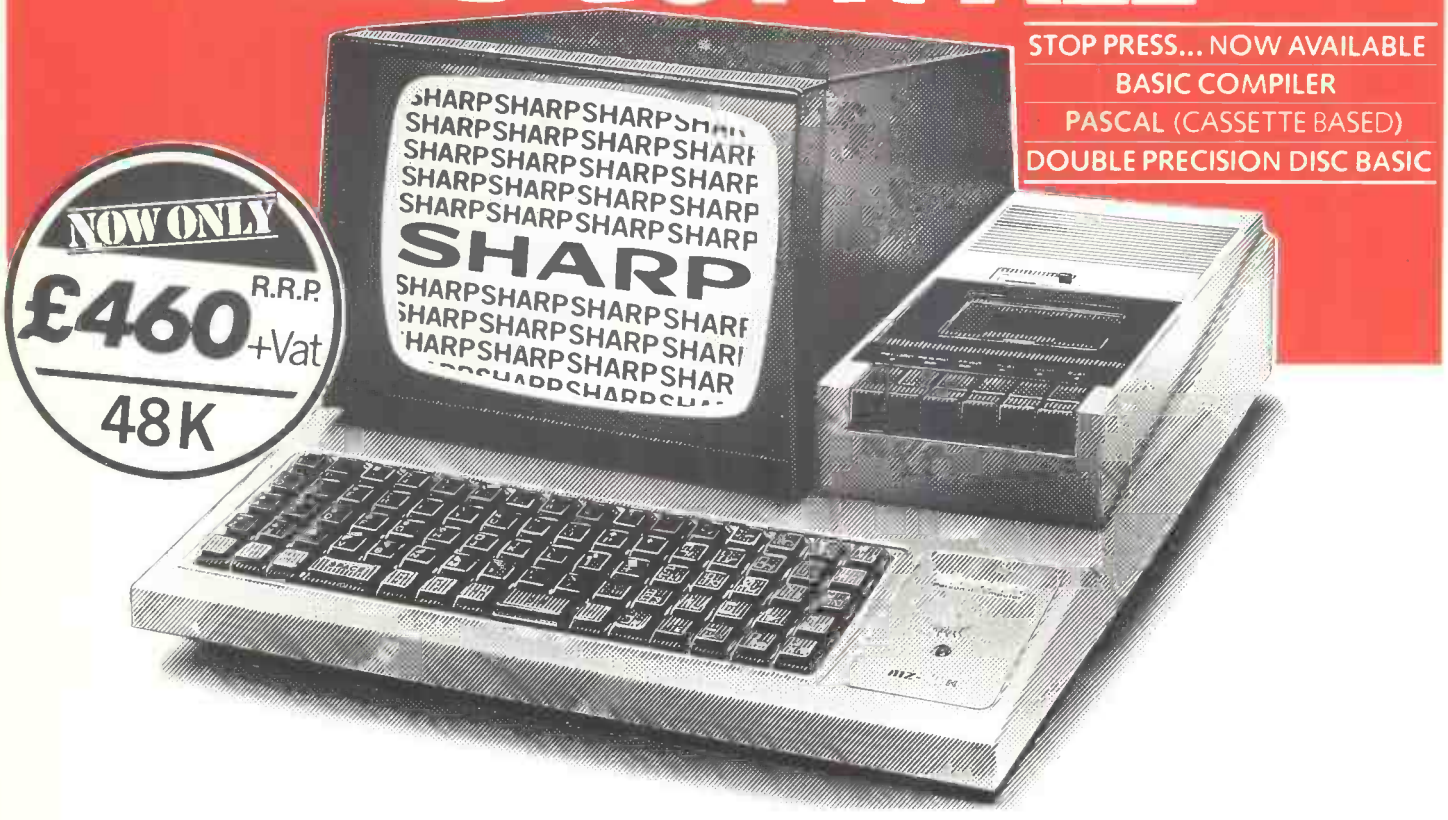

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