Electronics & Music Maker

JANUARY 1982 75p

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JANUARY SALE

Yes, it's sale time again folks! We have many demo or ex-hire keyboards, guitars and amps going at silly prices. Everything is fully guaranteed we can even offer extended warranty on all goods. We have to clear many current lines to make way for new goodies, someof which are already here for you to compare the sale bargains side by side.
You can pay with good old-fashioned cash for the best deal or we accept Access and Barclaycrd Credit Cards; we can arrange fast personal finance and we are offering interest-free credit on selected items: please ring for further credit details and a quote to match your intended outlay. Direct sales line 01-267 7851.

INTEREST-FREE CREDIT ON SELECTED ITEMS

Everything, yes, everything, is in our sale:
Moog, Yamaha, Hohner, Fender Rhodes, HH, Roland, Korg Keyboards; Amps, Cabs and Combos by Roland, Carlsbro, Fender, Aria Loco, Session, Vox, Music Man, OHM, Bose; Fender, Gibson, Aria, Ibanez, Hamer, Washburn, Ovation Guitars even the amazing Roland Electronic Guitars!
MXR, Boss, Guyatone, Aria Loco Pedals and Accessories: 10% at least off rrp of all accessories (Leads, Strings etc.) during the sale period.
See our advertisements in 'Melody Maker' and 'Musicians' Classified' for full listings of all sale items: once the bargains have gone that's it! This is a **genuine** sale.

SESSION

Session:
15:30 standard studio combo; 15:30 deluxe studio combo; PM: 120 powered monitor/EV
— Send S.A.E. for session brochure.

— This new breed of British-built valve amplification is ace! Prices start around £250 for the basic, loud 1x12" combo and it has the sound. The powered monitor is an ideal 120W extension of the 15:30 combo and is also suitable for boosting the Roland 'Cube' combos.
— 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?

FOSTEX

Personal multitrack has come to Camden Town — when will these incredible Japanese ever stop producing such a stream of new products?
Both the A-8 8-track ¼ inch reel to reel tape recorder and the cassette Multitracker are now on permanent demo in our first floor showroom.
If you want to get involved with personal multitrack, then bring a tape we'll show you what its all about.
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ampeg

Yes, Ampeg is back in force! The original brute force bass stack is now being unleashed again in the U.K.

Ampeg SVT 300W valve bass head: **£684**
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£1,081 complete SVT bass stack

We have the Ampeg SVT Stack, Gallien-Krueger, Moog Synamp Stack and Roland JC 200 Stack side-by-side for comparison:
Watch out Mr. Peavey, Mr. Marshall and Mr. H/H you'll be blown off-stage! Here comes Rocky...

GALLIEN-KRUEGER

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 4x12"/two folded horn cabinet with two additional direct-radiating 10" speakers for increased top response.
The 250W (into 4 ohms) head comprises:
4-band tone system; Input/Output gain controls; 22dB foot-switchable boost circuit; Contour filter switch; Bright switch; Input attenuator switch; Preamp out jack;
Power amp in jack
— 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.

Roland

All the newest gear from Roland is due in at the end of December just in time for our sale! This includes the stunning 16-channel mixing desks, the 'Drumatix' computer rhythm, new cube 40k and 60k specifically designed for keyboards — and much, much more.
As usual you can rely on the London Rock Shop snapping all the new equipment as soon as it lands by air, sea or pony from Japan!
Everything made by Roland and Boss is in our sale — if you haven't seen the incredible range of equipment that they manufacture then just call in and ask for **all** the catalogues — Rocky's got 'em all! Remember Rocky never sleeps — he works seven days a week *and* goes to gigs to check out the gear being used.

BOSE

Bose for Pros is their slogan and Rocky knows his Bose is ours! If you want the best small, portable P.A. system then Bose is unbeatable....

Bose 802 speakers (300W each)
Bose 802 equalizer
SS3 tripod stands
We have a double pair system on permanent demo powered by Roland power amps: why not come and hear it for yourself? A little extra investment in your P.A. system will not only improve your overall sound but save you a hernia or two!
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Electronics & Music Maker

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Editorial Offices 282, London Road, Westcliff-on-Sea, Essex SS0 7JG.
Tel: (0702) 338878/338015
Advertisement Manager Graham Butterworth
Tel: 01-527 3376.
Advertisement Sales Terry Day, Dennis Hill
Advertisement Offices Electronics & Music Maker, Hillcroft House, 16, The Avenue, Highams Park, London E4 9LD. Tel: 01-527 3376.
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During November, E&MM attended both the 'Hands On Show' and Breadboard Exhibition'. Hands On organisers, Turnkey, were very pleased with the big turnout and their evening lectures on various aspects of electro-music were well attended. At Breadboard, the Spectrum was demonstrated to packed audiences and we have already received enough orders to be able to offer a full kit of components from next month. Its synthesis capabilities exploit the Curtis chips fully and we are grateful to Curtis' UK suppliers, Digisound Ltd, for their helpful advice in this exciting project.

At last we have caught up with Tangerine Dream — during the year many readers have requested a feature and we are sure this will be the first of many on this experienced group.

We start two new columns this month — Fact File which highlights the equipment and methods of musicians in the current music scene; and a Guitar Workshop by Peter Cook who is well known as an expert guitar maker in the music industry.

Electronic music appears in many commercials, documentaries and films nowadays so it is interesting to discover that Richard Mitchell is producing film music using Powertran's kit synthesisers. This article should show a new direction for the electronic music composer.

Our Demo Cassettes are proving extremely popular and besides giving examples of music from the reviews and features, we are trying out two music study tracks for you to use with E&MM's music supplements. They are really practice 'backing tracks' that you play along with and require you to listen carefully to Rick Wakeman's '1984' LP and Tangerine Dream's 'Exit' LP. It's a great way to improve your reading and at the same time learn the composing and performing styles of today's electro-music.

Finally, Christmas is always the best time for musicians to do plenty of gigs and concerts. But it is also a time when many musicians can be giving some of their musical enjoyment to others less fortunate — why not give up an hour or so to play carols to Senior Citizens, hospital patients, or the disabled? Playing for charity can usually be organised with your local authorities and is another way the musician can contribute to this Festive Season.

Mike Beecher

E&MM wishes its readers a very happy Christmas and a musical New Year

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 ou which 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 lou sounds – just like an acoustic piano. The digitally controlled multiplexed system makes practical t 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 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 whic 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 ensel 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 bo which interconnect with multiway connectors, just four of which are removed to separate the keyb circuitry and the panel circuitry from the main circuitry in the cabinet.

The kit includes fully finished metalwork, solid teak cabinet, professional quality component 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

SAVE ££s!

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DIGITAL DELAY LINE

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

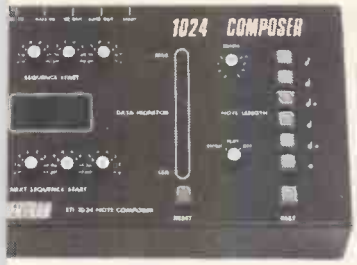
U.K. ORDERS: Subject to 15% surcharge for VAT. *No charge is made for carriage, *or at current ra changed. Quote E&MM on all enquiries

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

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

TRAN ELECTRONICS

4 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

tured in Electronics Today International — July Issue!
rsatile new mixer, shown here fitted to our console, has 2 stereo for magnetic cartridges, a stereo auxilliary (e.g. cassette or jingle e) input and a microphone input. The decks can be automatically either fast or slow and all 3 music inputs can be mixed with slider s. There is a 5-section graphics equaliser and a beat-lift control. Also s a voice-over unit (ducking) and an override button for interrupt ncements. The microphone input can be modulated at a variable rate uce 'growl' effects and there is monitoring of any music input (pre-ten) via the stereo headphone socket and a pair of LED PPMs. The it includes fully finished metalwork fibreglass, PCBs, controls, wire complete down to the last nut and bolt!

- sole is shown fitted with two 19" panel units
- romatheque 5000 lighting controller
- SP2-200 stereo 100W/channel power amplifier. For a 200W/nnel system two SP2-200s could be fitted.
- er supply for mixer with screening metal box £9.90 + VAT.
- sole complete with switch panel, lid feet and carrying handles 9.50 + VAT.
- P256 — their latest belt-drive disco turntable £29.50 + VAT each.

VOCODER

es as a construction article in Electronics Today International this design enables a vocoder of great versatility and high ibility to be built for an amazingly low price. 14 channels are achieve its high intelligibility, each channel having its own ontrol. There are two input amplifiers, one for speech either icrophone or a high level source e.g. mixer or cassette deck e for external excitation (the substitution signal) from either low level sources. Each amplifier has its own level control ather special type of tone control giving varying degrees of oost with treble cut or treble boost with bass cut. The level of eech and excitation signals are monitored by LED PPM with 10 lights – 7 green and 3 red which indicate the level at eps. There are three internal sources of excitation – a noise tor and two pulse generators of variable frequency and width. Any of the internal sources and the external source mixed together. There is a voiced/unvoiced detector which utes noise for the excitation signal at the points in speech the vocal chord derived sounds of the speaker are uted for by the unvoiced sounds of sibilants, etc. There is a ate control which smooths out the changes in spectral e and amplitude enabling a change of the speech into g or chanting and other special effects. A foot switch is ed to permit a complete freeze in spectral balance when the is in operation.
put mixer allows mixing of the speech, external excitation coder output. The majority of the components fit into the nalysis/synthesis board with the rest on 8 much smaller with the controls and sockets mounted on them for ease of uction. Connectors are used for the small amount of wiring en the boards.
t includes fully finished metalwork, professional quality nents (all resistors 2% metal oxide), nuts, bolts, etc – even a ug!

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!

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DEPT E&MM/1/82

ojects 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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ELECTRONIC MUSIC FOR FILMS

RECORDED ON CASSETTE NO. 5

by Richard G. Mitchell, B.A.

Getting into the film music business is hard and is usually a happy accident when it happens. When I was 18 or 19, I never thought I was going to write music for films. My musical background came from doing quite a lot of music at school, including having piano, classical guitar and theory lessons.

I have always had some kind of small studio set-up at home for multitracking experiments. Turning away a career in architecture, I changed direction at the last minute and ended up at St Martins Art School in London doing a 'film based' sound degree course. During 1976 to 1979, I started writing film music for people at the Royal College of Art and the National Film School, from a small studio I'd put together in Charing Cross. In fact, most of my time from then on has been spent with film makers rather than musicians, so my work has been almost entirely directed to the world of sound dubbing and writing music for film from the outset, putting me out on a limb from most composers.

The film sound course was an invaluable foot in the door and after I had obtained my degree I had to go out and meet film makers and producers to get the first few contacts. One good piece of work for the same studio usually brought more work until I had sufficient contacts to maintain the flow. Some producers also did TV commercials, so that led to another area and although I've only been writing music professionally for two years (I'm 25 now), most of the successful producers are also freelancing from one job to the next and keep me busy. Now that I'm writing full time, what in fact happens is that several jobs all come at the same time and then there'll be a break where I'll write letters, send demos and make contact with the film people again. Out of this hopefully comes some more work, but only one contact in a hundred may give you something. Writing music for a living doesn't happen overnight — it has built up during my student years when I took on composing and arranging for agencies as well.

Early on, I joined the Performing Rights Society as an individual, although many composers do their work through their publishers. All my music legalities are handled by the PRS and they take their 14% of all royalties, but I'm completely independent and don't use an agency. I completed my first film, which was a Thames TV documentary for the Ministry of Defence on free-fall parachuting, whilst I was still at college.

Richard Mitchell.

Learning the Business

If you want to write film music, you must learn about sound editing, track laying and how the whole sound dubbing process works. For example, you might be producing a full symphonic style electronic score and if it's for a scene in a car, for a start you won't hear any of the bass because the engine noises will dominate. So each film sequence needs careful choice of the frequencies used (i.e. the instruments for electronic effects) in order to let the music through, as well as the sound effects and general dialogue. This can often be highlighted at the final dubbing stage, when the music is mixed with the soundtracks for the film spot effects, sound effects and dialogue. One way round this problem is for me to do all the sound effects as well as the music.

Many musicians like to doodle around with ideas when composing until something good comes out of it. I have to work to deadlines! Recently I had to do a Sensodyne toothpaste ad and the production company gave me a 'line test' on video. This was a 3-dimensional line image of the product moving about on the screen, which eventually ended up as an animated series of shots that fitted into the images. The company spent the weekend doing that part whilst I was getting the music done, but by Monday morning the music written was not at all satisfactory and I was told to have it finished by the next day. So in 24 hours I had to conceive, write and record the whole thing. The shortest time I've ever been given is around eight hours to do a job, but it's surprising what can be done when you're under pressure!

Writing Film Music

I often think that doing pure maths and statistics at school has given me that kind of logical approach one needs for getting timing and sequences exactly right. Each film poses different problems and I am expected to solve these myself. Sometimes I am given a 'rough cut' film which contains all the sequences, but not necessarily with the correct time lengths. The film editor and I work out where we are going to use music and whether we are going to cut or fade from one sequence to the next.

The other alternative I get is the 'fine cut'

the future of

The Fostex Multitracker is a Personal Recording Studio, that challenges the quality and facilities of open reel.

4 track

Separate but together?

Mixer and recorder work as one but you can use them independently. The mixer is four in, four out, with gain, tone, echo and pan. The four track tape deck has remarkable features.

How about noise?

Sound quality is astonishing. The latest Dolby 'C' circuitry achieves a dramatic 71dB signal to noise ratio. It's performance you would expect from open reel. And there's more. Dolby's new system has side benefits that result in tighter, more transparent recordings.

DOLBY C NR

Full function four track?

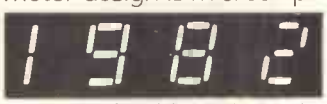
There are no restrictions, all four tracks can be recorded at once. Any input can be switched to any track. Or plug into the recorder direct, from another mixer, to add more channels or to capture a live performance.

Is ping-pong possible?

Selsync is fully automatic, and you can bounce adjacent tracks with quality. With a little forethought, you can perform the ten track bounce with hardly any noise build up.

It's a solenoid transport?

The high speed, two motor design is microchip



controlled, with varispeed and a digital counter plus return to zero. It's all there to speed your creativity.

Why a footswitch?

Have you ever tried to work a tape recorder while playing an instrument? With the Multitracker you simply preselect the tracks you want to overdub or correct, then run the machine in 'record ready' and hit the footswitch on cue.

Are four inputs enough?

The whole point of multitrack is to record a tune a part at a time. With one or two musicians, four is plenty. When you overdub, the inputs are used over again.

Is monitoring complicated?

An automatic 'monmix', switches between live and signal already on tape, depending on which tracks you select for record. All you adjust is level. You can also check the stereo mixer output for quality and balance.

How about effects?

Your echo unit connects to the 'aux' send and return sockets. You can also use limiters, equalisers etc or existing pedal effects.

Why Personal Multitrack?

The Fostex Multitracker, and each product in the range is designed for musicians and songwriters. Easy to use and own. We don't believe you need to go into the studio business to own the tools of your trade.

Visit a Fostex Dealer and discover the remarkable Multitracker for yourself. It will make you think twice about open reel.

Call or write for a full dealer list and 12 page brochure covering the entire range of Personal Multitrack products.

FOSTEX

Bandive Ltd. 10 East Barnet Road New Barnet Herts EN4 8RW. Tel. 01-440 9304

— a completed film ready for final dubbing of the recorded dialogue and sound effects, and I have to match every frame to the music. On the video film that's given to me, there is a time code which is a numerical readout superimposed at the bottom of the picture indicating hours, minutes, seconds and frames. Since each frame lasts a precise time, I can time the frame count to each part of the section and write the music to that length. The cinema film works on 24 frames per second, but TV is 25 to synchronise within the 50 cycles span.

Initially, I meet the producer who is responsible for all aspects of the film's make-up. He would outline what is required, whether music alone or with sound effects as well. Time schedules are decided and often depend on the amount of work involved — the longest film I've done lasted 1½ hours and contained 70 music extracts. The commercials I do are normally the shortest, lasting around 30 seconds. Within this time, there can be up to 12 'Sync' points. The sound starts at 1½ seconds in (after 34 frames silence) and stops ½ second before the end — that's an IBA requirement and avoids consecutive commercials running into each other. The video machine I use is the standard rental type of equipment with 'still' frame control.

I next view the film around 10 times and during this, certain 'Sync' points begin to show. These are the major dramatic events defined by a single frame. A 'Sync' point can be a cut, an image jumping out at you, a product close-up and so on. I then decide what musically would be interesting to hit — whether it's to be a 'sting' or whether the bar indicates the 'Sync' point. A 'sting' is a phrase of music or sound that embraces a short event in the film — it might be, for example, to cover the action of a man jumping off a burning ship into the sea. 'Spotting' music is the name given to the task of selecting sync points (or, as Hitchcock often said: 'where not to put the music'!). One of the first big lessons to learn is when not to use music and effects — silences can be all important.

An example of a dubbing cue sheet that shows the music synchronisation in terms of frames is given in Figure 1. I use a calculator to work out the seconds for each event and record on to four tracks using the A-3340S Teac machine. Occasionally I've used a mono Nagra portable for live recording of effects. Since 99% of film music only requires mono, I don't often prepare a final stereo master tape. Another important point is the monitoring of the mix through a small 'average' speaker to get the feel of its sound

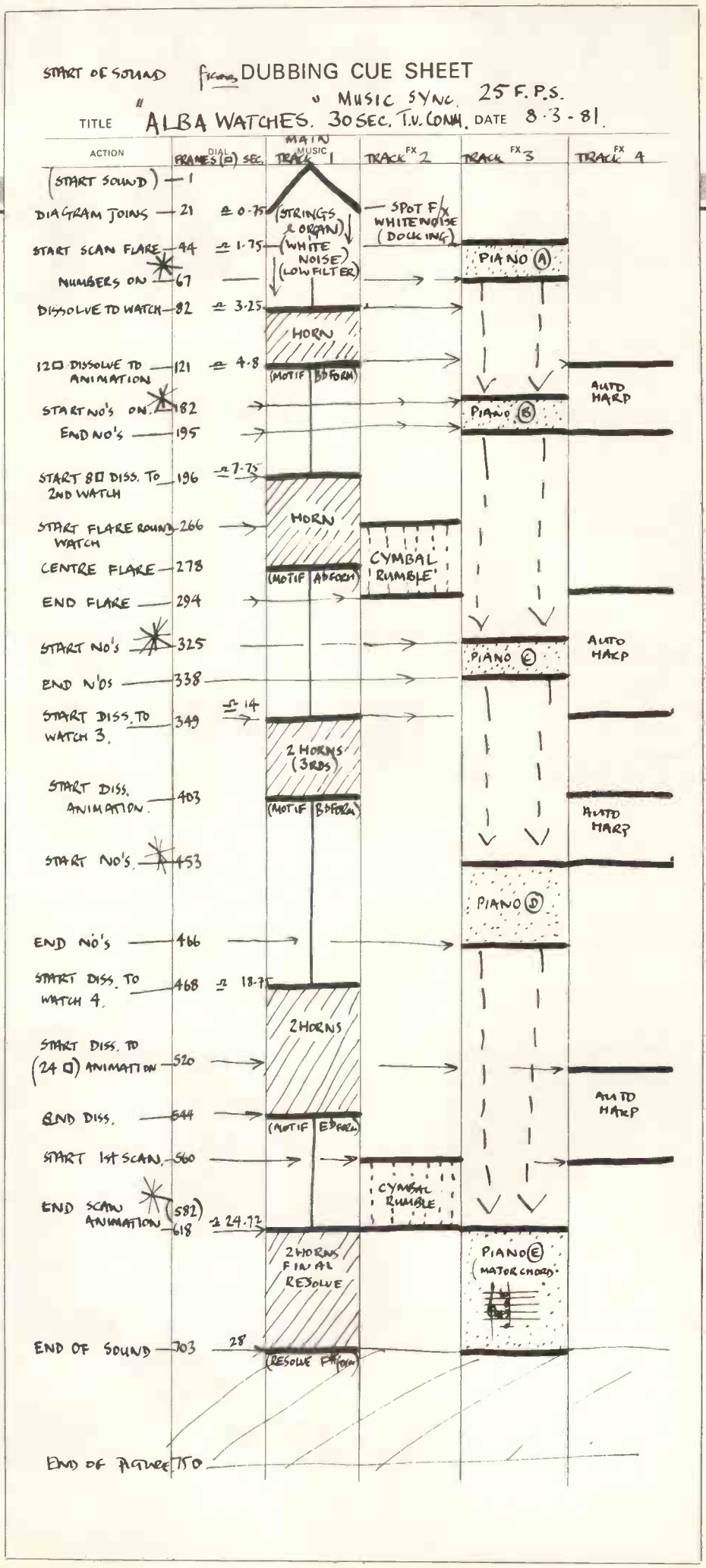


Figure 1. Dubbing Cue Sheet for 'Alba watches' (played on Demo Cassette 5).

Recording the film music.

on the television, although I do use full range speakers as well.

The first step in preparing the tracks for recording is to use a click track or constant beat as the sync guide. I find the Boss Dr Rhythm very useful — you can leave it set at a tempo and it will still be virtually the same when you come back to it later. The sync points are then calculated to be a multiple of the rhythm/click track (the tempo of which is chosen to be suitably fast to embrace all syncs, unless it's actually going to be a drum rhythm in the music).

Beginning the process of composition doesn't entail putting together one sequence after another in order — it usually starts with the highlights giving you some musical themes or melodic/rhythmic ideas to work with which become the underlying character of the film. So the horror film has an ominous, perhaps menacing atmosphere, but the TV commercial aims to be bright and punchy, or warm and homely. Video cues can also be given by five second wipes — literally a diagonal chinagraph pencil line that is drawn over the film frames, leading you to a cue when it's moved across the screen.

Composing instruments

It may be surprising to readers (especially after hearing samples of my film music on Demo Cassette No 5), that I use very limited resources to make my electronic music. Because of this, I often have to resort to using acoustic sounds that can be electronically treated, as in *musique concrète* techniques. A lot of composers would not be happy unless they used multi-keyboards with micro control and so on. I have had to exploit every possible aspect of sound making from the few instruments I possess. In my early days I used the Dewtron synthesiser modules, but now I always use

the Powertran Transcendent 2000 monophonic and polysynth instruments which I find ideal for composing. These are synchronised by the Boss Dr. Rhythm and are complimented by a host of acoustic instruments such as piano, guitars (plus electric), bouzouki, autoharp, harmonium, violin, banjo, numerous flute/whistle instruments, a drum kit and various percussion instruments from bongoes to Indian finger cymbals.

These are recorded directly or with AKG and Shure mics on the Teac A-3340S (with remote) and mixed down to Revox B77 (with varispeed) using an RSD 12 into 2 mixer. I also use an EMI stereo tape machine (with independent tracks) for building up tracks and echo delay. They are monitored through a Leak Delta series amp with Wharfdale speakers.

I get a nice fat sound from the harmonium which I'll put through a slow modulated filter. In fact, nearly all the

A frame of film showing the time code.

instruments find their way through the synthesiser for some kind of treatment. But I've now reached a stage where I'll have to consider eight track and a more concentrated use of 'pure' synthesiser rather than the acoustic/electronic medium. Generally, I never go beyond using six tracks, which are made by mixing one set of four tracks to stereo on the Revox, then re-recording these on the Teac, leaving two more tracks to make the six. I *do* like to build up my string sounds with several tracks which are thickened up using a chorus delay. Ron Geeson and Robert Fripp's multi-tracking ideas come in useful too — I've used one oscillator to build up whole textures from multi-layered sounds and use tape loops quite a lot that have recorded rhythmic sequences from the acoustic drum kit. Echo often comes from the Revox and EMI tape machines. The parametric EQ on the mixer is useful for removing any unwanted hum or noises and two Accessit reverb boxes give extra depth as well.

When composing, I like to use a theme on a single, easily identifiable instrument sound that haunts you. Francis Lai is particularly good at this. Ridley Scott (writer of the Martini ad) also did this well, using a flute in the film 'The Duellist'. I avoid the early Max Steiner 'continuous film soundtrack' style. John Williams in 'Close Encounters' also has an expert way of finding the right frequencies to put the music around the mass of spaceship sounds in the film. I write most of the music on the piano or guitar using the cassette machine as a note pad. As yet, drums have not played a prominent part in the scoring.

After the music has been composed on tape, I then take it to the production company in a 15 IPS mono/stereo ½-track format. The sound editor will check out the music and effects and put them down in the right sequence. There is very little time for putting right any mistakes — it has to be okay when you take it in. At the transfer bay, the sound is put on to sprocketed magnetic film so that it can be run alongside the frame pictures. When we've laid all the tracks and cut them in, it's then taken for the 'dub' a few hours later (a day later for commercials/documentaries).

In the dubbing theatre, all the recorded tracks, about 10 for a documentary and up to 20 for a feature film are prepared for mixdown in the usual way, except that they come from individual magnetic film machines. The editor, mixing engineer and myself then decide whether to add more reverb or delay effects to give extra depth to the sound. It's a good idea for me to keep my master tapes fairly 'dry'. Often, by the time dialogue and effects (e.g. street noises or products in action) are laid down, the music becomes almost 'atmos' (background atmosphere). At this point my efforts at getting the sound frequencies right will show. A drawback is that top and bass can be reduced on the final film, although noise reduction is added to clean up the signal.

To complete the music for a film might require me to compose many more extracts than I'll eventually use, but I don't offer these as alternatives. Even though the company concerned may know exactly what they want, it is dangerous to give the options at the deadline stage. I have to convince the producers that I have the ideal music for their film!

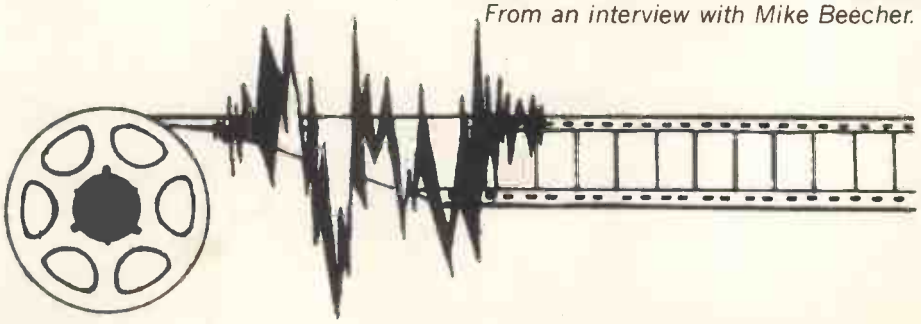
My work involves films for many countries and several music examples are given on E&MM Cassette No 5. Payment for film music varies quite a lot — commercials will give a lump sum, although I have to bargain for a good fee and make sure that I estimate the amount of time required carefully. A large amount of television music is now electronic and the economic situation has probably fostered this because of the huge costs of hiring an orchestra to do the job and so on. Certainly, because music is often the last part of film production (when every pound counts), electronic music is now a very viable alternative.

Writing electronic music for films is both challenging and rewarding, with the future offering the prospects of microprocessor control and computer music in small studios. My inspiration comes totally from the visual image of the film and each day brings the challenge to make a fusion of so many different things become an amazing great vista! **E&MM**

From an interview with Mike Beecher.

EXAMPLES OF RICHARD MITCHELL'S FILM MUSIC (1979-1981)

i A feature film — "Beastly Treatment" (presently undergoing distrib.).
ii A documentary about free-fall parachuting, "The Falcons", screened on Thames TV.
iii A TV comedy series being produced by Moving Picture Company entitled "Mister Harris".
iv A documentary entitled "Windsurfing", screened on LWT's "World of Sport".
v A children's animated cartoon TV series entitled "Uncle Hoja" for the Middle East (and possibly European countries).
vi A program for "TV Eye" by Thames TV.
vii Currently working with Illusra Films on a cinema short — "Rescue 9 Zero".
viii Documentary "Managing Energy" for Dept of Energy.
ix Music for the following TV commercials:
- a. SHOP ELECTRIC — a campaign for South & South West England, and North & South Wales involving six TV and radio commercials.
- b SENSODYNE TOOTHPASTE — a national campaign starting in the Autumn.
- c. WINDSOR SAFARI PARK & SEAWORLD TV and radio commercials.
- d FIAT STRADA — a National TV campaign.
- e. MARTIN DAWES — a "Hi-fi & Video" series of commercials for Northern England.
- f. ALBA WATCHES — a TV and cinema campaign for Hong Kong.
- g. B & N CIGARETTES — a TV and cinema campaign for Spain.
- h. KUWAIT COMMERCIAL BANK — two campaigns for TV in the Middle East.
- i. JORDAN TELEVISION — TV commercials for a dozen various Arabian products (fruit juice, cheese, washing powder, ice-cream, etc.).
- j. SENSODYNE TOOTHBRUSH — national TV campaign.



THE JAPANESE MUSIC FAIR

From the moment that I set foot in the Tokyo Science Museum (aka Kagaku Gijyutsukan) it was go, go, go! Many of you will have attended the British Music Fair at Olympia last year, and had a limited opportunity to try out some of the latest equipment around. The Japanese show has a similar aim, but taken far further. From each of the five corners of the Science Museum (it's a funny shaped building) came a wall of sound. Noise restrictions aren't for the Japanese; 'unless you can't hear yourself think you can't be enjoying yourselves', seems to be the philosophy of the day. In case you haven't realised it, the Japanese Music Fair is a public event, designed to show off all the latest Japanese produced musical equipment to the fanatical Japanese punters. There were quite a few manufacturers of non-Japanese origin at the show, but only as 'guests' of their oriental distribution companies.

Sound Master Latin Percussion Unit.

"Touch the Music" was the theme of the show, so every stand offered the visitor a chance to get his hands on the products. The Japanese are a very honest race - no one would consider stealing from such an exhibition, consequently none of the demonstration instruments were tied down, not even effects pedals, and there was an almost total absence of security staff. If only it could be the same over here in the West. But alas!

The Fair lent heavily towards electronic products and keyboard instruments. There were many new keyboards, effects and processors, and automatics - rhythms etc. on show, and over the next few pages I hope to engage your interest and bring you some of the exciting new things we are likely to see in the UK over the next twelve months. Unfortunately, in many cases, pricings of these products is impossible at this stage, with very few stands having any export staff available to comment, in fact it was hard enough trying to track down anyone that could even speak English. The personnel on the stands seem content just to let visitors examine, play, and find out for themselves exactly what was going on with the new products. In some respects this was a good thing, especially since many manufacturers had set out five or six models of each new line, wired up and ready to go with headphones.

One of the more intriguing aspects of the show were the competitions. Every major manufacturer seemed to have organised a competition for the younger visitors to enter, so everywhere you went, you seemed to be tripping over youngsters busy answering questionaires on the products at the show - there wasn't a spare flat surface to be found.

Okay then, so what about the new products? Well the two 'biggies' as I saw it, were on the Casio stand and in the Roland room. And I hope that you'll forgive me if I devote a major part of this report looking at these two products.

Firstly, Casio, a company at the forefront of digital technology, have come up with three new keyboard products - the MT-31, the MT-40, and the CT-701. It is the latter that is going to create one hell of a stir. At present the CT-403 is top of the tree in the Casio catalogue, but in the new year the CT-701 is bound to take over. It is hard to know where to start with a development of this nature so I'll start with the price. It would seem that for under £500 you can be the proud owner of one of these remarkable instruments that features: a five octave keyboard; a wide variety of accurate and very lively preset sounds; a memory function which can read and store a musical score and replay it in different rhythmic variations etc; and a memory guide function which indicates how to play the stored score, thus making the CT-701 one of the most advanced musical teaching aids so far developed. At first this may generate the reaction, "Oh yes, we've heard all this before," but when you look more closely at the CT-701, you'll realise what an amazing instrument the CT-701 is. The main feature, the score memory, centres around the use of a light pen. Casio, in conjunction with the American Publishing company Sight & Sound, have developed a bar code system of representing musical notation. To program a particular piece of music, three separate groups of bar codes are used - one for the pitch of the melody line, a second for the relative timing, and the third for the accompaniment chords, so for a standard three minute song about twenty lines of bar coding has to be scanned. A parity system is used for each line of code, so that the CT-701 will emit a tone to indicate whether that line has been correctly scanned or not. It's quite an idea, and perhaps one that a few home constructors might be able to utilise.

The Roland EP-11

Once the information is loaded into the 701, it is a simple matter of selecting a preset voicing and a suitable rhythm to get the tune to be played back. It can of course play along with it. This is just part of the facilities offered by the CT-701. With the tune loaded in the memory, a series of LEDs above the keys can be used to teach the player which note to press next in order to follow the melody line — this makes initial learning very easy.

Other features include the programming of your own particular series of chord changes and melody line. 345 steps are available for storing notes, and 201 steps (equivalent to 100 measures) can be used for chords. A series of procedure buttons can be used to save on memory by instructing the 701's computer to record desired memory loops. It wasn't possible to unearth all the potential of the CT-701 at the show, but just from the time I had with the machine, I was convinced that this instrument is going to be one of the biggest sellers of 1982 (see our Keyboard Review this month).

Also to be seen on the Casiotone stand

Casiotone CT-701 ▶

Detail from the Casiotone MT-40.

Roland TB-303.

were two new mini-keyboard instruments - the MT-31 and the MT-40. The former is basically a revision of the MT-30 (one of my all time favourite electronic keyboards), with a restyled control panel, and the inclusion of a fine tune control; the MT-30's were set up for A-442 which made things a bit tricky if you were playing along with other instruments. The MT-40 is another bit of revolutionary Casio design; it is based on the MT-30/31, but includes a rhythm unit and automatic bass generator. The rhythm unit offers six basic patterns (Waltz, Samba, Swing, Slow Rock, Pops and Rock) with two different fill-ins. It is, however, the automatic bass generator that is of most interest here. Located on the left hand side of the keyboard are a series of calculator buttons arranged in the format of an octave of the keyboard (*à la VL-1*). When one of these is pressed, the bass pattern relevant to the selected rhythm and in that keys major chord, will sound. Minor and seventh variations can be achieved by pressing one or two keys to the right of the root note. I was very impressed by the quality of the bass patterns, they really 'felt' good - full marks to Casio here for creating an automatic section that doesn't sound particularly mechanical.

Lest I be accused of favouritism, I think that I should move onto some other products, and the other particularly important instruments on show were to be found behind Roland's doors. We've been hearing rumours for some time now about the Drumatics range of automatic programmable devices which are going to "turn the market upside down". Well, two of them were to be found at the Japanese show. When I say two, I mean two different model types as there were about half a dozen of each product wired up with headphones for visitors to try out - an admirable arrangement. The two in question are the TR-606 rhythm unit, and the TB-303 programmable bass line generator. The TR-606 is, as the model number implies, a scaled down version of the TR-808, but (if the yen prices are anything to go by) it will sell in the UK at one third the 808's price! Place your orders now.

The TR 606 is a battery powered unit with seven percussion voices, which are assigned to four attenuable output channels prior to the master mono output. The operation of the unit is very similar to that of the TR-808; there are a series of sixteen buttons which represent the sixteen steps of a measure. These buttons also double as selectors for the 16 programmable memory locations that are used to store the rhythm patterns. To program a rhythm, the percussion voice is selected and the steps in the measure that the voice is to sound loaded via the 16 buttons. This procedure is repeated for the other percussion voices until the desired pattern is achieved. The TR-606 can then be used to sequence the patterns, thus providing a complete rhythm track for an entire piece of music. The TR-606 has a possible storage capacity of 256 measures, which can be made up of a maximum 8 separate percussion tracks.

The TB-303 is so new that Roland had no printed information available at the show. It is designed to operate alongside the TR-606 providing a programmable bass line backing. As with the 606 it is possible to load both pattern information and track information to form a possible total composition of up to 256 measures. The programming buttons are arranged in the shape of an octave of a keyboard (like the MT-40) with extra buttons to determine octave transposition, slide, accent etc. Triplets can be interjected into the patterns, and the unit provides audio, control voltage and gate outputs. The sound produced by the TR-606 is fully variable; a voltage controlled filter with envelope generator is provided and all the major control elements are variable. Again the unit is battery powered, but as to price, I can only suggest that it should be around the same mark as that of the TR-606 - they both seem to have similar functioning levels.

Other new products on the Roland stand included the Juno 6 - a smart non-programmable version of the Jupiter 4 (but with six voices, gulp). Roland seem to be introducing a lot of new products with white control panels, which I personally feel look a lot more contemporary than the rather traditional looking black panel with white graphics, sandwiched between two nice

◀ The Studio Model 4000 from Dyno-My-Piano.

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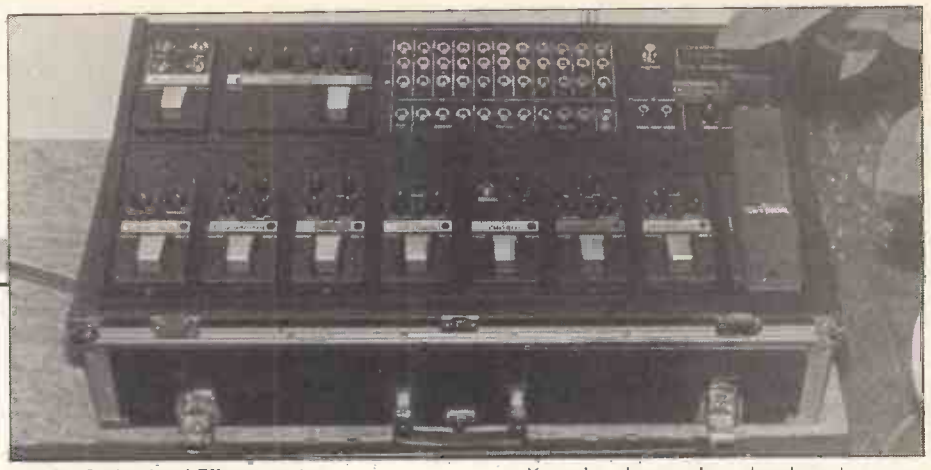
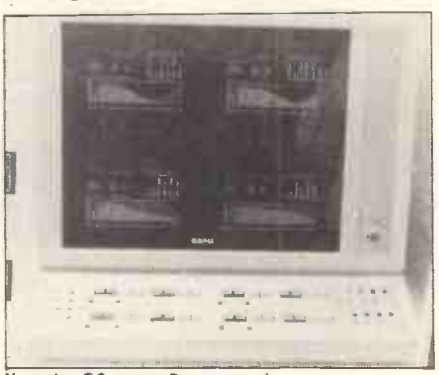
The Japanese Music Fair



Yamaha Professional Effector system.

Bass range of effects pedals. Note patch panel enabling the units to be hooked up as desired.



Yamaha GS range Programmer.

wooden end cheeks. The Juno 6 would seem to sell in Japan for half the price of the JP-4, so it could be quite an attractive proposition if it appears over here. One of the more interesting points relating to the Juno 6 is that, according to the control panel it uses a device known as a DCO to produce the basic tone. This is a digitally controlled oscillator, which presumably receives a digital code from the unit's processor and counts down from that number to generate the desired pitch. The rest of the control parameters are standard to those normally found on a synth - LFO, HPF, VCF (low pass), VCA, Envelope Generator, and chorus. In addition there is an arpeggiator facility. As far as I could tell this instrument is fairly conventional, and mostly analogue, but unsubstantiated rumours have it that the Juno 6 was produced by Roland in conjunction with Sharp (the calculator people) and is almost entirely digital. We will have to wait and see if this is true or not - the demonstrators on the stand wouldn't say anything.

There are a lot of Roland products in Japan that never find their way over to us. This is basically due to cost of shipping making them unattractive pricewise. I was interested to find, though unable to explain, that Roland were heavily into the 8-track cartridge market (they're very popular in Japan), and that they produce several models, some built into combo amps! Other products include the Piano Plus line. There are three models: the 70, six octaves, touch responsive, and with integral amp and speaker; the 60, as above but with just a five octave keyboard; and the Piano Plus 11 (also known as the EP-11), which has a five octave split keyboard, auto rhythm, auto bass, and harpsichord and piano voicings. The latter may soon appear in the UK, especially as the Casio and Yamaha small keyboards are doing so well, though this one will be a bit more expensive. Did you know that Roland also produce a range of upright electronic pianos - nice bits of furniture with the gubbins of the MP 600 stuck inside.

Onto Yamaha, where it was difficlt to move let alone see any of the new products. They didn't have a lot new on show, save for the CE 20, a four octave machine with 14 monophonic preset sounds, and six voice assignable polyphonics, including Brass, Horn, Organ, Electric Piano, Harpsichord and Strings. It plays well, and sounds nice, though it has one rather strange feature - a performance wheel that is used solely for introducing glide to the monophonic section. I couldn't really see the relevance on using a wheel for this purpose. One item that caught my eye on the Yamaha stand was sealed away in a glass case - the programmer used to create the sounds for the GS range of products. These instruments (the GS1 and GS2) use what are known as FM equation generators to produce incredibly complex waveforms that come closer than any other system to simulating existing acoustic instruments (they can of course be used for abstract synthesis too). These instruments are desperately expensive (£10,000 and £5,000 respectively) and rely on magnetic cards to feed in information required to create a specific sound. These cards, or strips, are supplied by Yamaha, you can't create your own, so it was interesting to see the equipment used to determine and programme the sounds. As can be seen from the photograph there isn't a great deal to the programmer, it is basically a custom designed Yamaha computer which enables the timbre, pitch and amplitude created by the FM equation generators to be precisely defined for each time element of the sounds duration.

Yamaha have also developed a new professional range of effects pedals which go under the group heading 'Effectors'. All the usual pedal effects are available - Phaser, Chorus, Flanger, Octaver (divider), Distortion, Tone Booster, Parametric, Limiter, Noise Gate, Compressor, as well as a line selector, and Analogue Delay. The unusual thing about this system is that a floor mounted board is available into which up to ten units can be accommodated. This board incorporates a jack field, power supply, a patch lead checking circuit, an output level indicator, master volume control, a bi-pass circuit, headphone output, echo send and return, even a gooseneck mounted light! Quite a system, I just can't wait to see what the UK price is going to be.

There wasn't much happening at the show for drummers. Pearl had a new kit called the Ponta, with very deep 8-ply maple shells, and they also had a range of toms which they called 'Extenders'; these were designed to enable heads of a larger diameter to be fitted to the shells, i.e. a 14" head could be fitted to a 12" drum. I'm not too sure what they are trying to achieve. Yamaha had a few new additions to their System series of kits, but Tama had nothing new to show at all. SoundMaster who produce a wide range of electronic devices (although we only really seem to see the SR-88 rhythm unit over here) had one or two new goodies including an Analogue Chorus Echo (SE 4300) with spring line reverb included, and an interesting variation on the SR-88, a programmable Latin Percussion generator with Bass Drum, Low Conga, High Conga, Timbale and Clave voice generators.

If Yamaha's stand was crowded, Korg's was a veritable ants' nest of teeming bodies. I don't know how we all got out alive. The crush was worth it though because when you got through there were three fascinating new products being heavily promoted. We saw nothing new from Korg at the British Music Fair, but things are now rectified by two new keyboard instruments and a smart little tuner. The first of the keyboards is known as the Mono/Poly — an apt, but rather clumsy name. This is a 'four voltage controlled oscillator' synthesiser. It is different to any other synth that I've come across in that the four VCOs can either be used to construct a single note, i.e. in unison, or they can be assigned to individual notes of the 3½ octave keyboard, thus the Mono/Poly can play up to four notes at any one time. Each oscillator has independent controls, and will generate triangle, ramp, pulse, and pulse width modulated waveforms switchable over four octaves (16' to 2'), in addition there are separate level controls and four LEDs to indicate which oscillators are being used at a given time — pretty important when in Poly mode. The 'catch' is that the Mono/Poly has just one voltage controlled filter and asso-

you don't need a pilot's licence to play one...

The Korg Delta is very easy to play and yet incredibly versatile. The strings and polyphonic synthesizer section are separated to give you complete control of sound.

The synthesizer section is fully polyphonic with easy to operate voltage controlled filters and envelope generator. The strings sound has attack and release controls which are independent of the synthesizer. There are also separate outputs for the synthesizer and string section which enables you to obtain a stereo effect. In addition a joy stick control gives quick, convenient control of pitch bend vibrato and other effects.

The facilities of the Korg Delta can be further expanded by connection to other keyboards, rhythm units and effects pedals using the input and outputs on the rear panel.

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Roland Sound System Rack unit. Note the cartridge units.

ciated four stage envelope, and one voltage controlled amplifier, again with a four stage envelope, so the synthesiser can only be considered as a pseudo polyphonic. It is a nice machine though, with pitch and modulation wheels, an arpeggiator (they seem all the rage now), two LFOs, noise, sync, sample and hold etc., etc.

The second new synth from Korg could be a real winner. It's the Polysix, a six voice programmable with a five octave keyboard. This could be the best new thing Korg have come up with for a long time (then again it might not). Each voice consists of a single VCO with ramp (sawtooth), pulse and pulse width modulated waveforms switchable over 16', 8', and 4' octaves. A sub oscillator has also been provided that can be introduced either one or two octaves down. A low pass VCF shares its ADSR envelope generator with the VCA, though a gate pulse can be used to shape the amplitude if required. Various modulation facilities are available, which can be routed to either the VCF/VCO/VCA via the modulation wheel. Again there's the Arpeggiator — a particularly variable one, and the Polysix also has a comprehensive effects section — chorus, phase and ensemble with separate speed/intensity control. An eight location programmer section is to be found to the far right of the synth. Every parameter is programmable (not the performance controls) and a simplified tape dump system enables permanent storage of a large number of programmes.

Korg's other new product is the Micro Six guitar tuner. Their GT-6 has been one of the most popular tuners for some time now, so the Micro Six is an updated version that is pocket size. These exciting additions to the Korg range, which includes their new Lambda and Sigma synthesisers, should be available in the UK early next year.

Technics were drawing very large crowds for demonstrations of their U Series organs. We have seen these instruments over here for a while now, but there is a further addition to the range, the SX-U80, which should fill the gap in the Technics range at about £2,500.

A company known as BIAS, whose products we don't seem to get in the old country had a most interesting multi effects pedal, which included, in one package, a compressor, distortion, flanger/chorus, analogue delay, octivider, parametric EQ, touch wah, and at the end of the chain, a rather necessary noise gate. The unit comes in two sections, the control panel for setting up the desired effects, and a multi footswitch with nine buttons to introduce the various effects. It's a nice idea, and known as the BIAS All-in-One.

The American company Dyno-My-Piano managed to find themselves exhibiting at the Music Fair. These people doctor Rhodes pianos. You name it, they do it to them. The most interesting device that they hook up to the Rhodes is known as a Percussion Pedal. This is a mechanical footpedal that actually moves the harp of the instruments such that the hammers strike the tines at different points. The effect is something akin to the variation in timbre achieved by plucking the strings of an acoustic guitar at different points - the closer to the bridge the string is plucked, the greater the harmonic content of the sound. The percussion pedal relies on the same principle, so that a much wider variation in tone can be attained from one's Rhodes. The latest model that Dyno-My-Piano had on show was their Studio 4000 model, which from the States will set you back $5,000. It's some instrument though, with: split keyboard, percussion pedal, tri-state vibrato, graphic EQ, overdrive - the works! The sounds emanating from the two EV cabs alongside it was awesome.

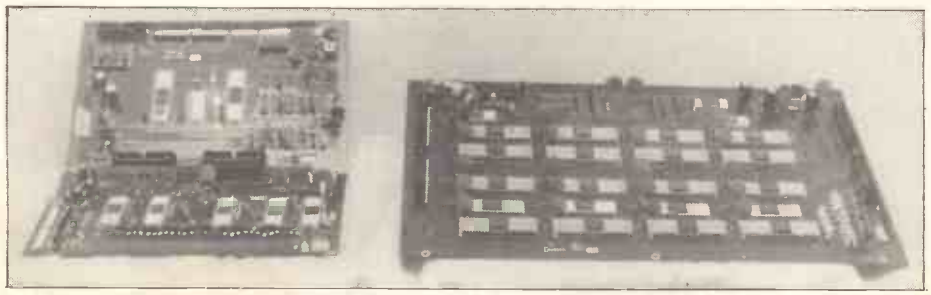
We are just beginning to see Teisco products appearing in the shops here in Britain. Actually they've been around for over twenty-five years in Japan. The company was bought out by Kawai (the world's second largest manufacturer of keyboard instruments) many years ago. However, Kawai have only recently decided to resurrect the name and market group gear products under it. There were several new products here for the first time, and we should see them in our shops round about spring time. John Hornby Skewes & Co Ltd are the distributors in Britain and they seem determined to make a big success of these products. The SX-400 (see review in this issue) was at the UK show, and attracted a lot of interest. To sustain the momentum Teisco have the QP-88 (quartz Piano - but with 61 not 88 keys), a nice looking four preset electronic piano; the EX-300, a multi-ensemble with strings, brass, human voice ("ah"s and "uh"s!) and bass sections; and the S-60P, a scaled down version of the excellent S-100P (one of the all time great preset synths), this has 15 good monophonic preset voices, touch keyboard (37 notes), bend, vibrato, etc. It's almost as good as its predecessor.

Guitarwise, there was very little new and exciting to see at the show. Aria, however, had a good eight new models to add to their phenomenal range. These included the PE-R100, TA-100, TA-70, U-60T (a bizarre pointed body), CS 350T electrics, and SB-R150 fretless bass. I find it almost impossible to keep up with this company, which incidentally is handled world wide by Arai. Ibanez had little new, save for a couple of additions to their Signature range, and some new colour options including the rather tasty polar white.

The Japanese Music Fair is held every two years, and it is an experience like no other. I just hope that I can manage to get to the 1983 show, which I understand is going to be held in much more spacious surroundings. Japan is a fascinating country, so I suggest if you are ever contemplating a trip out East, try and fit it in with the "Touch the Music" experience.

Dave Crombie **E&MM**

Yamaha CE-20.



An FM Equation generator from the Yamaha GS range.

Casiotone 701

Electronic Musical Keyboard

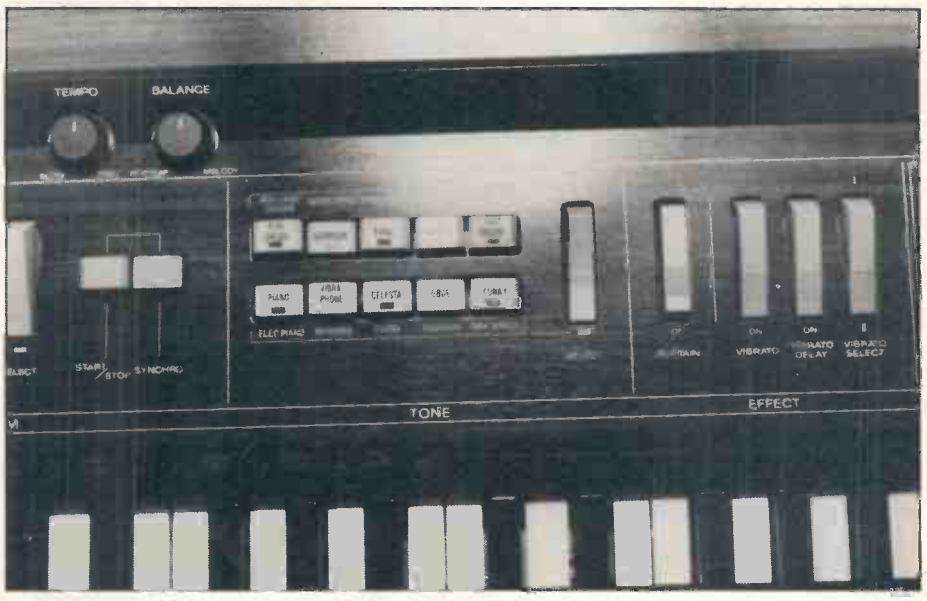
RECORDED ON CASSETTE NO. 5

1st UK Review!

Reading music notation has always been a problem for many people and our Making Notes series should go a long way towards helping the understanding of traditional notation. Another alternative is the Klavarscribo method but, despite the appearance of graphic and simplified stave VDU displays for micro computer music programs, nothing innovative utilising high technology electronics has been offered. Not until the Casiotone 701!

The 701 has two outstanding features — its ability to 'read music' and also to be able to 'program' your own music. Some preparation of the music is in fact required (see photo) and consists of a series of vertical lines of two widths, divided into rows that form three sections. These bar codes hold digital information (very much like the strips on many supermarket goods) for melody pitch/rests, their duration and accompanying chords. They are manually scanned from left to right, starting with the top row and working down the rows in order, which connects at the instrument's rear and looks like a rather fat biro. The music printed on the reverse of the supplied cards (about A4 size) shows the melody and chords names (guitar style), as well as simple instructions for loading the program and suggestions for instrument sounds and rhythm.

The programming capabilities of the instrument let you enter your own melody and chords from the keyboard and both this method and reading with the light pen will synchronise the instrument's rhythms, arpeggios and auto bass to melodies and chords on selection of a rhythm preset.



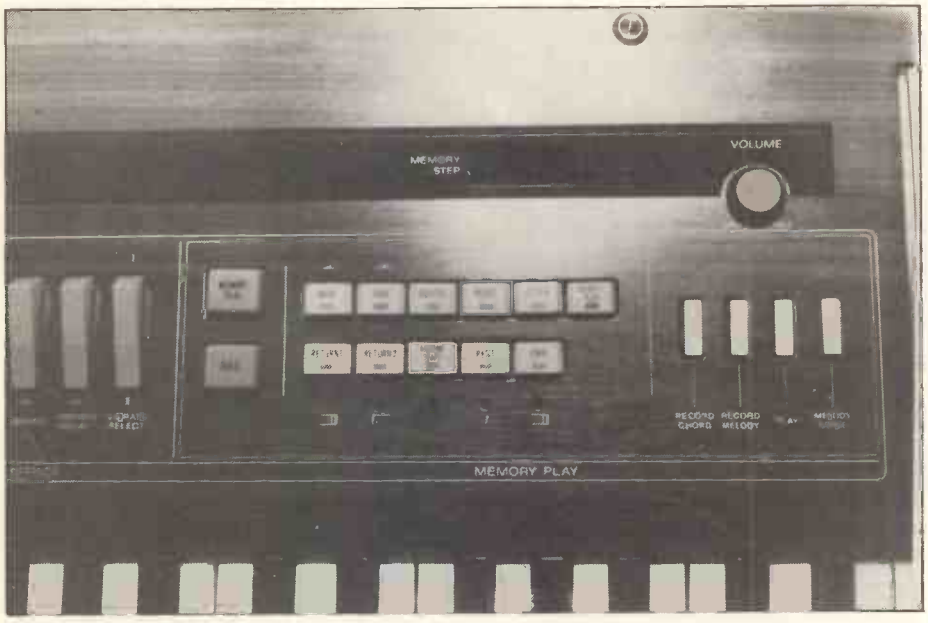
Part of the left hand controls.

Chord Section

The 701 is a polyphonic instrument that has 20 preset sounds and 16 drum rhythms that operate in three modes. In Normal mode, it becomes an eight-note polyphonic instrument over its full five octave keyboard — up to now, Casio have used four octaves maximum. In Figured chord mode, the left hand two octaves play your four-note chords, leaving the three upper octaves for melodies or chords (also up to four notes). Left hand information is constantly scanned by the instrument's digital micro system so that with 'memory' on, the notes played are held on after release of keys. Casiochord is the third mode and provides an auto accompaniment from the rhythm selected and note(s) pressed in the lower two octaves C-B (labelled clearly with red and green LED indicators).

The three most used chords of major, minor and dominant seventh are obtained by playing the correct chord root as the lowest note for major and simply adding any second or second/third note for minor and seventh. Minor 7th, major 7th, diminished and augmented chords are also possible. Once a rhythm is started, the accompaniment chords play in a suitable syncopation to it and a walking bass joins it all up nicely, leaving you to add the melody.

In this section there is choice of an 'octave down' and a useful arpeggio accom-



Memory Play controls.

paniment that runs up and down two octaves of the 'figured' or 'auto' chord. There's also an 'accompaniment tone set' switch that programs the sound for the accompaniment independently from the melody by simply moving the switch on and off. Whatever instrument is selected at the time will be stored leaving you to change to another sound for melody if you wish. Changes can be made frequently during a piece if you are agile enough!

Rhythm Section

A choice of 16 rhythms are available from eight push buttons and a channel select switch, including: Bossa Nova, Samba, Swing 1&2, Disco Rock, March, Boogie, Waltz, Jazz Waltz, Rumba, Beguine, Tango and Mambo. The rhythms are derived from bass drum, side drum, high and low bongoes, clave, hi-hat and cymbals. The bass drum sound has a very short decay that is adequate but lacking in body. The cymbal does sound like filtered White Noise! The rest of the sounds are quite usable. Bearing in mind the big improvement in analogue drum sounds of late, Casio still have some way to go although the variety of rhythms makes them fun to use. 'Start/Stop' and 'Synchro' buttons are provided, the latter starting the rhythm when the left hand is played. An LED shows every beat prior to play and then changes to new bar pulse indication. Two rotary controls set 'Tempo' and 'Balance' of accompaniment with melody. There are two sound effects buttons that can be manually triggered for high and low filtered downward pitch sweeps — giving a 'Star Wars' flavour to your music! In addition there is a 'drum fill' touch plate on the front of the keyboard panel that gives some interesting solo breaks.

Tone and Effects Sections

Twenty preset sounds can be selected here from 10 select buttons and a channel select switch, including: Jazz Organ 1&2, Flute/Piccolo, Tibia/Full Tibia, Diapason/Woodwind, Pipe Organ/Brilliant Organ, Piano/Electric Piano, Vibraphone/Marimba, Celeste/Chime, Oboe/Bassoon, Funky/Wah Brass. I have listed all of the presets because some compromises have obviously been made. First, many of the sounds have a distinct 'organ' tone and this reduces the potential offered by 20 presets. Nevertheless, the organ sounds are quite pleasant, especially jazz organ and pipe organ. Some instruments definitely need more top (which is filtered off quite sharply) — the vibraphone in particular lacks the 'padded stick against the bar' feel. Some are simple octave/filtered variants of their partner e.g. flute/piccolo. Funky and Wah Brass are not anything of the sort and you'll notice Casio's nice string sound is not evident. I do like the flute, piccolo, electric piano, oboe, vibraphone and organs (although the latter lack top mixtures at times). There's plenty to experiment with considering presets are not *the* big feature on the 701.

The basic effects of sustain (about two seconds) and vibrato can be applied to the presets, with fixed delay and two degrees of depth/speed for vibrato to choose from.

Reading Music

So far I have discussed the controls that appear on the first half of the panel from left to right. The second half consists entirely of the programming 'memory play' controls. Entering music with the light pen is as follows. First, the control mode has to be selected. We can either be recording a melody, chord sequence, using melody guide, or be in normal play. This latter mode is required plus 'Memory Play' and 'Memory Store' buttons on. A three-digit display shows 000. The light pen is moved left to right along the coded lines in turn. At the end of a line there is a 'peep' for a correct entry or a low 'pop' for an error, which is also displayed e.g. E03 = error on line three. A correct entry shows P03, indicating pitch entered for line three. The length of notes and rests is entered next e.g. L01 etc. Finally chord sequences, shown as C01 etc. A complete entry gives 000 back on the display.

To playback, the MS (Memory Store) button is released and then the Memory Play button will start, stop or continue the digitally coded music. The 701 then gives a perfect rendering of the chosen music — it's 'Jingle Bells' on the example shown (and played on E&MM Cassette No 5) — with your selected drum pattern (yes, it gets it right for all the presets!), three-note chord and bass line accompaniment plus the melody. Selection of the preset sound for both melody and accompaniment can be changed as already

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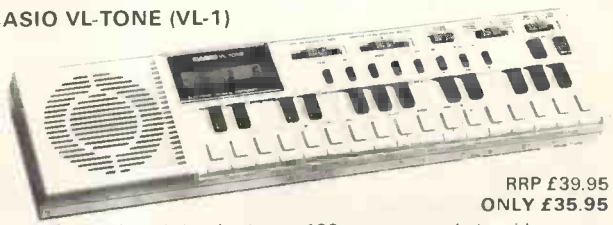
CASIO VL-TONE (VL-1)



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Rear connections.

mentioned. With the rhythm switched off using the 'start/stop' button, you'll hear the melody only and at any time the tempo can be set to play the music faster or slower. In addition, you can play along with the music using up to three notes on the keyboard. As if that was not enough, the LEDs (green for black notes and red for white notes) light up the melody line notes.

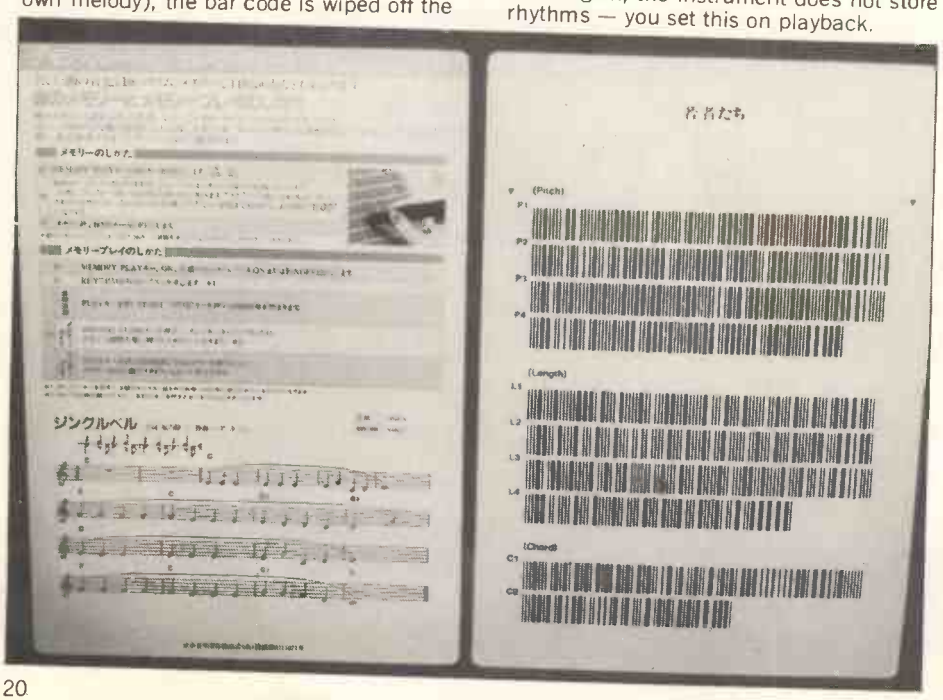
If you wish, you can practice the 'timing' of the stored melody by using two fingers in turn on the dual 'One Key Play' buttons.

Switching to 'Melody Guide' mode gives you the opportunity to learn the melody (with or without the music) by playing the note indicated by the illuminated LED. As soon as you do this, the next note's LED lights and so on.

Recording your Melody

In 'Record Melody' mode (i.e. to play your own melody), the bar code is wiped off the memory with Play, Reset/Delete buttons pressed. Melody notes are then played (speed is not important) whilst the 3-digit display counts the notes (to a maximum of 345). Entry of the correct rhythm is done by pressing Reset and then using the One Key Play buttons until the melody is completed. An editing facility in Record Melody mode once again lets you correct, delete, and insert notes (or rests) using Back, Forward, Delete, and Rest buttons. Incidentally, a note will only last up to six seconds playback no matter how long it is held on record.

Next, in 'Record Chord' mode up to two plays of one chord per bar can be entered in sequence for that piece. The desired chords are played with the left hand in the lower two octaves in Fingered or Autochord mode, whilst one or two taps on the 'One Key Play' button enters the information for each bar. Once again, the instrument does not store rhythms — you set this on playback.



One of the 701 music cards and its bar codes.

Several more features in this section point to the instruments of the future, with one touch button giving programmable Accompaniment Start, Repeat, 1st Time Bar with Return Point, Rests and End. The latter is important otherwise the sequence will finish and the clock will merrily count on to 345, ruining your repeats!

Connections and Extras

High and low output jack sockets are provided for external use, although the built-in speaker gives a good six watts or so. There's a mono phones socket at 8 ohms, footswitch sockets for rhythm start and sustain plus the light pen socket. The instrument is housed in a smart brown veneer case or black metal cabinet with wood end cheeks. Two books of music plus a wire music stand come with the 701 and a library of popular music will become available in due course. The approximate cost will be just under £500 and it is expected to be available from January 1982. A hard case and pedalboard are optional extras, as are the footswitches.

To sum up, the Casiotone 701 is certainly an instrument that opens up home music making for all the family. There's so much playing to be tried on the instrument and, hopefully, all the while you'll be learning to read music and getting to know your chords and harmonies. Note my comments about the presets, although once you start to make music with this machine I doubt whether you'll be bothered!

Mike Beecher **E&MM**

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ELECTRONICS & MUSIC MAKER DEMONSTRATION CASSETTES

Electronics & Music Maker is the first monthly publication to produce its own cassettes that will provide a unique aural complement to the magazine. Produced in our own recording studio, these C60 cassettes will allow you to hear the sound of instruments and electro-musical effects in our features and reviews.

Demo Cassette No. 1 (March/April issues) contains:
1. Matinee Organ. 2. Yamaha SK20 Synthesiser. 3. Guide to Electronic Music Techniques. 4. Sharp MZ-80K music/sound effects. 5. Warren Cann plays Syntom Drum Synthesiser project. 6. Paia 8700 Computer music. 7. Frankfurt Music Fair.

Demo Cassette No. 2 (May/June issues) contains:
1. Tim Souster. 2. Adrian Wagner plays Wasp & Spider. 3. Lowrey MX-1 Organ. 4. Apple Music System. 5. E&MM Word Synthesiser. 6. Fairlight Computer Musical Instrument. 7. Sharp Composer program. 8. Yamaha PS20 keyboard. 9. Vero musical projects. 10. David Vorhaus LP "White Noise" excerpt.

Demo Cassette No. 3 (July/August issues) contains:
1. PPG Wave 2 Synthesiser. 2. Synwave project. 3. Wersi Pianostar played by Hady Wolff. 4. Alphadac 16 music. 5. Atari 400/800 music. 6. Duncan Mackay. 7. Hexadrum project. 8. MTU music. 9. Casio VL-Tone. 10. Irmin Schmidt's Toy Planet LP extracts.

Demo Cassette No. 4 (Sept./Oct./Nov. issues) contains:
1. Linn Drum Computer. 2. E&MM Harmony Generator project. 3. City University music. 4. Casio MT-30. 5. Roland instruments: Jupiter 8, TR808, MC-4, & GR300. 6. Steve Howell piece. 7. 'Ecstasy' LP by Georg Deuter excerpt.

Demo Cassette No. 5 (December/January issue) contains:
1. Teisco SX-400 Synthesiser. 2. Polyphonic ZX81 music. 3. Movement Drum Computer. 4. Study Music 1: Backing Music on synthesisers for you to play solo with of Dec. '1984' music. 5. Casiotone 701 light pen music and presets. 6. Dave Bristow plays Yamaha CS70M. 7. Roland CR8000 excerpt. 8. E&MM Synclock project: control examples. 9. Study Music 2: 'Exit' music minus theme for you to solo with, from Jan. issue. 10. Alpha Syntauri computer music. 11. Elka X-50 Organ. 12. Soundchaser Computer pieces. 13. Richard Mitchell's electronic music for film: examples of commercials, etc. 14. Ian Boddy music.

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The Movement Computer Systems Percussion Computer

RECORDED ON CASSETTE NO. 5

In our September issue Warren Cann, in the course of his review of the Linn LM-1 Drum Computer, took a long hard look at the present situation regarding electronic percussion instruments and discussed possible future developments in this exciting new electro-music field. The problems, though, with this field are primarily commercial ones. Of all musicians, drummers are probably the most conservative and least ready, as a generalisation, to accept innovations resulting from technical advances. You can see their point to some extent. A drum, in essence, is the simplest of all musical instruments — you hit it and it makes a sound! So why start confusing things with all forms of electronic trickery?

To those of us who are, shall we say, more technically minded, electronic percussion is the next obvious step. Drums are large cumbersome beasts that take up a lot of space, have to be miked up individually (not always the case), and are basically one sound devices. With electronics as the drummers' workhorse all this is changed; he can get a far wider variety of sounds, the units are smaller, they cost much the same amount; but as yet they haven't caught on in a big way. Why? Several reasons are put forward, but the prime one seems to be the massive gap between the acoustic world and the electronic. A drummer just needs a kit and he's away; unlike electric keyboard players and to some extent guitarists, all drummers learn on an acoustic kit (there may be the odd exception, but the number is insignificant) so there is an initial hurdle for all electronic drum manufacturers to get over. Also if a drummer is going to go 'electric' he has to invest in some form of amplification, and that's quite a large investment. So drummers aren't rushing to get themselves an electronic kit by the thousands; consequently manufacturers aren't producing vast quantities of these kits.

The drum machine which is player programmed, such as the Linn, the Roland TR 808, and this MCS unit are, however, starting to take off in a big way. This is due, as Warren pointed out, to the rather jaded image people have had of the rhythm unit for the past fifteen years, being swept away by the increasing popularity of electronic music. These machines do so much more than simulate a load of Latin rhythm patterns — they are a whole new breed. But as things are starting small and building up, then so it is possible for a smallish company such as Movement Computer Systems to enter the field and to make a big name for themselves. Certainly with these units constantly appearing on Top of the Pops (backing Depeche Mode), and in the possession of such luminaries as Gary Numan, Jimmy Page, etc, the music industry is certainly aware of MCS.

Player programmable units have become more popular over the past few years because they allow any instrumentalist to compose rhythm tracks to put to their work without having to get hold of a drummer and hire a studio so as not to upset the neighbours. Whereas you have to be a drummer to play an electric kit, anyone can

View of the back panel, showing the comprehensive interface facilities.

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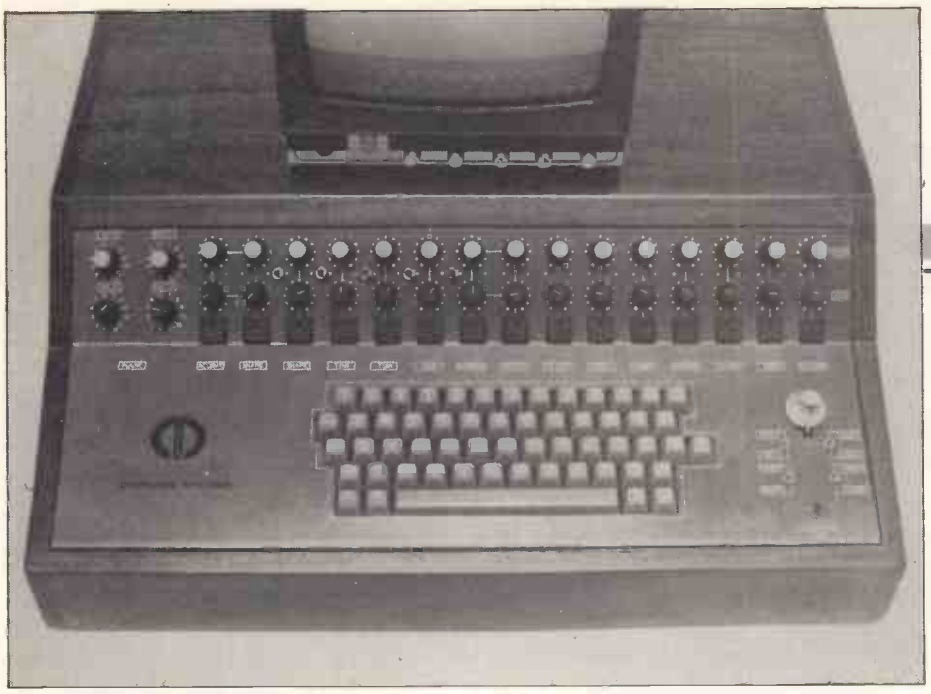

Close-up of the keyboard and controls.

use an instrument such as the Linn or MCS, though drummers do have a distinct advantage in being able to feel what should go where, and how to tell the machine to do it.

Anyway, the MCS Percussion Computer originates from the West Country of England, Bridgewater to be precise, and was designed by Dave Goodway, in conjunction with John Dickenson. Although the Linn unit wasn't actually designed by a drummer it was very much orientated towards the musician rather than the technician, the MCS machine goes the other way more, which isn't necessarily a bad thing. It may seem somewhat more daunting when first considered, but it is basically a simple instrument to operate. Indeed, to look at, the MCS appears much like a microcomputer with a monitor and full alpha numeric keyboard; this isn't altogether surprising as the Percussion Computer is based on the Nascom II and can be used as a microcomputer in its own right. MCS can supply the usual range of business and consumer software that turns the drum machine into a word processor or a games centre, etc. We're going to be considering the rhythmic applications only, though the MCS could come in handy on sessions, issuing an invoice at the end of the percussion track!

Whilst on the subject of money I should point out that the MCS unit will set you back £1,799 plus VAT, and an additional £54 plus VAT if you want a monitor — you will want a monitor if you haven't already got one, because the instrument is almost impossible to operate otherwise. MCS supply a Crofton monitor and all the necessary leads.

So the MCS Percussion Computer is less expensive than the Linn LM-1, but how good is it? Well, once you get over the 'instrument looking like a computer' hurdle it is a very good instrument indeed. There are fourteen percussion channels that could, if the need took you, sound simultaneously. Five channels offer either digitally recorded or synthesised voices, whilst the other nine are all synthetic. This is a good idea because it eliminates the cost of having all that storage memory for voices such as tambourine, claves, etc, and concentrates on getting right the most important sounds — snare, bass drum, and the three tom toms. If requested you can have your own sounds loaded into the computer at the factory, or you can have digital recordings of hi hat or cymbals loaded instead of a couple of the toms. The five channels of digitally recorded voices can also be switched to produce electronic simulations of the relevant sounds, so with an MCS you get the best of both worlds. I must say that the quality of the percussive voices throughout is excellent — I don't know if it was due to the ambience of the room in which I was testing the unit, but it seemed to produce a phenomenonally powerful sound if so programmed.

The digitally recorded sounds each use up 8K of memory, which is all stored on a plug-in board, so changing a sound is a very simple matter. MCS do produce 16K voice cards if requested, but I was surprised how effective the results were from just the 8K, which gives about 400ms of sound with a bandwidth up to 12kHz (which sounds quite sufficient).

The synthesised voices are, like the digitals, housed on separate plug-ins, so they can be swapped around as necessary; in addition there are numerous trimmer pots on each card, so a bit of jiggery-pokery will tailor the voices to your own specific requirements.

I won't delve too deeply into the programming of the unit, as the machine really just takes the player through things step by step. There are ten separate rhythm memory locations, and each rhythm can consist of up to 16 bars of 32 beats thus giving a fairly impressive resolution to the pattern. Each pattern can then be sequenced, or chained, providing a possible composite percussion track of over 300 steps. I think that it would have been nice to have had more than ten available rhythms, but then each one can have a pretty complex internal structure; the MCS can handle almost any serious time signature.

Programming a rhythm is done by telling the machine the number of beats required per bar, and how many bars are required; it will then sound the claves in order to lay down a beat. Simply hitting the relevant voice key at the required moment will register that voice to be sounded at that part of the rhythm, and in this manner the whole 14 channel percussion track is built up — simple.

Each voice has a separate volume and envelope decay control, though for the digitally recorded voices, this control doubles as a clocking rate adjustment, and can therefore be used to tune the drums.

On the rear panel is almost every conceivable interface outlet. There are separate audio outputs for each voice; independent triggers in and out for each voice; a printer interface (RS 232); audio output jacks for left, right and mono; as well as a cassette dump/load DIN socket (1200 baud, giving a load time of around 90 secs) and both monitor and TV video outputs. There really is everything here.

The fact that MCS is a relatively small company is a good thing, because it enables clients to have their instruments tailored to their own requirements, and with an instrument of this nature that's important. In a way, though, I feel that MCS aren't sufficiently convinced of the strength of the market to go fully into the design of a percussion computer. I'm talking here in terms of presentation and ergonomics; it's great that you can run ordinary computer programs on this instrument, but I think that MCS might have won wider acclaim if they'd concentrated on producing just a percussion unit, and designed it accordingly.

It is possible to play the MCS in real time, but it is rather awkward — if they did away with the conventional keyboard and used touch pads that could be tapped, or even hit with a stick, I'm sure that the unit would appeal to a wider market. A strange concept, though, narrowing the performance to attract greater sales; but in this case I think that it would hold true. There are facilities on the back for individually triggering the drums with an external signal, but it would be so much nicer to have the facility easily available on the front panel. This is just my personal opinion, but I'm sure everyone would benefit. Otherwise this is a fine piece of British equipment, well made in the old tradition with ideas that are bang up to date. I suggest that anyone considering a Linn should at least give this one a try out — and give it time, it grows on you.

Dave Crombie **E&MM**

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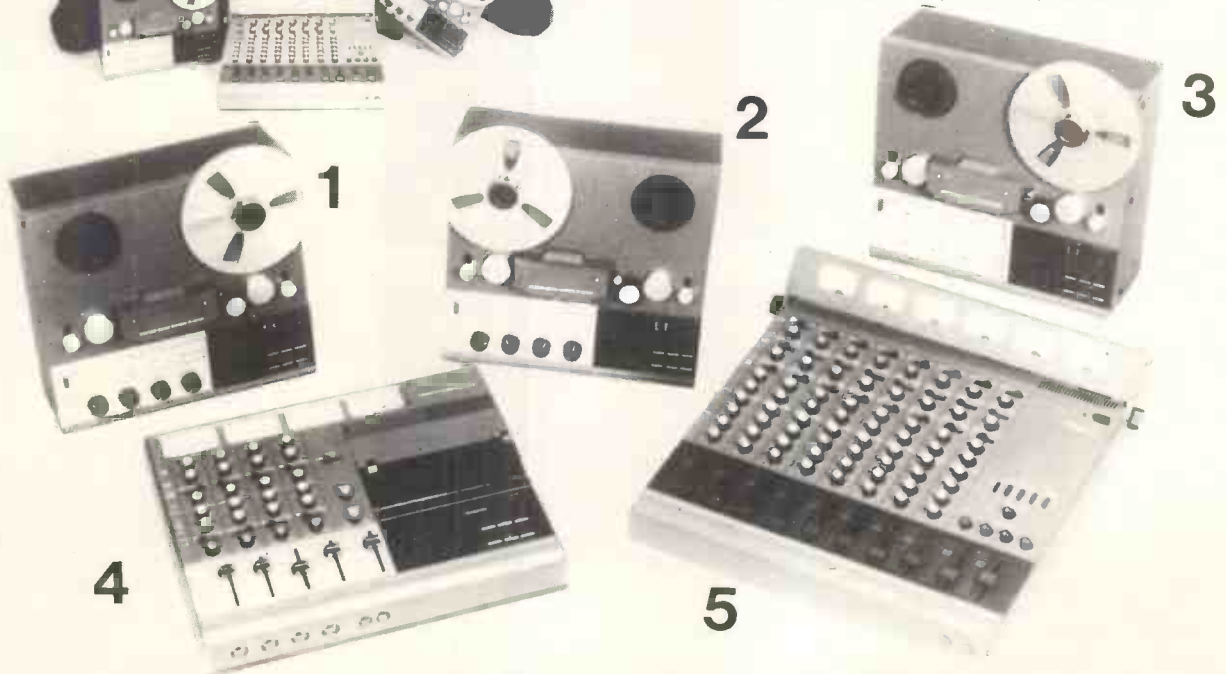

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Soundchaser Computer Music System

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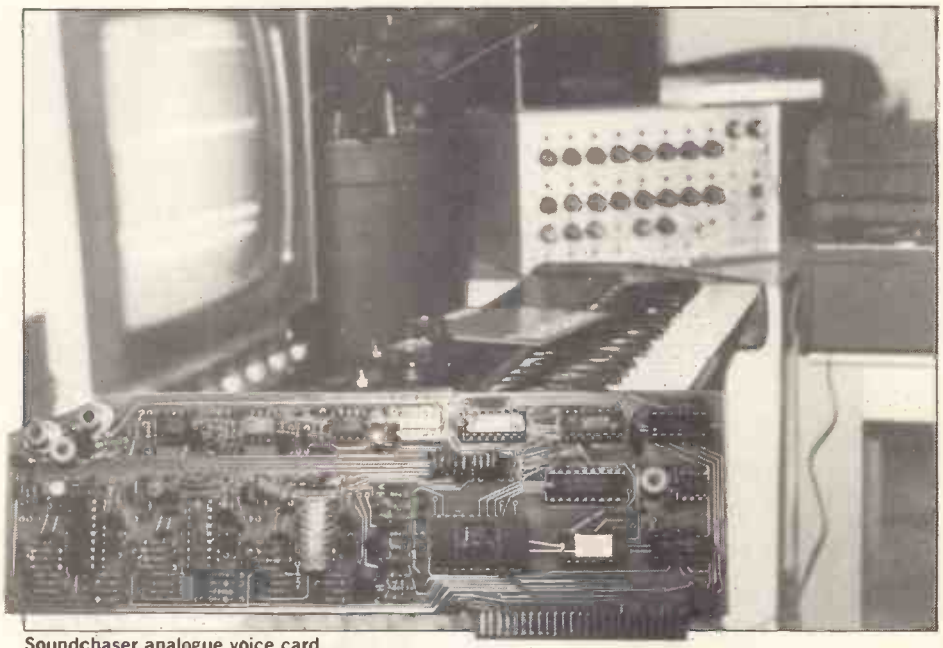
Computer music systems seem to be dividing off pretty cleanly into two camps at present: those that use additional hardware (analogue or digital) for waveform synthesis (e.g. MH MusicSystem, Fairlight CMI, PPG Wave 2, etc.); and those where synthesis is totally software driven with no additional hardware other than a D/A converter (e.g. MTU Instrument Synthesis).

The Soundchaser Computer Music System falls into the first category, but, unlike the majority of its competitors, uses analogue voice cards for synthesis. As a result, the synthesis of the Soundchaser is inherently limited to hardware-fixed waveforms, but what's lost on the swings is gained on the roundabouts, as the analogue voice card approach allows filter sweeps to be easily implemented. Such filter sweeps can also be executed by a system using wholly digital means of synthesis, but this involves multiplying or dividing the contents of a wave-form table before it's directed to the D/A converter, and this takes too much time (100 to 150 microseconds for an 8-bit by 8-bit multiplication) to be really practicable for real-time music synthesis with present-day microprocessors. Perhaps the hundred-times faster Josephson computer will change all that and provide you with a deep, deep-freeze at the same time!

Digital systems therefore opt for the more palatable alternative of switching the D/A converter input between different waveform tables, each of which may correspond to a different harmonic complex, thereby producing dynamic waveform changes or 'timbral sequencing'.

In practice, it's not actually that easy to digitally reproduce the soaring filter sweep so beloved of the present generation of 'futurist' synthesists, even with an instrument like the Fairlight CMI, although, in theory, the sampling of a bog-standard analogue synthesiser doing its VCF thing via a fast A/D converter should provide the instrument with suitable fodder for it to manufacture something pretty close to it.

What this means for digital synthesis systems lacking the sophistication of fast sampling techniques, or multiple waveform table entries for each voice, is that the sounds produced lack the hallmark of a Moog-type VCF that's more-or-less *de rigueur* for pop musicians concerned with imitating each other's sounds and styles. As supply and demand is the name of the game, it makes good sense for a computer music system like the Soundchaser to aim for the best of both worlds by using digital control of largely analogue circuitry.



Soundchaser analogue voice card.

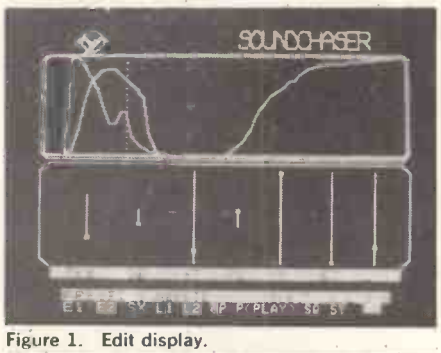


Figure 1. Edit display.

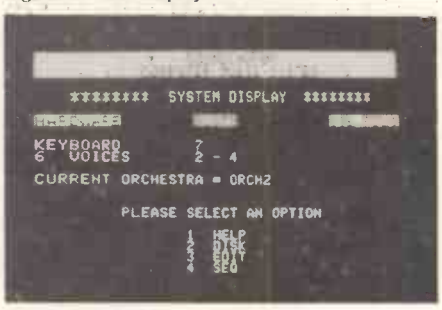


Figure 2. Main menu display.

The System

The Soundchaser is configured around an Apple II with 48K RAM and Applesoft BASIC, a disk drive, and a monochrome monitor. Additional hardware consists of a four-octave keyboard, with the standard type of diode encoder, sending key-down data to 4051 analogue multiplexers on an interface card. This plugs into an expansion connector on the Apple II motherboard along with one or two three-voice cards.

Each voice on the card uses standard chips and circuits for the 24 dB/octave low-pass filter (CEM 3320 VCF) and VCA (LM3080 transconductance op-amp), but, rather than following this traditional analogue approach through with a multi-function VCO like the CEM 3340, Passport Designs have elected to use an Intel 8253 for the purpose of a primary waveform source. The 8253 contains three 16-bit timers (one for each voice) which are used to count down from the 2 MHz Apple Q3 system clock in accordance with a binary number output along the data lines, thereby producing a square wave of a particular frequency. Obviously, the larger the reference frequency and the number of bits being used for counting down, the greater the accuracy of high frequencies. The Soundchaser programmable 'oscillators' perform well in this respect and achieve the value of 6649 Hz for 8th octave G sharp rather than the spot-on equal tempered value of 6645 Hz. The hardware picture is completed by a 'wave shaper' (ramp generator), which turns the 8253 square wave outputs into sawtooth waveforms, and a multiplexed D/A converter for control of the VCFs and VCAs.

The preliminary Music Operating Software comprises two principal programs: EDIT, which allows the musician to preprogram the oscillators, VCFs and VCAs of the voice cards by using an interactive display to enter parameters in the form of 'soft' switches, sliders and contours; and the SEQUENCER, which assigns record or playback modes of four independent multi-event banks holding presets and polyphonic sequence data entered from the four-octave keyboard.

Edit

The Soundchaser EDIT program and display (Figure 1) are accessed via the main menu (Figure 2). EDIT uses conventions of analogue synthesisers in programming the various parameters of the voice card processor chain, but with distinctive features that are both good and bad.

One really powerful feature is the ability to draw four contours on the screen (using

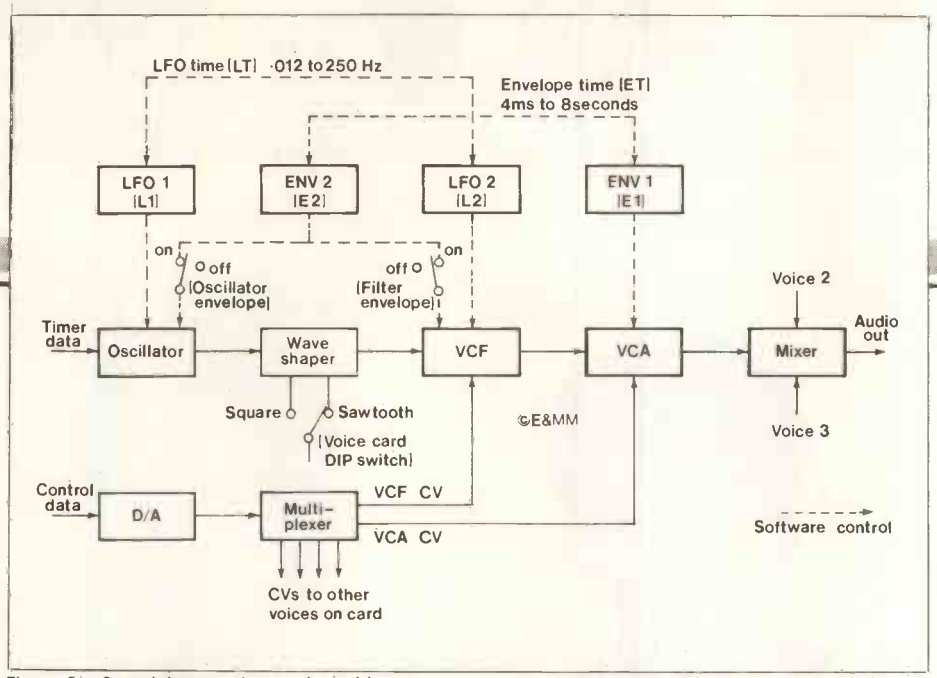


Figure 3. Soundchaser voice card patching.

game controls) and then use these to control the various sections of the voice cards. Figure 3 illustrates the patching options for the modules and the controls that can be assigned to them. As these contours can, in theory, be any size, shape, or form (in fact, Passport advise the user to think of the display as a 'space in which to draw your ideas'), it does open up remarkable possibilities for creating complex sounds.

Whilst it is feasible to draw and use a complex envelope or LFO waveform, the fact that each contour is actually read by software as 64 points, rather than a continuous function, means that such artistic extravagances have a habit of producing choppy sounds. Drawing the sounds is fairly straightforward, but the 'small, blinking cursor', used for locating the contour points on the bottom line of the top half of the display, is very small indeed, which doesn't help matters. Furthermore, changing just one aspect of an envelope (say, the gradient of the attack portion) necessitates re-drawing the entire envelope!

These aren't the only limitations to one's synthetic aspirations. Having drawn in some likely contours, the bottom half of the EDIT display is engaged by entering 'VP' (Voice Panel). This allows the user to set the 'soft' switches and sliders with which to apply the contours to the voice card operation. Once this has been done, 'P' (Play) can be entered and the keyboard actually played.

But where aspirations really fall badly down the hill is in the realisation that all these voice card changes have to be entered in non-real time, so that, unlike a conventional analogue synthesiser, it's impossible to change knob settings or patches (i.e., the 'soft' switches, sliders or contours) as one's playing, a curious deficiency for a synthesiser proclaiming itself to be capable of 'providing a very wide range of sounds and effects unsurpassed by computer synthesisers costing $5000 and up'.

Another point to bear in mind is that each voice is derived from only a single oscillator, with none of the facilities normally used in synthesisers to 'thicken' this sort of voice, such as pulse-width modulation (PWM) or the mixing of the sub-octave and other waveforms to the basic oscillator output. Whilst it's true that a sawtooth waveform is also available, courtesy of the wave shaper, it's only as an either/or option, and that's as a result of fiddling about with a

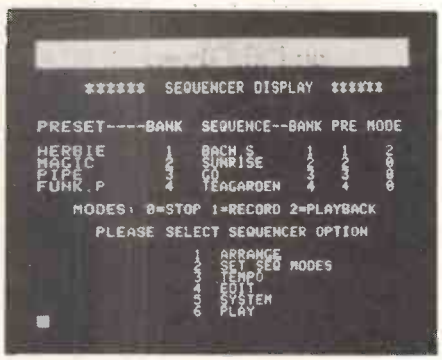


Figure 4. Sequencer display.

DIP switch on the voice cards - inside the Apple - hardly a real-time control!

To be fair, Passport Designs tell me that they do intend implementing some form of real-time control of the voice card parameters in the near future, and also plan to bring out a dual two oscillator/voice card using Curtis chips throughout for VCOs, VCFs and VCAs. This should provide a range of sounds equivalent to those obtained from a processor-controlled synthesiser like the Prophet 5, which also uses Curtis chips. Mind you, I do think it's a little imprudent to launch a system like the Soundchaser with voice cards that are likely to be upgraded in the near future to something nearer the real McCoy - especially when each three-voice card retails for $350 (probably £250 here) - perhaps Passport would consider a trade-in of the old cards for the new?

Sequencer

According to Passport, 'the Sequencer is an extraordinarily flexible and expressive sub-system which expands your role from a performer/programmer to an arranger/conductor'. The SEQUENCER display in Figure 4 shows that four banks of presets (instruments programmed with the EDIT program) and sequences (notes or chords played on the keyboard) are available for arranging (setting a preset to a sequence), mode assignment (record, playback or off), and tempo variation (1 - fastest to 16 - slowest). Though the SEQUENCER will store a fairly long monophonic line if the tempo is slow, Passport are tempting providence by stating that each bank is 'capable of storing 2 to 16 minutes of music', as each of these is limited to only 256 events. This isn't exactly generous by contemporary standards of polyphonic sequencers, but the future is likely to see this extended to something like 16K-worth of storage.

The system allows the keyboard to be played on top of a sequence playback (up to the limit of available notes), and it's also possible to program the real-time playing with a different voice to that of the sequence playback. When playing on top of a sequence the keyboard always takes priority for note assignments, although, if one does try to play with more than one's fair share of notes, strange things start to happen to the sequencer timing, i.e., parts get inexplicably out of sync. Actually, this is the easiest way I've ever found of setting up overlapping loops - it's a shame it's all accidental!

Onwards, Ever Onwards

The basic sound quality is good, even though some quantisation noise creeps in via the timer chips (a further section of the DIP switch applies a 10kHz cut-off to remove this), and the range of synthetic possibilities is considerable owing to the 'etch-a-sketch' contours.

In the States the total system sells for $1350 ($650 for the keyboard and software, $350 for each of the voice cards), but, over here, I don't see much chance of the price being less than £1,000.

The future is likely to see much greater expansion of the Soundchaser's capabilities, with 'professional series software' for teaching, and 'musician series software' offering more advanced musical utilities such as instant recall of presets and layered sequencing. Also, a Music Sketcher offering real-time transcription onto the monitor screen of monophonic lines played on the keyboard, together with subsequent editing of the entered music, is under development and likely to retail for around $100.

Another item that Passport are developing is a software package for running the Mountain Hardware MusicSystem boards from their own keyboard. They hope to sell this for £650, which will put them in direct competition with the Alpha Syntauri system selling for more than double that amount in the States.

Passport Designs obviously have plenty of bright ideas and some considerable programming ingenuity, but these qualities only make it more difficult to understand why the Soundchaser has been released with limitations that can only serve to frustrate musicians being introduced to computer music systems for the first time.

Dr. David Ellis **E&MM**

FACT FILE

Tony Bacon

Thomas Dolby

"I'm more of an inventor, I enjoy original systems of working. I don't regard myself as a player, it makes no difference if I program something or play it. I've never been interested in personal bravado as a keyboard player. Keyboards cover the abstract in my music. If I'm imitating, I'd rather get a player in to play the real instrument."

Keyboards

Roland JP-4; Micromoog (filter range extension mod); Solina string synth; PPG 340/380 wave computer. "The Roland I like because I think assignment of oscillators is important, and you have control over that, as opposed to the Prophet syndrome where you can make it unison and that's about it. The Solina's got a sound of its own and'll cut through anything. The Micro's quick to set up, and I like the pitchbend ribbon more than a wheel — take your finger off and it'll bounce right back.

"Other makers might look at the control on the Micro called 'Filter Modulation By Oscillator' which basically puts the filter into overdrive, a useful effect especially on noise and ring modulation effects, almost like a feedback control. I tend to use studio effects and recording techniques to push my keyboards further. An edit facility is handy: I slightly miss one on the JP-4."

Sequencers

Uses the PPG: "about 20 times the parameters of an analogue synth".

Amplification

Live (most recently with Lene Lovich): Teac Portastudio as mixer and for tape fx; output to amp and speaker set-up. Studio: DI: some amps.

Percussion/drum machines

Simmons SDS-V module + suitcase/seven pads; Boss DR-55 for "basic patterns".

Favourite studio/engineer

Liked John Kongos' Tapestry studio which was "geared to my needs". Marcus 'big' studio/Tim Hunt (tape op). Townhouse/Nick Launay. Battery studio "sounding good".

Home recording

Teac Portastudio; Revox stereo; "I steer clear of being too careful with demos now — I use the Teac to write".

Chris Heaton

"All the greatest music throughout the centuries has appealed to listeners on many levels and is rewarding to people with prior musical knowledge, and to those with no knowledge at all. I work at that in all my music."

Keyboards

Yamaha CS80; grand piano (prefer Bosendorfer or Yamaha); Rhodes Stage 73; Minimoog; Casiotone 202. "The Yamaha for the keyboard touch controls, it's the only polyphonic with that. The Mini is an alternative to the CS80's multiple triggering, and is better as a soloing instrument. The Rhodes is good as a 'gelling' instrument when recording, and the Casio has those high, digital sounds and is good for orchestrating.

"It'd be good if other makers could look at the question of touch sensitivity. I don't see the point in having an eight-voice polyphonic, which they make in the hope that people are going to use all their fingers, when there's no real way of introducing expression. For example, if you use the new Jupiter-8, there's a button that automatically adds vibrato. I find that totally unresponsive and, for me anyway, totally useless. And of course you've got to take one hand off! Any instrument can only be judged by what musicians can express through it, and I think the majority of synths on the market don't live up to that judgement for me."

Amplification

Live: MM 8/2 mixer; Quad 405 power amp "but don't drive it too high"; two cabs each with Gauss 12in. driver; two Piezo horns. Studio: Mainly DI, although "I'm beginning to tire of that and may use some rock amps soon".

FX

On Rhodes, uses a "range of pedals", ending up with Oberheim ring modulator.

Percussion/drum machines

Boss DR-55 for home practice.

Favourite studio/engineer

Utopia/Andy Jackson (now left Utopia to freelance).

Home recording

Two Pioneer cassette decks recorded back and forth via mixer, "but the quality's not too good".

Dave Stewart

"I do everything, I'm not just a keyboard player — but I see the keyboards' role as not being subservient to anything else. I've never subscribed to the theory of keyboards being a kind of 'decoration' . . . I try to use them as the driving force for the whole music."

Keyboards

Prophet-5 rev 2 (second LFO mod); Minimoog; Rhodes Stage 73. "The Prophet I like for the Poly Mod section, which makes it more versatile than the OB-X, and the programming facilities which are good for quick changes; I like its *sound*. The Mini's reliable, very in-tune, great for fat bass-lines, the best basic synth. The Rhodes is pretty weedy in some ways, but I have a personal sound on it — it's incredibly delicate, and it's nice to go to an instrument with some touch sensitivity.

"I'd like to see manufacturers make multiple envelopes available, without a lot of patching. I think a fault of the Prophet and the Mini is that they only have one envelope each for the filter and the volume — it'd be nice to have more than one for subtler sounds. I think the envelope shaping is one of the most important things in synthesis . . . they can add oscillators till they're blue in the face, but they should work on the other side of it. I think, overall, the Fairlight-type instrument will become more available and cheaper."

Amplification

Live: Synths — RSD 12/2 mixer; Roland Space Echo; Amcron amp; two Mega full range cabs. Rhodes — H/H amp; WEM 4 x 12 cab. Studio: All through Roland Chorus/Echo; stereo output to DI.

FX

MXR Distortion on half of Prophet split; Electric Mistress flanger; plus "secret, revolutionary" feedback effect.

Percussion/drum machines

Simmons SDS-V module + suitcase/four pads; Claptrap.

Favourite studio/engineer

Matrix/Nick Bradford.

Home recording

Teac Portastudio; plus stereo bouncing between Akai reel-to-reel and cassette, adding mic input each bounce. Teac mainly for adding vocals to resulting stereo tracks.

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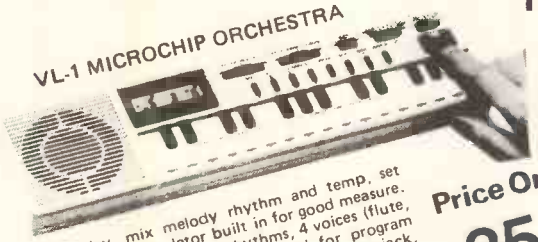

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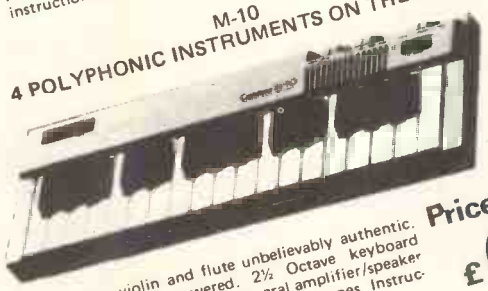

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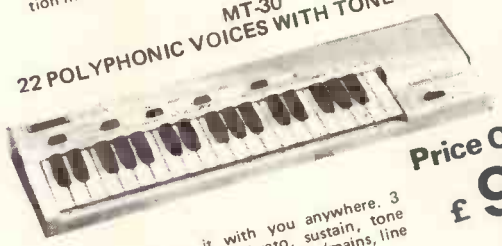

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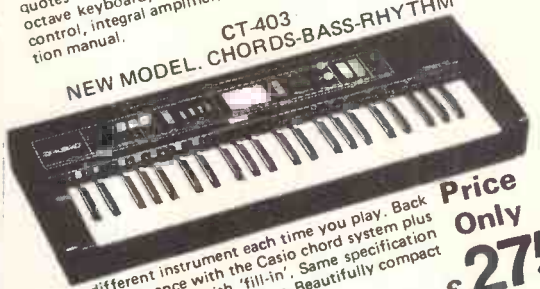

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Beyer Soundstar Mk II and M260 N(C)S

The fare on the menu this month takes us to the Beyer range of microphones. The importers, Beyer UK, have submitted the M400 N(C)S moving coil and given it the more easily remembered name Soundstar Mk II, together with the M260 N(C)S with a ribbon transducer.

Again, like last month, we will look at the models in a variety of situations and use them in company with a couple of other mics to allow the judgement to be relative and not in isolation. The other mics set up beside the Beyers will not be anonymous as far as I'm concerned, and are the EV PL91A from last month's issue and an AKG D330 BT, which should be featured in its own right shortly.

Background

Some background initially — ribbon dynamic transducers are still a Beyer speciality whereas other manufacturers largely seem to ignore this form of transducer. Its use in the M260 is unusual for the genre, in the accepted sense, as it is in a 'stick' mic and has a hyper-cardioid pick-up pattern as opposed to the more usual use of ribbons as figure of eights with a 'flat' stand-up presentation.

Beyer dub hyper-cardioid as super-cardioid. The term refers to a pick-up pattern half way between cardioid (heart shaped) and figure of eight.

The Soundstar Mk II moving coil is also supercardioid and for this there was a data sheet giving lots of details, including typical frequency response and polar patterns. The latter shows a narrowing of the front pick-up at HF. It's the variation of frequency response with angle to the mic which will account for changes in the sound, either off axis or in the total sound in more reflective acoustics. This latter is more likely to be noticed out and about in PA or location recording, as opposed to 'treated' studio situations.

Both mics come supplied with black leatherette 'presentation' cases with foam infill. The Soundstar has an additional slip on foam 'pop' filter and is supplied with a 7.5m cable with a Cannon connector for the mic and a tip and sleeve ¼" jack plug at the recorder/mixer end. The M260 is supplied with a machine run, on axis, frequency response curve. Both have stand adapters of the quick clip in type. On/off switches are fitted with the curiosity of them being operated in opposite directions for on! Must make life difficult for performers! Finally on background — both are the nominal 200 ohm rating requiring connection to input impedances of 1000 ohms or greater.

Beyer M260N(C)S

Beyer Soundstar Mk II (M400)

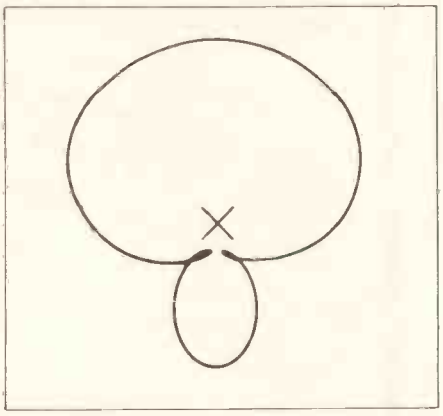


Figure 1. Super-cardioid pick-up pattern.

Performance

It is very difficult to list a set of specific uses for either (or any of the mics lined up). There are differences — the M260 being, as expected, more extended in LF and without the (albeit subtle) upper middle and HF lift of the M400. The latter is more the vocal mic although the literature does not think of it as this exclusively. It certainly gives a clear 'cut through' in this situation. For instrumental pick up both perform very well — again bearing out my adage that good mics always come through. OK, we are not in the crossed pair flat response situation, but the careful tailoring of mics such as the M400 enable clean vocal and instrumental pick up for recording and PA work.

The M260 Ribbon seems to be a little boomy on speech — or more particularly, it allows the room to affect the sound more; and yet on cymbals and guitar there is a HF delicacy — the ribbon sound? The M400 is less prone to proximity bars rise as there is a bass roll-off at normal distances. Also it is 'P' blast protected that bit better, and more so with the add on shield. All as expected as it is intended for vocal usage.

Both have a higher handling noise than I think I am really expecting. This aspect is certainly setting me on the lookout for mics which excel in this respect.

So summarising — mics in this class offer solid, no problem, usage. They will take high levels, and have a decent feel and expectation of reliability which will reward purchasers. Again, a pair of mics thoroughly recommended.

Mike Skeet **E&MM**

Both mics are available from Beyer Dynamic Microphones, 1 Clair Road, Haywards Heath, Sussex.

Aria TS-400

When this guitar arrived at E&MM's penthouse office suite, one of the girls played a trick on me. (Shame on you; you know who you are!) "My brother's just bought this guitar," she said, looking innocent, "could you check it out before I send it on to him?"

"That's a coincidence," I thought, falling for it fret, string and plectrum, "I'm supposed to be reviewing an Aria guitar later on this month. This one will give me an idea of what they're like."

Several minute's happy strumming later, I reported that the guitar was fine, but how on earth could her brother afford a guitar like that? I include this story not to destroy my credibility as a non-gullible guitar reviewer, but to illustrate three important points. I had put this guitar in the £300-£400 bracket; instead, for £224.60 including VAT you not only get a guitar that looks good, sounds good and plays well, but also a plush lined, fitted case and even a curly jack to jack lead! We are definitely talking about value for money here.

Secondly, Gigsville (Aria's importers) are fast movers. The guitar arrived long before I expected it would, which doesn't guarantee such fast service for everyone but is at least indicative of good organisation down there in Heston.

In the three years they have been importing Mr Arai's guitars — spot the anagram — Gigsville have gained an enviable reputation for thoroughly looking over every guitar before sending it out. While the TS-400 didn't leap out of the case into my arms and start playing itself, it didn't take long for me to get used to it. As it happens, the bridge was slightly out when I checked the intonation, but I hadn't noticed this whilst playing and the setting up was exemplary in every other respect.

In case you were wondering, the letters TS stand for Thor Sound, a designation that isn't explained in Gigsville's literature. If it means that a god-like being with a hammer appears at your concerts and threatens the audience to make them clap in time and sing along with the choruses, then I for one want no part of it. Actually I suspect it's a reference to the guitar's sound, which tends to be weighty and powerful rather than cutting or incisive, but more of that later.

Appearances

First of all, this is a good looking guitar; it isn't obviously based on any well known American designs, but Aria haven't had to resort to odd angles and sharp bits that stick into the player in order to be original.

Instead, the body is comfortably contoured and well balanced, and the cutaways allow ample access to the top frets. The fingerboard is rosewood, which I find much warmer and more pleasant to play than squeaky clean lacquered maple, and there are 24 frets.

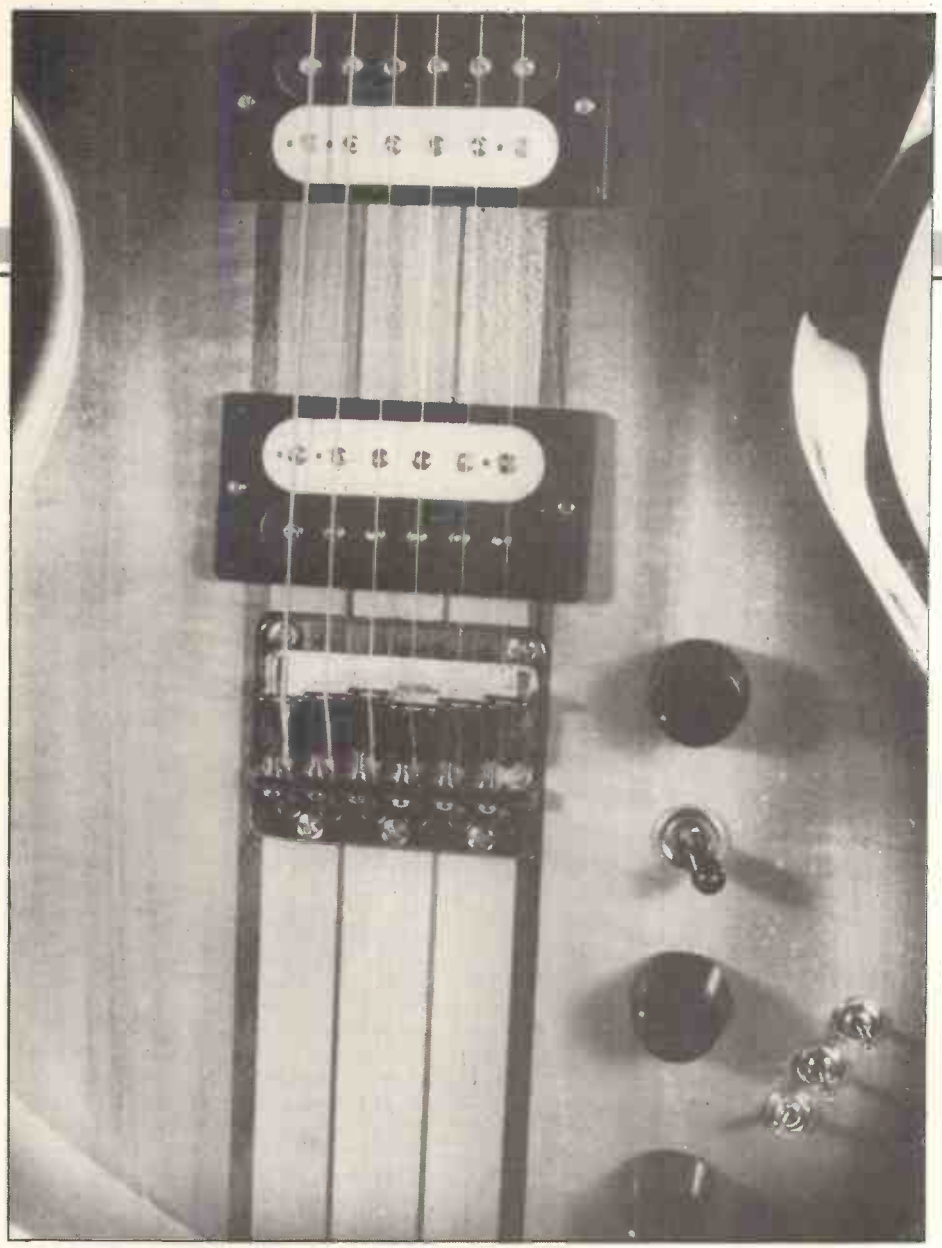
Twenty-four fret necks are becoming more and more popular nowadays, a move which I approve of; you're not going to use that top E in every song, of course, but it's handy to have it there when you need it. The guitar is finished in an attractive brown sunburst which I would have called violin finish, but Aria modestly describe as Japan brown. Walnut and metallic blue are available as options; if the latter is the same finish as used on the Gerry Cott model, I don't want to see one without a stronger pair of sunglasses being provided.

Don't be fooled by the maple and walnut stripes; this guitar has a glued on neck, a good move in view of the scarcity of suitably long pieces of wood. If you would prefer a real neck through body construction, rather than 'go faster' stripes, the top of the range TS-600 will oblige. This guitar also sports an ebony fingerboard, and an active preamp and tone control built in.

Hardware

As many guitarists are now aware, mass is a great aid to sustain, especially in the bridge area. There are many other factors, of course, but Aria have made a step in the right direction with a rather interesting bridge construction; they have avoided brass nuts and other tomfoolery in favour of making the bridge as heavy as possible, and joined to the body as well as possible. Many electric guitar bridges are still thin bits of metal screwed on to the body; Aria's is a hefty chunk which is actually inset into the wood.

Another feature of this bridge is that it has two distinct ways of anchoring the string ends; either by keyhole slots, or by passing the strings through holes in the back of the body. The slots are handy for quick re-stringing on stage, and also enable the re-use of old strings with curly ends in an emergency. The other advantage of having two anchoring methods is that it enables the player to alter the feel of the strings to suit his



or her preferences; passing the strings through from the back lengthens them and subtly alters the whole character of the guitar.

The scale length is long, a little over 25½", and the strings supplied were quite lightweight, ranging in gauge from 0.046" to 0.009". The guitar arrived with the strings in the slots, and like this, was ideal for string bending and other metallic guitar heoics; alternatively the light action would make it easy to pound out barre chords all night without getting cramp in your forefinger.

Unfortunately, I wasn't able to restring the guitar with the same strings since their curly ends wouldn't go through the holes in the back, and I wasn't about to buy a new set of strings just to experiment with. From my experience, a longer string length stiffens things up in quite a different way from using a heavier gauge set of strings; the only way to find out if you like this is to try it out when you fit new strings. In general, stiffer strings are good for fingerstyle and for very fast playing since they don't flop about so much under your fingers.

Back to the bridge; there are six string saddles, one for each string, and each individually adjustable for intonation and height. Intonation (string length) adjustment is by cross-point head screws, while string height (action) is adjusted with a small Allen key which is supplied by the thoughtful Aria people. They also give you a bigger Allen key to fit the truss rod, which isn't such a good idea; indiscriminate truss rod adjustment can damage your neck. Beware!

The machine heads all worked smoothly, the nut was accurately cut and didn't stick, and there wasn't a single sharp fret end anywhere on the fingerboard; ten out of ten for the mechanics of this guitar.

Controls and Circuitry

There are three knobs and four switches on the guitar's lower bout. Master volume and the pick-up selector are in just the right place and work well; no problems there. The only advantage I can see in having two tone controls, however, is in being able to predetermine a different setting for each pick-up used separately; when both pick-ups are on, there is total interaction, and both tone controls do the same job.

One of the small toggle switches puts the pick-ups out of phase when both are on together, and gives the familiar 'hollow' sound; the other two give parallel or series connection of the coils in each pick-up. As is common with these dual sound arrangements, parallel connection tends to sound more strangled than a coil tap, but has the advantage of being hum cancelling while still giving some treble increase.

As I've already suggested, treble is the one thing this guitar lacks, although it's easily put back with the amplifier controls; maybe the active circuitry of the TS-600 is better in this respect. The sound is smooth rather than cutting, although the pick-ups are really quite powerful; I measured 10 volts peak to peak output when playing loudly.

I was able to obtain a good acoustic strumming sound, and a creditable jazz sound. The appearance of the TS-400 is such that it won't look out of place playing such music, unless you get the bluer than blue version of course; and then you add a bit of overdriven amplifier distortion, its whole character changes. The sound becomes warm and thick, ideal for heavy metal and similar assaults on the senses; if you want to be a little more creative, the guitar is responsive enough to follow where you lead.

Before we leave the controls, the knobs are quite a surprise; they look just like black plastic — it's only when you touch them that you realise they are in fact metal! An example of the inscrutable Japanese sense of humour, perhaps?

The lead supplied with the instrument is fine, and has dismantlable plugs fitted rather than the moulded on sort, which makes it easier to repair if necessary. The jack socket is on the side of the guitar where you can't see it — black mark for that — although it does have a neat recessed surround to keep plug marks in the wood to a minimum. When you come to plug the lead in, however, a slight slip-up becomes apparent; it's normal to put the right angled plug into the guitar, but because of the recess you can't do this. To summarise, then, the only fault with the electrics is that the right angled plug has to go at the amplifier end . . . If any of you use those effects boxes which dangle off the guitar itself (and usually drop out of the socket in the middle of your ace solo) they won't fit either, which can only be a good thing in my opinion.

There are four guitars in the Thor Sound range, from the previously mentioned TS-600 down to the TS-300 which has a bolt-on neck and a phase switch only; no dual sound. The TS-500 is a mixture of the 400 and 600, as you might expect; it is basically a TS-400 with the addition of active circuitry, and may be worth considering if you have a little more money to spend.

The main features of the TS-400 are value for money and attention to detail; if I call it characterless, that is meant as a compliment. Distinctive, exciting guitars soon become a nuisance when you want to deviate from what they do best; with the Aria, it's easy to forget the guitar is there and just concentrate on the music. After all, that's what it's all about isn't it?

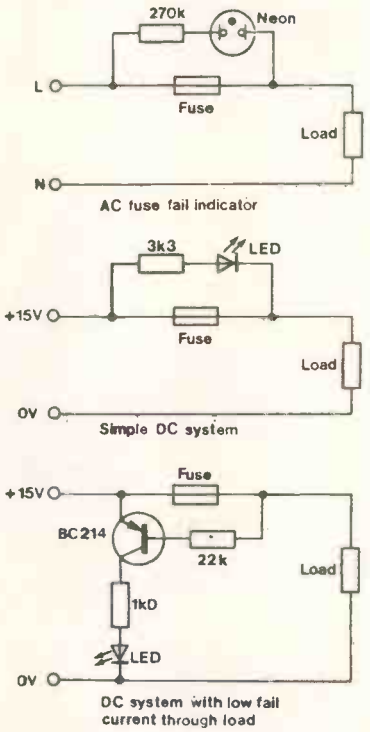
Peter Maydew **E&MM**

CIRCUIT MAKER

Fuse failure indication

The failure of a fuse either as a result of a fault or simple ageing and over-heating can be quite alarming because the piece of equipment in question usually stops working with no indication as to why. It is thus useful to arrange for some form of indicator to light when a fuse fails. The simplest indicator is for mains when a neon (together with a 270K resistor if not built into the neon) is strapped across the fuse. Obviously when the fuse blows the voltage at the load end drops and the neon lights. The small leakage current through the neon will be of little consequence to the following circuit, even in the event of a major fault. Failures in DC circuits can be a little more tricky depending on the nature of the following circuits. If a current of say 5mA is acceptable, even in event of fuse failure, a LED may be connected across the fuse in the same way as the neon. The polarity of the LED should be altered if the fuse is in a negative supply line. If even low current is not acceptable a transistor must be used to drive the LED. A PNP type for a positive rail system can be connected across the fuse with the base connected to the load side. A LED and suitable resistor are added to the collector. If the fuse fails the base voltage falls, switching on the transistor and causing the LED to light.

While on the subject of failures, the usefulness of connecting a small neon across the mains supply as soon as it enters a piece of equipment should not be underestimated. Such a neon will give immediate indication as to the state of the mains supply



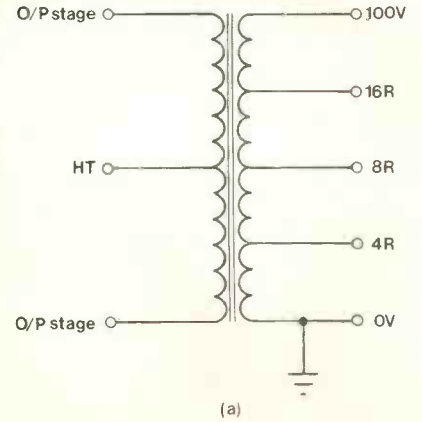
thus saving valuable time if the fault is in the mains lead, as it often is. Such miniature neons are cheap to buy and easy to fit. They also provide an added reminder when servicing that mains is supplied even though the equipment is switched off — something that it is all too easily forgotten.

Valve amp transformer repair

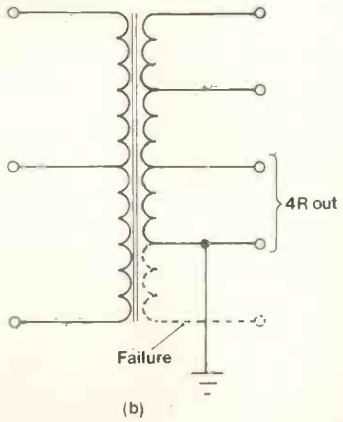
One of the most common failures of valve amplifiers (apart from valves and capacitors) occurs when the output matching transformer ceases to match. Under certain conditions of failure it is possible to give the amp a new lease of life by a simple re-wiring job on the transformer in question.

Most transformers have several taps to enable a wide variety of speaker impedances to be matched. These are arranged as shown in (a). If the coil between 0 volts and 4 ohms fails (usually) the output may be re-wired as (b) making use of another 4 ohm impedance winding on the transformer.

Having said this it is worth noting that this coil may be wound with lighter guage wire than the original windings, and will thus be more prone to fail if the amp is run at full power for an extended period. Note also that it is important to ensure that the original winding is not shorted to earth at the point of failure (in which case it must be disconnected) or that the failure did not cause several turns to be shorted together, which would result in large eddy currents flowing within the transformer, giving rise to overheating, and loss of efficiency.



(a)



(b)

Pseudo phaser

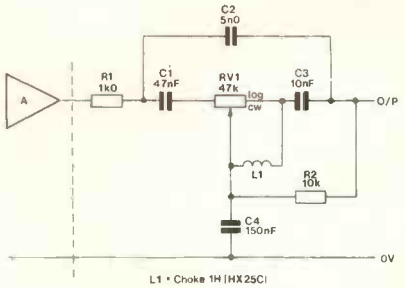
Dave Rogers-Walton

Tone stops allow the electronic organ player to select from different fixed filters whilst playing and so are really a type of performance control. There is no reason why a similar facility should not be added to the more usual performance controls (e.g. pitch bend) found on synthesisers. What is needed is some form of one-knob, complex tone control which, unlike standard tone circuits, should be able to shift the balance within the important mid-band as well as at the extremes, so varying the whole character of the sound. The circuit shown does exactly this. It has also been found to have a useful effect at the output of guitar overdrive circuits.

RV1 simultaneously alters the time constants of several high and low-pass signal paths which are then remixed at the output. One of the results of this is the formation of a notch which varies in centre frequency as well as depth, depending on the setting of RV1. L1 forms resonant circuits with the capacitors over most of RV1s range but is effectively faded out of circuit towards either end, thus adding another variable element to the frequency response contouring.

Used with a reasonably bright audio input, the perceived loudness is then similar for all settings, so a small turn of this single control can be used to obtain a distinct change in timbre without having to readjust the volume, while a back and forth rotation *during* a sound gives an effect like a manually swept one-notch phaser. A by-pass switch is not needed since with RV1 fully anticlockwise, the tonal response is almost identical to a 'straight through' path.

For best results this circuit must: (1) feed into an impedance of 47k or over, for example, a non inverting op-amp, which if given a gain of x5 will also more than make up for the insertion loss of the passive circuit. (2) be driven from a low impedance stage, designated 'A' in the diagram. This may already exist within a piece of equipment (emitter follower, op-amp, etc) in which case the present circuit can simply be added on passively. If the available output impedance is more than a few hundred ohms, however, a simple buffer stage should be included.



Tempo-Check

There comes a time in every musician's life when it's helpful to know the tempo of a particular piece of music. This could be the tempo of a solo in a concerto, the speed of a track on a demo tape, or whatever, but, until recently, there hasn't been a means of estimating this other than by using what could be called a successive approximation technique with a metronome, i.e., fiddling with it until the clicks just about fit. The Tempo-Check produced by Pulse Designs, a British firm, enables this to be measured with ease and offers a lot more to boot. Measuring 6¾" x 2½" x 2", the sensible wedge shape of the Tempo-Check makes it very stable in those situations where other units would merrily bounce on to the floor. It's perhaps not surprising to find a microprocessor responsible for its activities, but it is rare to find quite so much flexibility in such a compact package.

To start with, the unit offers a chromatic octave (middle C to B) of tuning pitches (referenced to A = 440 Hz), the output being of square wave variety and heard through either the built-in speaker or via an earphone socket. The transparent main control is used to select the pitch and this value is also displayed on the large three-digit LED display in the middle of the Tempo-Check. Some tuners on the market provide chromatic pitches in different octaves and allow for very precise null adjustment of the tuning via a mike input. I've never actually found it necessary to reject my ears in favour of a beat-detecting machine, and so I found it utterly straightforward to tune both a 6-string guitar and a 46-string harp from the 12 pitches of the Tempo-Check. Automation isn't always the answer — especially when tuning such obtuse things as harps which require you to slightly sharpen notes at the top end and flatten those at the bottom!

Measuring tempi is merely a matter of sliding a switch from 'pitch' to 'beats', pressing the red 'tempo' button in time with the music, and reading the display a short time later. Tempo indication is obviously not instantaneous as the processor needs at least two points with which to calculate a time interval, but, in practice, the delay is inconsequential unless the tempo you're measuring is itself fluctuating — in which case you've got problems!

I managed to register tempi from 5 to 500 beats per minute, so it should do the trick for any piece of music you care to tap into its Design Centre-selected case.

On first switching on, the metronome side of the unit ticks away in a thoroughly familiar manner with the main control selecting tempi ranging from 40 (grave) to 200 (presto) and displaying the same on the LED display. At this point, one also notes three LEDs ('downbeat', 'beat 1' and 'beat 2') above the main display flashing in synchrony. The really interesting things start happening when you press the 'beat 1' and 'beat 2' buttons. Pressing 'beat 1' and at the same time adjusting the main control results in the number of beats per bar being indicated on the display. Releasing the button results in the resumption of beating but with the red LED indicating the downbeat and the yellow LED the beats per bar. The 'beat 2' button can then be used to program in sub-divisions of the beats per bar in the same way as for 'beat 1' and the green LED then joins in the metronomic fun of the other two. As well as visually and audibly indicating sub-divided beats, the Tempo-Check also makes it child's play to enter cross rhythms, ranging from straightforward things like 3 against 4 to such physical and mental demoralisers as 11 against 12. Each of the three beat indications has a slight difference in pitch, and, furthermore, the balance of the three sounds can be varied according to the volume setting. I've used the earphone output of the Tempo-Check to provide a click-track on some recent recording sessions and I'm pleased to report that it really works extremely well.

A definite plus point of the Tempo-Check is that it uses rechargeable Nicad batteries rather than requiring you to be perpetually replacing batteries in a unit that accidentally got left switched-on. Would that more manufacturers adopted a similar policy with effects units!

Whereas the pocket-sized Tempo-Check is designed and priced (around £55) for the musician on the move, their other version, the Tempo-Check TCS 120, is a 19" rack mounting unit with a rather more solid price (£270 + VAT). This is intended for studio applications and includes a number of extra facilities in addition to those offered by the cheaper model. Tempo measurement and tuning follows the previous plan of action, but an optional tuning input card enables the TCS 120 to be used both as a tuning reference and as a tuning meter with the tuning error shown on the left hand digit of the display as a series of dashes.

On the metronome side of the TCS 120, the unit offers tempi references of frames per beat (for TV and film work) as well as the usual beats per minute. An instant start control (triggerable from a variety of sources) and multiple pulse and timing controls make the unit very easy to interface with sequencers, synthesisers, and so on. Instead of the rather boring click characteristic of the other Tempo-Check and electronic metronomes in general, the TCS 120 provides a much more interesting high-pitched drum sound. In addition, separate downbeat, crotchet, triplet and quaver outputs can be blended together with front panel controls to give musicians a rather more lively click-track foldback that's also easier to follow.

An excellent unit, the TCS 120, but I'm perfectly happy with the poor man's version. So, 'bye for now — I'm off to practice playing 11 against 12!

David Ellis **E&MM**

The TCS120. **The Tempo-Check.**

T.C. Electronic Effects Boxes

The T.C. Electronic Effects units.

Power Supply

To replace an endless array of PP3 batteries TC Electronics have produced a Power Supply unit, measuring 100 x 60 x 30mm. Finished in matt black with white lettering to compliment their range of effects units, the PSU has four nine volt @ 20mA outputs. Each output has its own 3.5mm jack socket and is fully regulated and short circuit proof. Mains, 240VAC @ 1.6W, is connected via two metres of cable terminated with a 2-pin plug. (A shaver adaptor socket will be required here.) Power on indication is shown by a red LED. The LED extinguishes if any of the four outputs are short circuited and the supply delivers 9.25V at 30mA, well regulated and with low noise. As most effects units require only a few milliamps to work, the supply is obviously generous in its rating, but then one may expect this for a price of £30.30 including VAT.

Integrated Preamp

This unit comes in a die cast aluminium box measuring, once again, 110 x 60 x 30mm; obviously a standard size container used throughout the range. Finished in matt black with a white legend, the controls cover bass and treble boost and cut with an output volume control. Signal input and output are standard 0.25" jack sockets. Power comes from either an internal battery or from a 3.5mm external power socket. Requirements are 9V @ 0.89mA and with this low current, battery life expectancy should be long. The usual output socket doubling up as a switch is incorporated, so that removal of the output jack lead turns off the pre-amp. Measurements taken at 1kHz showed an input sensitivity of 250mV RMS for an output of 1.75V RMS just at the onset of clipping. The pre-amp, adjusted for flat response, has an overall gain of seven from 60Hz to 18kHz, the -3dB points being at 18Hz and 20kHz.

The treble control peaks at 5kHz with boost and cut up to seven times the input level available. The bass control peaks at 60Hz with boost and cut being slightly less; up to four times input level. Both controls offer reasonable control of tone quality, especially for a guitar, as they lie within the most usable range of the instrument. However, the volume control has an effect on the output signal only and not on the input signal level. This allows the pre-amp to be easily overdriven by high output guitars or other effects units and this should be considered when the unit is in use. Background hum and hiss levels were extremely low and no colouration of signals was evident, making the unit pleasant to use even with a price tag of £39.20 inc VAT.

TC VII Emphasible Peak Phaser

Quite a mouthful for a simple device. Again, this effect unit is housed in the standard black and white box. Ins and outs are via 0.25" jack sockets, and external power supply input via a 3.5mm jack. Two controls adjust speed (phasing rate) and peak, or range of phase. A bypass foot switch, for straight signal or effect, is mounted on the box. The switch action is virtually silent, unlike most foot operated switches, and is still mechanical in operation — but electronically actuated. Quite a noticeable difference.

Phasing speed is variable from 0.06Hz up to 10Hz. As the speed is increased, the phase depth decreases, which is usually only a problem with 'cheap' phasers using simple integrator oscillators and all-pass filtering. The peak control alters the depth or degree of phase change during each sweep.

An external potentiometer can be used to alter speed and maximum speed is at the end with minimum resistance. External bypass requires a break action (normally made) switch for control of effect in or out. Current drain is about 2.5mA, low enough to ensure good battery life from the internally mounted PP3.

In use, the phaser gives an effect more like a VCF or auto-wah with bandpass characteristics; the effect lessens with increase in signal frequency, and requires a source rich in harmonics for full appreciation. Although quite a nice result is obtainable I was unable to find a true resemblance to phasing. When the effect is switched in, the sweep ramp always starts at the same point instead of anywhere along the sweep cycle. Quite a novel addition and useful for keyboard players. Finally, calibration of speed control starts from 0.1 to 10 in seven stages and does not match with the true oscillator rate. The same goes for the peak control, calibrated in seven stages from 0 to 6 'somethings'! So, useful as an effect of some sort, but definitely not as a phaser costing £79.30.

Dual Parametric Equaliser

The by now familiar 120 x 90 x 30mm black die cast case, with white legend, shrouds a very interesting signal processing unit. For those unfamiliar with parametric equalisation, conventional broad bandwidth bass, mid and treble controls (eg. Baxandall) offer boost and cut with a gentle 6dB per octave slope. Graphic equalisers offer up to 14dB, usually, of boost and cut with a separate control for each octave (or down to one-third octave) and have a usable bandwidth of 50Hz to 10kHz. The slope characteristic is usually from 6 to 12dB per octave.

This TC dual parametric equaliser has two centre frequency controls, one covering the range 20Hz to 2kHz and the other 100Hz to 10kHz. Together they offer individual control of lower and upper harmonics and dual control of the mid frequencies. Basically, two bandpass filters are used, the centre frequency selected can either be boosted to +16dB or cut to -16dB (measured +16 and -18dB) and the bandwidth control selects either a broad 1 octave band, down to a very narrow 0.1 ($\frac{1}{10}$ octave) band or notch. Particular frequencies can then be precisely enhanced or removed with very little effect on the rest of the music.

The unit also acts as a pre-amp. With all controls set to unity (flat response) the bandwidth measured 15Hz to 70kHz -3dB. A special treble control is fitted, which can be used to boost or cut up to 18dB of signal at 10kHz, and the overall gain is adjustable ±12dB @ 1kHz. Actually, most of these specification figures came out well above on measurement tests and were most impressive. A small slide switch is fitted, which bypasses the equalising circuitry, but leaves in the input and output buffer pre-amps. The high input (1M) and low output (600R) impedance, therefore, remain unaffected.

The internal PP3 battery supply is very low current and is replaceable with a 3.5mm jack external power socket. Supply switching is via the signal input jack, and output comes from a standard jack socket.

In use, I found the unit extremely versatile, from removing mains hum and acoustic feedback to enhancing the tonal qualities of my guitar. Noise, hiss and hum levels were extremely low, as one comes to expect with TC products, and at £65 this is good value for such an impressive parametric system.

Booster + Line Driver & Distortion

Generally, distortion units have been well exploited, and just about everyone either owns or makes them (or both). For those unacquainted, distortion is usually achieved by driving a pre-amp stage into clipping and then applying boost or cut to the upper harmonics to mellow the effect or sharpen it. Unfortunately, high gain input stages mean that all signals, including hum and noise etc. are amplified, producing a lot of noise in the absence of an input signal.

The booster-distortion unit under test has two separate modes of operation. Firstly, as a boost pre-amp with volume, bass and treble controls; and secondly, as a distortion driver producing soft clipping, with depth control from normal boost to maximum distortion.

The two effects are switched in and out of circuit with a foot operated bypass switch. The effect mode is selected with a slide switch and a noise suppressor control protrudes through the front panel. The electronics are housed in a (dare I repeat?) 120 x 90 x 30mm die-cast case, finished in matt black with white lettering. There are standard jack sockets for signal input (also controlling supply on/off) and signal outputs. 3.5mm jacks cater for an external power supply and external bypass switch.

I must mention the electronic switching. The foot switch (bypass) is very light in operation and electronically selects the effect in or out of circuit. The switch appears to work as a latching flip-flop toggle, making external switching simple and not dependent on the internal switch. A miniature red LED comes on for about 10 secs, indicating that the effect has been selected.

With boost effect selected, the unit acts as a pre-amp with a flat 20Hz to 18kHz response. Bass and treble boost of ±18dB @ 60Hz and 8kHz respectively is available and an input of 70mV RMS produces an output of 2.25V RMS @ 1kHz.

A noise suppressor ensures that any input signals below 5mV in amplitude, are not amplified and the threshold control is adjusted so that output noise signals are at a minimum. This 'noise gate' effects the dynamic range of instrument signals, but can be adjusted for minimum interference and is a useful addition.

In the distortion mode, the usual clipping of the signal waveform is apparent and upper or lower harmonics can be processed using the bass and treble controls. Used in conjunction with the distortion depth control, quite nice soft clipping effects can be produced and background noise and mush is just not there. A line output Cannon plug is fitted for remote mixer/PA applications making £77 worth of electronics nicely presented, and effective.

TC XII and XII B/K Programmable Phaser

I found this unit similar in effect to the emphasible peak phaser and have to admit that I am not sold on the effect created. Phasing, generally, is produced by changing the degree of phase shift between all pass filters, and a 'notch' is generated after every 360° of phase change. The more filter stages available, the more notches are produced at 720°, 1440°, 2880° etc known as a 'comb' response. Similar effects are created using delay line devices which have an added bonus of echo or reverb depth added to the phasing. The filters are swept or voltage controlled using a slow oscillator, producing the familiar 'phasing' effect, sounding much like a passing prop plane on a hot summers' day.

This unit has a speed control, varying the phasing rate from 0.06Hz to 10Hz, and sweeping the filters with a triangle wave form. The total number of filters (or notches) are selected with a three position toggle switch connecting 4, 8 or 12 filters into circuit, and the function control varies the phasing intensity from 'peak' through 'linear' to 'notch'. The effect of this control is to produce a normal phasing effect in the 'Linear' position, with decreased filter response producing a shallower phase towards the 'notch' position, and increased filter response producing a deeper, richer phase towards the 'peak' position. The 'Q' of the filter can thus be varied for best effect.

The sweep width is varied with the width control, which increases the upper and lower sweep limits when turned from 0 to 6. The working range of the phase effect can be shifted up or down, using the colour coded jack plugs provided, when inserted into the 'program' jack socket. The blue jack shifts the phasing range up above normal, and the red jack shifts the range down. A volume (or swell) pedal could also be used for manual (pedal?) control of sweep when connected to this socket.

Standard input and output jack sockets are fitted, with supply switching on the input jack. A 3.5mm external power supply jack allows a low noise PSU to be connected, or an internal PP3 can be used to drive the phaser which has low current requirements. The usual silent bypass switching is fitted and can be integral, with a foot switch, or external via a 3.5mm jack. Used either way, a miniature red LED lights up for five seconds, indicating that the effect has been selected.

All electronics are housed in a 120 x 90 x 30mm die cast case, finished in matt black with a white legend and looking thoroughly presentable.

Sound effects from very deep phasing and close to flanging can be set up, also a useful slow to fast rotor/vibrato simulation. The TCXII B/K is intended for bass guitar and keyboard use and has an extended frequency response and slightly different phasing characteristics. Both units are priced at £96 (inc VAT).

Dave Goodman **E&MM**

T.C. Electronic Effects are distributed by Gigsville, Phoenix Way, Heston, Middlesex. Tel: 01-897 3792.

A HISTORY OF ELECTRONIC MUSIC

Derek Pierce

As we have seen in the previous issue, by 1930 virtually all the prerequisites for the realisation of electronic music had been satisfied. However, although useful at first, the wire-recorder and the phonograph were soon superceded by the arrival of the tape recorder in 1935. Known as the 'Magnetophone', this first tape recorder allowed much greater 'sonorous transformation'. For instance it was now possible to alternate between various sound sources by splicing together pieces of tape. One other technique was also to prove very accommodating — the ability to overdub. These and variations in speed during playback and/or recording opened up a whole new world of sound and compositional possibilities. At this time, film-making was also to become more creative in its use of sound. Film-makers began to use sound effects and electronic music in their films. Amongst them a Mexican, Carlos Chavez, advocated the synthesis of all art forms via film. He saw the potential of using elaborate mixing desks, as well as dubbing, and filtering, for the production of film sound-track.

By 1939 his and other experiments had reached New York and Hollywood. At that time a Canadian film-maker living in New York, Norman McLaren, developed a form of optical sound-track by drawing or scratching on to the film. This was further developed by the Whitney Brothers, but because they wanted to retain the synchronisation between sound and image they were forced to work at slow speeds. However, in order to avoid sub-audible frequencies on playback, they speeded up the film. This speeding up changed the timbral qualities of the sound. A technique used much later by Stockhausen in the work 'Kontakte'(1).

Following the appearance of the tape recorder, primitive synthesisers began to appear. The most significant of these were built by Percy Grainger and Burnett Cross.

Later a collaboration between Grainger, Cross, and fellow American J. M. Hanert, produced a synthesiser which employed eight oscillators that could be accurately synchronised. Hanert's synthesiser used punchcards, as opposed to the paper rolls of the earlier machines. From this time onward, at least until the 1970s, America was to the fore in developing the synthesiser for commercial use.

Of course, all these technological developments were inevitably to have an effect on the realisation of new music. And in 1944 a broadcasting engineer working for RTF in Paris — Pierre Schaffer — was the first person to present a concert of sound effects and everyday noises composed entirely for magnetic tape. This new music was to be called 'Musique Concrète'. A year later he was to establish the first centre for tape composition with a young French composer, Pierre Henry.

At first they treated familiar sounds such as voice, trains, wind, piano and later amplified sounds, including creaking doors, sighs, etc. Pierre Schaffer's first composition was a concert of locomotive sounds entitled 'Etude aux Chemin de Fer'. It was, in fact, little more than sounds usually associated with trains or to use the parlance of painters, a study in 'traininess'. Although a modest little piece, it occupies a special place in musical history. It was significant on several accounts. First, the act of musical composition was accomplished by a technological means. Second, it could be played repeatedly in precisely the same manner. Third, its playing was not reliant on a human performer; and fourth, the basic elements were 'concrete' (not ephemeral) and thus required a different mode of listening from that employed in perceiving abstract music.

Within the next five years, 'Musique Concrète' was to attract musicians of the stature of Messiaen, Milhaud, Boulez and Stockhausen.

Some of the more important pieces to emerge during this period include 'Vocalise' by Pierre Henry, Messiaen's 'Timbres — Durées', and Boulez's 'Etudes I and II sur un son'. Listening closely to 'Vocalise' we are able to hear some of the tape manipulations available. For instance the variation of speed, both of recording and playback was very popular with Henry, and indeed 'Vocalise' begins with a clear pronunciation of the syllable 'Ah'. It is then transformed by replaying the tape at a higher speed. It then sounds like chirping birds. When it is slowed down, it resembles the roar of lions. By splicing both these and other effects, Henry was able to give the piece rhythm. This together with overdubbing also enabled him to vary the texture between one and several voices. Although only 2½ minutes long, its use of minimal sound sources would have been inconceivable without the use of the tape recorder, and it thus established the tape recorder as a compositional tool.(2)

The voice was a popular sound source, and a little later (1958) Luciano Berio employed part of the text of James Joyce's 'Ulysses' in his piece 'Thema'. Berio's use of this text was prompted by the sonorous nature of the text itself. It makes use of such onomatopoeiac(3) words as hiss, smack, and trilling. Having begun with an unaltered statement of the basic material, it is then altered over a period of six minutes by various tape manipulations and filtering.

All the pieces mentioned so far were realised at RTF Paris. During the early 50s, however, other studios were set up, usually by radio stations, and they all encouraged composers to use their facilities. Of these new studios the Columbia studio, later to merge with the Rockerfeller-financed Princeton University studio, became very well known. Founded by composers Vladimir Ussachevsky and Otto Luening in 1952, it has been used by composers from over twenty countries. The first works to emerge were realised using the piano as a sole sound source. The most important of these was probably 'Sonic Contours'. The piano is modified in the usual ways and also by the simultaneous mixing of sounds, thus retaining the fidelity which was often lost during overdubbing. Ussachevsky presented this and other pieces at a concert in New York on May 9th 1952.

Otto Luening also played some pieces at the same concert, including 'Fantasy in Space', a piece built upon a simple melody played on the flute; it features echo and reverberation derived from multiple head tape decks. Its similarity to Ussachevsky's pieces led not surprisingly to their collaboration on a piece entitled 'Incantation'.

The results of these collaborations, as

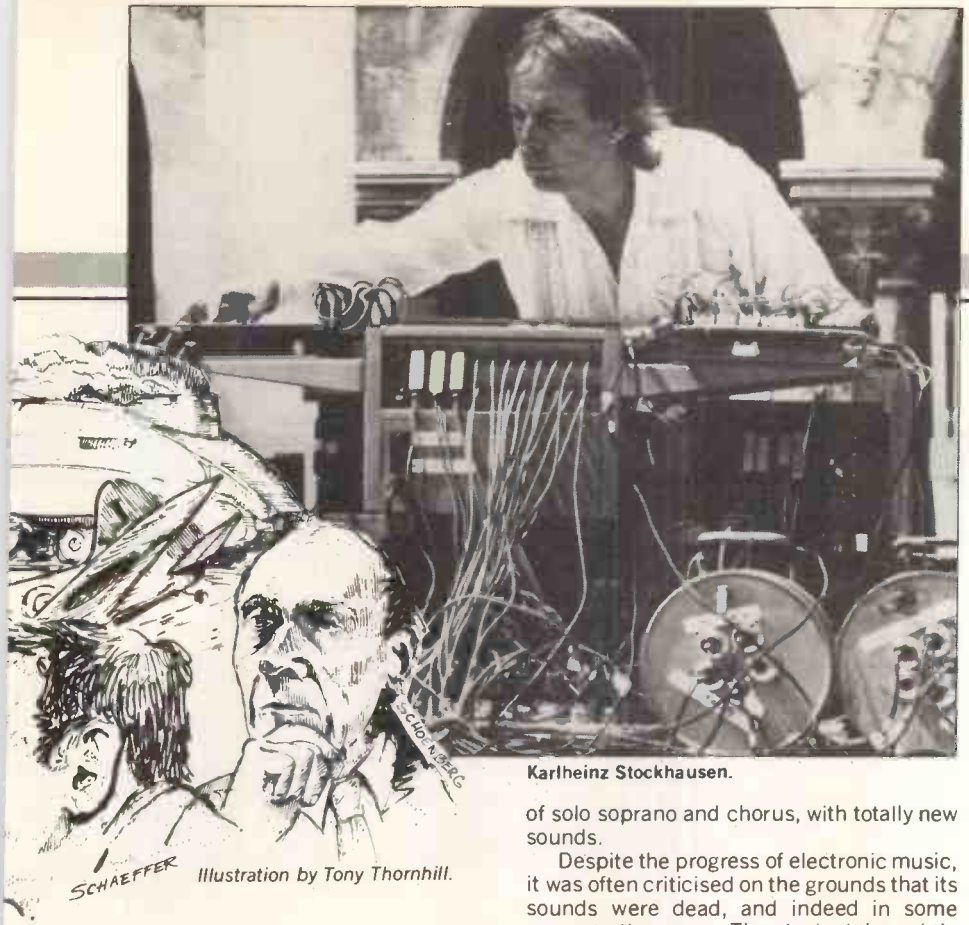


Illustration by Tony Thornhill.

Karlheinz Stockhausen.

well as the works of other composers, influenced many German researchers and musicians, who tackled the possibilities of further exploration with typical Teutonic thoroughness. A collaboration between Werner Meyer-Eppler, Robert Beyer and the composer Herbert Eimert was broadcast in October 1951. It featured the 'Sound-world of music created on a *melochord*'. After encouraging reviews they decided to establish the Cologne studio. It was originally directed by Eimert, and later Karl-Heinz Stockhausen.

Although most of the composers who used the studio were followers of the Schoenberg-Webern tone row approach to composition, Stockhausen and his colleagues were more concerned with creating *pure* electronic music than transforming existing sounds. Stockhausen thus looked forward to the synthesis of any sound from pure frequencies. He first attempted this in his 'Studie I' (1953). It failed to some degree, but later (1955-6) he used both electronically generated sounds plus that of a boy's voice in his 'Gesang der Jünglinge'(4). This was much more successful and effected a fusion between opposed extremes — i.e. natural and synthesised sound. By using several banks of speakers he was able to move the sounds around in space (an idea later used by Boulez in his 'Poesie pour pouvoir' for electronic sounds and spirally disposed orchestra).

Meanwhile, in America, Varèse — who had been pressing for various electronic means of producing sound — received his first tape recorder, and by 1954 realised 'Desèrts' for tape and orchestra. It was not until much later, he was in fact in his seventies, that he created one of the masterpieces of music on tape. This piece, 'Poeme Electronique'(5), was commissioned by Philips for their pavilion at the 1958 Brussels Exhibition. It was played via a multi-speaker set up in a building designed by Le Corbusier. The piece combines the sounds of solo soprano and chorus, with totally new sounds.

Despite the progress of electronic music, it was often criticised on the grounds that its sounds were dead, and indeed in some respects they were. They lacked the subtle changes which always take place when a performer is involved — i.e. variations in pitch, tone, rhythm and tempo. This criticism was often countered or pre-empted by the use of a live element in the music. The total organisation and the ability to precisely define complex sounds needed to be countered by some outside influence. Composers needed to get away from, on the one hand the inflexibility of serial composition, and on the other the free play of the imagination which could so easily lead to incoherence.

The answer was 'Chance' music — or 'aleatory music'. One man's influence played a large part in the use of 'Chance'. His name was John Cage. He defined 'Chance' as 'a choice between defined parameters'. His association with New York visual artists Jackson Pollock and Alexander Calder led to what Earle Brown was later to call 'the creative function of *non-control*' — in other words 'indeterminacy at the level of form' — a good example of this being Earle Brown's 'Twenty-five Pages'. Twenty-five sheets of musical material are arranged in any order by the player or players, giving 'chance' within defined parameters. The piece is then performed as read.

Cage later expanded the idea further, so that he was not aware of the outcome himself. His Variations series (1958-1968) shows this attitude. Its notation is extremely enigmatic, or else non-existent. When combined with film, television images and lighting etc. they were, in fact, the forerunners of 'mixed media' happenings, popular in the late sixties and early seventies, particularly in America and Germany.

This use of chance in music is, of course, destroyed once a piece is committed to tape or disc. Various ways around this have been suggested — for instance instructions with regard to altering the listening level, balance, tone controls, have been issued with records. One other way around this was to construct the music in such a way that there is too much to perceive in one listening, and this perception changes with the individual's mood. The listening experience itself then becomes aleatory. Many pieces of music exploited this 'aural illusion', none more so than the music of Steve Reich. Its extremely repetitive nature simulates 'false' perceptions analagous to those produced by the paintings of Bridget Riley. The mind is mesmerized by repetition and small motifs leap out of the music with a distinctness quite unrelated to their acoustic importance. Stockhausen also used this technique in his later works, including 'Stimmung' (Tuning 1968). Possibly the most widely known composer to use this fascinating, if not maddening, technique is Terry Riley, particularly in his 'In C'(6).

The use of chance and/or repetition did much to make electronic music more listenable. The techniques of tape manipulation, together with the use of chance and repetition, however, were probably surpassed by the development of one instrument — the *Synthesiser*.

In 1955 RCA demonstrated the Olson-Belar Sound Synthesiser. It was capable of imitating existing instruments, as well as previously unheard of sounds. Its subsequent purchase by Princeton University enabled Otto Luening to collaborate with Belar to produce his 'Synthesis for Orchestra and Electronic Sound'(7). In 1959 the RCA Synthesiser Mk II was installed at the Columbia-Princeton Electronic Music Centre. This Mk II version was developed with the help of Professor Milton Babbitt. Its sound sources included saw-tooth and white noise generators, as well as inputs for microphones, tape recorders, etc. Some of the available modification devices included amplitude modulator, filters, 16 mixing amps, glissandi controls, and various resonators.

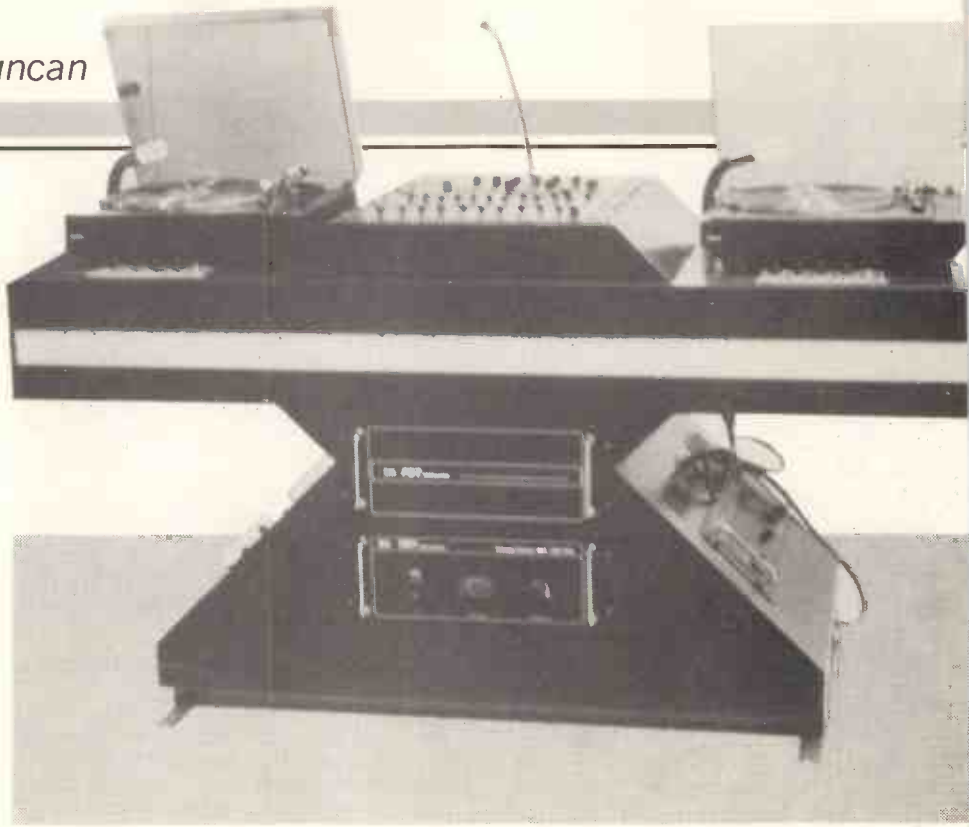
The design of the synthesiser dictated to some degree the character of the music produced, and Babbitt's melodic and rhythmic motifs could be easily obtained on the Mk II instrument.

We will see the importance of the synthesiser in the forthcoming parts of this series, and also look at some earlier works for synthesiser. **E&MM**

(1) Kontakte: D.GG 138811.
(2) Vocalise: Pierre Henry. DUC-9.
(3) Onomatopoeia: Words which sound like that which they describe.
(4) Song of the Youths: D.GG 138811.
(5) Poeme Electronique: Col. Ms 6146.
(6) Terry Riley 'In C': Recorded on CBS 61237. This was reviewed in E&MM August 1981 with another work 'Shri Camel' (CBS 73929).

DISCO TEK

Ben Duncan



Monitoring

The console's monitoring circuitry is first and foremost a means of cueing in discs and line sources by ear; nevertheless, it's helpful when signals go amiss to be able to extend the monitoring facility to other areas in the console, this scheme being akin to the metering facilities. There are three ways of interfacing the monitor amplifier, depending on the style of switching which suits you and the degree of flexibility you require.

In Figure 1, a single rotary switch is used. This is a simple and compact arrangement, but it isn't really suited to the rapid A-B comparison of sources at opposing ends of the switch. Additionally, if two or more sources are available simultaneously, it's necessary to carefully count the switch clicks or peer at the panel legend to be sure you're hearing the signal you require! The series circuit in Figure 2 solves this niggle by making use of discrete SPDT switches; note that the switches towards the bottom (on this diagram) have priority.

Mounting can be in a line — with enough space for large paws(!) — or the switches may be spread around the panel, being sited adjacent to their associated faders or EQ controls. In this case, the priority of the switches in relation to their function must be arranged thoughtfully; otherwise the desperate operator may be unable to hear 'disc A' because another, obscurely sited switch in the series with priority over 'disc A', has been inadvertently switched on. This underscores the expedience of choosing switches which boldly display their status, e.g. toggles, illuminated push buttons or lever switches.

In Figure 3, the problems of serial switching are overcome by enabling each source via an independent SPST switch, their outputs being summed. Thus any combination of sources may be monitored in rapid succession, A-B'd — or even heard mixed together.

Although they call for differing degrees of dexterity and attention from the DJ, the three switching techniques have but one aim — to enable the show to run smoothly, and the choice should accord with whichever method will enable you to do this best. At the same time, the switches used for cueing will be amongst the most used in the console, so be sure to invest in reliable switches with the right 'feel'; this is not the place for 'agricultural' switchgear!

Figure 1. Monitor source selection by rotary switch.

Amplification

Figure 3 also shows the general arrangement for the remainder of the monitoring circuitry. If the only supply rails available are ± 15V, then the TDA 2030 IC power amplifier is a simple and cheap general purpose choice for driving headphones. Attention should be paid to the powering arrangements, however, for whilst most 'cans' will usually be driven to 500mW at most, peak currents circa 200mA may be drawn from ±15V rails; apart from reviewing the power supply capacity, careful routing of the amplifier's supply cables — in particular the 0V rail — will be necessary to avoid oscillatory misbehaviour from the preceding small signal stages.

Referring again to Figure 3, and noting that small DC offsets considered innocuous to loudspeakers can be effective headphone assassins, C1 and C2 are wired back to back to protect the phones from DC offsets to either polarity, whilst R1 prevents a build up of charge, which would otherwise cause the headphones to 'thump' when plugged in. R2 limits the potential 10 watts or so of output power to a value roughly equal to the capacity of the 'cans'; although apparently messy, this technique is simpler and cheaper than designing and debugging a precisely tailored discrete stage. At the same time, ten watts can terminally damage both ear drums and headphone drivers, so be wary of being unduly generous when selecting R2's value!

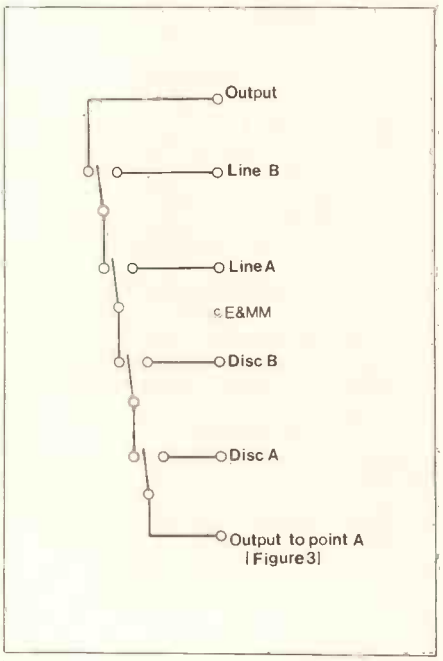
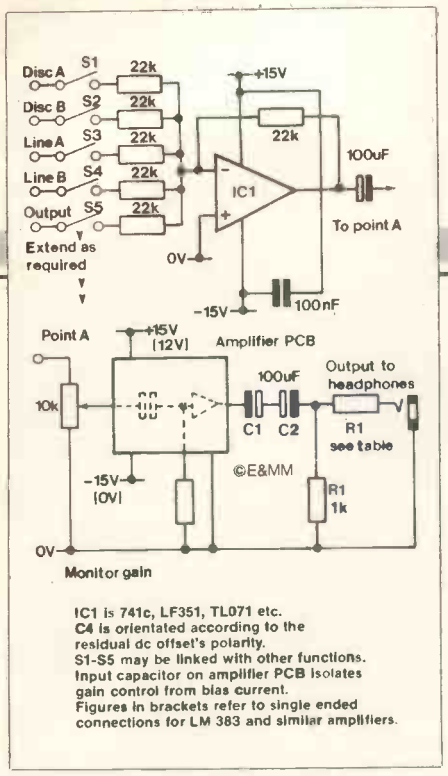


Figure 2. Serial switching with priority from the right, using discrete switches.

Some consoles feature a single high current 12V auxiliary rail for powering switches, relays and the like. Being apart from the critical small signal audio rails, it's an ideal power source for a monitor amplifier. In this case, IC power amplifiers intended for single rail operation are most suitable, e.g. the TBA810S or better, the LM383/TDA2002. Being single ended, an output isolating capacitor will be required to partner these amplifiers as a matter of course, and since this component is invariably provided for on the PCB, C1 and C2 may be omitted.



IC1 is 741c, LF351, TL071 etc.
C4 is orientated according to the residual dc offset's polarity.
S1-S5 may be linked with other functions.
Input capacitor on amplifier PCB isolates gain control from bias current.
Figures in brackets refer to single ended connections for LM 383 and similar amplifiers.

Figure 3. Summed monitor sources and headphone amplifier circuitry.

The sound pressure battle

When in proximity to particularly high power speaker stacks busily displacing the air with heavy metal bedlam, the DJ is frequently unable to hear the more subtle aspects of the record he's intent on cueing up. Indeed, such sonic assault can render the intuitive approach to choosing the next record very dicey. Apart from investing in headphones featuring good insulation against ambient sound, signal processing may also be called in to play. As the ear is most sensitive in the midrange, a simple means of making the monitor output 'cut through' is to remove high and low frequencies with an equaliser, and then boost the resulting midrange-ridden signal.

This stratagem is somewhat similar to that adopted for stage monitoring about a decade ago, and the unpleasant and damaging results of listening to telephone quality music for several hours at levels of 110dBA+ are by now well known; ask Roger Daltrey or Pete Townshend! In short, unbalanced 'middy' sound rips the ears and the temporary threshold shift it causes is indicative of potential hearing damage. Thus telephone quality monitoring, whilst effective, should be restricted only to occasions where short bursts are all that's necessary to cue-up.

A more elaborate alternative, better suited to those who regard headphones as clothing is to compress the signal. Compression will bring the subtle and quiet sections of the record into prominence and permit higher average monitoring levels with less risk of driving both the monitor amplifier and your ears into prolonged clipping. At the same time, it pays to be aware of the ability of compressors to convert music into Musak, such that judging the impact of the energy and dynamics in an unfamiliar piece may be impossible.

Headphones

Although a cheap pair of headphones costing only £10 can provide acceptable sound quality, and discotheque monitoring doesn't call for high fidelity results, the right choice is more subtle, being governed by other parameters; principally physical robustness, reliability, the cable pattern, acoustic isolation properties and comfort.

Suitable disco headphones must withstand being thrown to the floor and then trampled on. Their cable anchoring must be superb, and the driver compartments must be readily accessible so that cable or driver failures and intermittent connections can be made good, or at least verified. A 'no tangle' cable pattern simply demands that the cable enters at one side of the headset only; the trendy 'Y' pattern cables can all too easily become a vexatious embroilment when you desire to tear the cans from your head.

Equally annoying is straight cable, the length of which alters in inverse proportion to your distance from the console: here, a number of strategically placed hooks along the underside of the console stand lip can sometimes be usefully employed to guide a long cable out of the entanglement zone. The elegant alternative — curly cable — is often feared because of the tendency for internal fractures to occur spuriously in the 'curlies' fitted to low cost oriental 'phones. This fear is strictly irrational, and you need only spare a moment's thought for the tens of millions of British Telecom curlies which survive the daily abuse meted out to them. Lamentably, standard British Telecom curlies are a trifle too short for our application, but reliable three metre curlies are readily available from most electronic component suppliers, without the need to explain to a GPO engineer why your telephone lacks a cable!

Acoustic isolation is at best a compromise. Unless you're prepared to part with several hundred pounds in exchange for a pair of helicopter pilot's cans that will squeeze like a mousetrap and distort the finer features of your visage accordingly, then the 20 to 25dB of isolation available from a well padded pair of headphones will have to suffice. Many manufacturers fail to specify the isolation parameter in their brochures, in which case it's advisable to insist on testing the goods; hunky padding doesn't necessarily indicate good isolation.

In return for greater comfort, lightweight 'phones offer greatly reduced isolation, typically 10dB in the midrange, and little if any at low frequencies; thus higher sound pressure levels (SPLs) will be called for to achieve equivalent audibility, and aching in the temples and ear lobes is simply exchanged for the psychological fatigue of high SPLs.

The options of headphone ownership are broadly twofold. A cheap oriental pair with an amenable balance between acoustic isolation and comfort will give good service provided they're treated with due respect. Moreover, you will probably be able to afford a spare pair as a backup, in which case the suspect reliability of low cost 'phones needn't be a deterrent. Hands up those of us who've arrived at a gig to discover that the cans are still back at home plugged into the Hi-Fi?(!). If you frequently indulge in this frustrating habit, the value of carrying a second pair in the 'disco kit' is self evident!

Alternatively one can invest in a pair of high quality, yet robust cans which can be 'shared' with the domestic Hi-Fi or used for sundry other electro-musical pursuits. The Beyer DT 100, 202 and 480 are highly recommended here; indeed, these rugged models are virtual music industry standards in the UK. Beyer also produce a single earpiece version of the DT 100 — the DT 102 — especially for discotheque applications. Finally, a simple task that begs attention regardless of the headphones you've chosen is the ruthless pruning of the ubiquitous moulded/hard plastic plugs, these being replaced with a high quality metal-bodied connector. **E&MM**

Headphone Impedance	Power from 100mW	±15V rails 1000mW	Power from 100mW	±12V rail 1000mW
4 ohms	56R	12R	22R	3R9
8 ohms	68R	15R	27R	3R9
16	100R	18R	39R	NIL
100	150R	**	33R	**
400	180R	**	**	**
600	120R	**	**	**

**Quoted power not available: Omit R2
All resistors are 1 watt carbon film.

Table 1. R2 Values

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"THE COMPUTER BAND-BOX"

(As Published in conjunction with 'Practical Electronics')

Complete Kit £289

MANFD. £399

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(As Published in conjunction with 'Practical Electronics')

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(As Published in conjunction with 'Practical Electronics')

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CLEF PRODUCTS (ELECTRONICS) LIMITED

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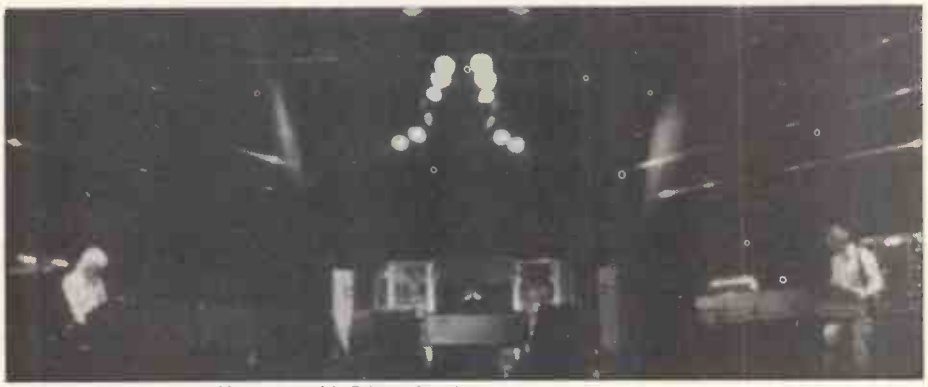
TANGERINE DREAM

RECORDED ON CASSETTE NO. 5



Tangerine Dream at the Hammersmith Odeon, London.

Edgar Froese.

An interview with Edgar Froese and Christoph Franke during their recent UK tour

Tangerine Dream was formed in 1967 by Edgar Froese, who derived the name from 'Sgt. Pepper', and initially started as a powerful and unpredictable rock band. Froese's exposure to modern contemporary and electronic music made him determined to go beyond conventional modern music of the time. Despite a strong Underground following, TD was not exactly a commercial success, reforming twice for short periods. Then in 1969 Klaus Schulze (drums) and Conny Schnitzler (cello, violin and flute) joined Froese to make the group's first LP, *Electronic Meditation* in 1970, that consisted of tape sounds and experimental effects. Soon after, Christoph Franke (known for his jazz drumming) and then Steve Shroyder joined Froese to make 'Alpha Centauri' in 1971. Peter Baumann then replaced Shroyder to reform TD with Froese and Franke for the next six years.

A whole series of albums followed: *Zeit* representing their furthest departure from rock, yet coinciding with *Ultima Thule Parts 1 and 2* that certainly was rock; *Atem* marked the group's move from Ohr Records to the British 'Virgin' Record Company; *Phaedra* which reached the Top Ten in the UK without much airplay, press interviews or British tour — this soon followed with performances in almost total darkness! An Australian tour in '75 put Michael Hoenig standing in for Baumann and brought many equipment problems in transit.

From 1977 some preconceived structure in live performances was used and TD gave a notorious performance at Rheims Cathedral and other unusual venues such as Coventry Cathedral, Liverpool Cathedral, York Minster and the Royal Albert Hall. Two further albums *Rubycon* and *Ricochet* emerged, the latter recorded live with the group's sound output often reaching 130dB. Then *Stratosfear* employed recognisible instruments and melodies, and a North American tour introduced laser effects.

Next came *Sorcerer* film music and shortly after Baumann left the band to pursue a solo career. Froese and Franke still remained the nucleus of TD, and added Steve Jollifer (vocals, keyboards and wind instruments) and Klaus Krieger (drums) to record *Cyclone*. 1979 highlighted solo projects and experimentation, despite the more traditional *Force Majeur*. In February 1980, TD became the first Western rock group ever to play live in East Germany, joined by Johannes Schmoelling who remains current third member of the trio. *Tangram*, *Thief* and *Exit* have since been recorded and the latter shows yet another side to the music of Tangerine Dream, who continue to pursue their innovative production of electronic music.

Edgar's main keyboard console.

Christoph's keyboards.

Instruments

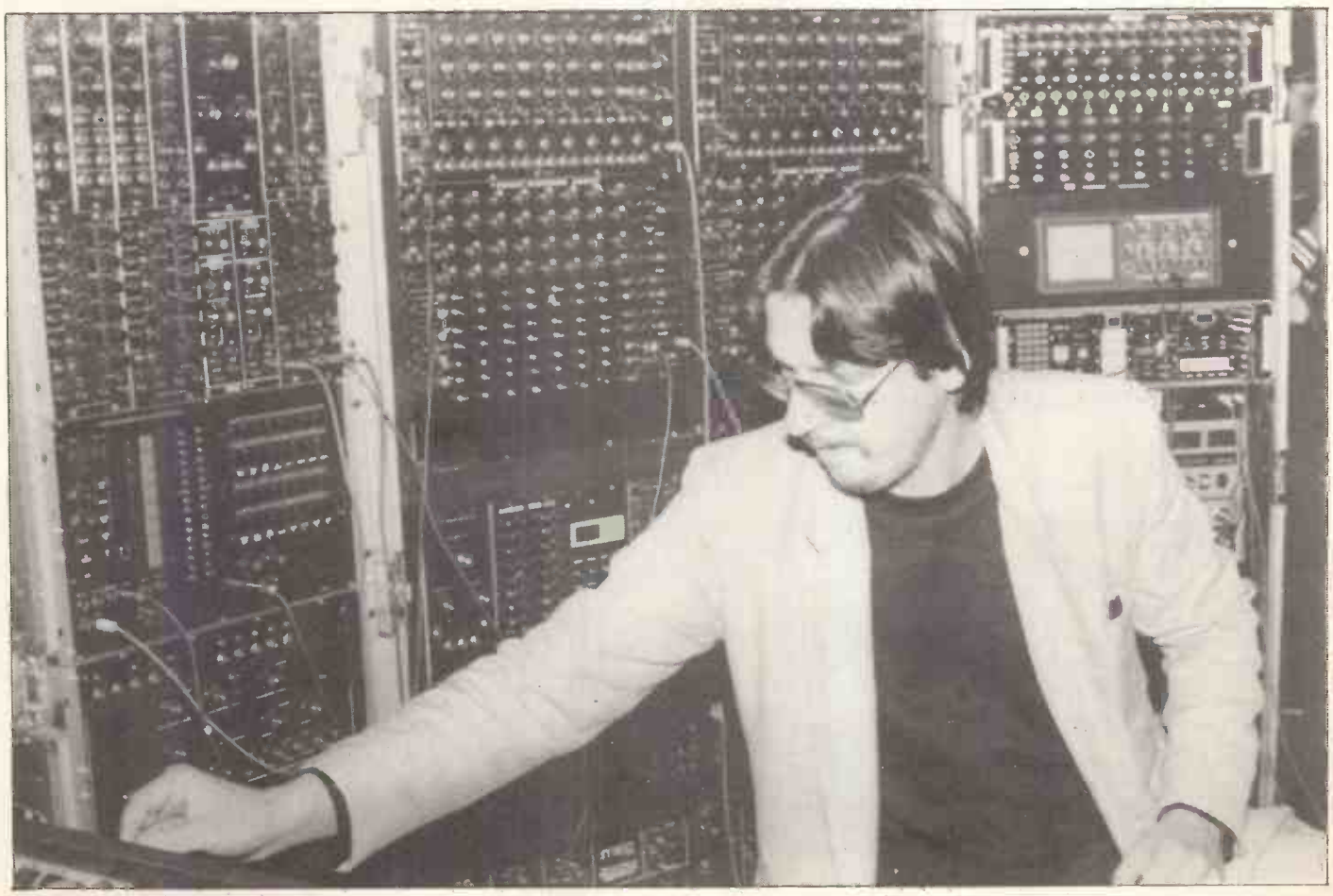
Edgar: We get hardware mainly from America and Japan and the instruments are adapted by our engineers to our specifications. I have a number of keyboards including the OB-X, PPG Wave Computer 1 & 2, various Arp equipment, and four custom built sequencers made in Germany. I also play guitar and I use various instruments including Fender and Gibson. I don't really need to use guitar synthesisers as we have the keyboards. I like to work with the Roland MC-8 Micro Composer and TR808 drum machine. These are some of the instruments I use regularly, although we do have links with most of the synthesiser producing companies who supply us with new equipment from time to time.

For this present tour, I play one large keyboard rack containing the PPG2, PPG1, Korg Polyphonic Ensemble (which I use only for strings), and the Arp Pro-Soloist. There is also a Conn Strobe Tuner for matching pitches. To my right I operate the Soundcraft Series 1S 20 into 4 mixer which takes both keyboard and guitar signals. For the guitar, which is a Gibson on this tour, I have an Ibanex UE400 Multi-Effects unit and an MXR Digital Delay. The Ibanex effects are controlled by a foot switch box with compressor/phaser/distortion/chorus/flanger and I set the guitar volume with a Boss pedal.

The new sequencer unit on a large stand behind me was built by Helmut Grothe, and has 1068 steps for programming control voltages and triggers. We have a system that enables any one of us to send control triggers to the others. So from one piece to the next we would alternate 'control' responsibility. There are two 6" TV display screens in the instruments for checking out memory allocations and control function settings, along with numeric LED displays in each section that indicate mode selection, multiple sequences, tuning, program parameters, random note selection, routing and further sequence storage. Some of the PPG software is also here, and there's a Grundig Stereo Cassette which we use for setting up, but not in performance. In front of the sequencer unit is a PPG 61 note keyboard which is used to program the note sequences.

Incidentally, we don't work with voices at all. Any sounds you hear resembling voices are usually from the PPGs. Each of us has a mixer to balance individual sounds and we have a monitor mix (which we hear through the foldback speakers on stage) and the main PA 'out-front' mix for the audience. Sometimes we do put everything together on a two track mix-down and like to be totally open about the way we balance the sounds. For instance, at one concert we started improvising totally without any sort of agreement. On the next night we might be tired from a long journey and use our 'corners which we walk along' to bring the music together.

Christoph Franke.



Tangerine Dream

Besides the new presentation and equipment used by Tangerine Dream, what is new about the music?

Edgar: It's now much more structured. That doesn't mean we have forgotten how to improvise. We can still do both — we can sit and structure the music as we want to play and yet we can still maintain our individual identity gained throughout the years. The whole idea of TD was to just sit down and try to perform a creative piece of electronic music. But one thing we have all had to agree to is the jump from analogue to digital to computer equipment. Of course, one has to be much more aware of the controlling abilities as well as the sounds. You can't just say 'let's drift away and let the hardware work'. Therefore we now have to structure much more carefully.

Chris: I use the rack mounted modular system behind me for most of the short repeating sequences and electronic drum sounds. A lot of it is Moog and contains various synthesiser modules (some of which we don't use in performance any more). In addition, there's a brand new digital sequencer and trigger selector which I designed with a 16 step, 64 program capability. The great thing about it is that it runs like an analogue sequencer, even though it has digital storage and can be continuously modified in performance. Linked to it is its own programmer and synth sound bank. There are more synthesiser modules from Projekt Elektronik (plus one EMU Oddity voice card, PPG filters and Sequential Circuits sequencer) as well as drum voicing boards with VCO, noise, ring mod and EGs. Projekt Elektronik is a company that produces scientific instruments generally and makes music equipment only for us.

The analogue sequencers from Moog have 64 steps and switches for semitones, step (1-12) division, two control voltages of switchable 12 semitones, five octaves, two time controllers and eight select triggers. Six rows of separate pots derive control voltages for VCF, VCAs etc. We use one volt per octave CVs and have various interface units to match up to this and use 15 volt triggers throughout the systems. Gate lengths of each note can be altered and notes can have a delayed trigger which can take away some of the 'machine-like' feel that the sequencers produce. I have two random generators for slightly modifying time delays as well as pitch.

At home in my 24 track studio, I use the MC-8 and I'm building my own editing system with a large computer, capable of writing a three hour program with 10 million byte storage. Edgar also has a 24 track studio in his home, giving us 48 tracks in all!

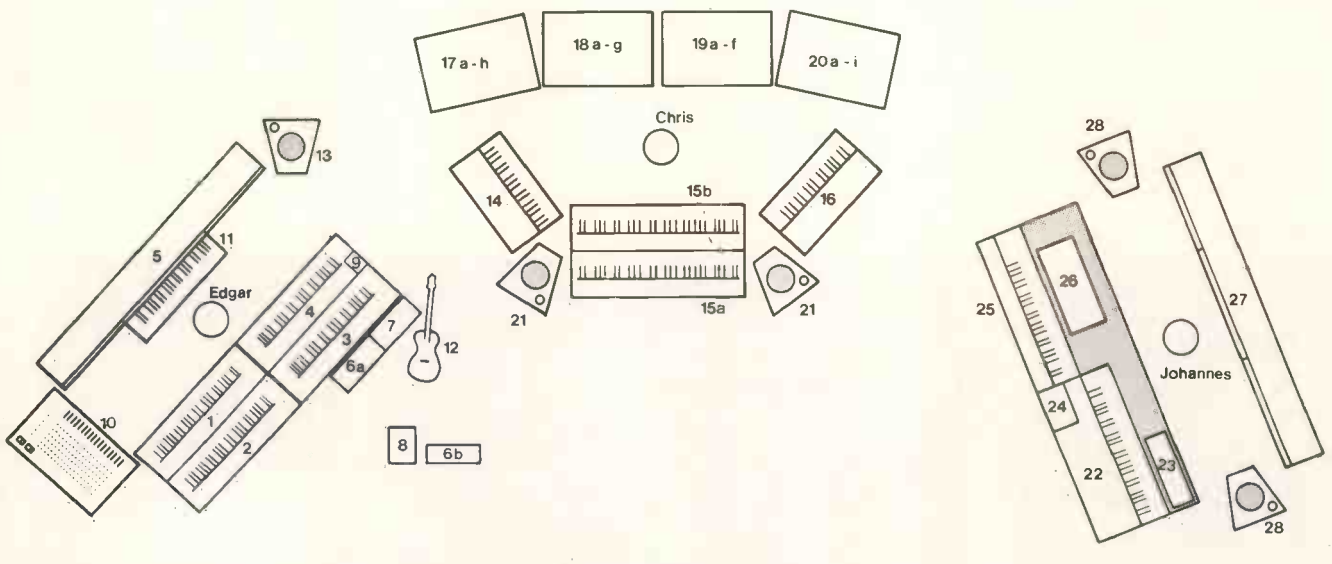
Some people think that we are technicians as well as musicians, but we concentrate on the music and only learn the technical operating requirements for us to fully exploit our instruments.

Edgar: Johannes uses another sequencer similar to mine behind him and has the OB-X and MiniMoog synthesisers in front. Mixing is done through a Boss KM-60 6 into 2 mixer, with an MXR Digital Delay and Korg WT-12 Chromatic Tuner completing his line-up.

Comments

Edgar: Now that you can buy very sophisticated instruments that have done all the work for you in creating a range of sounds, it is easy for musicians not to bother to invent their own. (For example, we have been told that 90% of Oberheim/Prophet synths come back for service with the original programs in them.) They do go for the sound in the first place, but only 10 or 20% of the way!

Chris: There is this gap between 'synthesist' and 'keyboard player'. We find some people have the ability to create new sounds whilst others have the ability to play them.



Front stage

TANGERINE DREAM EQUIPMENT

Edgar Froese

1. PPG 1 Computer
2. PPG Wave 2 Synthesiser
3. ARP Pro-DGX Synthesiser
4. Korg Polyphonic Ensemble
5. Custom Sequencer

6a. Ibanez UE-400 Multi-Effects
6b. Foot control (of above)

7. MXR Digital Delay
8. Boss Volume Pedal
9. Conn Strobo Tuner
10. Soundcraft Series 1S 20 into 4 Mixer
11. PPG 5 octave Keyboard/Controller
12. Gibson Guitar
13. Foldback speakers, etc.

Chris Franke

14. MiniMoog Synthesiser

15a. Elka Rhapsody
15b. Prophet 5

16. Arp Oddyssey

17a. Moog Osc/R.M./VCF/VCAs
17b. Projekt Elektronik VcEnv x2 & Proj. Elek. 2VCO/W.Noise/R.M./Waves (for Drums)
17c. PPG VCF High/Low/Band x2
17d. Digital Sequencer & Trigger Selector (16x16)
17e. Programmer (for above)
17f. Synth Sound bank (for above)
17g. Roland SPV/355
17h. Trigger/gate matching panel.
18a. Moog 960 Sequential Controller
18b. Proj. Elek. Sequence Controller
18c. Moog VCF Random Trigger & Reset System for 960.
18d. Moog 930 Voltage Store Units
18e. Moog 3-Band Parametric
18f. Moog 12 Stage Phaser
18g. Tape Interface
19a. Moog 960 Sequential Controller
19b. Proj. Elek. Sequence Controller
19c. Moog 920 Programmer
19d. Moog 930 Voltage store unit
19e. Moog 16 Channel Vocoder
19f. Klark Technik DN27 Graphic EQ
20a. Drum Envelope Unit
20b. Drum EPROM Sampled sounds
20c. Phillips PM3207 Dual Trace Oscilloscope
20d. Rhythm Robot Sequencer
20e. Boss KM-60 6 into 2 Mixer
20f. Roland SRE-555 Chorus Echo
20g. Link Panel
20h. 12 Analogue Drum Sounds
20i. Klark Technik DN36 Time Processor
21. Foldback speakers, etc.

Johannes Schmoelling

22. Oberheim OB-X
23. MXR Digital Delay
24. Korg Tuner
25. MiniMoog
26. Boss KM-60 6 into 2 Mixer
27. Custom Sequencer
28. Foldback speakers, etc.

Electronics & Music Maker

TANGERINE DREAM

"CHORONZON" from 'EXIT' LP

Edgar Froese.

Christoph Franke.

Johannes Schmoelling.

This exciting piece is a good example of the new Tangerine Dream music and will be a rewarding challenge for any electro-musician to play. Every note of music is given, along with sound effect suggestions for you to experiment with. This type of electronic music is based on repeated sequences that are faded in and out — in fact there are five 'note groups' for DRUMS (D), BASS (B), SEQUENCE 1 (S1), SEQUENCE 2 (S2), and POLYSYNTH (P) that could be recorded continuously throughout the piece on separate tape tracks and simply faded in or out as shown on the score. Only two further tracks remain: EFFECTS (E) and MONOSYNTH theme (M). Thus the piece is suitable for an eight-track recorder (e.g. Fostex) or it can be layered on to a four-track (e.g. Teac) or bounced across two stereo machines (e.g. Sony, Revox, etc.). For simplicity, whenever a note group is repeated, it is labelled with its letter code instead of being written out. This is quite normal when composing and leaves room for EFFECTS, MONO theme and any other new music that is used. Do listen to this track on the EXIT LP and study the way sounds blend together — the balance is important, although you may prefer to try your own mix. Because it is possible to learn one part at a time (merely a few bars), it should not be difficult for a music reader to enjoy Tangerine Dream's world of electronic music.

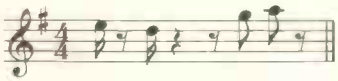
RECORDED ON CASSETTE NO. 5

You'll need to study the music with this track from 'Exit' LP Virgin V2212. In addition, a sample interpretation is played on Cassette 5 minus the theme for you to practice with.

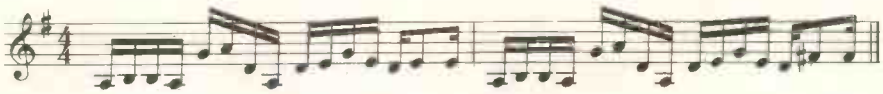
Tangerine Dream's "CHORONZON" from 'EXIT' LP

NOTE GROUPS:

POLYSYNTH (P)



SEQUENCE (S1)



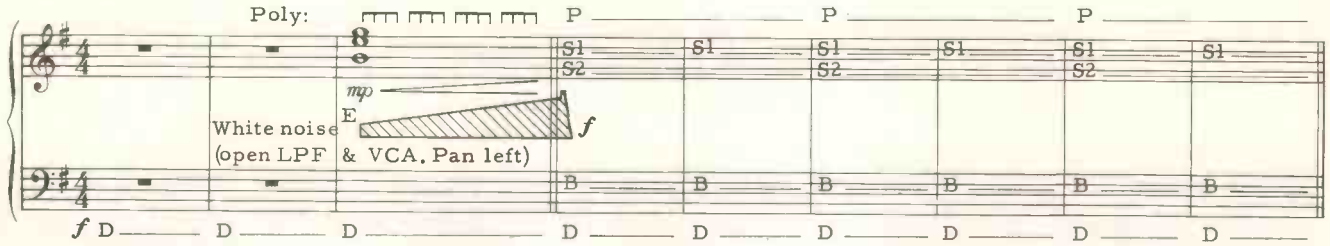
SEQUENCE (S2)

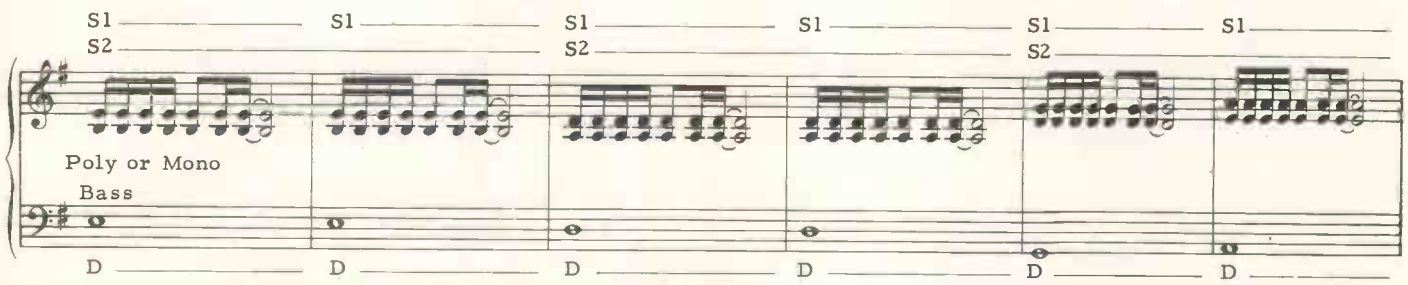
BASS (B)

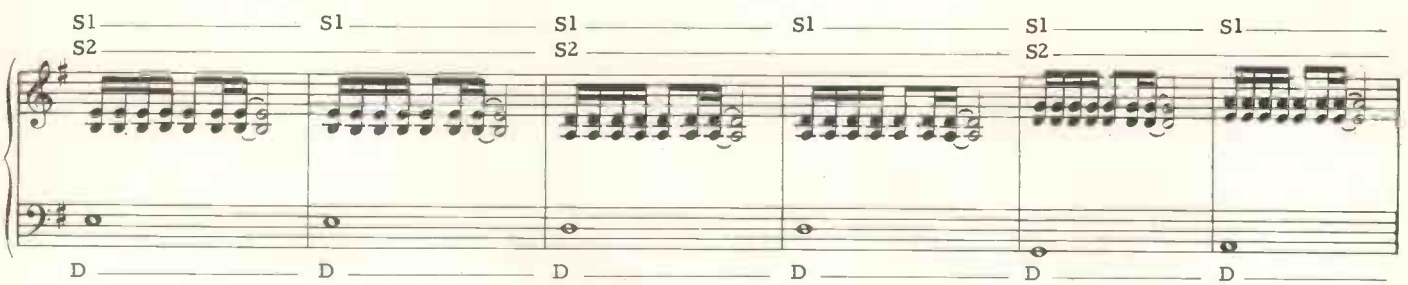
DRUM (D)

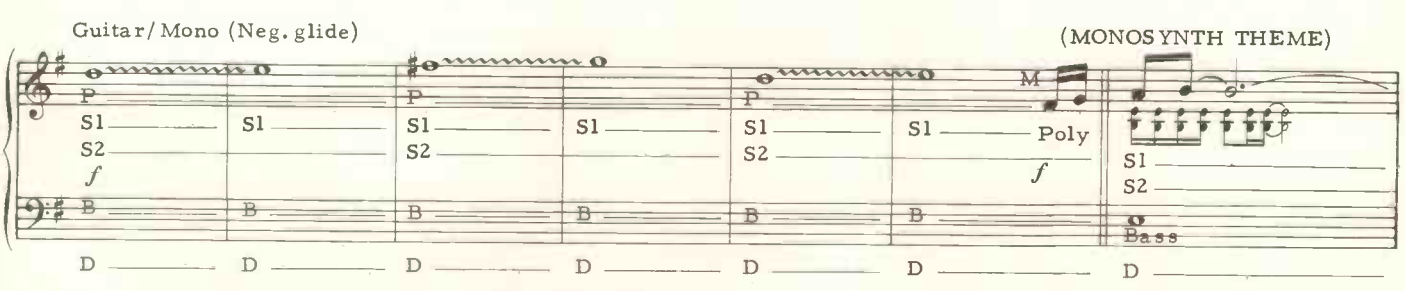
1 Short cymbal (or white noise)
2 Brush on S.D. + closed hi-hat top
3 Low Tom-Tom
4 Bass Drum

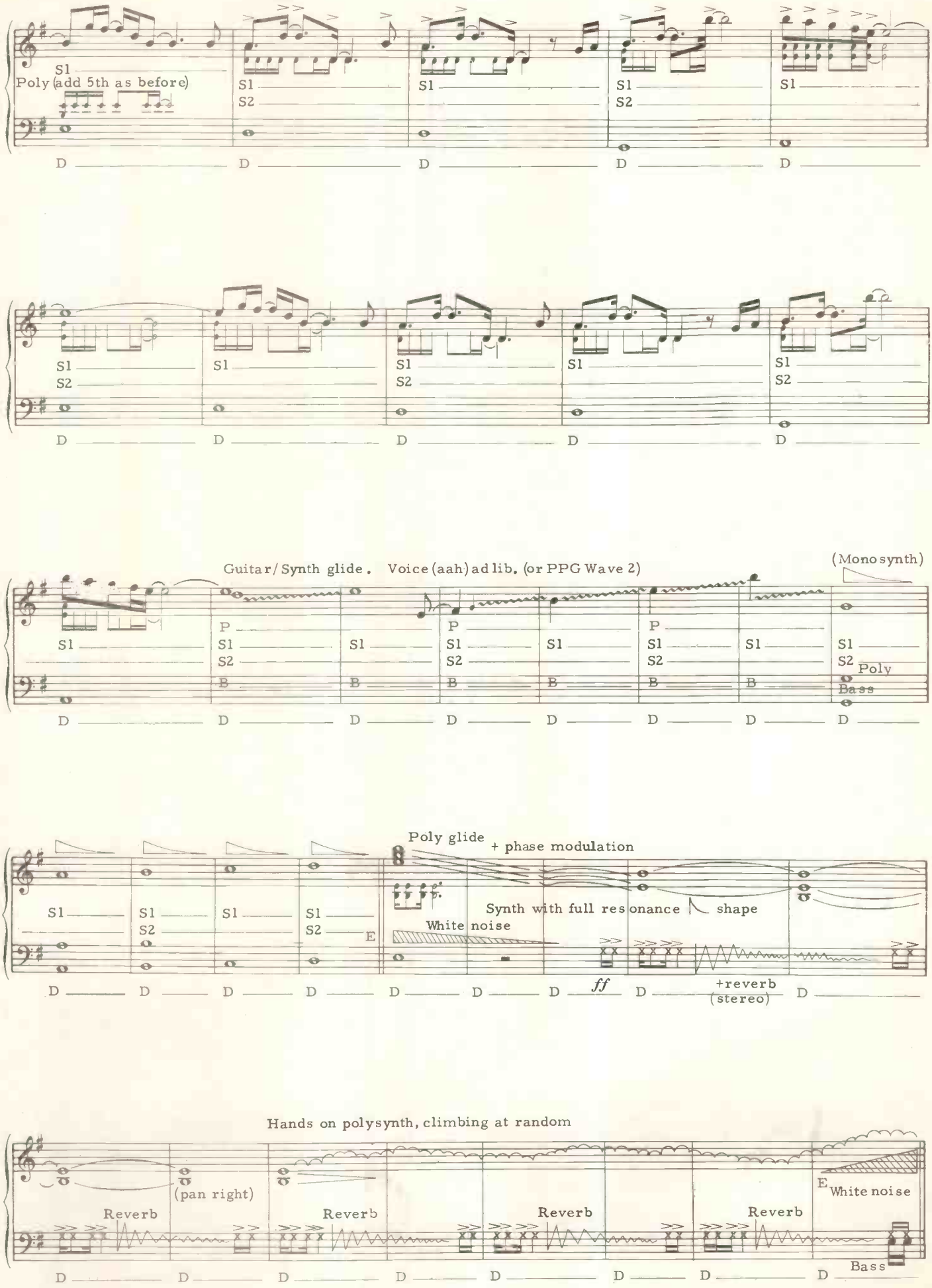
MUSIC:



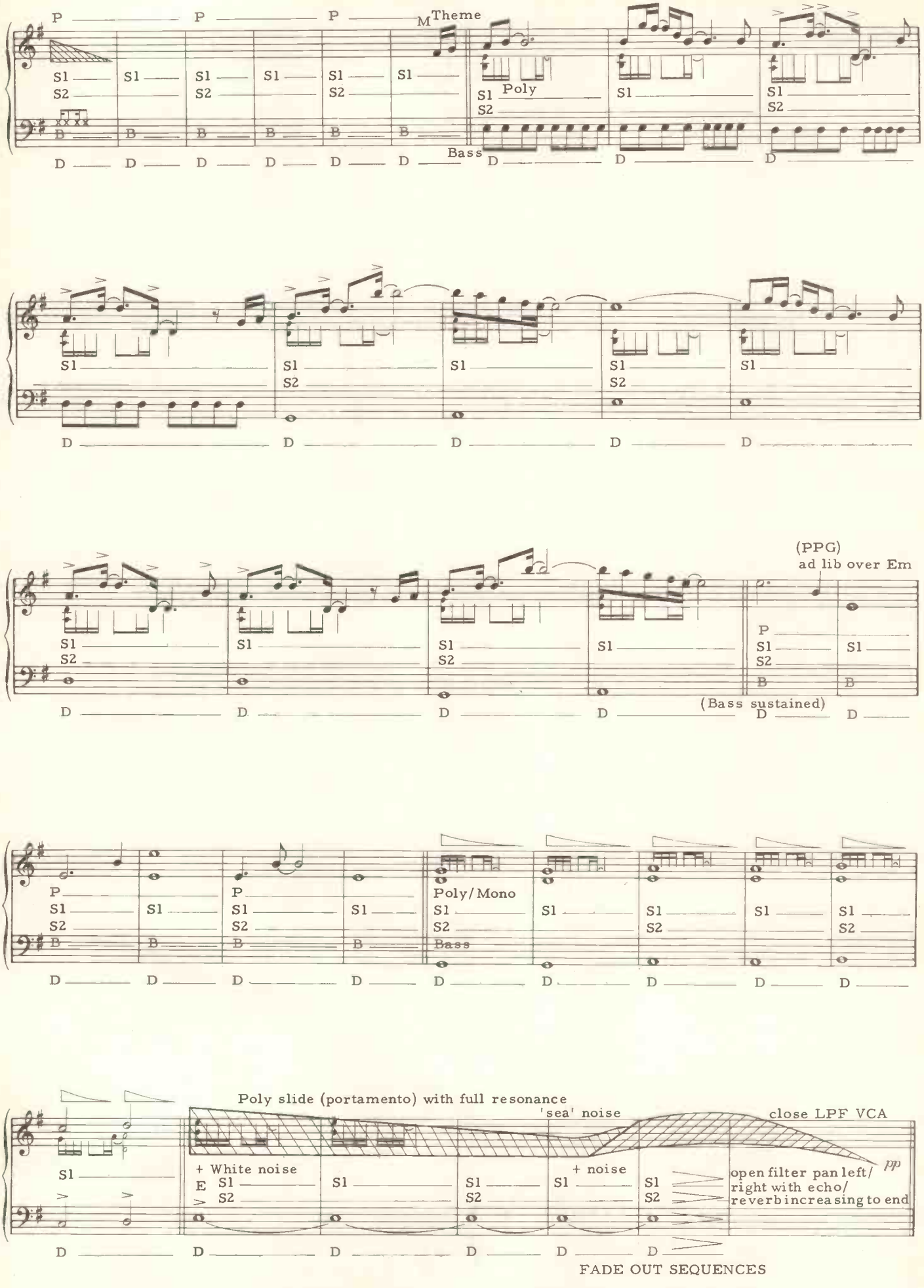








"CHORONZON"



Johannes' keyboards.

We discussed how the non-musician is often able to come up with some extraordinary sounds by a different thought process to the musician — many young people in schools are now getting the opportunity in their music classes to do this.

Edgar: Through the centuries, we have been told what good music is and how we should play it. People never had the personal experience to be creative in making sounds to find out what music, besides all the traditions, could be. The last 10 years have shown us the possibility to *create* things, not just to overtake it from the past. My belief is that the young teenagers could be the first to step into this new approach to music making.

We have seen something that links with this happening on our tours. On one such tour recently, we were getting the 'Superstar' kind of image as we were escorted from one place to the next. But we wanted the contact with our audience and so we fired our managers and did the tour on our own with the help of a few friends. After the gig, we wrote autographs and met people as we wanted — but what astonished us was that the people were so young, around age 15 and hardly any older than about 22. Certainly, there is no awe attached to these machines we play for the youngster, in the way we felt when we began — and that means that young people will approach the electro-music of the future with an open mind.

TD have a reputation for playing loud.

Edgar: That's right, but we don't have distortion and the signal is clear. We never listen to very loud signals on stage through the foldback speakers.

Certainly the TD sound covers a very wide gamut of dynamics, from the quietest whisper to (if you're sitting a few rows from the front!) the loudest piercing penetrating soundwaves.

Edgar: We don't use as much classical material as we have done from time to time in the past. But we do want to keep the classical 'dynamics', because this is one of the most important aspects of any music making. The presence of strong rhythm in our pieces has in some countries, such as Spain and America, brought the audiences to their feet to dance to the music.

Johannes has been part of the new TD for nearly two years.

Edgar: Yes — we are very pleased with his contribution and also our efforts working as a group. You know, what split the band three or four years ago was purely the social aspect. For example, Peter Baumann had a totally different attitude about spending his money, and since we invest about 90-95% of our profits back into getting new equipment, it was an important factor.

One of the most complicated tasks for TD has always been the fading out of one part of the music whilst fading in the next one. It's a most complicated physical/aural function. It's easy to stop and start sequences but the skill lies in fading in and out, learning how to put a cluster underneath, how to fade in a new sequence, how to build bridges, how to keep the dynamics, how to explain to each other the structure of a piece and then to be able to carry out these procedures without any mistakes in half a minute.

It was very difficult when Johannes first came with us. Remember, it took Chris and me about six years to work out things with Peter Baumann. We realise how fortunate we've been to be able to work together as equals who contribute to the music composing, structure, interfacing and manipulation of the instruments in performance. When we split with Peter, we could have contacted many respected musicians across the world, but no-one would have fitted into the band. There were a lot of big names wanting to join us, but we ended up taking an absolute unknown musician who worked as a sound engineer in a Berlin theatre.

Setting up and presentation

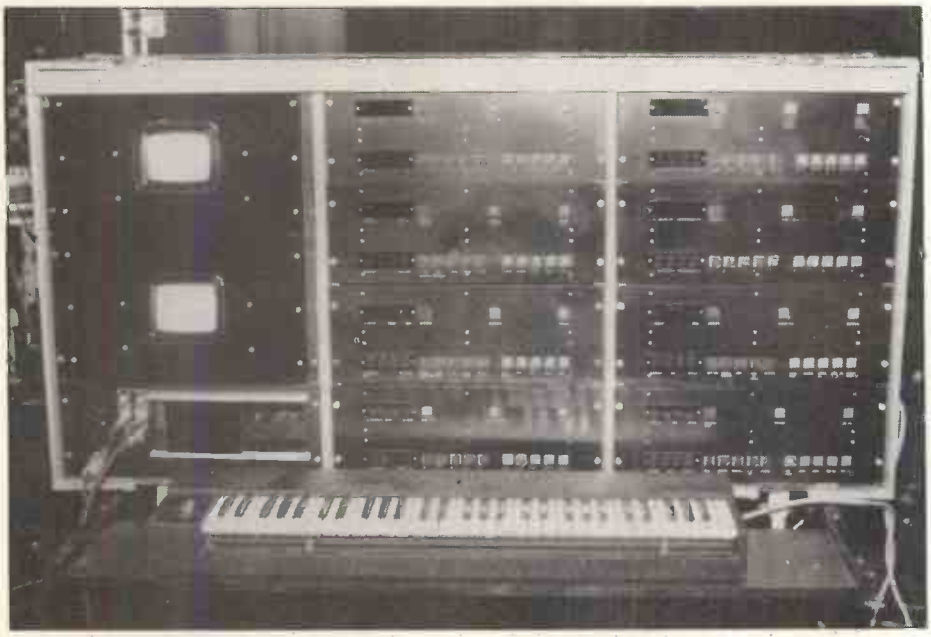
The new TD layout on stage is impressive, yet economically well planned. Each player sits at the keyboards and can easily manipulate sequences and other control functions from one position. There is, of course, the danger of becoming too static so that visual interest is not maintained, but somehow this is never the case and although the laser lighting has been dropped and a more or less standard light show remains, a feeling of space is created by the perspective of the overhead scaffolding and see-through net curtains. On the recent U.K. tour, at Hammersmith Odeon, London, one of these curtains spanned the entire front of stage so that you always 'looked through', and the back-projected lighting cast effective images across it.

Having seen the Revox tape machine in operation during the Coventry Cathedral Concert televised some years ago, I was interested to find out that it was merely used for echo effects and did not contain effects or music tracks at all.

Edgar: We never suspected that anyone would think we were using a backing tape. Of course, digital delays now replace the tape machines.

Chris: The effects we use comprise the usual delays, flangers and equalisers. I still have five Electro-Harmonix 'Big Muff' distortion boxes on each of the mono outputs from the Prophet 5. It gives it an amazing 'digital' flavour. The 'Big Muff' is the only fuzz box that I like with synthesisers, because it works well on the overtones without producing too much distortion.

In the past TD used curtains with laser lighting projection on them, but it was too



One of the new sequencer systems used by Edgar and Johannes.

Tangerine Dream

Edgar and Chris at the soundcheck.

expensive to keep on bringing new ideas out with this equipment. So we are trying the gauze now to produce more three-dimensional depth. If you use lasers, you are restricted to the creativity of the controller, the lack of sufficient rehearsal time, and also the high cost of the equipment.

The mixing desk for the audience sound (a Soundcraft 32 into 8 Series 800) is placed at the back of the auditorium along with the lighting desk. JBL/Gauss speakers are used in the 6000 watt PA and part of the stack is flown when necessary. We used to use electronic links to control the light directly, but now we rely on the operator to synchronise with the music.

Composing

Edgar: The composition of our electronic music is a long process that first involves setting up the equipment in the way we want it to interface — that takes 60-70% of our time and includes the tuning, etc. We've got quite a good system to find out our good days for composing the music. A few days from time to time are totally forgettable to work with, so we look at the biorhythmic aspects of each of us and find that some days, although we feel we can do something, our subconscious has closed down and whatever we do the results are no good at all.

Chris: What we are suggesting is that to write our music, over the years we have found ways of putting ourselves in a state of mind that enables us to compose. Some people use meditation, and others will receive triggers almost subconsciously.

Edgar: I never think that 'I am doing something'. I always think 'I do it with myself', which is a completely different aspect.

We don't meet every day. The compositional ideas sometimes come from doodling at a session, other times we have the idea which can be a musical theme or structural framework and we need to develop this. There are always times when something happens by chance, especially when interfacing instruments together.

We already have plans for linking our studios by telephone datalink through a modem. But, of course, it *is* very important that we mentally interact together on a piece and don't just pass a tape over for the next person to work on. So there are three main factors playing their part in our compositions. First, our way of composing is very personal. Secondly, we need to interact emotionally to the piece, and finally we need to transfer ideas and program data.

Johannes is still learning our ways and at this time is in the process of getting closer to becoming a third part of the band in terms of involvement.

There is a much wider dimension in our music than simply making use of sequences. One LP can never embrace our range of musical experience and experimentation. There are a lot of times when we'll make a sequencer orientated piece, then others will start with drum and bass lines. Our varied backgrounds also help to make different pieces and often we'll simply try to paint a picture in sound. For example, at the beginning of December we've got a concert for TV going out all over Europe and we gained a lot of our inspiration by going to the Picasso art exhibition in London.

Prior to their latest LP, Tangerine Dream brought out their film music for 'Thief' (now entitled 'Violent Streets' and on general release in the U.K.) composed in 1980. Edgar commented that it enabled him to buy a lot of computerised equipment. And so we moved on to Tangerine Dream's latest recording.

'Exit' LP

Edgar: It's the last record of a decade for TD. Whatever we release will not be that sort of TD anymore. It will be a total change, and it has nothing to do with our not using sequencers in the way we do. We simply want to risk a bit more in life. Most successful bands these days buy big houses and so on — rather than risk experimenting further afield with their music, but I think once in your life it's worth taking that chance.

We discussed the six pieces of Exit in turn and both Edgar and Chris diversified around the music make-up.

Johannes Schmoelling at the soundcheck.

Kiew Mission

Edgar: The basis of this piece came from improvising for some 1½ hours and out of this we took about five minutes of music. The opening collage of sounds with the gong was added later. The 'frequency modulated' gong is actually made on our Synclavier (which we keep in the studios at present), and the pink noise output is controlled by one of the digital sequencers. Our instruments in performance for any of the pieces are not necessarily the ones we used for the LP. On stage we now use the PPG2 and the MiniMoog pink noise.

The drum rhythm is the same for every bar of the piece — often the case on the other tracks as well — but without consciously analysing the drums alone it's certainly not evident in the music and has none of the monotonous feel that home organ rhythm units can produce.

Chris: Our drum part does not play the same role as in the rock band — it merely supports the music at the appropriate places. We have a number of 'clock' oscillators that give the drums' pre-programmed tempo. We also set up tempos for the triggers that control the sequencers with pre-programmed oscillators linked to digital counters.

Once the sequencers are running, the melodic parts and the sound effects for the pieces are interchanged amongst the three of us. Since all the instruments can become the bass or monophonic melody and most can be polyphonic, there is plenty of scope for experiment. On stage, each person would know the part he had to play in the piece, and this is where the pre-defined structuring is important to create the required balance, but within that framework there is freedom to improvise and experiment.

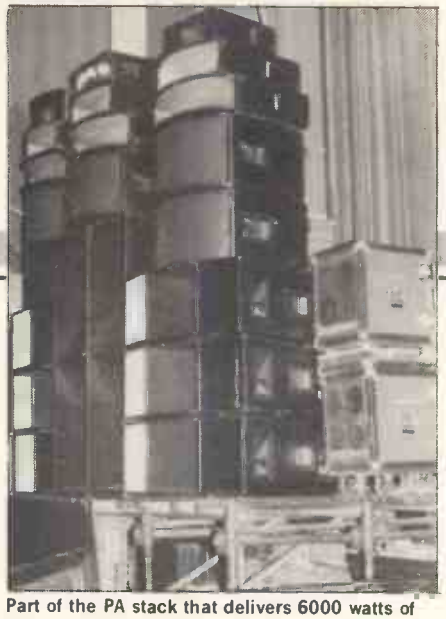
Edgar: The words in this piece are Russian — we have many friends in Russia and it's a sort of message for the peace movement, against Nuclear Power. The words are spoken by an actress from Berlin.

The sonorous synthesiser bell effects come from a PPG2 and the make-up of the piece highlights another extremely important aspect of TD music: the sequence ends before you become tired of it. (Consider the number of experimental electronic music recordings you've heard that seem to say it all in a few moments, yet plough on for the whole side.)

Edgar: Don't forget one thing, working it out on record is totally different to doing the live concert. All the adjustments we have to do in the live concert make it much more complicated and even if you want to press a particular knob, it's so easy to miss it in a certain bar or press another, so that the sequencers are slipping out of sync, and the piece then develops in a slightly different way.

Chris: When we record a piece, it is some time before we are able to put it on stage. Some parts can be very difficult to set up in real time.

Edgar: In the studio, I have an editing facility that shows me the notes I play as I'm improvising. Afterwards, if we find something interesting, all the notes are there for us to play. We don't follow the old fashioned way of writing down everything exactly. We memorise our parts for the keyboards and my guitar in performance and that, of course, implies knowing the control settings required as well as the notes. If any writing is done, it's in the alphanumerical code



Part of the PA stack that delivers 6000 watts of electronic music.

required by the computer system in use. Once the information is stored in the computer, we don't have to recall it again. We define semitones, octaves and even 100ths of a semitone (micro and macro tones).

Many of the sounds on the LP as a whole are of the same character and therefore help to amalgamate the pieces together. Generally, the pieces on the album have no direct link to each other apart from being written within the same time period. In the past, we have put together all the pieces for an LP in the space of a few weeks and then there is an obvious feeling of affinity from one piece to the next.

Chris: Because there are only three of us, we have to program a lot of the sequences to run themselves, once they are started, throughout a piece (as in Choronzon). That's why our music is much more complex than four or five years ago.

A 'sequencer' is perhaps not the right word anymore — I now call it a 'consequencer' because a sequencer means really just a repeated group of notes — but often our layers are long and don't repeat within a piece.

IN CONCERT

Tangerine Dream at Hammersmith Odeon, London

The last time I caught Tangerine Dream live was in Coventry Cathedral in the autumn of 1975, the recording of which became a best-selling album, 'Richochet'. The three outstanding features of the '75 concert were: (a) the volume, (b) the precision, and (c) the lack of fluffs. Six years on, Tangerine Dream provided all that and a good bit more at that haven for standing waves, the Hammersmith Odeon. Fortunately, for this reviewer, the dire acoustics of this venue relaxed their muddy strangle-hold in the position of centre stalls, and here the quality (and quantity) of sound was pretty stunning — good proof, I guess, of the quality of Bose speakers.

Much of the material was new to me and displayed the sort of seamless coherence that one has come to expect from this group. More than that, the frequently-maligned and oft-imitated textures that TD spin out with such effortless skill create real excitement, even though occasionally the music comes perilously close to sinking beneath its own weight. In part, this must be a case of over-adherence to the principles of Teutonic thoroughness (cram every nook and cranny with a note), and also a consequence of the somewhat archetypal repertoire of sounds and synthetic techniques used.

Apart from a brief excursion with a real drum kit on 'Cyclone', courtesy of Klaus Krieger, TD have always used drum machines, and this concert saw them using the latest product of digital technology, sequencer-controlled accessing of real drum sounds burned into EPROMs. Paradoxically, this sort of playback of real drum sounds can often sound even more mechanical than the average rhythm box — mainly, I suppose, because the listener is deprived of the flexibility of beat automatically associated with drum kits but not drum machines. TD use their 'digital drums' in a quite remarkable way. Even though a rhythmic pattern may repeat with no variation from one bar to the next, the ways in which patterns are constructed, both in terms of dynamic and timbral variety, creates such a hypnotic fascination that criticism is momentarily suspended. This is also because subsequent parts are very carefully overlaid and integrated with the drum track to create a precise continuum of sound (the filling-up of 'nooks' and 'crannies'). Mind you, there were times when one felt that these patterns had been somewhat miscalculated in terms of audience staying-power, and other times when notes seemed to be crying out for room to breathe in the frantic rhythmic melée.

The group has certainly had its fair share of personnel changes over the past few years, including Peter Baumann leaving in 1977, Steve Joliffe (vocals and wind instruments on 'Cyclone' — an album that I felt [and still feel] had a remarkable gut-stirring intensity) joining and leaving in little more than a year, and finally, the latest member, Johannes Schmoelling, who joined TD at the end of 1979. It's good to report that TD has really benefitted from this new addition to their fold, not least in the way he brings a real emotional lift to the music. The Odeon concert saw some superb MiniMoog solos from Schmoelling, full of yearning lyricism, and a much-needed contrast to the almost austere coolness of Froese and Franke. Whereas Froese and Franke appear detached from what they're doing, Schmoelling is visibly moved by the music he's playing — let's hope they don't insist upon gluing him to his seat!

High points of the concert included the opening number, with a sax-type duo between Schmoelling and Froese above a stunning texture of FM 'shrieks' and gongs, ending with some syncopated descending temple block sounds; the tight, almost funky number just before the interval, with superb polysynth work and an empassioned solo from Schmoelling subsequently taken over by Froese on guitar, organically developed into a really thrilling climax; and the encores — various tracks from TD's latest album 'Exit' — where at times it was really hard to believe that one wasn't listening to the album itself.

Tangerine Dream have been convenient scapegoats for much misuse of printing ink, but, on the basis of this concert, it's clear that they have armament powerful enough to strike down their critics by the thousands.

David Ellis **E&MM**

Coming back to the first piece, the interesting string unison that arrives in the middle comes from the Prophet. But once again, actual instruments are not too important — it's the character of the sound that is interesting. The track is dominated by the sound of digital PPG waveform shaping, which was a new sound for the group at the time. The 64 waveform scan can make a tremendously rich harmonic sound with no lack of high frequencies that is often noticeable in analogue LPF systems. (The PPG Wave 2 was reviewed in detail in E&MM July 1981 and is also on demo Cassette No. 3.)

The piece ends with a reference to the opening theme and fades away to end.

Edgar: We had to do this on the record because of the time factor and we preferred to fade out rather than add a poor ending point — it was a compromise, and we don't like to do it.

Pilots of Purple Twilight

This uses just one sequence running through the piece. The way the music begins half way through the bar gives a fascinating start to the rhythms and it takes a while to orientate yourself to what is happening. The OB-X is the sound maker except for the 'bleep' melody line later, produced on the Wave 2.

Edgar: A lot of the melodic lines we compose are more easily played directly on the keyboard. Other complex sounds lend themselves to sequencer treatment, but if you want to add accents it is better done manually in performance. The best thing about the sequencer is that it frees you from the notes to concentrate on tonal adjustments.

Choronzon

The noise effects come from the Mini-Moog. Edgar pointed out that a lot of the effects TD do are much simpler than you imagine! Chris could not recall the notes of the sequence as this was programmed some time ago and so I have made an approximation that fits in suitably on the printed music. The electronic drum start is unusual for TD and reminded me of a recent Ultravox concert where nearly all the pieces started in this way.

The polyphonic glide is done on the Oberheim and the main theme is played on the MiniMoog using two oscillators. We agreed that synthesiser sounds never need be static — they can always be changing and this makes electronic music much more acceptable in the long term.

Edgar Froese.

Chris: As far as panning is concerned, it's nicer if you see a spectrum where you see every instrument sitting instead of walking around in a field! That's why we do not use it very often except for one or two effects such as noise sweeps.

Edgar: Maybe one secret in the way we mix or record music in general is that we don't think of panning a sound in a single movement, but move the colour of the sound. There's a different sort of feel this way — for example, the same signal can be derived on the PPG2 in stereo but with completely different tonal qualities that can be panned from left to right.

The voice sound on this track is again the PPG (Preset no. 60!). The PPG slap sound in the middle piece comes from the MiniMoog with envelope two working on the oscillator to make a sudden sweep down in pitch within 10 milliseconds, so you are just left with the sound movement. The resonance is increased, but not enough to put the filter into oscillation as a resulting sine tone would be too weak. The two oscillators are set to a pulse wave with noise added. The reverb that follows the effect is done with two EMT plates in the studio, but on stage if we do have to add anything to the hall acoustics, we use the AKG BX-15 or BX-20.

That led to us questioning the use of echo and reverb on certain instruments and not on others.

Edgar: Where have these rules come from? They are just a fashion — one producer's good for four or five records and then someone else takes over!

Chris: We produce all the material for our LPs ourselves — right down to the final mixdown. So really the studio itself becomes an instrument for us.

(You can play the Choronzon piece from the music in this issue.)

Exit

This is a smoothly performed piece with a floating quality that is pushed gently along by the repeated two bar two-note sequence and 'spiked' bass sound. There's a tape reversal effect at the start which is a cymbal backwards and Edgar calls the filter sweeps 'splashes'. Once again a very strong theme is played on the PPG which appears four times. The syncopation is very precise and gives the subtle move away from the beat that is a feature of TD music. It is derived from Chris and Edgar's liking for modern jazz. The fast running notes up and down in the next stage of the piece are made on the PPG1 Sequencer with a random reset point selected by Edgar during recording to give a free feeling. As the music moves on, real thunder sounds are treated with flanging and phasing.

Edgar: We love to use natural elements against our electronic sounds and as a result we don't actually perform this piece on stage. Some effects such as this do restrict us from playing several pieces live, although for example, we now do the reversed cymbal effect on the MiniMoog.

Chris: In our performances we don't play too many pieces — our program is in two parts lasting around 45 minutes each (plus two planned encores!).

The piece ends with treated 'rain' washing away the music.

Network 23

Treated sampled sounds reveal a steady tempo with ringing filtered notes and a passing 'seagull' effect. Once again the filtered single sequence dominates, until a split channel (left and right) three note motif overtakes, with interesting interjections from flute-like and other echoing sounds. Panned 'seagull' flies past, with polyphonic chords anticipating the beat and 'voice' PPG sounds crying out. Finally, the Bass Drum is noticeable as the music fades away.

Remote Viewing

Here's a different sound altogether, with ethereal blends of strings, voice images and ad lib beats. A more ominous mix of sounds brings metallic PPG notes and continuous fades of other layers that eventually become a single flute. Behind the flute hangs three repeated sequences and an octave bass quaver group. As the flute whistles a meandering melody with vibrato, maracas shake semiquavers gently. The volume gradually increases as other PPG sounds improvise over the rhythmic sequences and the bass changes imperceptibly. Back comes the flute to close.

Mike Beecher **E&MM**

TANGERINE DREAM
A SELECTED DISCOGRAPHY

ALBUMS

Electronic Meditation, Ohr, OMM 556 004	1970
Alpha Centauri, Ohr, OMM 556 012	1971
Zeit, Virgin VD2503 (double album)	1972
Atem, Virgin VD2504 (double album with Alpha Centauri)	1973
Phaedra, Virgin V2010	1974
Rubycon, Virgin V2025	1975
Ricochet, Virgin V2044	1975
Stratosfear, Virgin V2068	1976
Sorcerer, MCA, out of print	1977
Encore, Virgin VD2506 (double album)	1977
Cyclone, Virgin V2097	1978
Force Majeur, Virgin V2111	1979
Tansram, Virgin V2147	1980
Thief, Virgin V2198	1981
Exit, Virgin V2212	1981

TANGERINE DREAM IS ALSO FEATURED ON:

Ossiach Live (BASF compilation) Track: Oszillator Planet Concert	1971
V (Virgin compilation) Track: 'Overture'	1974

SINGLES

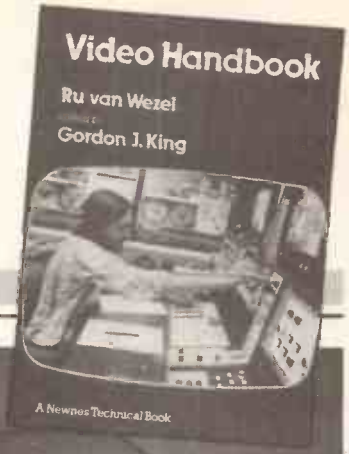
1966 The Ones — "Lady Greengrass/Love of Mine"
1972 Tangerine Dream — "Ultima Thule Parts 1 & 2"
(Only singles featuring material unavailable on albums listed).

SOLO ALBUMS
by Edgar Froese:

Aqua, Virgin V2016	1974
Epsilon in Malaysia Pale, Virgin V2040	1975
Macula Transfer	1976
Ages, Virgin VD2507 (double album)	1978
Stuntman, Virgin V2139	1979

WORKING WITH VIDEO

Andy Emmerson



With the New Year not too distant thoughts of New Year Resolutions start to materialise. My resolution for this column is to try and make it more practical . . .

The title of this piece is *'Working with Video'* and the idea is to cover the more creative facets of video. In just one thousand words a month this tends to be rather a challenge and what I try to do is point you in the right direction and keep you informed of new developments and trends, hopefully before you see them elsewhere. Manufacturers' hype and vague mumblings about the video revolution are carefully excluded!

If you ask what we are trying to get out of this video hobby of ours it must be a bit of enjoyment and self-fulfillment. Otherwise why would we spend possibly hundreds of pounds which could instead buy a very creditable hi-fi system or an impressive library of books? The reason is because we want to do our own thing. To preserve the TV programmes or performances we think are too good to see only once, to use our own camera and be our own video producer. The former needs only a VCR and a TV aerial, the latter needs additional equipment, at least one camera and ideally a selection of lenses, some lights and an effects generator. It also needs a bit of skill and experience, which you can build up as time goes by; the cameras, etc. don't come quite so easy, but there are ways round this.

For instance do not be obsessed with colour to begin with. Colour cameras are expensive - the "cheap" £300 ones give very disappointing results, a low resolution (fuzzy) picture and need a kilowatt of lighting in most indoor situations. Black and white cameras on the other hand are cheap even at new prices, can be bought secondhand from £50 upwards and usually give far better resolution than colour ones. They are much more tolerant of low light levels, less complicated internally and still worth hanging onto if and when you upgrade to colour. You can even build your own from a kit. I will continue this theme next month but now I want to tell you about a new book which you still have time to put on your Christmas list.

It's an expensive one, in fact it costs £19.90 but it's worth every penny of its price. The title, not very original, is the *'Video Handbook'* and it is written by Ruw van Wezel, published by Newnes Technical Books. It contains more information on *practical* video techniques than I have ever seen before and this is why I think it is worth the price. Its 396 pages have a photo or diagram on virtually every page and unlike other books it gives actual circuits, so that if you wish to copy them yourself you can. Build-it-yourself projects cover a black and white camera and a complete mixing, effects and control desk to enable you to make a home studio at a fraction of the cost of professional gear. Even if you do not have the skill or the inclination to build your own equipment you will find the comprehensive descriptions of how the apparatus works instructive. Subjects covered in great detail include monitors, processing amplifiers, sync pulse generators (including commercial integrated circuits) and effects circuits. Plugs and sockets in their infinite variety are covered as is the audio side. The author discusses cameras, monochrome and colour, and just as important he goes into the subject of lighting and optics, the various types of lenses and how they are used. Too many publications assume that if someone can afford a £750 colour camera they already know all there is to know about focal lengths, F stops and quartz-halogens; this is of course not necessarily true and to get the best out of your investment a book like this is cheap at the price.

Broadcast video is not neglected in the book either. Van Wezel explains how TV works, the various TV standards (with tables of data) and gives examples of test cards and how they are interpreted. All this is done, not in simplistic terms, but in language any enthusiast can follow and in a way that avoids boredom and technical details for their own sake. The book is international in outlook - it is written by a Dutchman and has already appeared in Dutch and German editions. Equipment described includes Sony (Japanese), Philips (Dutch), Grundig (German), Ferranti (UK) and Texas (USA), so there is no bias.

In a book as large as this there have to be a few shortcomings, but they are few. I spotted an error in one diagram (only one) and some of the technical expressions have been translated literally from the Dutch and make nonsense in English. In case you buy the book, you may care to correct the following:

"open net" - public network
"MF" - the author means Intermediate Frequency (IF) and not Medium frequency
"LF" - the author means Audio Frequency (AF), not Low Frequency
"Picture Sync" - Field or Vertical Sync
"Total Syncs" - Mixed or Combined Syncs

I would also question his use of BNC plugs for audio and his recommendation of Belling-Lee plugs for RF; in British practice DIN, phono or minijack plugs would be used for audio and his BNCs for the RF. But these are minor criticisms of a remarkably comprehensive book, which must have been a labour of love. In fact the author's enthusiasm shows through. This British edition has apparently been edited by Gordon J. King, though judging by the errors noted above and some more trivial ones I think he must have done it last thing on a Friday afternoon!

Joking apart, the book is highly recommended and despite its price is well worth having. If you can afford video as a hobby you can afford this book. For the price of two three-hour tapes you too can be a video expert! I make no apology for concentrating on this book this month - you can learn a lot from books and nobody is an expert on video just because he owns a video camera. Reading the monthly video mags is useful but for solid fact you can't beat a good book!

Next month we'll talk about getting hold of secondhand equipment and setting up your own studio **E&MM**

The picture shows Mitsubishi Electric's new HS 302 video cassette recorder. Recommended price £549.

Hi-Fi

Jeff Macaulay

One of the joys of technical writing is the opportunity it gives to chew over ideas and basic principles. Often these deliberations lead to experimental circuits which in turn enhance one's understanding and experience in electronics.

This month I have been engaged in writing an article on how to design one's own sub bass woofer. Much of the thrust of speaker technology has been directed at the problem of gaining as much bass as possible from existing enclosure types. The manufacturers suffer from the drawback of having little influence over the electronics used to drive their creations.

This is just the area in which the electronics enthusiast can make his mark. Existing Hi-Fi installations can easily be manipulated by the addition of external circuitry to compensate for the shortcomings of speakers etc.

The obvious example of this is the graphic equaliser which seems to be doing better in the American market than here. One of the reasons for this is probably the fundamental dichotomy between the design philosophies of the British and Americans.

Our friends across the 'pond' are almost conditioned to accept that the more EQ that can be fitted into a preamp the better. We, of course, tend to be more conservative about these things arguing that if the system is flat from the microphone to the speaker then all will be well.

It is interesting to note that several American speaker manufacturers employ active EQ boxes designed to be used with their speaker systems. One of the most obvious uses of such an EQ box would be to boost the deep bass response.

As part of the research for the above mentioned bass article I designed just such a box for use with I.B. enclosures. Most speakers encountered nowadays are of this variety and in consequence most could use a little judicious bass boost.

Normal tone controls are useless for this particular application because they are mainly designed for the maximum effect. In practice this means that they start to boost the signal just below 1kHz. In consequence the mid-range is boosted as well and the whole signal becomes severely coloured if the lift is advanced far enough to counter the roll-off of the speaker system.

A better solution is to design a filter that gives a known amount of boost at a very low frequency with a response that complements the speaker's own roll-off.

The most important information, where to start boosting the response can be obtained from the data included with the speaker. This will quote the low frequency -3dB limit. Once this information is known it is a relatively simple matter to design a filter with the right characteristics.

Figure 1a shows just such a circuit. Since the roll-off of I.B. enclosures is some 12dB/octave the circuit contains two separate 6dB/octave boost sections. Each section works as follows.

With reference to Figure 1c, A1 is a conventional op-amp connected as a non-inverting amplifier. This means that the output signal is in phase with the input signal which is applied to the +, non-inverting input. It is a characteristic of an op-amp connected in this manner that the voltage gain is equal to $R_f/R1$. So even if R_f were to be a short circuit the gain cannot fall below unity.

At high frequencies the capacitor, C1, will appear to be a short circuit and as this is shunting the signal across R_f it follows that for practical purposes the amp's gain will be unity. As the input signal's frequency is lowered there will come a point at which the impedance of the capacitor is equal in value to the resistance of R_f. This is the much vaunted '3dB point' in the frequency response of the amp. As the input frequency is lowered towards DC, C1's impedance rises. Eventually it is large compared to R_f and the amps gain becomes as predicted by the above equation.

The impedance of a capacitor can be defined by the following simple equation, $Z = 1/(2\pi fC)$. C is in Farads, f in Hz, and Z in ohms. To take a practical example let's suppose that we want our amplifier response to be +3dB up at 50Hz. In order not to upset the power amp unduly it's a good idea to keep the maximum gain to 6dB, 4 times. This sets the ratio between the value of R_f and R1 at 3 times. For the sake of example let's make R_f 47k. The nearest standard value for R1 is then 47/3 = 15k. Having settled this the next stage is to determine the value of C1. For 3dB at 50Hz we need to choose a value which will have an impedance of 47k at 50Hz.

Rearranging the equation for impedance we obtain $C = 1/2\pi fZ\ [10^{-6}] = 6.77 \times 10^{-6}F$, i.e. 68nF.

When such a single stage amp is placed between the pre and power amp feeding the speaker the results are quite dramatic. For starters the rapid 12dB per octave roll-off is halved instead of being 12dB down at 25Hz the response is only 6dB down. The result is an increase of deep bass without detriment to the rest of the frequency range.

A still more elegant solution is to cascade two such circuits in series. This will extend the -3dB point down by half an octave. Our speaker will then be 3dB down at 38Hz! This will allow bass drums, for example to be reproduced at their proper volume.

For this return to Figure 1a. Here the resistor values have been adjusted to give a maximum gain of 2 per stage, 4 in total. The capacitor values have also to be changed in order to ensure that the response is 1.5dB up at the selected frequency in each stage.

Keeping the feedback resistor at 47k the right value for C can be determined from the table. Other values can be determined by using the equation $C = \frac{4.8 \times 10^6}{f}$ (C is expressed in Farads).

The circuit can easily be built on a piece of Veroboard and mounted in a suitable, preferably metal, box. A PP3 gives a reasonable life. Only one channel is shown, the other is identical. **E&MM**

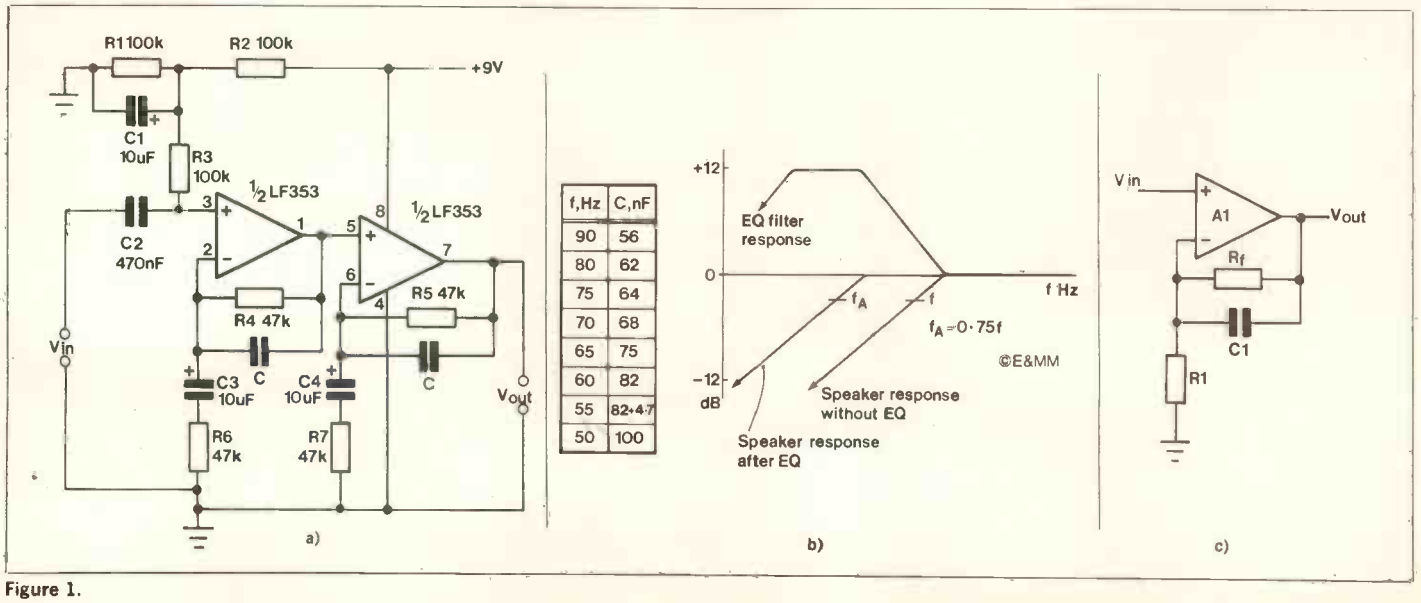


Figure 1.

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MAKING NOTES

Here is Part 2 of a new workshop series 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.

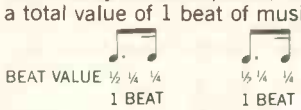
In last month's article, I established that notes of music are written upon the Treble and Bass Staves to represent a specific sound or 'pitch'.

The notes also represent 'musical time', which is measured in BEATS rather than in seconds and minutes. The form of the notes determine their BEAT VALUE and will indicate the length of 'time' a note will be held when played. RESTS in their various forms represent 'silence' in music and each rest will have a time or beat value (see Figure 1).

Each note, apart from the semibreve, has a 'stem' connected to it. The quaver also has a single 'flag' attached to the stem ♪ and the semiquaver has two 'flags' attached to its stem 𝅘𝅥𝅯.

When a 'DOT' is placed beside a note its BEAT VALUE is increased by half as much again (see Figure 2).

The dotted quaver, ¾ beat, is usually followed by the semiquaver, ¼ beat, to make a total value of 1 beat of music.



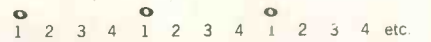
For convenience of writing two quavers, the flag of the first quaver can be joined to the second quaver to form a single line. The flags of the semiquavers can be joined between notes to form a double line (see Figure 3).

I am often asked, 'How long does a beat of music last?' or 'How long do I hold a minim, crotchet or quaver?' and many more questions on 'musical time'. My answer is that by learning how to count EVENLY, in your own time, and lightly tapping on a note of the keyboard, or anything else within reach, a pattern of musical time will emerge.

Count EVENLY from one to four, 1 - 2 - 3 - 4. Repeat the counting several times over and as you count tap once for each number:

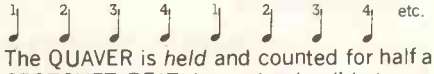
1 2 3 4 1 2 3 4 1 2 3 4 etc.
tap tap tap tap tap tap tap tap tap tap tap tap

Each number will represent the time value of ONE CROTCHET BEAT.
The SEMIBREVE is *held* and counted for 4 CROTCHET BEATS.

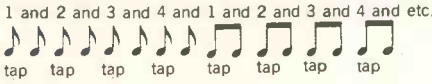


The MINIM is *held* and counted for 2 CROTCHET BEATS.

The CROTCHET is *held* and counted for 1 BEAT.



The QUAVER is *held* and counted for half a CROTCHET BEAT, by saying 'and' between each number.



When counting for the quavers the 'tap' will occur on the 1234 only, not on the 'and' (see Figure 4).
Count evenly, in your own time.

When a 'TIE' joins two notes together, the first note is held, or will sound, for the total beat value of both notes, even when the notes have a different beat value.

The first crotchet is held for a total of two crotchet beats.

The dotted minim, value 3 beats, is tied to a minim, value 2 beats, and is held for a total of five crotchet beats.

𝅘𝅥𝅰 DEMISEMIQUAVER. There are 32 DEMISEMIQUAVERS in a whole note (semibreve). Space does not permit showing 32 of them on the above illustration.

Each stave is divided into BARS or MEASURES by 'Bar Lines'. In the final bar of the music two lines are drawn, these are known as a 'double bar lines' (see Figure 6).

The METRONOME or 'musical clock' is the standard method of learning precise 'musical time' and although it is now included as a feature on the rhythm unit of some electronic organs it is not normally used by the home musician. (There is a metronome project in May 1981 E&MM and this month's special offer features the Tempo-Check.)

Most musical arrangements include the 'timing sign', such as ♩ = 80, above the treble stave at the start of the music, which means that 80 crotchet beats should be played to the minute. Only the use of the metronome can ensure that the music is played exactly to the time indicated by the sign. A group performer, a pupil taking grades of music, a member of an orchestra,

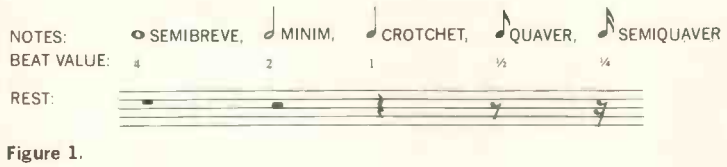


Figure 1.

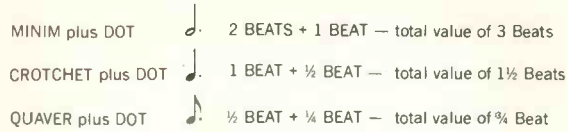


Figure 2.

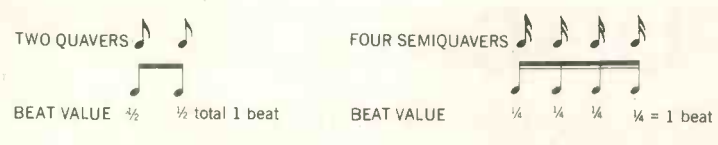


Figure 3.

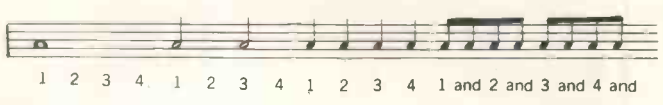


Figure 4

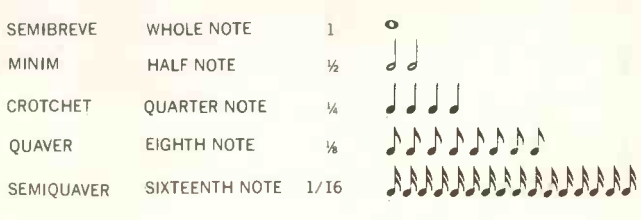


Figure 5.

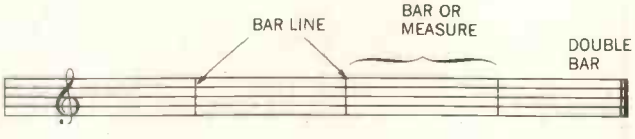


Figure 6.

by Brenda Hayward

a musician playing for dancing, name but a few who must strictly observe exact timing. While it is desirable for the home musician to fully understand and try to achieve correct timing, it is not so important when playing for pleasure. After all, simply creating music can be very satisfying.

What is a TIME SIGNATURE? Why is it there and what does it tell you? The Time Signature consists of two numbers, written on the stave, one above the other to represent the timing, 'beats in a bar' of the music.

The UPPER number is simply the total number of BEATS in each bar of the music. If the upper number is '3', then there are three beats in each bar. If the upper number is '4', then there are four beats in each bar.

The LOWER number determines which TYPE of note receives 1 beat of the music. To interpret the lower number, each type of note is made a division, or part of the semibreve 'whole note', the largest note value in modern music.

When the semibreve is divided, each MINIM is a half note (½), each CROTCHET is a quarter note (¼) and each QUAVER is an eighth note (⅛) (see Figure 5).

The two most common TIME SIGNATURES are  and 

In the $\frac{3}{4}$ time signature, the upper number is 3 beats in each bar and the lower number 4 represents the crotchet (¼) Note (see Figure 7).

Each bar can contain notes and rests of different beat values, but the TOTAL beat value of each bar will be equivalent to the time signature.

In the $\frac{4}{4}$ time signature, the upper number is 4 beats in each bar and the lower number 4 represents the crotchet (¼) Note (see Figure 8).

The $\frac{4}{4}$ time signature can also be written as 'C'.  It is known as 'Common Time' and indicates 4 crotchet beats in a bar.

The 'cut common' time signature, 

could also be written as $\frac{2}{2}$.

though this form is not normally used in popular music. The upper figure '2' represents TWO BEATS in each bar and the lower figure '2' represents the minim '½ note'.

2 - BEATS
2 - THE MINIM
Two MINIM BEATS in each bar.

'Cut common time' usually occurs in music with a faster tempo, when it is easier to count two minim beats rather than four crotchet beats in a bar (see Figure 9).

A 'TRIPLET' is a musical term for three notes grouped together with a figure '3' written above or underneath them.

When 3 quavers are grouped together in this way:  they are played to the TIME value of TWO quavers, and are named a 'quaver' or 'eighth triplet'. (A quaver is a ⅛th note of a semibreve.)

When 3 crotchets are grouped together in this way:  they are played to the TIME value of TWO crotchets, and are named a 'quarter note triplet' (a crotchet is a ¼ note of the semibreve).

Fingering

A common problem when playing a keyboard instrument is incorrect fingering. The fingers of each hand are numbered one to five. The thumb is No. 1 and the little finger is No. 5. It doesn't leave much to the imagination for the other three fingers to be numbered 2, 3 and 4.

When reading the manuscript the notes *ascending* the treble stave are played with the right hand moving to the right of the keyboard. In 'fingering' the sequence of white notes in the following examples, the thumb will be tucked *under* the hand — never over the hand (see Figure 10).

Example 2 illustrates how to continue playing the sequence of notes in an upward movement, without running out of fingers. In a downward movement, the finger numbers remain the same, but the 4th, 3rd and 2nd fingers will now reach *over* the top of the thumb to play the next notes in the sequence.

The fingering for playing each note, black and white, known as a 'Chromatic' movement, is an excellent exercise for keeping the fingers supple. In an upward sequence tuck the thumb *under* the hand (see Figure 11).

Starting on the upper note of 'G', play a *downward* sequence of the notes in the illustration, using the same fingering, but with the 3rd and 2nd fingers reaching over the top of the thumb to play the next note in the sequence.

Spend a little time and perseverence playing the preceeding examples to learn correct fingering, which will eventually become automatic. **E&MM**

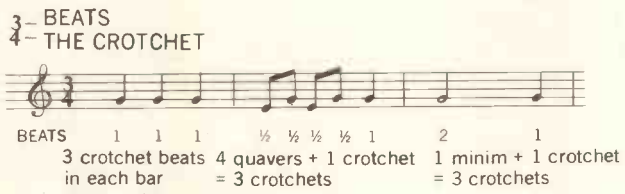


Figure 7.

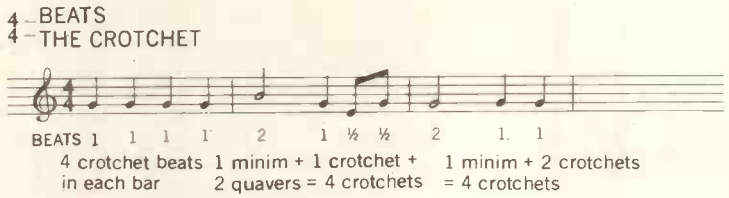


Figure 8.

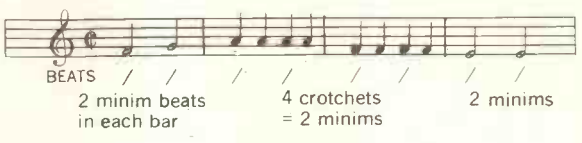


Figure 9.

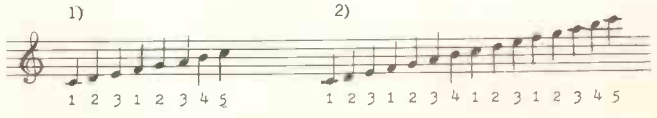


Figure 10

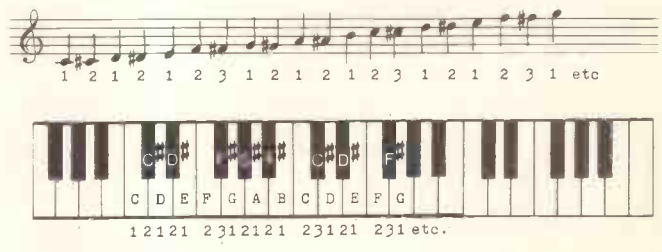


Figure 11.

ELECTRO-MUSIC ENGINEER

by Ben Duncan

Audio Connectors

Whilst connectors are very literal 'links' in the belaboured musical communications chain, their simple role belies the fastidious attention they deserve - at least in respect of initial choice and installation. For connectors suffer almost ritualistic physical abuse, greater than that offered to any other stage or studio equipment with the exception of drumsticks, headphones and microphone stands! It's perhaps out of context, but nonetheless a sobering thought to remember that £100,000 of sound equipment frequently hangs on the end of a weary jack plug during a solo performance on stage.

Similarly, certain key connections - notably mixing desk multicore and power plugs impose a ransom on the whole sound system, demanding to be made as reliable as money and ingenuity will allow.

Countless sound system failures occur unnecessarily and many can be traced to misguided visions of prudent economy via low cost plugs or half-hearted wiring up, coupled with an ignorance of Murphy's law: "If anything *can* go wrong - *it will*, and at the worst possible moment." If your favourite, but utterly decrepit guitar lead has caused concern amongst your colleagues, but has 'never let me down', you can be sure it's still awaiting the worst possible moment!

Jacks

Being a single pole connector, the standard ¼" Jack is extremely versatile; it's also easy to wire and cheap. These factors make it the mainstay connector in small sound systems, and provided you eschew false economy and use high quality soft plastic or metal bodied versions, viz Rendar (RS) or better still, solid brass bodied types, e.g. Switchcraft and Whirlwind, then the problems of ill-timed disintegration need not apply.

However, the high quality jacks tend to make use of screws in their assembly, and these have been known to slacken under duress of bass-induced vibration. Even so, potentially slack nuts are preferable to the loose and flimsy rivets so common in low grade jacks of oriental origin, and the problem can be deftly side-stepped with a drop of thread locking compound e.g. 'Loctite'.

In studios and extensive PA systems, there's a need for a multiplicity of stereo and/or send-return connections. These requirements can be handled with versatility by the standard jack, viz, inverted lefts and rights can be readily straightened out. By the same token the margin for errors is much greater, so provided the wiring is initially correct, the use of stereo or 2 pole jacks is preferable - and can also save a lot of panel space in large installations. Unfortunately, this convenience only applies to unbalanced lines - for the balanced variety, we would need a four pole jack or a pair of two pole jacks.

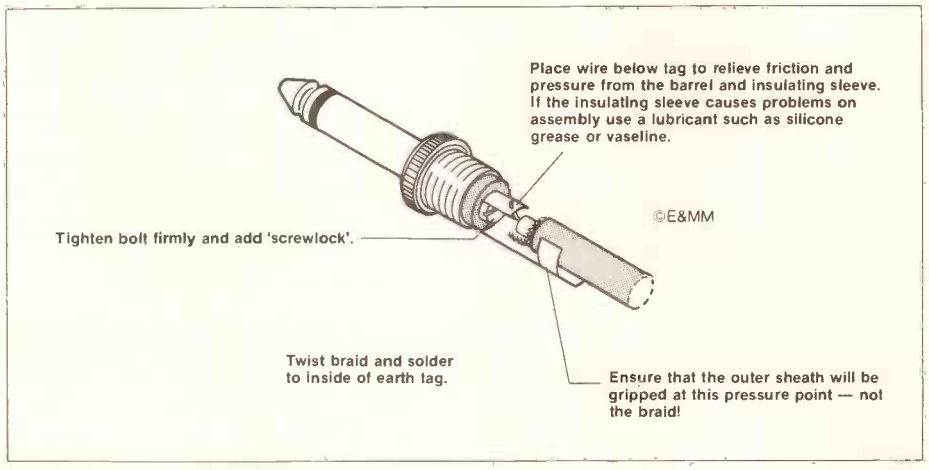


Figure 1. Jack connector wiring.

The beauty of jacks in applications of this nature (i.e. patching) is the ease with which they can be pushed in and pulled out, and their ability to perform switching operations in conjunction with the socket. Using standard ¼" jacks, we're restricted to something akin to a double throw switch - insertion of the jack re-directs the signal out via the plug. However, by using the 'GPO', 'Telephone' or 'B gauge' jacks - these feature a smaller tip - the versatility of the switching functions can be greatly augmented, jack insertion being able to switch auxillary functions such as lamps, apart from re-routing the signal.

Additionally, by using the 'B gauge' pattern, the need to use two plugs for stereo, balanced line operation is overcome, because 4-pole (2-finger) plugs are available. Note however that the 'B gauge' plugs are *not* compatible with standard jack sockets, and that attempts to ram a standard jack into an apparently normal socket of the surreptitious 'B -gauge' variety will damage the latter.

Apart from their limited latching abilities, the major shortcoming of the jack is that plugs are always cable mounted and it's all too easy for the inebriate to plug microphones into power amplifier outputs! In addition, during insertion and withdrawal, the live tip is prone to short on the chassis terminal of the socket. For this reason, these connectors are best restricted to mic and line level stages, where little harm can occur, and they're best avoided altogether for DC distribution and high power (>100 watts) audio connections.

The XLR

The 3 pin XLR or 'Cannon', having tripartite advantages over high quality jacks, is the alternative up-market universal audio

connector. Firstly, it features a latching facility which neatly obviates the tendency for plugs to fall out/be torn out by clumsy footwork at vital moments. At the same time, the latch is readily disenabled, which makes the XLR suitable for patching purposes (where the space and expense can be justified), or wherever cable tension causing disconnection of the plug is preferable to causing equipment to topple over, viz: microphone leads at the amplifier end. Also, male and female XLR plugs (or cable mounting connectors) are very definitely assigned to inputs and outputs respectively.

Apart from being a universal standard, the male to female XLR cable also lends itself to being plugged together, not only to make extensions, but to outwit the tendency for cables to turn into spaghetti *en route!*

Finally, all XLRs feature excellent cable clamps, so once they're properly assembled, they will withstand months or years of severe abuse before the cable termination succumbs.

There are broadly four makes of XLR, each with foibles and of varying price, available in Britain; and compatability isn't automatically assured, as successful mating is crucially dependent on fine tolerances. So it's wise to seek the conformity of one manufacturer from the outset. At the same time, the purchase of XLRs is a long term investment, involving a large outlay, so choosing the right XLR - one which will suit

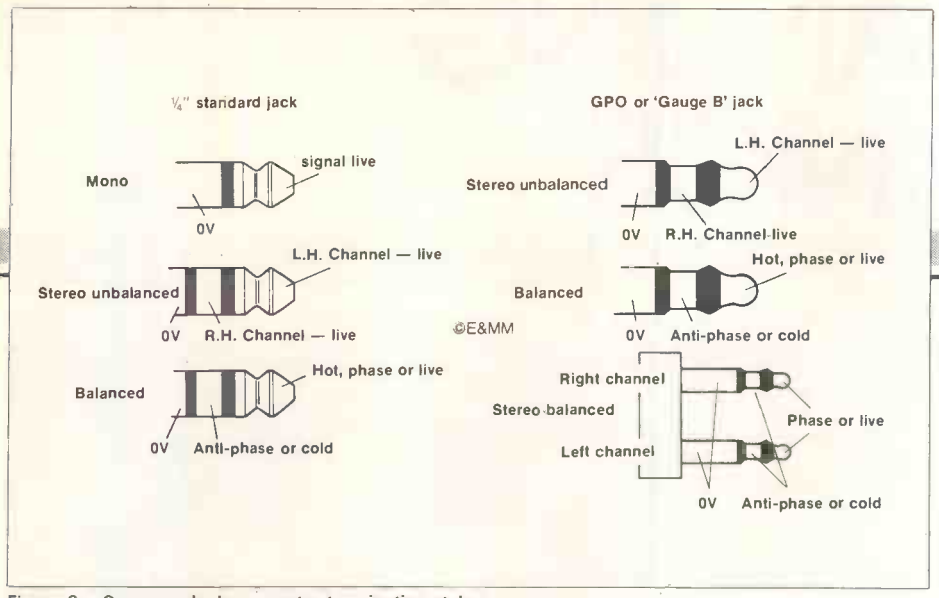


Figure 2. Common Jack connector termination styles.

your needs best - is equally essential.

The ITT-Cannon XLR, also available under the RS brand name is the most expensive of the four, but it features rubber insulation on the female inserts, which makes it particularly durable and resilient to misalignment. As a result, Cannon plugs and sockets are frequently the exclusive female connector in systems using other varieties of male connectors. The main shortcoming of Cannon XLRs is the use of non-captive grub-screws involved in their assembly. These frequently go astray, to make wiring up backstage very tedious, although once they're in place, a drop of threadlock compound will keep them captive for some time. If all else fails, kits of spare screws, bushes and clips are available from Cannon distributors such as PSP and Future Film Development.

The Switchcraft, Neutrik and Deltron types feature hard plastic insulators throughout, which makes them more prone to shatter, but they are all considerably cheaper and whereas they are not entirely devoid of small screws, assembly in awkward situations tends to be much easier.

In general, the PA business is joined together with Switchcraft and Cannon XLRs - mainly because these are the most rugged, and the two styles usually mate and latch without tolerance worries. Also, the Switchcraft plugs feature a chassis terminal; this makes an extra terminal available in DC power distribution and other idiosyncratic applications, quite apart from giving greater flexibility in groundlifted and quasi-balanced sound systems.

Deviations

At some time, we all have to inferface items of equipment that sport sub-standard 'consumer' terminations of the DIN and Phono variety. If you own the offending equipment, tearing out the offending sockets and replacing them with jacks or XLRs will save no end of hassle in the long run. Frequently, however, this approach is a little too extreme, particularly as regards the re-sale value of the equipment in cosmetic terms. As a compromise, replace the sockets with an up-market equivalent, (viz: gold-plated phonos and latching or screw-locking DINs). Then, using corresponding up-market DIN and phono plugs, wire into a diecast box containing the appropriate jack or XLR sockets. The box can then be bolted to the equipment, or simply retained on the flying umbilical cable. The general idea is to avoid unplugging the domestic style plugs, for if treated as permanent connections, their lifespan will be greatly enhanced. the 'patch box' can also usefully bring the awkward-to-reach sockets out into an accessible position.

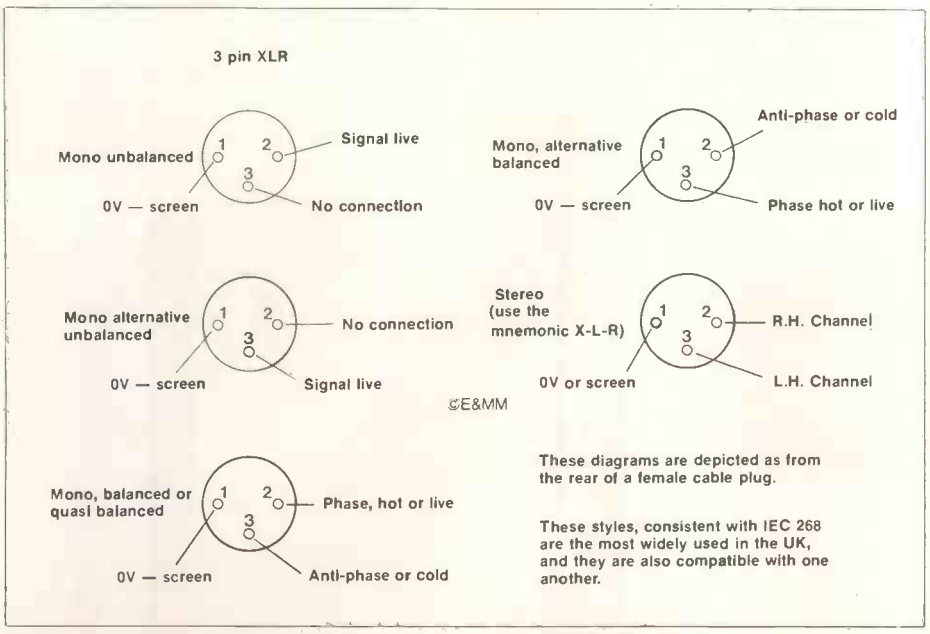


Figure 3. Common XLR connector termination styles.

Of course, the above arrangement will also suit equipment you don't own, but a more flexible solution is simply to make up a number of leads to convert other standards to your own. As Murphy's Law ensures that DIN sockets invariably beg for connection to XLR systems when shops are closed and soldering irons have been left at home, the motto for on-the-road is to be prepared for all manner of ad-lib connections.

Wiring up

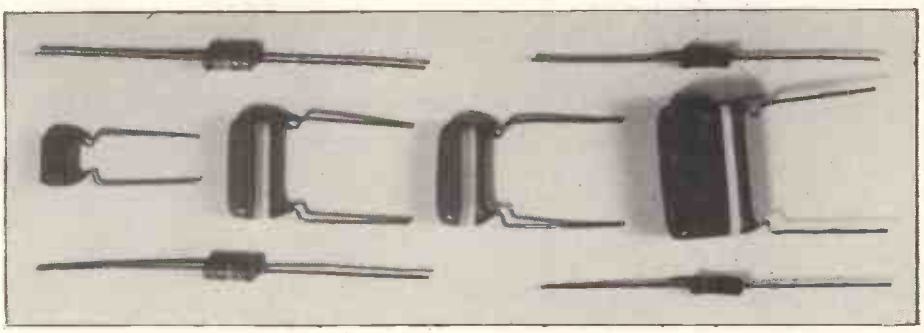
High quality plugs do not alone make for reliable and hassle free interconnection; a partnership with skilled wiring is paramount. The pre-requisites for the latter are good tools, good lighting and a relaxed atmosphere. As the musicians' environment habitually lacks these, it makes sense to wire and check your connectors at home or in the workshop, so that on-the-road repairs can be as infrequent as possible. Figure 1 depicts the elements of a well wired jack plug, the essential requirements being two-fold. Firstly, the uninsulated wire - including *whiskers* - should be cut flush to curtail the opportunity for short circuits. Secondly, due attention should be given to strain relief, both tensile (tearing the cable from the plug) and flexure (bending the cable causes metal fatigue) by testing the action of the cable clamping and bushing for each combination of plug and cable style. If you lack the confidence or the enthusiasm to become skilled at making your own cables, the services of specialist audio cable makers are worthwhile, particularly as regards the most vital leads. Alternatively, the heavy duty, ready-made guitar leads (e.g. Whirlwind) or XLR cables (e.g. Red Devils) are an excellent investment.

Finally, a plea as regards the poetry of terminology. Although a number of unprosaic people insist that a plug is any male connector, viz, something with pins, regardless of whether it's cable or chassis mounted, a more down to earth attitude is to use the term plug for anything hanging from the end of a cable, and likewise, a socket is a fixed, or chassis mounted connector. The arrangement is then made totally unambiguous by adding the terms male or female to specify pins or holes. Thus, a Switchcraft 'A3F' XLR, or in shoddy electronics industry parlance, a cable socket, is termed a female cable plug. A description of this kind can attain a uniquely unambiguous vitality through imagery. In other words, use the description to build up a mental picture, and you won't waste time and money buying or wiring up inappropriate connectors. **E&MM**

UNDERSTANDING ELECTRONICS

Robert Penfold

Colour Codes



Newcomers to electronics could be forgiven for thinking that colour codes are used on certain electronic components purely to make life difficult. In fact, there are a couple of good reasons for using colour codes, and one of these is simply that a value marked in this way is less likely to be obliterated than one marked in figures and numbers. Even if the colour coding should become partially removed it is still likely that easy and accurate decoding would be possible. Partially obliterated letters and numbers are almost certain to be meaningless, or worse still, misleading with the value being read incorrectly. Another point in favour of colour codes is that they enable experienced users to quickly pick out a component of the desired value from a large batch of components, or quickly locate a component of a certain value on a large circuit board. With experience you learn to read colour codes without really having to consciously think about it.

Resistors

Resistors usually have their value marked by means of four coloured bands around the body of the component, and very few types have the value marked by other means. The first band, which is the one nearest to one end of the component (see Figure 1) gives

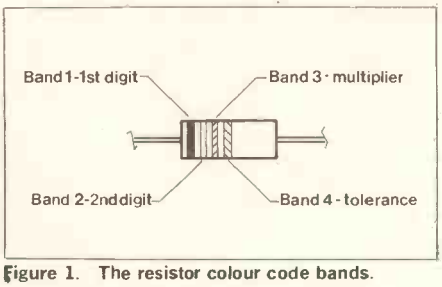


Figure 1. The resistor colour code bands.

the first number of the value, the second band gives the second digit, and the third band gives the multiplication factor needed to bring this two digit number to the correct figure. The fourth digit gives the tolerance of the component's value. The power rating of the component is not indicated by the colour coding.

The colours used in the resistor colour code and the figures they represent are given in Table 1.

It we now take a few examples it should make the code perfectly clear. A component having red, violet, orange, gold as its markings would have 2 as the first digit of the value and 7 as the second digit. This gives 27 which must be multiplied by orange, which represents 1000 when it appears in the third band, and this gives a value of 27000 ohms (27 kilohms or 27k in other words). The gold fourth band indicates that the tolerance of the component is ± 5%, by which we simply mean that the actual value of the component is within 5% of its marked value.

A resistor having bands one to four with the code brown, black, blue, silver would have a value of 10000000 ohms, or 10 megohms (10M as this would normally be written). The brown and black bands give the first two digits of 1 and 0 respectively, and then the third band gives the multiplier value of one million. Ten multiplied by a million is obviously ten million ohms, or ten megohms. The silver fourth band indicates a value which is within 10% of the marked value, so that the actual value of the component would be between nine and eleven megohms.

A resistor having a coding of red, red, gold, red would have a value of 22 x 0.1 which equals 2.2 ohms. The tolerance would be ± 2%.

Capacitors

Not many capacitors use colour coding these days, but one common range of capacitors that do is the C280 range of printed circuit mounting polyester capacitors. The first three bands indicate the value in the same way as the first three bands in the resistor colour code, but the value is in picofarads (pF) not ohms, of course. The figure indicated should be divided by 1000 to give the value in nanofarads (nF) or 1000000 to give the value in microfarads (uF). Green is used in the third band of the C280 colour code, unlike the resistor colour code. The first band of a C280 colour code is the one at the top of the component, opposite the leadout wires, as shown in Figure 2.

The fourth band indicates the tolerance of the component, but the code here is different to that used for resistors. Only two colours are commonly used in the fourth band: black which indicates a tolerance of ± 20%, and white which indicates a ± 10% tolerance.

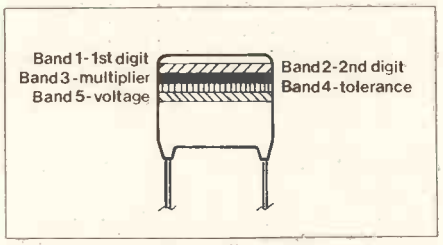


Figure 2. The C280 capacitor colour coding.

The C280 colour code has a fifth band and this indicates the maximum DC working voltage of the component. Again only two colours are normally used here; red for 250 volt components, and yellow for 400 volt types.

For example, consider a capacitor with the marking yellow, violet, orange, black and red. The first three bands give 4, 7 and a multiplier of 1000 as with the resistor colour code. Thus the value of the capacitor is 47000pF or 47nF. The fourth black band indicates that the tolerance is ± 20% and the fifth red band a maximum DC working voltage of 250V. **E&MM**

Table 1. The resistor colour code.

Colour	Band 1/2	Band 3	Band 4
Silver	not used	0.01	± 10%
Gold	not used	0.1	± 5%
Black	0	1	not used
Brown	1	10	± 1%
Red	2	100	± 2%
Orange	3	1000	not used
Yellow	4	10000	not used
Green	5	100000	not used
Blue	6	1000000	not used
Violet	7	not used	not used
Grey	8	not used	not used
White	9	not used	not used
No colour	not used	not used	± 20%

GUIDE TO ELECTRONIC MUSIC TECHNIQUES

Paul Conway

Flanging

Last month I explained how phase effects could be produced electronically, and mentioned briefly how this was produced in the early days by using two tape recorders.

In actual fact, the method used by broadcasting and recording studios was referred to as "flanging", because the speed of one of the tape machines was varied by pressing the tape reel "flange". However, modern flange effects are more sophisticated than the early attempts, and some modern electronic phase effects sound subjectively more like the early flanging effects!

If you are now completely confused, do not worry as all will be revealed; but it must be realised that in electronic engineering, many words used to describe effects are often chosen for historic reasons, and flanging is no exception.

There is one other point that should be made here, and that is that there is nothing to stop a particular manufacturer producing an effects unit and calling it a flanger, although it may not comply with the generally accepted meaning of the word. Each unit must therefore be taken on its own merits and its features carefully examined.

The term flanging in general relates to an effect that is produced by having a series of notch filters, with the frequencies of the nulls being harmonically related; for example 100Hz, 200Hz, 400Hz etc. An audio delay line can be configured to produce a comb filter response as described last month and by slowly changing the delay, the basic flanging effect can be achieved.

"What is the difference between flanging and phasing?" you may ask. The simple answer is that from a systems point of view they are very similar; the main differences being in the frequencies of the notches, and in the overall frequency response of the filter. Phasing is often defined as when the rate of the sweep is higher and the frequencies of the notches need not be related harmonically.

Flanging effects are always produced, then, by notch filters whose frequencies are harmonically related. Another characteristic of flanging is that the notches of the comb filter response extend down to lower frequencies than those of the phaser; and as shown in a previous article, this requires a longer delay because the lowest notch occurs at a frequency corresponding to a half wavelength at the maximum delay. For example if it was required to extend the lowest notch frequency to 50Hz, then:
1 Wavelength = 1/50 = 20ms.
i.e. ½ wavelength = 10ms = Maximum delay time.

Flanging is often described as "Tunnelling" because of the characteristic sound produced. It is also sometimes referred to as a "Soft Phase" or L.F. (low frequency) phase.

A block diagram of a flanger system with all the effects that have been described is shown in Figure 1 although the facilities available with any particular unit will obviously have a bearing on its cost.

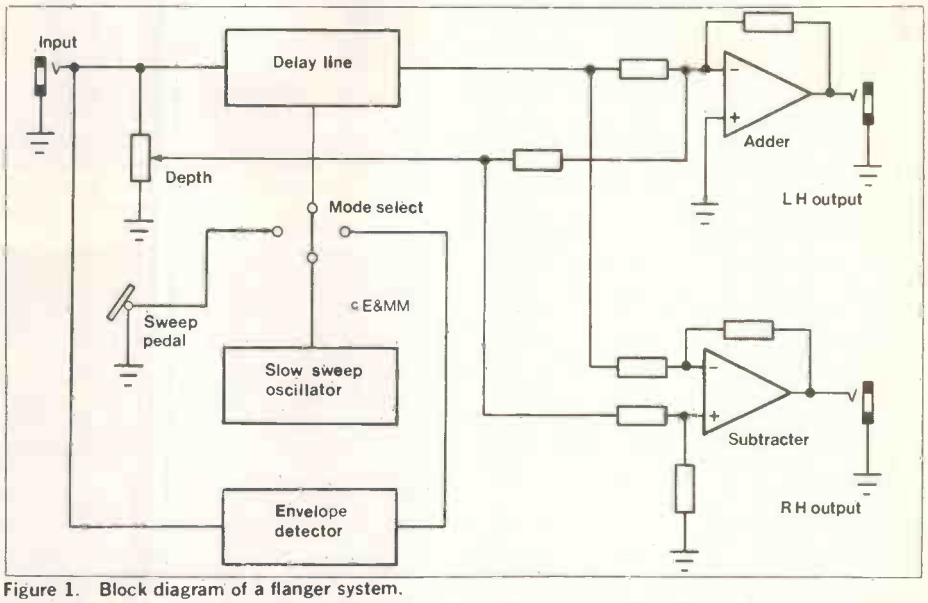


Figure 1. Block diagram of a flanger system.

There are many flanger units on the market today, but they differ mainly in the range of variations of the basic flanger effect that can be produced, and in the technical quality of their output.

However, facilities possible with this effect are as follows:

Slow Sweep

In this mode of operation, the delay is varied by a low frequency oscillator which has the effect of moving the peaks and notches in the filter response up and down the frequency range. The rate at which this is carried out is usually slower than that used to produce phasing effects and is typically 3 to 5 seconds per cycle, i.e. a frequency of about 0.2 to 0.3 Hz. Most units allow the sweep frequency to be varied manually to give some variation of this effect.

Depth

This control varies the amplitude of the delayed signal that is mixed with the original; hence the depth of the notches in the comb filter response can be greater. More depth will increase the attenuation at the frequencies of the notches, and will increase the height of the peaks, therefore causing the tunnelling effect to be more prominent; whereas the converse will occur when the depth is reduced. Zero depth will result in the original signal appearing at the output.

Manual Sweep

Rather than have the comb filter sweeping automatically, as in the slow sweep mode, the operator can control the sweep manually in this mode. By connecting the sweep control in the flanger either to a manual control knob, or as is more usual, to a foot pedal, the performer can control the sweep whilst keeping both hands free for his or her musical activity.

Envelope Control

This again exercises control over the sweep of the flanger but in this case uses the envelope amplitude to control the sweep. This means that the position of the peaks and notches in the filter response are proportional to the instantaneous amplitude (i.e. volume) of the instrument that is driving it.

Pseudo Stereo

There are various methods of producing stereo effects from a mono signal, and in fact some of the up-market professional flangers produce some rather interesting pseudo stereo effects. One method of achieving this is to take the output of the delay line and add it to the original signal for the left hand channel, whilst the delayed signal is subtracted from the original signal for the right hand channel.

The positions of the filter notches will now be different in each channel, but still harmonically related. For example, a signal that has been delayed by a half wavelength at a particular frequency or multiple thereof, when added to the original will cause cancellation and therefore a notch; and when subtracted it will produce a peak. So, if the filter is now subjected to a sweep, frequencies that are cancelled in one channel will be enhanced in the other channel, the sweep effect causing cancelled frequencies in one channel to appear to "tunnel" in the other channel.

This produces an effect which subjectively can be described as producing a feeling of space, and one which some would describe as "rotational".

Before we leave the subject of flanging, it should be mentioned that not all flanger effects use a delay line to produce the comb filter response; although this is the most effective method, it is also the most expensive. Another method which produces a softer flange is to have three voltage controlled filters whose notch frequencies are harmonically related. This produces a three notch comb filter which can be controlled using the same sweep features previously described. The flange produced using this method is not as prominent as the delay line approach, but may be preferred by some.

E&MM

GUITAR WORKSHOP

Selecting and fitting a replacement bridge

Peter Cook

Gone are the days when you had to accept your instrument in its original form or leave it, for the replacement hardware now available in great abundance allows the musician to upgrade his instrument to his own personal requirements. With the bassist in mind I will suggest how to make a simple but sometimes dramatic improvement.

Obviously it is impossible to cover every bass available, so as a general guide I intend to use the Rickenbacker 4001, Gibson EB2 and Fender Precision and Jazz Bass (for bridge replacement purposes this is identical to the Precision, so for Jazz read Precision).

Before thinking about which replacement unit should be fitted, first ascertain the reason for your disenchantment and choose accordingly.

Gibson EB2

I doubt if many EB2 players are really happy about the tuning; until recently the only option was to *make* a replacement adjustable unit, but at least one company that I know of (Schaller) now market a completely adjustable direct replacement bridge. Fitting couldn't be simpler; once the bass is de-strung, remove the old bridge and slide on the new. At this stage it will be noticed that there are two screws providing a variable amount of forward movement on the height adjusting studs. To set these, first position the bridge saddles in the centre of their travel. After taking the strings up to pitch, test for octave accuracy on G(1st); if the octave is sharp turn the adjacent screw clockwise, and vice versa. When the tuning is approximate repeat for E(4th). Now that E and G are roughly in octave the bridge is set in the correct position, so final critical adjustment of the four strings can be made via the individual saddle length screws.

Fender Precision

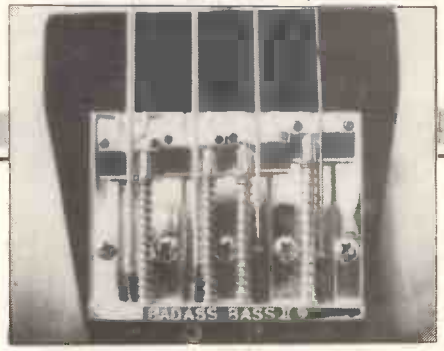
Apart from the visual desirability there are four considerations leading to replacement.

(1) Rusty and inoperative. Obviously something is needed, but if the old unit was satisfactory in every way the answer is probably to replace it with an identical one, either an actual Fender or one of the reputable replicas (Mighty Mite, Schecter, etc.), if not read on.

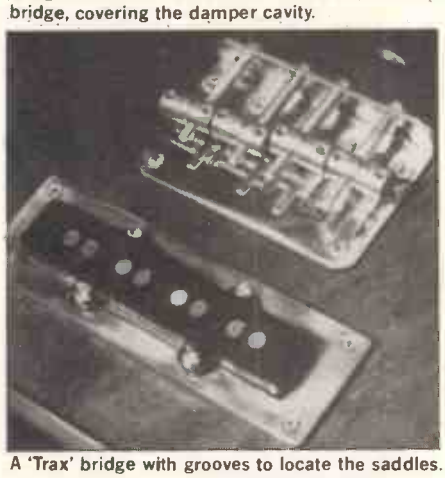
(2) The advent of brass has made many players hyper-sensitive to sustain, so for some the old style pressed steel base has lost its appeal. Generally more sustain can be obtained by increasing the mass, so a number of milled or cast brass bridges are marketed with thicker bases and/or thicker backs (Fender Brass masters, Stars Guitars, Badass, DiMarzio, Schaller etc.).

(3) The playing style of some bassists can actually cause the saddles to slip about across the baseplate, and the problems caused are obvious. If this is your particular *forte*, a choice of a grooved (Track, Trax etc) bridge would be recommended.

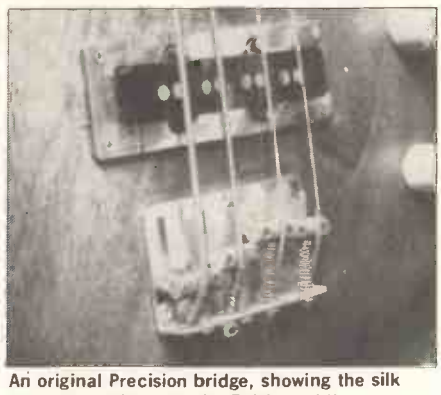
(4) Last, but certainly not least, is the problem facing all but 'Superwound' users; the distance between the E(4th) saddle (when correctly octaved) and the bridge back is usually too short, allowing the string's silk winding to pass over the saddle and thereby mute the sustain.



A Rickenbacker 4001 bass fitted with a Badass II bridge. Note the shim, cut to the shape of the original bridge, covering the damper cavity.



A 'Trax' bridge with grooves to locate the saddles.



An original Precision bridge, showing the silk winding passing over the E(4th) saddle.

Highly recommended for (2), (3) and (4) are Badass II, Schaller, Stars Guitars and Fender Brassmaster, although don't take my word for it, look around; one man's meat is another man's poison.

Fitting these units is again relatively simple, after de-stringing withdraw the existing fixing screws (five) and remove the redundant bridge. Before fitting the replacement first determine whether the fixing holes are correctly positioned for this modification; in the case of the Badass II and Fender Brassmaster, an original or replica, the holes will line up, but in other instances it may be necessary to re-locate them. As most of the replacement bridges will have at least the central hole in the original position use this as a guide. Place a piece of masking tape across the existing holes and draw a line through their centres, marking the mid point; measure the 'between centre' spacing of the new fixing holes and transpose them on to the tape line (this will ensure that the new bridge sits square to the strings). If at this stage any of the new locations half correspond with the old it will be necessary to plug the holes involved before proceeding further; if not, using a centre punch first, drill to the correct diameter and length. Remove the tape and as a precaution check that the earth tag is still positioned correctly for good continuity; then fit the replacement* and after stringing to pitch adjust the octaves and action as required.

*As there are no preset string location grooves on the Badass II, before proceeding further it will be necessary to nick the saddles with a four square needle file on G(1st), D(2nd), and with a small round needle file on A(3rd) and E(4th). Use a junior hacksaw first to lightly cut a guide groove facilitating accurate filing.

Rickenbacker 4001

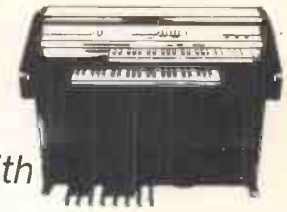
I reckon the weakest feature of these basses is the bridge, so a great improvement can be made at a stroke. Unfortunately I haven't come across a direct replacement that is marketed in the U.K. (if there are any around please let me know), so an acceptable alternative is to use a Precision style bridge mounted on a plastic or brass shim echoing the original outline. As the string spacing is narrower on the 4001 my first choice for this application would be the Schaller bridge which has adjustable width saddles. The type of bridge being used for the modification is, of course, quite different from the one it's replacing; so as would be expected none of the fixing holes will be correctly located, making it necessary to calculate the situation of the new unit. To do this, after de-stringing and removing the old bridge measure the distance between the nut and the centre of the 12th fret, then transpose this measurement from the 12th frst to the body. Place a strip of masking tape across the body at this point and mark with a pencil (on the tape) the exact distance (scale length).

Set the G(1st) saddle on the replacement bridge to within 3/16th" of its furthest length of travel (towards the nut), and position the bridge on the bass with the G (1st) saddle lining up with the scale length; again using masking tape mark the centre fixing hole. Using the original holes as centre and square guides mark, punch and drill the new holes.

Next, using 1/16th" plastic or brass (which of course could be chrome plated) cut out a plate using the original bridge as a template, allowing for any oversize dimensions that may be required to accommodate the new bridge; then drill the required fixing holes (screw clearance size) and earth tag hole (centrally located under new bridge). A new earth wire will need to be run from the electronics screen, and positioned on top of the shim so as to make contact with the bridge. After fixing the replacement, string up, and adjust the action and octaves as required. The difference should be quite noticeable and does, I think, more than offset the loss of the damper. **E&MM**

Organ Talk

Ken Lenton-Smith



THE LEFT HAND

The last article in this series was angled towards the organist who can read and knows basic music theory but needs help in playing rhythmically from Chord Symbols. In that issue I described my musical 'shorthand' for assembling the four basic chords (Major, Minor, Diminished and Seventh) in any key.

Useful as they are, those four chords alone will not be sufficient for popular music. Here are four more chords to add to the repertoire: there is nothing particularly difficult about any of them as they are extensions of either the Major or Minor chords.

MAJOR SIXTH 1 3 5 6
(Chord Symbol X6)

MINOR SIXTH 1 3♭ 5 6
(Chord Symbol Xm6)

MINOR SEVENTH 1 3♭ 5 7♭
(Chord Symbol Xm7)

AUGMENTED 1 3 5#
(Chord Symbol X+)

Four New Chords

It is worthwhile training the ear to recognise the *type* of chord heard. Try playing these chords in various simple keys, inverting the notes so that they fit the F - F compass either side of middle C.

The *Major Sixth* sounds bright and satisfying, whereas the *Minor Sixth* sounds even more sombre than the Minor itself. The *Augmented* chord, which is simply a Major chord with sharpened fifth, has that same 'leaning' sound as the Dominant: the subsequent chord is nearly always, and predictably, the tonic.

Does the *Minor Seventh* sound like any of the others in quality? It sounds much like the *Major Sixth* because:

Cm7 =	C	E♭	G	B♭	
E♭6 =		E♭	G	B♭	C
Am7 =	A	C	E	G	
C6 =		C	E	G	A

etc.

- two apparently different chords are inversions of each other. Both chords are widely used in popular music, so it is helpful to remember the inter-relationship.

Having looked at the 'shorthand' for eight different types of chord, twelve key signatures allow us to form up to 96 chords. A great number of these will be required only occasionally whilst the commonly used chords will recur so often that they will soon become committed to memory. They can all be tabulated, of course, but this approach should be avoided if possible.

Gating

Knowing how to interpret the majority of Chord Symbols likely to be encountered, we can turn to methods of using them in the left hand part.

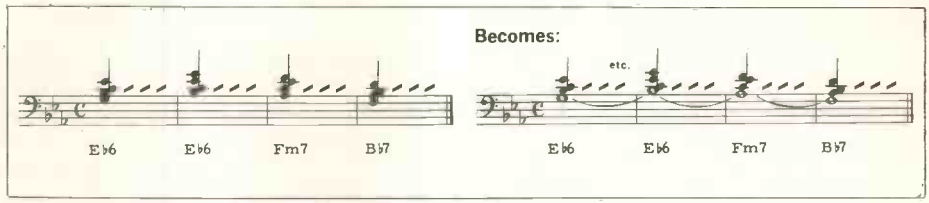


Figure 1. Playing the upper part of the chord to fit the rhythm.

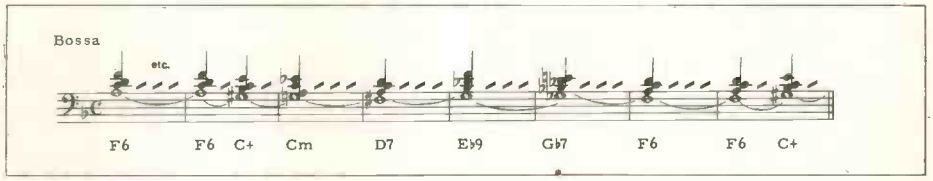


Figure 2. Chromatic progression to suit chords of Nov. E&MM tune.

The indicated chord may simply be sustained. Certain parts of an arrangement may call for this technique but in general the result is highly uninteresting.

Still using sustained chords, an 'Autochord' or similar facility will turn the signal on and off on instructions from the rhythm unit. Although an improvement, the pulsed chords soon begin to sound increasingly mechanical.

Better still, use the left hand itself to 'gate' the chords. It can interject them at will, whereas rhythm unit ROMs have very fixed ideas! Using the left hand enables accents, syncopated beats, changes in the rhythm pattern/tempo. This is, I feel, one aspect where a manual method is a far better proposition than relying on electronics. This very topic is on the boundary between a science and an art and where the latter should take priority.

Split Chords

How and when the chords are played will of course depend on the time signature and a number of other factors including personal taste - ad lib., in fact.

The chord can be split - sustaining part of it while playing the remaining notes rhythmically. This can be most effective, especially in fast numbers. Not many organs can boast a double-touch manual these days, but I fancy that this method of playing chords owes much to that feature. Double-touch allows the player to register two different sets of voices on the same manual, extra downward pressure on the key bringing in a second voice. The second-touch voice is usually stronger than the first, allowing the performer to play both solo and accompaniment parts on one manual.

Using a standard keyboard, the effect of double touch can be re-created to some degree. Figure 1 shows a simple left hand arrangement and, by making the upper part of the chord sufficiently staccato, the sustained note line will be heard clearly above the others - even though the registration is necessarily the same across the keyboard.

Counter-Melody

Some tunes have an associated counter-melody which is well known but, more often than not, one has to look for the possibility of counterpoint in the harmonic sequence.

An effective form of counter-melody is found by extracting a *chromatic progression* suggested by the chord changes. Figure 2 gives an example of this idea. In all probability, no two players would choose to interpret these split-chord sequences in exactly the same way - once again demonstrating the extemporisation possibilities with two manuals and a pedalboard.

Other Chord Symbols

A *Ninth* chord (symbolised as X9) is similar to the *Seventh* in that both are Dominant chords. However, *Major Seventh* and *Major Ninth* chords (Xmaj7 and Xmaj9) are simply major chords with those extra intervals added. The first inversions of these chords in F may be compared:

	F7	played	F	A	C	E♭		
and	F9	played	F	A	C	(E♭)	G	
but	Fmaj7	played	F	A	C	E		
and	Fmaj9	played	F	A	C	(E)	G	

Occasionally, fairly straightforward chords are complicated by the addition of accidentals in the Chord Symbol, which are sometimes placed in brackets. Various publishers have differing methods of indicating somewhat unusual chords: here are two examples:

E7(♭5) or E7-5 means
E Dominant Seventh with *flattened fifth*
played E G# B♭ D

F7(♭9) or F7-9 means
F Dominant Seventh with *flattened ninth*
played F A C (E♭) G♭

This sort of notation calls for extra thought at times but, if a complex chord is indicated by the arranger, it is always well worth making use of it.

HARMONY? I hear a somewhat discordant note from Dallas, Texas. One of the town's music stores has just completed a 'Shotgun Spectacular' sale: it was offering a free shotgun with every piano or organ sold. Apparently a very popular form of sales promotion in that trigger-happy part of the world but will the shotgun dissuade would-be music critics, I wonder? **E&MM**

BASICALLY BASIC

Graham Hall, B.Sc.

The microcomputer is becoming an increasingly valuable music making instrument and we continue this regular series that teaches the fundamentals of BASIC.

BASIC Functions

One of the features of the BASIC language which makes it suitable for such a wide range of applications, is the set of pre-written instructions that can perform commonly used operations. These instructions are called 'Functions'. The functions to be described are the more common ones available on most personal computer systems. The list is not exhaustive, and the way in which they are used in the particular version of BASIC used by your machine may be slightly different from the description here. You should check the users reference manual, for your computer for the complete description of functions available in your machines version of BASIC.

There are three types of functions: math, print and string. Math functions perform mathematical operations, print functions cause operations on terminal output and string functions perform operations on quoted strings or string variables. String functions will be described later in this series.

Math Functions

There are two types of math function - arithmetic and trigonometric. Table 1 lists and summarises the common math functions which are fully described below.

ABS Function

To use the ABS (Absolute value) function the function keyword is followed by an argument enclosed in parenthesis, on a statement line. The result returned is the magnitude, regardless of sign, of the argument. For example the absolute value of both +15 and -15 is 15. The following program demonstrates this:

```
10 PRINT ABS(15), ABS(-15), ABS(0-10)
20 END
RUN
15  15  10
```

The argument of the function can be any valid BASIC expression, variable or constant. The ABS function is useful for scientific applications where the magnitude of a number is required and not its sign.

EXP Function

The EXP (Exponential) function computes the value of the mathematical constant 'e' raised to the power of the numeric argument specified to the function within parentheses. The constant 'e' is the base of natural logarithms (to six sigificant digits, e = 2.71828). For example, to raise e to the power of two the EXP function can be written in a program as: 10 PRINT EXP(2). The inverse of the EXP function is the LOG function, which computes the logarithm to the base e of an argument (this is known as the 'natural logarithm'). This relationship can be demonstrated by combining the EXP and LOG functions:

```
10 PRINT "EXP (2) = " ; EXP(2)
20 PRINT "LOG(2) = " ; LOG(2)
30 PRINT "LOG (EXP(2)) = " ; LOG (EXP(2))
40 PRINT "EXP (LOG(2)) = " ; EXP (LOG(2))
50 END
RUN
EXP(2) = 7.38906
LOG(2) = 0.69315
LOG(EXP(2)) = 2
EXP(LOG(2)) = 2
```

Lines 30 and 40 of the above function program are the inverse of each other. They illustrate how the argument to a function can be another function. The EXP function is useful for scientific applications.

INT Function

The argument to the INT (Integer) function can be any valid constant, variable, function or expression. The value returned is the largest integer less than or equal to the argument, i.e. the integer part of the argument is separated from the fractional part. For example:

INT (3.142) = 3, INT (0.69) = 0 and INT (-4.15) = -5

Note the value returned for a negative argument is a greater negative integer.

LOG Function

The LOG (Logarithm) function computes the natural logarithm (logarithm to the base e) of its argument. The argument can be any positive constant, variable, function or expression which evaluates to a positive number. An error message will be printed if the argument is equal to or less than zero.

Some versions of BASIC also have a logarithm function which determines logarithms to the base ten (common logarithm). However, if your version of BASIC does not include this facility it is possible to convert the arguments natural logarithm to another base by dividing the natural logarithm of the argument by the natural logarithm of the new base. For example to find the logarithm of five to the base ten (common logarithm):

```
10 PRINT "LOGARITHM TO BASE 10 of 5 = " ;LOG(5)/LOG(10)
20 END
RUN
LOGARITHM TO BASE 10 of 5 = 0.69897
```

RND Function

The RND (Random) function generates a random number between zero and one (but not including zero or one). The argument of the RND function can be any positive integer, zero or negative integer. The way the argument determines the operation of the RND function differs for different versions of BASIC. Usually, any positive integer within parentheses gives a new random number each time the RND function is used in a program. With zero or a negative integer specified, the same random numbers are generated. This is useful for debugging a program because if the numbers generated by the RND function is varied for each execution, program errors would be difficult to find. Some versions of BASIC do not require the RND function to be specified with an argument. In this case a RANDOMIZE statement is included in a program before the RND statement, if different random numbers are required for each program execution. The random numbers generated by the RND function can be modified by expressions involving other BASIC functions and operators. For example, to generate a random integer between one and one hundred:

```
10 PRINT INT(100 * RND(1)) + 1
```

The argument of the INT function is '100 * RND(1)' which is an expression consisting of a constant, 100, multiplying a random number generated by the RND function. The result of this combination of functions is a random integer between zero and ninety-nine. The range is adjusted from one to a hundred by adding the constant one to each number generated.

The RND function is especially useful for games programs and simulations.

SGN Function

The SGN (Sign) function returns a result which depends on the sign of the argument. The argument can be any valid constant, variable or expression. If the argument evaluates to a positive value the SGN function returns a 1; a zero would be returned if the argument evaluates to zero; otherwise a -1 is returned when the argument evaluates to a negative value. An example of this is:

```
10 ON SGN (x) + 2 GOTO 200,300,400
```

Here the constant two is added to the result returned by the SGN function. The result is now a positive integer (1,2 or 3) which is used as an argument to the ON GOTO statement to make a branch.

If X is negative, the result of SGN (X) +2 is 1, which directs program control to line 200. If X is 0, the result of SGN (X) +2 is 2, which directs program control to line 300. A branch is made to line 400 when X is positive because then the result of SGN (X) +2 is 3.

SQR Function

The SQR (Square Root) function determines the square root of its argument. The argument can be a positive constant, variable or expression. An error message will be returned if the argument specified is negative. However, some versions of BASIC convert a negative argument to its absolute value and return the square root of the converted value. For example, PRINT SQR(4) will output a 2 to the terminal. The command PRINT SQR(-4) will cause an error message to be output unless the absolute value of the argument is taken by the SQR function.

Trigonometric Functions

ATN Function

The ATN (Arctangent) function is a trigonometric function that accepts a numeric argument. The ATN function computes and returns the principal value of the arctangent of the argument in radians (or angular measure). This will be within the range: $-\pi/2 < ATN(x) < \pi/2$.

The relationship between the radian and degree is:
1 degree = $\pi/180$ radians, where π represents the circular constant 3.1415927.

To convert the result of the ATN function from radian measure to degrees the value returned is multiplied by $180/\pi$, (i.e. 57.2957795). For example, the command

```
PRINT ATN (1Ø)
```

prints the arctangent of 1Ø in radians. The command,

```
PRINT ATN (1Ø) * 57.2957795
```

will print on the terminal the arctangent of 1Ø in degrees.

The ATN Function is the inverse of the TAN (Tangent) function. This is shown by the following short program:

```
1Ø PRINT "ATN(1Ø) = " ; ATN(1Ø)
2Ø PRINT "TAN(ATN(1Ø)) = " ; TAN(ATN(1Ø))
3Ø END
```

The expression 'TAN(ATN(1Ø))' will evaluate to 1Ø because of the inverse relationship between the ATN and TAN functions.

COS Function

The COS (Cosine) function requires an angular argument in radian measure and returns the cosine of the angle. To convert an angle from degrees to radian measure so that it can be used as an argument to the COS function, the angle in degrees is multiplied by the ratio $\pi/180$ (i.e. 0.0174533).

For example, the command PRINT COS (45 * 0.0174533) will print the cosine of the 45 degree angle.

SIN Function

The SIN (Sine) function requires an angular argument in radian measure and returns the sine of the angle. The same method as described above can be used to convert an angle from degrees to radians. For example, the command PRINT SIN(45* 0.0174533) will print the sine of the 45 degree angle.

TAN Function

The TAN (Tangent) function requires an angular argument in radian measure and returns the tangent of the angle. This is the inverse of the arctangent (ATN) function previously described. For example, to print the tangent of a 30 degree angle the command PRINT TAN (30 * 0.0174533) can be used.

ABS(X)	**Returns the absolute value of X.**
ATN(X)	**Returns the arctangent of the value X in radian measure.**
COS(X)	**Returns the cosine of the radian value X.**
EXP(X)	**Returns the constant 'e' (2.72828) raised to the power of X.**
INT(X)	**Returns the largest integer value of X.**
LOG(X)	**Returns the natural logarithm of the value X.**
RND(X)	**Returns pseudo-random numbers.**
SGN(X)	**Returns an indication of the sign of X.**
SIN(X)	**Returns the sine of the radian value X.**
SQR(X)	**Returns the square root of X.**
TAB(X)	**Positions output to the terminal beginning at column X on the output line.**
TAN(X)	**Returns the tangent of the radian value X.**

Table 1. Common Math and Print Functions.

Print Functions

TAB Function

The TAB (Tabular) function is used to position output on the terminal. The argument to the TAB function is numeric and moves the start of printing to the specified column. For example, the command PRINT TAB (2Ø); "MESSAGE" outputs the string MESSAGE beginning at the twenty-first column. On most personal computer systems an output line is divided into 72 columns numbered from Ø.

User Defined Functions

BASIC allows the programmer to name and formulate a function using the DEF (Define) statement. The DEF statement has the following format:

line number DEF FNn (x) = expression

For example, you may wish to define a function which would return the area of a circle given the radius. Such a function would be;

1Ø DEF FNA (x) = 3.1415927 * X↑2 (since area of a circle = πx radius squared).

The function name consists of three letters. The first two F and N must always be present but the last can be any letter from A to Z. This allows defined functions in one program (although some systems allow a letter immediately followed by a single number as a function identifier).

The argument to the function is the 'dummy variable' within the parenthesis (x). This reserves memory space for the arguments given to the function later in the program. Any legal variable name can be used as a dummy variable.

The expression on the right hand side of the equal sign is the calculation the function is to perform. The following program demonstrates how the function would be defined and then used to calculate the area of ten circles:

```
10 REM - CALCULATE AREA OF CIRCLES OF RADIUS 7-10cm
2Ø DEF FNA (x) 3.1415927 * X ↑ 2
3Ø PRINT TAB (5); "RADIUS (CM)"; TAB (20); "AREA (CM2)"
4Ø FOR X = 1 to 1Ø
5Ø PRINT TAB (8); X; TAB (22); FNA (x)
6Ø NEXT X
7Ø END
```

The program is composed of the following lines:

Line 1Ø - The REM statement outlines the programs function. The characters following REM are ignored by the computer.

Line 2Ø - This is the function definition. The function is named FNA and is equal to the expression π*X12, where X is the functions argument. It is advisable to place all function definitions at the beginning of a program so that the program is easier to read and follow.

Line 3Ø - The TAB function is used to format the output to the terminal. The heading 'RADIUS (CM)' will begin at the sixth output line column and 'AREA (CM2)' will begin at the twenty-first column.

Line 4Ø - The FOR statement intialises the loop index to one and sets the range to ten.

Line 5Ø - The PRINT statement outputs the value of X (underneath the heading 'RADIUS (CM)' because of the formatting of the TAB function) followed by the value of the area of the circle of radius X computed by the FNA function defined on line 2Ø.

Line 6Ø - The next statement increments the value of X by one and directs program execution back to line 4Ø.

Line 7Ø - The END statement signifies program completion. **E&MM**

Micromusic

Make music with the ZX81

RECORDED ON CASSETTE NO. 5

Last month we covered programming the ZX81 in machine code; this month is more hardware orientated, starting with the input/output part shown in Figure 1. No construction details are given, since this is a straightforward circuit; the prototype was built on Vero DIP board, wired up with ordinary single core wire. One aspect that will be covered, however, is the actual connection to the ZX81.

The appropriate 23 way double sided edge socket is now fairly easy to obtain through various advertisers in the computing magazines, but we still need to fabricate a plug to enable the RAM pack to be connected at the same time as the port. Figure 2 shows how one may be made from 1.6mm double sided PCB material. No etching is necessary - simply divide the copper into 23 0.1" strips with light hacksaw cuts. This plug may now be soldered onto the pins on the back of the socket. Since the contacts are not gold plated, they will need cleaning from time to time; tarnished contacts make the RAM pack very sensitive to vibration, and it is very easy to lose several hours' work through one careless knock.

The port circuitry itself consists of an output latch IC3, an input gate IC4 and an address decoder IC1. IC2 buffers the data lines so that several latches may be driven for polyphonic use; if only one output is required the data bus may be connected straight to IC3. Several alternatives are given for IC3; in this application it does not matter whether a D type flipflop or a transparent latch is used. The author's prototype in fact used 74LS373 latches.

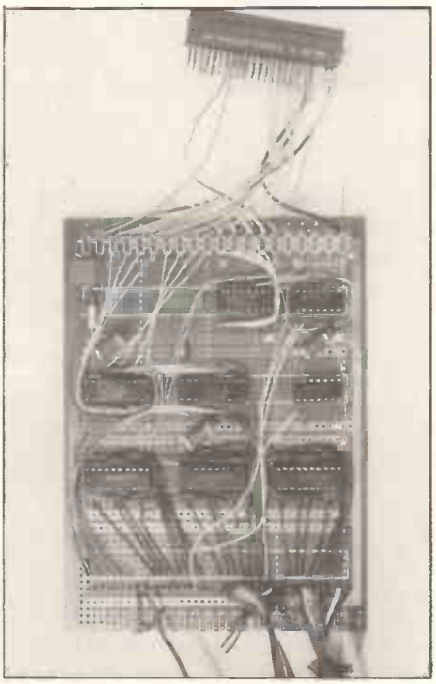
The links on IC1's enable inputs allow the port addressing to be in I/O space when links 'B' are made - in which case machine code must be used for input and output routines - or memory mapped when links 'A' are made. Memory mapping allows input and output to be performed solely in BASIC using PEEK and POKE - the port acts like a memory location with wires connected to it - and as such is useful for logic experiments, light flashing and so on as well as simple sequencer programs.

Figure 3 shows the ZX81's memory space divided up into 8K byte blocks. Due to the incomplete address decoding used in the machine, the ROM repeats itself between 2000 and 3FFF (hex), whilst the operating system only ever uses the bottom copy. D1 deselects the ROM whenever A13 is high, freeing this address space for use by the port. The actual addresses selected by IC1 are given below:

IC1 pin no.	Memory mapped address		I/O map. address
15	3F1F(hex)	16159(dec)	1F
14	3F3F "	16191 "	3F
13	3F5F "	16223 "	5F
12	3F7F "	16255 "	7F
11	3F9F "	16287 "	9F
10	3FBF "	16319 "	BF
9	3FDF "	16351 "	DF
7	3FFF "	16383 "	*dnu

*do not use

Since the port's address decoding is also incomplete, these are not the only addresses that could be used, but it will avoid confusion if one figure is used throughout. Note that IC1 pin 7 should not be used to select a port when in the I/O mapped mode, since this will be addressed by the ZX81's internal workings.



The prototype port board, with three output ports and one input port. The push button is connected to one bit of the input port.

Connection to a Synthesiser

The easiest synthesisers to connect to will be those that use a digital encoding system already; instruments with a control voltage input will require an additional digital to analogue convertor, and this will be covered later.

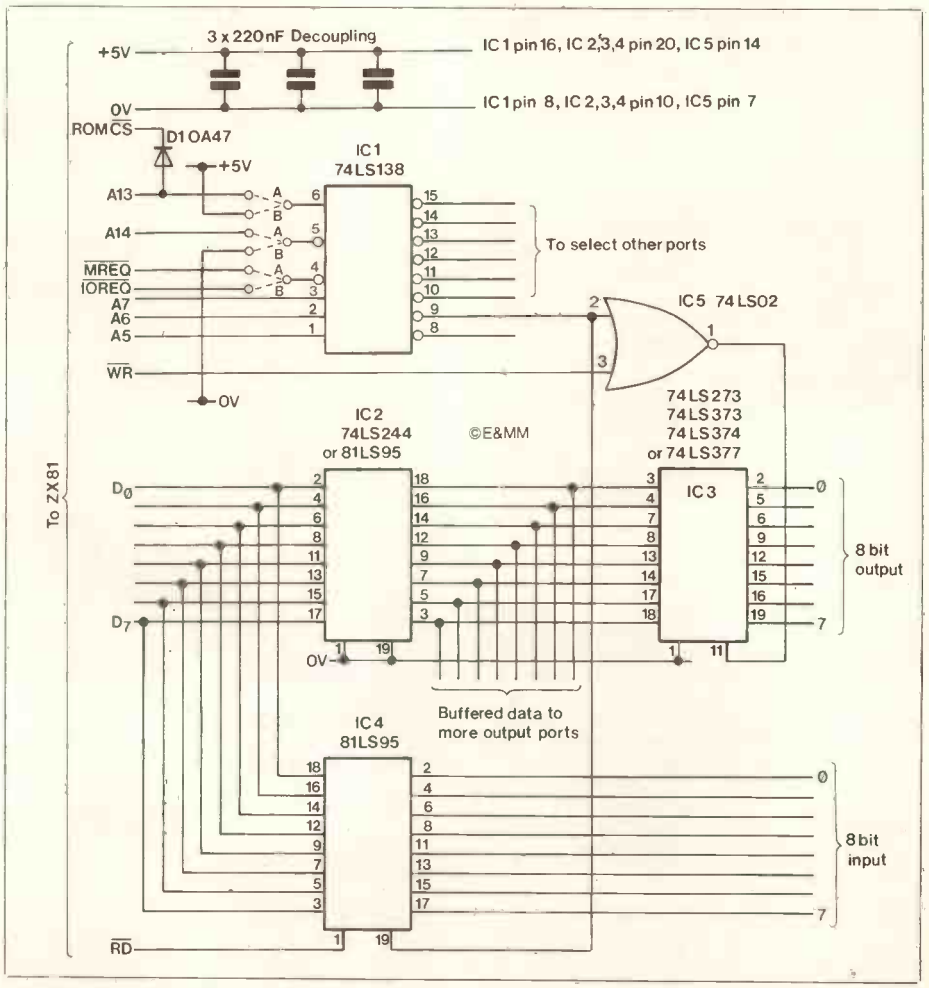


Figure 1. Circuit of an input/output port for the ZX81.

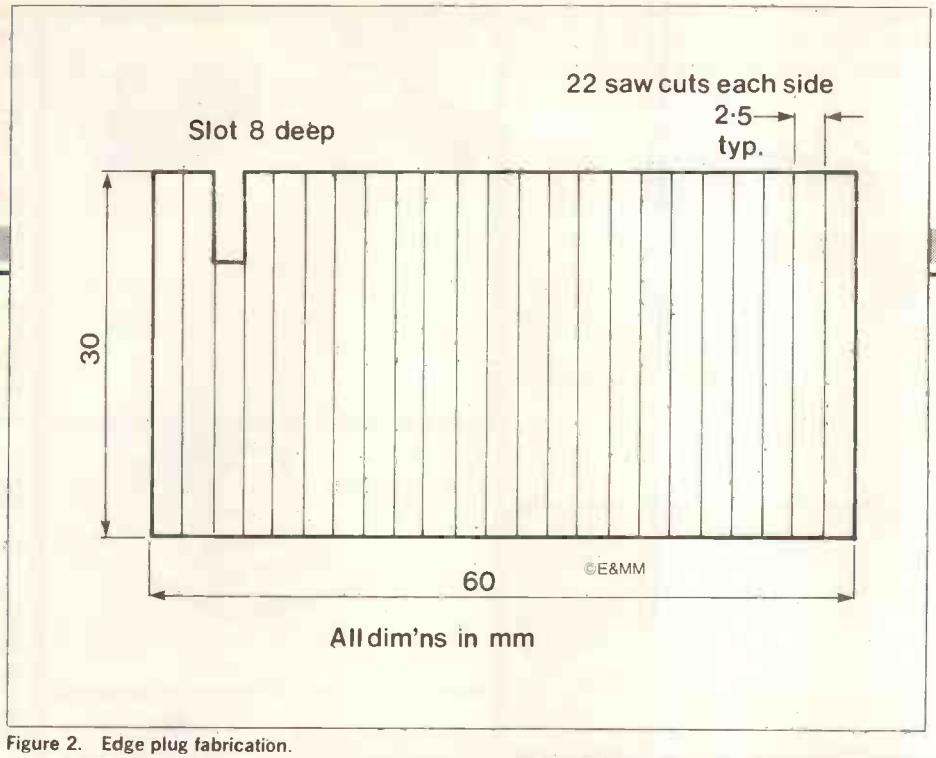


Figure 2. Edge plug fabrication.

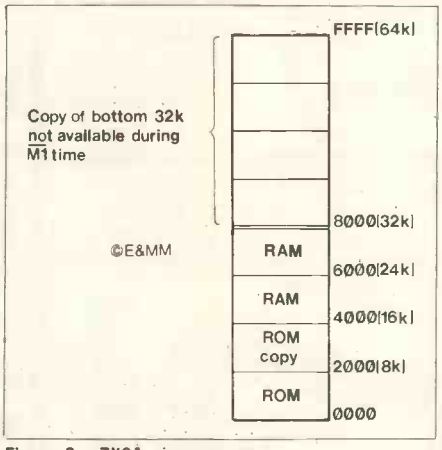


Figure 3. ZX81 memory map.

Synthesisers with their own internal D/A convertors generally use 6 bits to specify the note, giving a range of 5 octaves plus 3 semitones (64 notes) and the Maplin 3800 and 5600S work this way. For reasons that will become clear later on, the bottom 6 bits of the 8 on the output port will be used to select the note required, giving a range from B (code 0) to D (code 63). The top bit will be used to operate the gate, so that a note which is sounding will have 128 added to its code. Note that rests must have a code too, since the bottom 6 bits need to stay constant while the note decays; in this case the code itself would be output, a number between 0 and 63. Remember that a 0v connection will also be required between the computer and synthesiser.

The Wasp and Gnat also have digital in/out sockets, but the system used is rather different. Four bits are used to select one of twelve notes in an octave, and two bits specify the octave. Although the Wasp's keyboard is only two octaves, three are available when driving the 'link' socket. The author's Wasp is connected this way:

DIN plug pin no.	output bit no.
1	0
2	2
3	4
4	1
5	3
6	7 (gate)
7	5

0v goes to the plug casing. Remember that DIN plug pin numbers do not go in numerical order: refer to the numbers moulded next to the pins if in doubt.

Using the above wiring, the basic codes for the notes (without the gate high) are:
Octave 1 C# to C (a.s.*) : 43 to 32 (n.d.‡)
Octave 2 C# to C (a.s.*) : 27 to 16 (n.d.‡)
Octave 3 C# to C (a.s.*) : 11 to 0 (n.d.‡)
*(ascending scale) ‡(numbers descending)

Note that firstly, bottom C is not available; secondly, the codes descend whilst the notes ascend, and finally, some codes are not used. To sound a note, 128 should be added to the code as before; but note that when driving the Wasp via the link socket the notes do not sustain, and so long notes are difficult to program. Information on this point would be welcome if anyone has the answer.

A Sequencer Program

One easy way to store a sequence of notes is to split up the passage to be stored into segments of equal duration, each one shorter than the shortest note value. Each segment may then be represented by a single 8 bit byte, and the sequence may be stored as a series of characters in a string array.

Here is a simple program, written entirely in BASIC, which allows entry of notes into an array, and subsequent replay.

```
10 LET A = 1
20 LET A$ = ""
30 SCROLL
40 INPUT N$
50 PRINT A;
60 PRINT TAB 6; N$;
70 IF N$ = "R" THEN GOTO 100
80 LET A$ = A$ + CHR$ (VAL N$+128)
90 GOTO 130
100 LET L$ = A$ (A-2)
110 IF CODE L$ > 127 THEN LET L$ =
CHR$ (CODE L$-128)
120 LET A$ = A$+L$
130 INPUT L
140 PRINT TAB 12;L
150 LET A$ = A$ + CHR$ L
160 LET A = A+2
170 GOTO 30
200 REM REPLAY
210 FOR I = 1 TO TEN A$ STEP 2
220 FOR J = 1 TO CODE A$ (I+1)
230 POKE 16351, CODE A$ (I)
240 NEXT J
250 POKE 16351, 0
260 NEXT I
270 GOTO 200
```

Instead of using the 'equal time segment' approach, this program stores the note value and its length as 2 consecutive elements of A$. Lines 10 to 170 allow entry of notes into A$, which expands automatically with each entry; and hence does not need dimensioning. The note is entered first, either as a number between 0 and 63 or the letter R for a rest; note that a rest cannot be the first entry without some fiddling. Lines 100 to 120 also allow for the possibility of entering two rests consecutively.

Next, the note length is entered as a number between 1 and 255; normally, the shortest note in a sequence would be given the value of 1. The program will then step on to the next note; to finish entering, input **RUBOUT** followed by **STOP**.

To replay, use the command **GOTO** 200. The sequence will repeat until interrupted by the **BREAK** key unless line 270 is deleted. Line 250 is included to retrigger Wasps, and should be omitted if other synthesisers are used.

This program is fairly simple, and so it has no editing facilities; if you make a mistake entering a note, you will have to alter it in a roundabout way afterwards. More seriously, there is no speed control; a **PAUSE** statement can be inserted as line 235 to slow things down, but in practice the use of BASIC will make things slow enough already.

This is where machine code comes in, as covered in part 1. Next month we will put parts 1 and 2 together to make a fast sequencer program, deal with D to A converters for those of you without digital synthesisers, and hopefully get a bit polyphonic.

Peter Maydew **E&MM**

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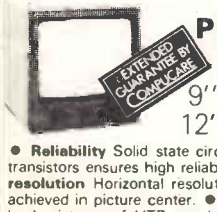

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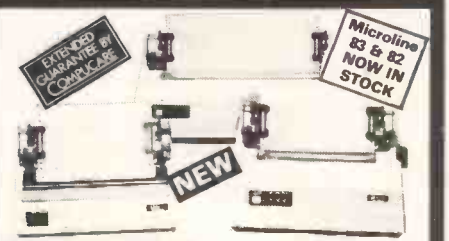

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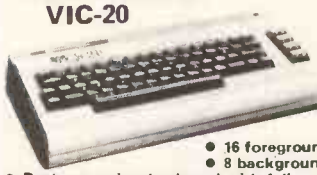

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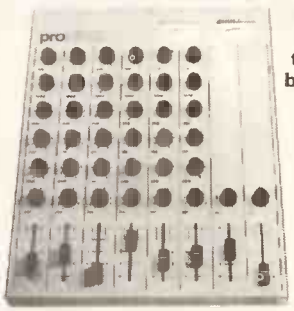

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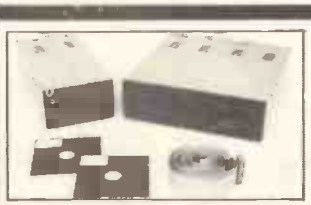

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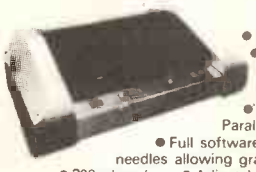

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ELECTRIC DRUMMER Part 2

Peter Kershaw B.Sc

The circuit diagram of the control board is shown in Figure 2. P1 is the edge socket for the MPC board interface connector.

IC5 is connected to the processor's maskable-interrupt input ($\overline{INT}$) to control the timing of the system. A 10-turn potentiometer on the front panel gives fine tempo control.

Input/Output is controlled by IC1, 2 and 3. ICs 1 and 2 give 24 lines each of general-purpose I/O lines; 16 lines are used for driving the instrument triggers, 16 drive the front panel lamps, two are used for cassette I/O, one for downbeat indication and 12 lines for scanning the control keys (see E&MM September 1981, p42). IC3 is a multiplexing driver for the Electric Drummer's four-digit LED display.

The I/O addresses are as follows:

IC1: Port A — 40H
Port B — 41H
Port C — 42H
Control — 43H
IC2: Port A — 80H
Port B — 81H
Port C — 82H
Control — 83H
IC3: 00H — 05H

The trigger outputs are standard +15V pulses. The cassette interface is implemented without the use of a USART; all timing is carried out by the processor, and to ensure correct operation, a software error-checking system is used.

As no PCB will be produced for this project, it is suggested that it is constructed on DIP board using Verowire or wire-wrap. It is, of course, possible to put the processor and memory on the same board, but the use of the MPC board makes the task far easier. Remember to include several 10nF decoupling capacitors.

Two options are available for connecting the board to the front panel and trigger output sockets. The cheapest method is to use Veropins on the board and wire each to the appropriate lamp/switch. As there are so many connections, however, you may prefer to use edge connectors and ribbon cable for this purpose.

Power Supplies

Figure 1 shows the suggested power supply. All voltage regulators should be mounted on heatsinks or, if a metal cabinet is used, they could be mounted on the back panel (using mica washers for insulation, of course). The 0.47uF and 0.1uF capacitors should be connected as close to the pins of the regulators as possible. The -15V supply is required for the sound generator board, and may therefore be omitted if the Electric Drummer is used only to drive other equipment.

In the next article we will look at the optional battery backup circuit, and at a suitable sound generator board to use with the Electric Drummer. **E&MM**

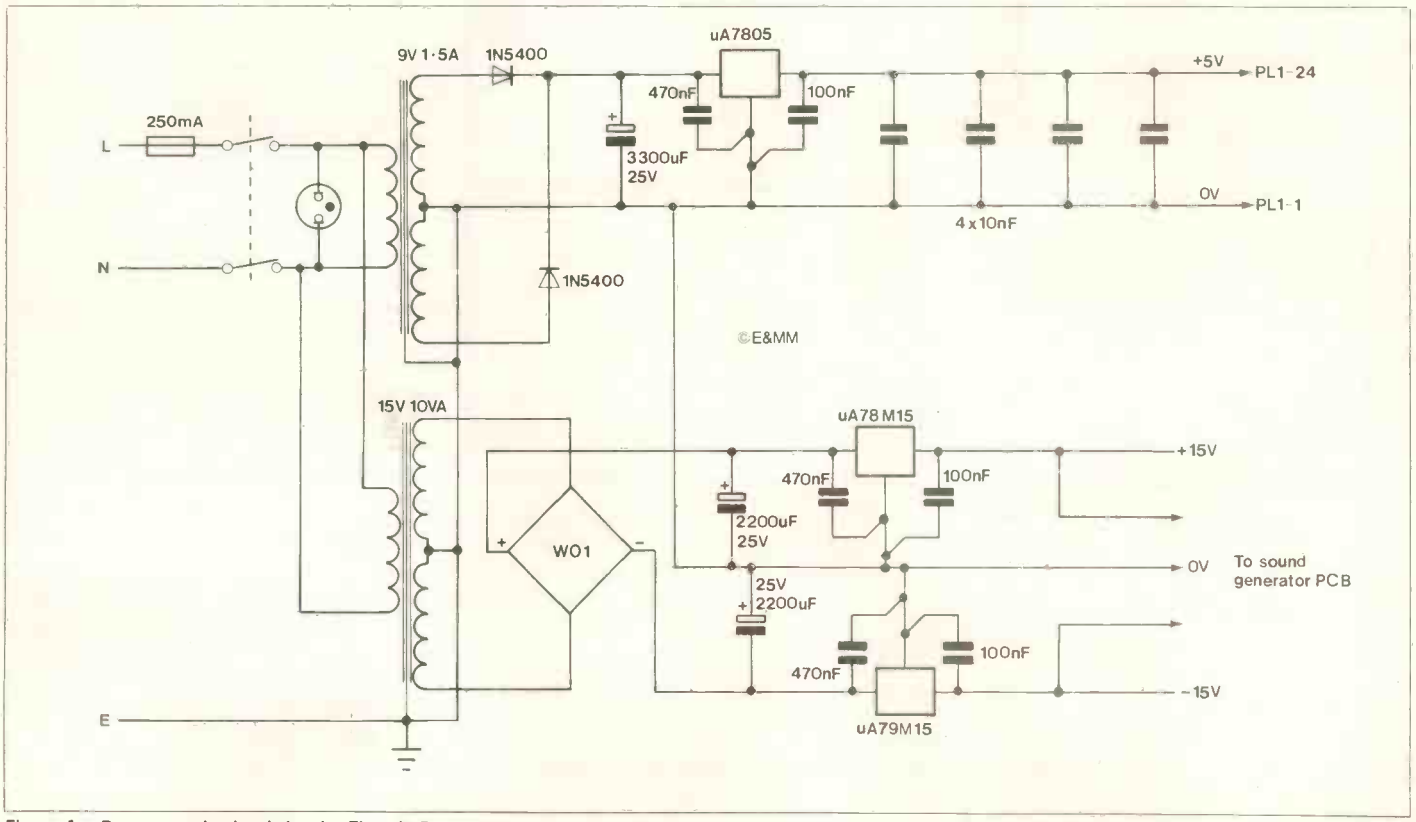


Figure 1. Power supply circuit for the Electric Drummer.

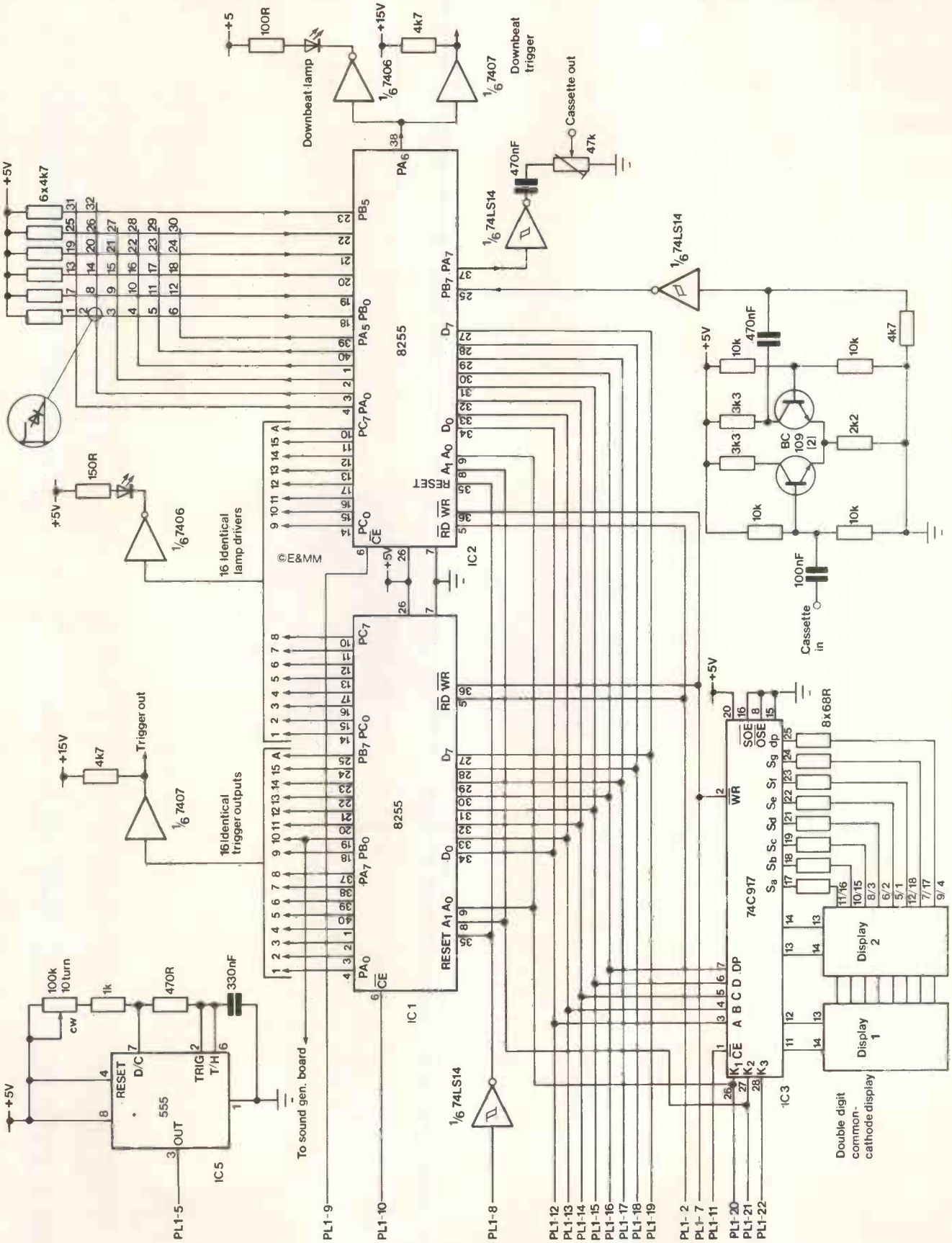


Figure 2. Circuit of the control board.

RECORD REVIEWS

Architecture and Morality
by Orchestral Manoeuvres in the Dark
Dindisc DID 12

These beardless Liverpudlian youths are virtually the only contemporary musicians to have incorporated synthesisers with total success into the framework of songs with such traditional elements as melodies and lyrics. Despite chart acceptance of their work, they have not been content to rest on their laurels for this, their third album.

They can now confidently set their familiar, chiming Korg-induced melodies alongside blocks of rasping Mellotron orchestration which would be unrecognisable as such to anyone used to that instrument's usual soothing applications. Some of this work, particularly the title track, recalls the late 50's electronic music concrete and the dynamic but directionless bleeping of early Morton Subotnik. The miracle is that OMD take this non-melodic, almost unmusical sound and make it listenable.

The introduction of snatches of radio broadcasts, and other found-source material such as clanking, rhythmic machinery, is done with an elegance which makes it perfectly acceptable. Even the wobbling of the choral tape loops on 'Souvenir' adds to, rather than detracts from, the song's fragile beauty.

Of the nine tracks offered, 'Joan of Arc' (waltz version) on side two, is the obvious masterpiece. Choral and pastoral symphonic electronics are conjured up over double drumming rhythms which propel it, in a continual crescendo, to a powerful but haunting climax.

Their total disregard for accepted standards of spatial location in their stereo mixes also results in some satisfying, if initially surprising, juxtapositions of synthetic textures and melodic strands. Although they would probably now deny it, the Kraftwerk influence is still here, most evident in the structure of 'Georgia,' with its surreal bursts of radio noise and abrupt switch of mood near the end.

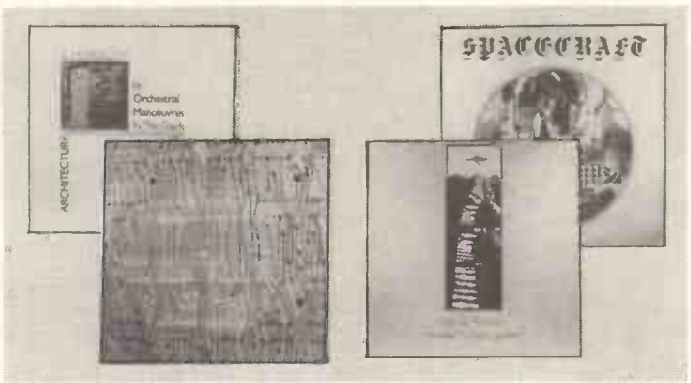
If they can avoid the stagnation that often comes with success, OMD could go on to become the standard by which to judge electronic pop.

Johnny Black

Paradoxe by Spacecraft
Dist. Lotus Records
23, High St., Newcastle Under Lyme ST5 1QZ.

Spacecraft is two musicians: one French (Ivan Coaquette) and one British (John Livengood). The music is hard to classify, but its origins lie more with the 'progressive' techniques of the late '60s than the coquettishness of the present decade. This is for two reasons: firstly, they use the sort of tape delay in extremis technique that made Terry Riley infamous, i.e., wall-to-wall Revoxes sending sounds initiated on the left channel over to the right channel x seconds later; and secondly, they use bass and electric guitars with the sort of super-distorting fuzz guaranteed to induce nostalgia for guitar heroes of the past. Whilst phasing (rather noisy), echo (rather excessive), and distortion (rather obvious) are universally spread over all the tracks on this album, harmonic flow is not a conspicuous element. One main technique predominates for the construction of tracks: firstly, a more or less percussive backing is set up (usually distorted) with a more or less harmonic wash (phased noise, for instance); secondly, a fairly minimal electric piano riff or sustained Farfisa chords may be added on top; and thirdly, guitar (or, occasionally, synthesiser) duos are played 'live' with the tape delay so that phrases played on the left channel reappear four seconds later on the right. There is of course no reason why all this shouldn't produce very pleasant music, but Spacecraft are rather let down by the excessive harshness of their sounds (which may or may not be intentional) and the rather poor mixing of the album, which tends to stick everything to the sides with rather a large gap in the middle. That said, some playing of real quality emerges from beneath the drone-like framework of tracks like 'Cosmic Wheel' and 'Harabizant', the former using a continually unfolding guitar line that works more like a Raga than any Western equivalent.

David Ellis



Audion
by Synergy
Passport Records PB 6005

This is the fifth album to be released by Larry Fast recording under the name of Synergy. (See the June issue of E&MM for a review of 'Games').

On his previous records he hinted that he would be exploring computer-controlled equipment in the future and the cover notes on this album run as follows: "All compositions on this album were realised entirely on electronic sound synthesis equipment under manual and microprocessor control. Instruments and devices manufactured by Moog Music, Inc., Sequential Circuits, Inc., PAiA and Apple computers, Oberheim, 360 Systems, and Synergy Electronic Music, Inc."

Although not always obvious to the listener, the use of microprocessor control in synthesis can make the composer's job easier in terms of technical performance and more accurate in terms of tonal control and actual sound realisation.

Larry Fast has always been a great orchestrator of electronic music. Not satisfied with a repetitious bass riff, a string drone and an improvised lead line, he actually integrates his sounds as if they were a part of a great orchestra. Any technical help from the equipment can only be to the good.

The most interesting aspect of the Synergy records is the compositional technique. The overall sound is very full, layered as it is with various string sounds (a Fast hallmark). A wide variety of percussive fills, excellently synthesised, provide rhythmic backing where required and medium-key arpeggios compliment the sound and mood. The music has much of the light and shade imparted by piano and forte passages, flowing from crescendo to diminuendo - a humanising touch when compared with much electronic music which plays at a constant volume.

Many of the tones produced sound like orchestral instruments and the form and structure of many pieces have classical roots. All the tracks are easy to listen to and interesting from many aspects but you are unlikely to be humming them to yourself when the record is finished.

From a classical (or semi-classical) point of view, the themes are not given enough time in which the develop and from a more modern aspect, such short tunes (5 on each side) seem to demand a slightly stronger melody to enable them to assert an individuality. As it is, the whole album could flow into one. This is not necessarily a criticism, merely an observation.

The album is subtitled, "Electronic compositions for the post modern age" and is true to Fast's individual style: melodic and lyrical; but after 5 records I can not help but wonder where he goes from here. I would like to see a little expansion in style and development and exploration in his compositions. Some overtly melodic pieces or some with the slight dissonance of, for example, some of Mike Batt's orchestrations. Excellent though the Synergy albums are, he must reach a point where he begins to repeat what has gone before. That point must be very near.

Overall, another excellent album. Recommended on many levels to anyone interested in electronic music and electronic music composition.

Ian Waugh

Moving Pictures
by Michael Gilbert
Gibex Recordings

I'd imagine that self-promotion is something that many composers have considered doing, in the face of what they take to be universal philistinism, but few have the gall or apparent self-confidence of Michael Gilbert to release their own music on their own record label and write their own promotional material. I can't say that I blame him, and, fortunately for us, he does have something to say and says it in a unique way to boot.

The first track on Side 1, 'Moving Pictures Logo', very effectively twists the railway line(?) print on the record sleeve into a sound landscape with a nice interplay of sequenced FM timbres, resonant drums and a gentle backcloth of string chords. However, it's over before it has been given the chance to get anywhere, and, instead, we find ourselves in the almost schizophrenically different sound world of 'Ascents', the longest (12') track on the album. This starts with a wood flute gently calling across some vast primitive landscape, with metallic rustlings and earthy thumps shifting the perspective. This ethnic counterpoint is replaced by a short-lived harmonic wash reminiscent of early Vangelis with the addition of gongs and other percussion. Organ chords suddenly break through the calm, but they, in turn, become sustained, interwoven with fleeting and gentle percussive flourishes, and then joined with a vocal solo distantly echoing the wood flute. Chinese cymbal strokes take us back to the original landscape with a soaring line for two wood flutes. The slowly-shifting wash re-enters dominating the scene with a dark mysterious quality to which the wood flute adds its call. A ravishing track, this, demonstrating the power of understatement and a quality of sound that seems thoroughly authentic for the subject matter.

The final track on this side, 'Unwinding', really is a bit of a letdown; it's back to shifting cycles of FM timbres which, like a watch mechanism, gradually run out of steam and come to a full stop.

Side 2 starts off with 'Other Voices/Other Rooms', a track that drifts by with voices sounding suspiciously like the song of the humpback whale, the occasional sample and hold gurglings of a synthesiser, and some more of the ever-popular sequenced FM timbres.

'Steel Clouds' is primarily based on close-miked gongs, skin and metallic percussion instruments, hollow synthesiser lines and some splendidly sonorous non-integer harmonic complexes. 'Winter Light' is another slowly-drifting track with the majority of material derived from what sounds like processed guitar. 'Plant Life' is paradoxically an overtly electronic track and doesn't seem to make much effort to break out of mechanical conventions of sequencer usage and a very limited range of sounds.

The final track on Side 2, 'Phase', is much more interesting with a bass line that bounces across the stereo image, some high synthesiser tweets that phase around themselves, phased string drones, and a super-animated final fade. All in all, a curious album, but 'Ascents' alone makes it worth purchasing.

David Ellis

This record can be obtained from Gibex Recordings, Riverglade 104, Amherst, MA 01002 (as yet there are no British distributors).

ELECTRO RECORD

Going into the New Year it looks as if the Teutonic stranglehold on electro-music is threatened. Best sellers include records from France, Japan and U.S.A. according to distributors and mail order companies. Could any talent emerge from the U.K. in 1982 — in the serious electro-music field that is? Through the YHR cassette scheme run by David Elliott, a few fine British talents have already been uncovered. Perhaps to ensure recognition they should change their names to Klaus . . . Wolfgang or Eberhard!

Rumour has it that Bernard Szagner is discussing his future with Virgin Records. With the obvious signs of trouble in the Branson empire and with legions of Virgin musicians (past and present) lamenting their royalty situation . . . maybe he should think hard. In the meantime Virgin are still trying to recoup the advance they paid Mute's Daniel Miller for DAF. For his part Miller was only too pleased to get rid of the idiosyncratic German band.

A bombshell for many of the European Indie distributors handling K. Schulze's I.C. label. After promoting, and in some cases advertising the new I.C. releases, the distributors were shattered by the news that they were going to be licensed through a major. Quite a volte face for the avowed major company haters.

Recent visit to New York proved that synthesisers are selling as fast as MacDonalds! Packed shops with virtual conveyor belt systems meting out instruments to thousands of punters. No wonder good sounds are beginning to be heard from the other side of the Big Pond.

The Kuckuck label with its beautiful sounds is becoming a power in the land — a Kitaro double LP has followed "Silence Is The Answer" into the best sellers.

Program makers' favourite band Jade Warrior are apparently contemplating a Fairlight CMI. The Beeb's Radiophonic Workshop has just bought one too. Doyen of the CMI, David Vorhaus, is reportedly taking the opportunity of an enforced convalescence, following a hang glider accident, to produce THE definitive CMI album. An intriguing prospect.

Congratulations to many of the Our Price shops in the London area for introducing synthesiser sections into their stores. Each month we want to feature shops throughout the country stocking electro-music; please drop me a line if your shop merits a mention.

Matthew Gavin **E&MM**

BOOK REVIEWS

Electronic Music

by Andy Mackay
Published by Phaidon
Price £7.95

The idea of a saxophonist in a rock band like Roxy Music producing a colourful and informative book on electronic music would not be everyone's idea of a logical move, but that is Andy Mackay's background and what he has done with this book. The first section, 'The Instruments', takes the reader through the development of electronic (or, more strictly, electric) instruments, from Thaddeus Cahill's extraordinary Telharmonium — a monstrous device using a 200 HP motor to drive a 60ft shaft of rotating cogged wheels — up to computer-based instruments like the Fairlight CMI. This is well done, though I wish the publishers had seen fit to include a flexidisc with the book to illustrate what the instruments actually sounded like. Mackay is on the right track by relating experiments in alternative sound generation to the elaboration of tone colour in late 19th century orchestration, but he misses the point that this was also due to a desire to explore the upper reaches of the harmonic series, i.e., where Western tonality stops and ¼-tone 'sound fields' start. At the end of this section comes an 8-page chunk (about 10% of the book's main text) on the modern recording studio with plentiful photos featuring Mackay 'in session'. This seems out of place. It would have been more to the point to show an early electronic studio, such as that at Cologne Radio, and then, at a later stage in the book, provide the contrast of the rock studio.

'The Classic Studio' gives a brief consideration of acoustics and synthesis, as well as the musique concrète techniques initiated by Pierre Schaeffer at the RTF studios in Paris and typified by his Etude aux Casseroles — based on the sound of saucepan lids! 'The Synthesiser' includes a concise (though not 100% accurate) explanation of Moog's innovation of voltage control and takes the Prophet 5 as an example (surprise, surprise) of a "sophisticated polyphonic machine", but, curiously, no mention is made of the role of microprocessors in such programmable synthesisers. 'Live Electronics' discusses the work of oddballs like Percy Grainger (including his 1948 'Free Music Machine'), philosophical luminaries like Cage and Stockhausen, and enlightened choreographers like Merce Cunningham to integrate the 'new music' into multi-media performance. This is an interesting section ending with the highly perceptive comment that "a melancholy extension of the idea of a sound environment is the piped Muzak which replaces bad drains as the pervasive nuisance of industrialised society".

The second section, 'The Music', considers the appliction of the instruments and techniques discussed in the first. Separating the music from the instrument is always dangerous and, in the case of musique concrète, stochastic techniques, or whatever doubly so as one is by definition the other. This section would have made more sense if musical examples had been included in the text (and or disc) — not necessarily those limited to conventional notation but also including the various attempts by Schaeffer, Stockhausen, Messiaen and Ligeti, to mention but a few, to notate the sound fields of electro-acoustic scores. As it is, Mackay's discussion, though intelligent and informative, offers little in the way of concrete evidence of innovation, and falls into a cosy pattern of critical clichés. There's also a large amount of repetition of information between the first and second sections which I frankly found annoying, and not to be expected in a book "which looks set to become an authority on the subject" according to the publicity blurb accompanying my review copy. 'The Business' ends this section and takes a look at the commercial applications of electronic music. The BBC Radiophonic Workshop hardly even gets a mention (a serious omission considering that it has become something of a model for many European studios) before we're back in the land of rock. Whilst it's undoubtedly true that the 'wall of sound' production techniques of Phil Spector supplied the bread and butter for a whole generation of rock musicians and producers, the debt owed is more to classical techniques of orchestration than to those of electronics *per se*.

The last section, 'The Musicians', consists of 50 mini-biographical entries for "important figures in the field". I'd certainly question the inclusion of at least 10 of them; would you consider Bowie, Cale, Cardew, Davies, Hendrix, Jolivet or Oldfield as having made a real, identifiable contribution to electronic music? I suppose it all comes down to whether or not one should include 'electric' musicians.

In summary, then, 'Electronic Music' is a well-written book, though a shade on the humourless side, with excellent and colourful photos to liven up the text. It should provide an excellent introduction to the subject for the novice, but it only scrapes the surface of many parts of the genre and may well frustrate the committed electro-musician.

David Ellis

Teisco SX-400

RECORDED ON CASSETTE NO. 5

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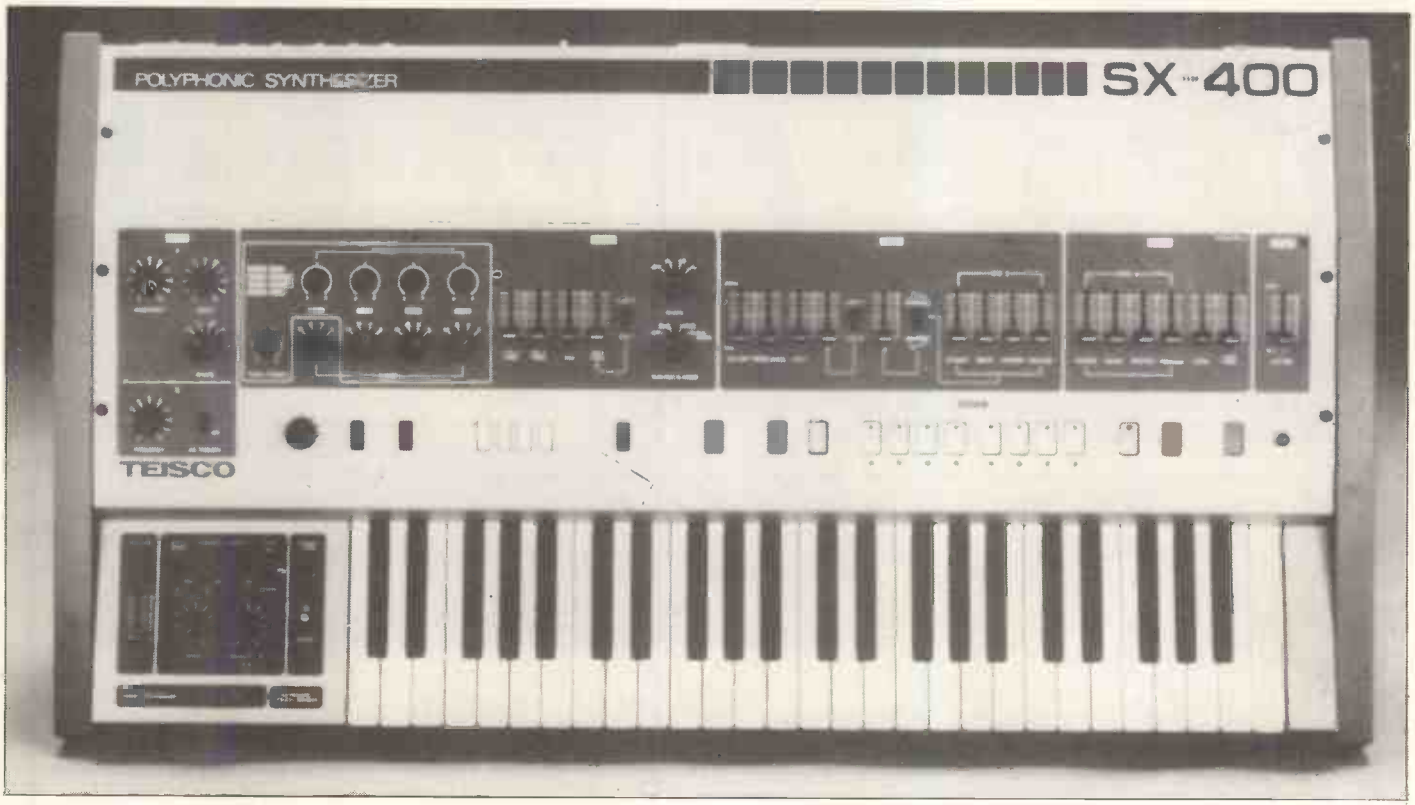

Teisco musical instruments are relatively new in the UK and are made by the large Kawai manufacturing company in Hamamatsu, Japan, well known for their fine acoustic pianos. The comprehensive range of professionally presented Teisco products includes synthesisers, mixers, PA and group gear amps, plus effects and accessories.

The Teisco SX-400 Synthesiser is the top model in the range featuring computer memory for preset and user voices, plus a complete programmable synthesiser that can be edited and played on up to four notes at once from its pressure sensitive keyboard. In addition, special features like touch sensor, hand controller, ensemble and note assignments make this instrument something out of the ordinary.

The instrument is well laid out with the main panel divided into LFO, VCO, VCF, VCA and HPF sections from left to right. Also on this panel directly underneath these synthesiser programming controls are the keyboard, note selection, preset programming and edit buttons. To the left of the 49-note keyboard, are the 'performance' controls. All the in/out connections are located at the rear including the on/off switch. The synthesiser's all metal cabinet is well made to withstand knocks without being too heavy for one person to carry around. Unfortunately, no lid is supplied so a flight case or similar would probably be needed.

Sound Making

Let's start with the basic sound making controls on the SX-400. Like most varieties of polyphonic synths, *one* set of controls sets the parameters for all the notes played at any time. There are four VCOs that can be assigned to the keyboard in four ways using the Poly Mode switches:

1) QUAD where one VCO is assigned to each key at a time, allowing you to play chords of up to four notes by pressing four keys. Channel 1 pitch/range group has its LED lit to indicate that all four VCOs will be adjusted simultaneously from its rotary pitch control and range switch. Each mode will bring into operation one or more of the four pitch and range controls, indicated by the LEDs in the four groups and a 'total tuning' control sets the overall pitch to match other instruments. Pitch controls will give over an octave change and range switches select 16', 8', 4' and 2' basic keyboard pitch. Only channel 1 range setting can be stored in the memory.

2) DUAL mode assigns two VCOs to one key at a time, with a maximum two notes playable. Channel 1 and 2 pitch/range controls let you detune the two pitches and set individual ranges too. The oscillator sound is therefore much richer and great for semi poly/mono solos.

3) MONO puts all four VCOs on to a single note played and brings all the pitch/range controls into operation. Besides creating a big oscillator unison sound, it is ideal for making fixed interval chords, played easily from a single note. The levels of each VCO are the same but filtering can balance them in many ways.

4) SOLO. This is a little disappointing after the other modes, but nevertheless does add further versatility to the instrument by turning it into a monosynth with 'one oscillator/one note' only playing.

These options immediately open up the playing styles and I found that I was selecting these frequently to match solos, chords and instruments. For example, the 'violin' preset can be a solo violin in SOLO, a string quartet in QUAD, or a rich vibrating (from detune) string orchestra sound in DUAL and MONO. Going one step further, using QUAD mode with ensemble gives a superb stereo phased image of a string section.

There are two LFOs on the instrument — still quite a luxury for most machines without patching facilities. LFO 1 has a wide range frequency control giving an adequately slow sweep to a fast 14 cycle 'buzz'. Four waveshapes are available — sawtooth, inverted sawtooth, square and triangle. Incidentally, using triangle instead of sine for LFO control often gives a more natural tremolo and vibrato. A delay control will give up to a second or so pause on new keys before the effect begins. Polyphonic upward and downward slides, trills, wah-wah, tremolo, vibrato and echo-like effects can all be obtained.

LFO 2 gives a triangle wave modulation to the VCF section only. It can also trigger EG 1

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Allens Music Shop, 22-24 Broad Row, Great Yarmouth, Norfolk. Tel: (0493) 2887.

Elvic Electronics, 7 Fairfield Road, Braintree, Essex. Tel: (0376) 21439.

Honky Tonk Music, 302 London Road, Hadleigh, Essex. Tel: (0702) 553647.

Lynn Music, 29 Norfolk Street, King's Lynn, Norfolk. Tel: (0553) 4390.

Promenade Music, 1 St Andrew's Street North, Bury St. Edmunds, Suffolk. Tel: (0284) 2801.

MIDLANDS

Keith Baddeley Organs, 121 Church Street, Stoke-on-Trent, Staffs. Tel: (0782) 411401.

John Barrie Music Centre, Unit 2, Bradford Street, Shifnal, Telford, Salop. Tel: (0952) 461714.

J.K. International Organs, 6 East Street, Derby D1 2AU. Tel: (0332) 32005.

Jones & Crossland Ltd., 6 Smallbrook, Queensway, Birmingham B5 4EN. Tel: (021) 643 4655.

SCOTLAND

Gordon Simpson Ltd., 6 Stafford Street, Edinburgh EH3 7AY. Tel: (031) 225 6305.

WALES

Sound Centre, 9 St. Johns Square, Cardiff, South Glam. Tel: (0222) 34018.

Williams Bros., 130 Osborne Road, Pontypool, Gwent. Tel: (049-55) 2732).

NORTHERN IRELAND

M. Crymble Ltd., 67/71 Dublin Road, Belfast BT12 7LU. Tel. (0232) 26818.

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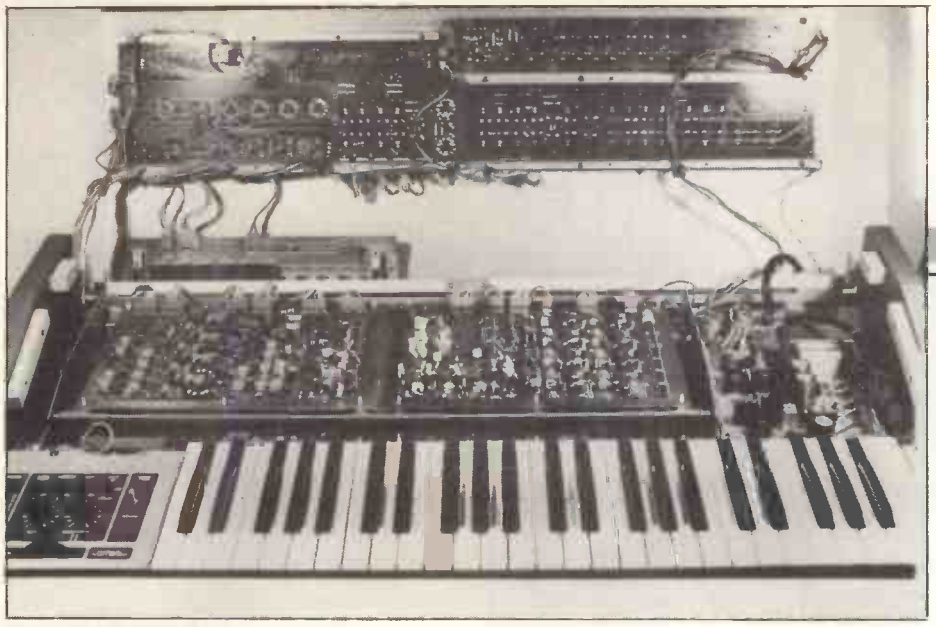
E&MM1/B2



Teisco SX-400 opened up.

and 2 when used on the VCF for plucking and multiple triggers on each note(s) played. This not only makes LFO 2 useful for banjo, mandolin and sound effects, but when used in conjunction with LFO 1 can create interesting cross rhythms.

Coming back to the VCOs, the waveshape of all of these can be sawtooth, square or triangle (or off). On an oscilloscope these waveforms are far from perfect, although the extra harmonics that appear seem to make them more interesting to use. Pulse width manual or LFO/EG 1 modulation of the squarewave makes brassy and tight thin sounds that 'move', and LFO 1 and EG 1 sliders can both modulate pitch at the same time. Another nice extra is the sub oscillator for lower octave depth. It is selected from one switch that also brings in noise with or without sub oscillator. EG 1 control of pitch is not common on polyphonics, yet it opens up plenty of experiment with pitch sweeps and jumps each time you play a note. This is still a 'musical' effect as the pitch can be brought back to normal before the note ends, thus maintaining the harmonic/melodic sequence. I should mention at this point that apart from using 'one' set of synthesiser controls for all notes played, this instrument is properly polyphonic with independent VCOs, EGs, VCFs and VCAs.

Moving on to the VCF Block, we find a low pass filter with Cut-off, Resonance, Keyboard Control Voltage (follower) and LFO 1 or 2 modulation slider controls. A separate envelope generator, EG 1 with the usual ADSR settings, can be used for normal or inverted shaping of tone. The Resonance control picks out the harmonics quite well, without going into oscillation.

The VCA block changes the volume with its own ADSR controls in EG 2 and LFO modulation.

A mixer adds all four synth sections together before LFO modulation takes place and, in addition, a useful high pass filter can progressively remove lower frequencies. Ideally, the HPF and LPF should allow you to cut top and bottom frequencies to form a band pass, but the lack of resonance on the HPF limits the peaking. Nevertheless, its an essential synthesiser component that adds the finishing touch to your sound making. Actually the signal still has some way to go, but all the programmable controls that can be stored in the microcomputer RAM memory have now been mentioned.

Effects

Before the 'line' signal reaches the left and right output sockets, it can be routed through Ensemble (a three-channel BBD section) to give a rich chorus effect in wide stereo. Listen to the demonstration on Cassette No 5 and you'll hear the normal mono output sound jump out into a spatial stereo sound that holds the brightness well. Some background hiss is evident if you listen for it, but there is a big signal available at the output to diminish this altogether during play. To complete the signal chain, there are in fact four more VCAs — two for external foot pedal control of the stereo signal and two for programmed volume.

The Key Hold switch is unusual in that it can only be set when notes are being held. An LED shows that it has 'captured' your notes.

One of the SX-400's major features is its 'Sensor Block'. The keyboard is pressure sensitive requiring a fair degree of pressure to make the full control 'sweep', but it really brings your performing to life. Extra keyboard sensor pressure can produce pitch and filtered effects with a separate oscillator for modulating VCOs and VCFs. The Sensitivity sets pitch jumps up to a major 6th not only up but down and sets modulation depth for either the keyboard sensor or hand controller (a left-to-right spring-loaded lever) which also operates these controls. A transpose switch puts the pitches down another octave and it is possible for the range to go from a few clicks to beyond hearing! Digital systems do offer semitone control and the SX-400 is no exception, having portamento slides and chromatic glissandos at the speed set between consecutive notes — always an exciting effect on a polyphonic.

Memory

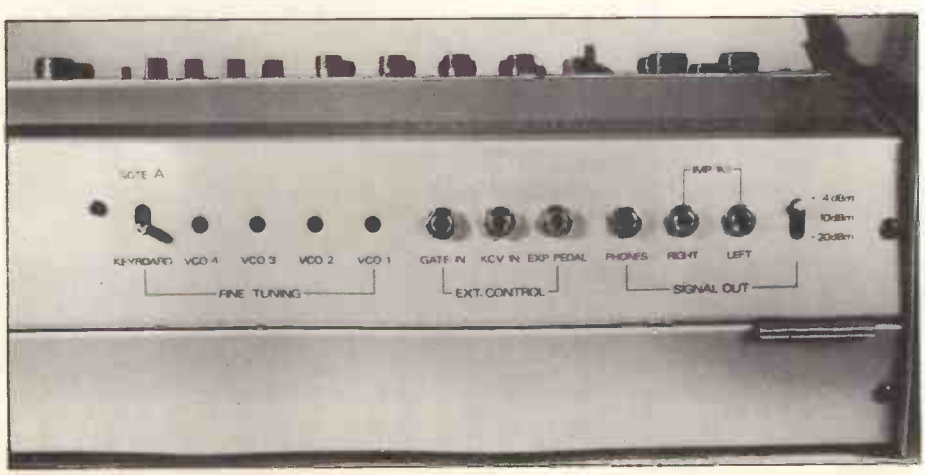
The memory section contains eight factory preset sounds selected from microswitch buttons with LED indicators. Since these buttons also serve to store eight of your own programmed sounds, a memory/preset switch is used to select one or the other.

The factory preset sounds cannot be erased and are stored in ROM (Read Only Memory). The selection provided is very good indeed and I have a feeling that many users of the SX-400 will play a lot of their music simply from these presets. There is a smoothness and clarity about the sounds that is set against a hum free background. The analogue to digital memory conversion/scanning system employed is well designed and allows accurate setting of control pots and sliders when programming your own sounds.

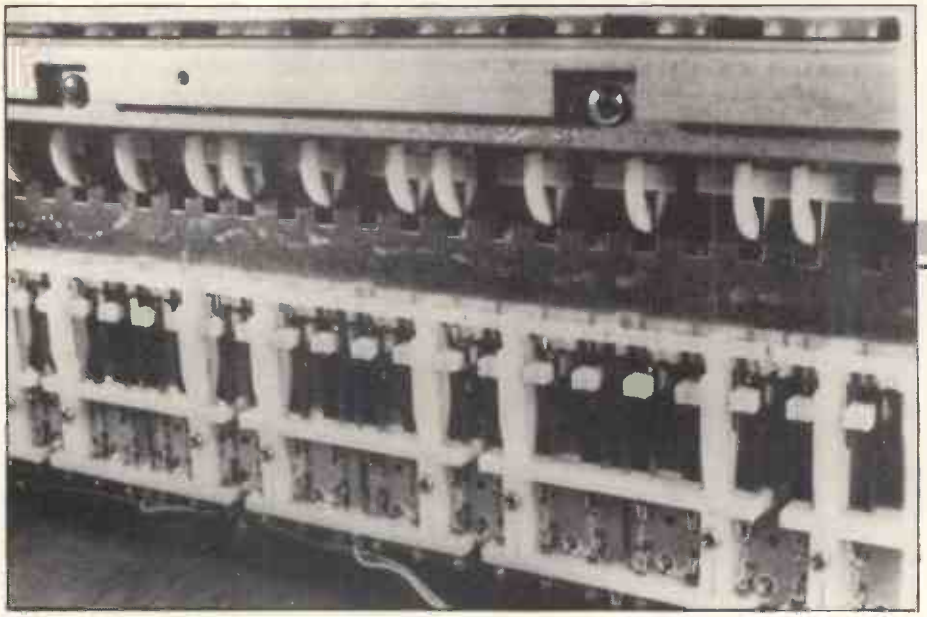
The presets are Trombone, Trumpet (both very good brass), Violin (ideal strings with Ensemble), Human Voice (you must listen to this one — *à la Tomita*), Electric Guitar (needs editing), Harpsichord (amazingly bright), Electric Piano (more like a vibraphone), and Sitar (really a good synth filtered effect).

Programming and Editing

As well as 'memory' sounds, you can select your own programmed presets using the synthesiser section. Once you've set the panel synth controls to get the sound you want, it's extremely easy to enter your sound into any of the eight memories with the write



Rear connections.



Keyboard close-up with pressure sensitive strip.

and memory protection buttons. That really gives you 17 sounds for performance: eight memory, eight program preset and one panel. But what makes it all the more versatile is the extra Editing facilities.

A sound can be selected from 'Memory' or 'Preset' and a touch of the Edit switch lets you change the sound entirely if you wish using the synthesiser panel controls. So the sound can be modified and re-stored in any of the eight memories.

The factory preset sounds (although permanent) can also be edited and/or moved to user memories. There's no waiting involved at all, it happens as soon as you press the buttons and your sound will be held indefinitely provided you don't lock the instrument away for a year.

Connections and Tuning

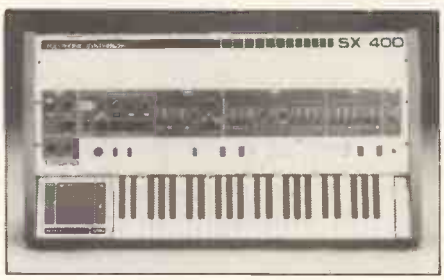
The Signal Out has left and right jack sockets, as well as stereo phones, with +4, -10 and -20 dB settings. An expression pedal can be inserted to change volume. Besides Gate IN there is Keyboard Control Voltage IN. This is unusual and gives pitch control with parallel tracking from a single CV (1 volt/octave) source. At last my sequencer can play poly chords as well as a bass line! Playing a different keyboard chord will set the sequence from the new root and so on.

Finally, fine tuning of the four oscillators is done with four screwdriver presets and a 'note A selector' switch that puts the lowest C, D, E and F keys as individual oscillator unisons.

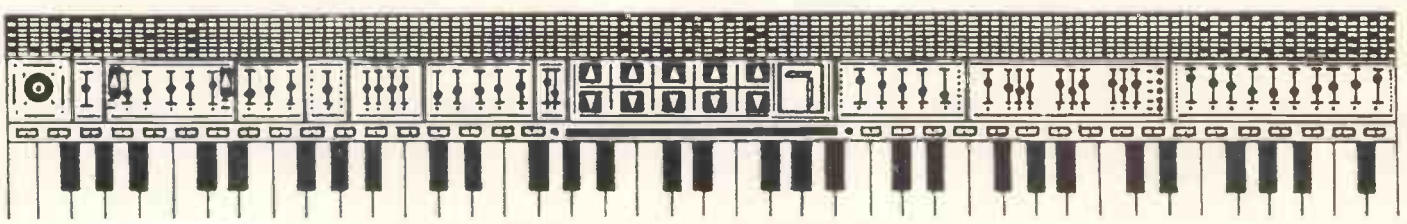
Conclusions

I must admit, that I've enjoyed this instrument very much — if you want to enter the polyphonic synthesiser world, at a reasonable price, the SX-400 at £1,690 inc VAT is well worth considering. Its playing modes and pressure sensitivity, not to mention the programming features, make it truly up to date and the only effect that's missing is arpeggio (but you can get that with an external CV/Trigger). I've recorded the Rick Wakeman music from the December issue on it (using the eight-track Fostex) as well as plenty of other sounds on Demo Cassette No 5, and the quality of the sounds is superb. You probably won't even know it's only playing four notes!

Mike Beecher **E&MM**



The Teisco SX-400 is distributed by John Hornby Skewes & Co Ltd, Salem House, Garforth, Leeds, LS25 1PX. Tel: (0532) 865381.

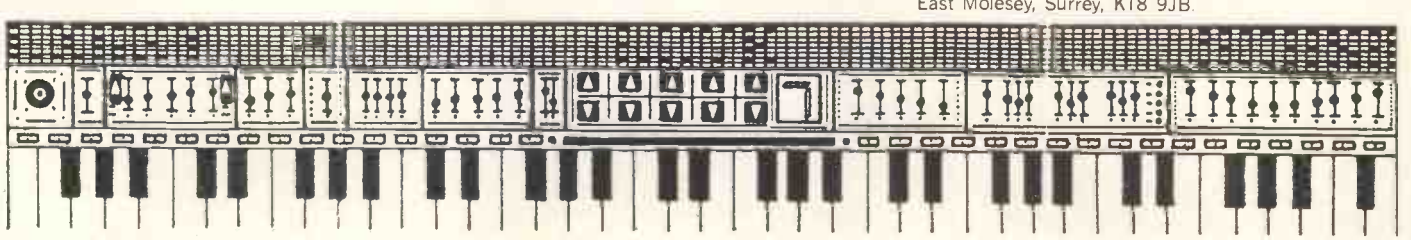


TOP 25 ELECTRO-MUSIC RECORDS

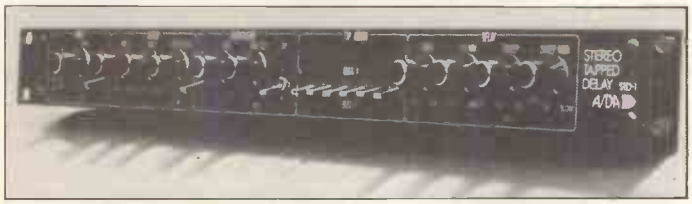
Compiled by E.S.S.P. (November 1981)

1.	Audion	Synergy/Larry Fast	LP&CS
2.	Exit	Tangerine Dream	LP&CS
3.	Logic	Logic System	LP&CS
4.	Dare	The Human League	LP&CS
5.	Games	Synergy/Larry Fast	LP&CS
6.	Magnetic Fields	Jean Michel Jarre	LP&CS
7.	Prisms	Michael Garrison	LP
8.	Repeat Repeat	Peter Baumann	LP&CS
9.	Computer World	Kraftwerk	LP&CS
10.	Bostich	Yello	7"
11.	Switched On B'burgs.	Wendy Carlos	LP&CS
12.	Under Your Thumb	Godley & Creme	7"
13.	Cords	Synergy/Larry Fast	LP&CS
14.	Ravel	Tomita	LP&CS
15.	O Superman	Laurie Anderson	7"
16.	Speak & Spell	Depeche Mode	LP
17.	Sequences	Didier Bocquet	LP
18.	Thief	Tangerine Dream	LP&CS
19.	Penthouse & P'ment.	Heaven 17	LP&CS
20.	Superficial Music	Bernard Szajner	LP
21.	Home Sapien	Peter Shelley	LP
22.	Sailplane	Obx	7"
23.	Non Stop Erot. Cab.	Soft Cell	LP&CS
24.	Architect. & Morality	O.M.D.	LP
25.	Incontinent	Fad Gadget	LP

These records can be obtained from E.S.S.P. Distribution, P.O. Box 37b, East Molesey, Surrey, KT8 9JB.



NEW PRODUCTS & NEWS



STEREO TAPPED DELAY

A/DA announces its new STEREO TAPPED DELAY, the STD-1, a Voltage Controlled analog delay which produces six delays simultaneously. Each of the six non-harmonically related taps can be assigned and mixed into either of two stereo output channels.

The Delay time of the STD-1 varies from 1.3ms to 55.5ms and is continuously variable over a 1 to 5X range. The Sweep Rate varies from .1 to 25 seconds for a complete cycle.

The Regeneration Level control determines the decay time at long delays (up to 15 seconds) and the amount of resonance at short delays (up to + 12dB). The High Cut control reduces the high frequency content in the fed back signal, and is adjustable from 12kHz to 800Hz.

Effects produced by the STD-1 include stereo high flanging, low flanging, highly resonant flanging, doubling, multi-voice chorusing, echo, reverberation, machine gun reverb, multiple doppler effects, vibrato, and "3-D" spacial placement which moves the sound source forward and back in the stereo field.

The suggested list price is $799.95.

For further information contact: A/DA 2316 Fourth Street, Berkeley CA 94710.

ZX LEARNING LAB

To enable ZX81 users to learn programming 'hands-on', Sinclair Research has introduced the ZX Learning Lab. This offers a practically-based alternative to the text-only method of the ZX81 BASIC manual.

The package comprises eight cassettes and a 160 page manual. Six of the cassettes contain 20 programs, each of which demonstrates a particular aspect of the ZX81. The remaining two are blank for practice purposes.

The Lab is available mail-order from Sinclair at £19.95 inc. VAT p&p.

Sinclair Research Ltd., 6 King's Parade, Cambridge, CB2 1SN. Tel: (0223) 312919.

BABANI CATALOGUE

The well known publishing company Bernard Babani Ltd has just released a catalogue of their current publications. These popular paperbacks cover a wide range of subjects in the areas of electronics, semiconductors, computers, television, radio and hi-fi. The majority of the books are priced between one and two pounds.

For a free copy of the catalogue send a SAE to: Bernard Babani (Publishing) Ltd, The Grampians, Shepherds Bush Road, London W6 7NF.

MF100 SYNC UNIT

The MF100 enables the user to record a clock pulse and two control signals onto a single track of any reasonable reel to reel or cassette tape recorder (not AGC type). The recorded signal is then decoded on playback through the MF100 to give synchronisation for most rhythm units, sequencers or any instrument requiring clock control or triggers. Thus different beats of a bar can operate 6 or more instruments in perfect sync. independently. It is also ideal for overdubbing and multitracking and its versatile connections at the rear give a wide number of alternative trigger steps, that divide by 2, 3, 4, 6 and 12 from the main pulse. Controls include clock tempo, stop/start, threshold replay, and buttons for continuous control of a unit plus manual switching on a separate channel. Several options are available including the MF50 and MF10 units.

For further details of this invaluable accessory for the electro-musician write to: Mac Fison, Electronic Engineers, 13 North Falls Road, Canvey Island, Essex.

AUTO-MATCH TRANSFORMER

Peavey Electronics Limited have announced the release of their Auto-Match transformer which allows impedance matching upwards or downwards whilst retaining the optimum power rating.

Peavey claim that the unit will handle optimum power ratings up to 400W and offers perfect speaker matching from 2R to 100V lines.

The unit is mounted on a welded bottom plate for installation in a rack or other suitable housing and the retail list price is £50.00.

For further information contact: Peavey Electronics (UK) Limited, Unit 8, New Road, Ridgewood, Uckfield, Sussex, TN22 5SX. Tel: (0825) 5566. Telex 95709.

RAVI SHANKAR TO WRITE FOR 'GHANDI'

Ravi Shankar has agreed to co-write the score for Richard Attenborough's epic film on the life of Mahatma Ghandi with National Theatre Composer, George Fenton.

The soundtrack is to be recorded in Bombay and London, where groups of selected solo artists will perform with Ravi Shankar, and George Fenton will conduct the Wren Orchestra.

BBC OPERATING SYSTEM FOR ATOM

Acorn computers have announced the start of production of a ROM set which can be added to the Atom to change the operating system and BASIC interpreter to a version near to the BBC microcomputer.

The 20K ROM will equip the Atom with the same BASIC as the BBC computer and an operating system as close as the hardware allows.

Availability of the ROM will be around January 1982 although an EPROM version will be ready six weeks earlier.

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

KAMAN STRINGS

Rose Morris are to market Kaman's 'Performers' Electronic Guitar strings. The core and wrap of these strings is one of equal gauge to improve harmonics and the stainless steel wrap makes the fourth strings flexible and biting. They are also coated with Duraflo to improve appearance and reduce damage. The bass strings are coated with Kanflow, Kaman's new patented coating which it is claimed keeps the strings cleaner and more durable.

They are available in the following sets: Ultralight (.008), Extra Light (.009), Light Gauge (.010) through to Light Top Heavy bottom set, 12 string set and Light Medium join sets.

For further information contact: Gwen Alexander on 01-267 5151.

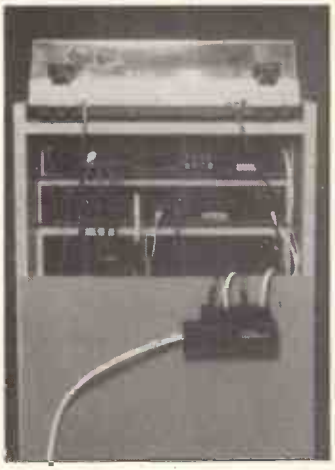
NEW SPEAKERS

Electro-Voice have developed a new range of speakers. These are the Force 10", 12" and 15". The power capabilities are claimed to be 150W per EIA standard RS-426A.

The construction of the Force speakers features a low mass voice coil on a laminated polymide coil frame driven by a 10lb magnetic structure. Both coil and magnetic structure are vented and they are packaged in an eight spoke die cast aluminium frame with a heat radiating pinned back cover. The recommended retail prices are as follows: Force 10 £82.50, Force 12 £86.00, Force 15 £89.50.

For further information contact: Electro-Voice Division, Gulton Europe Limited, Maple Works, Old Shoreham Road, Hove, Sussex BN3 7EY. Tel: (0273) 23329. Telex 87680.

MAINS MULTI-OUTLET ADAPTOR



Nu-Way Styli Components Ltd have developed the 'Masterplug', a mains multi-way adaptor which they claim will help eliminate the infamous 'spaghetti' usually found behind hi-fi and video installations.

The Masterplug uses a printed circuit which makes the adaptor very compact; 149mm x 44mm x 20mm. It has an overall power rating of 3840W and current rating of 16A with 6A maximum on each of its four outlets.

The socket outlets are fully shuttered and recessed so that the pins on the contoured, non-reversible plugs are never exposed on insertion or removal. It also has a neon on/off indicator. The unit complies fully with British Standards and Electrical Equipment Safety Regs.

It will be available from large stores and radio and electrical retailers complete with four plugs at £8.99 or £9.99 with a ready fixed 1.5m cable.

For further information contact Mr H. Kidby. Tel: 021-236 6366.

TWO NEW MICS

Shure Electronics Limited has expanded its range of microphones by two models; 517SA High Impedance and 517SB Low Impedance Unidirectional Dynamic Microphones. Both are designed for hand-held or stand use with a locking on-off switch and shock mounted control.

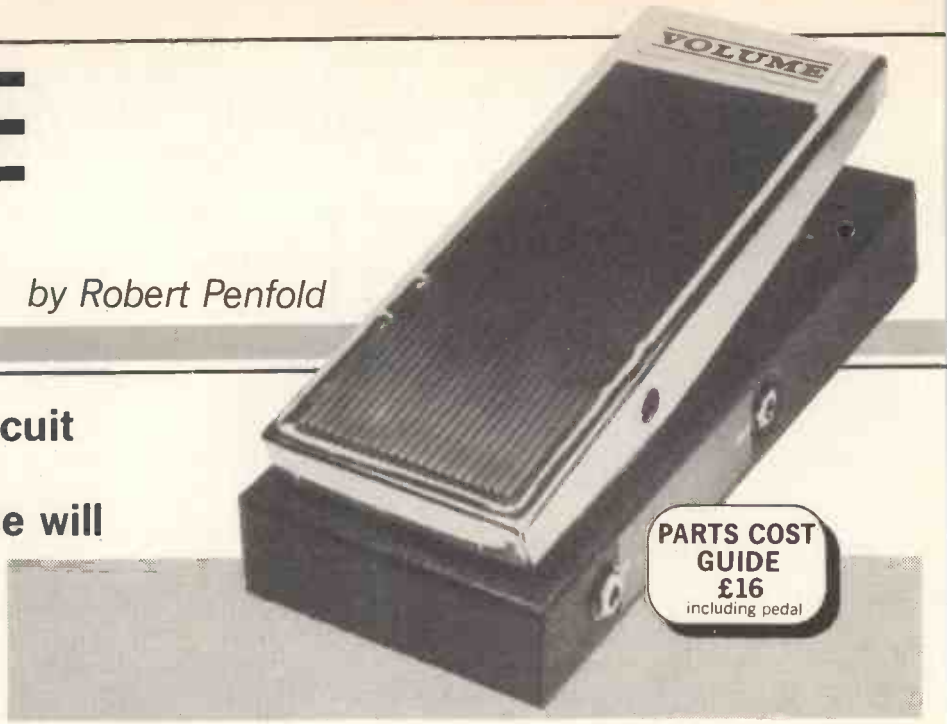
Shure claim a wide frequency response, rolled off low frequency response (to reduce proximity effect) and symmetrical cardiod pickup pattern (to reduce feedback).

The suggested retail price fitted with cable is £21.92 plus VAT, each.

For additional information write to: Shure Electronics Limited, Eccleston Road, Tovil, Maidstone, Kent ME15 6AU.

VOLUME PEDAL

by Robert Penfold



- ★ **Unique Hall effect circuit**
- ★ **Noiseless operation**
- ★ **Low output impedance will drive long cables**

A conventional volume pedal consists of an ordinary potentiometer connected in the usual volume control fashion, and operated from the foot pedal via a rack and pinion mechanism. This system works very well, but with a lot of use the potentiometer's track can become worn with consequent noise being generated as the pedal is operated.

The problem is overcome in this pedal, which uses a magnet and a Hall effect device instead of a potentiometer. As the pedal is depressed the magnet is brought closer to the Hall effect device, and the increased magnetic field is converted into an increase in voltage.

The input signal is passed to the output by way of a voltage controlled attenuator (VCA), and, like a volume control, this can provide a level of attenuation of anything from zero to around 80dB. However, it is of course controlled by means of a voltage applied to its control terminal.

The output voltage of the Hall effect device is slightly too high in terms of its quiescent level, and too low in terms of voltage change produced by the varying magnetic field, and so the device cannot directly control the VCA. A level shifter and low gain DC amplifier are therefore used to process the output of the Hall effect sensor and give a suitable control voltage for the VCA.

Pre-emphasis (treble boost) at the input of the VCA and de-emphasis (treble cut) at the output are used to give a slight improvement in the signal to noise ratio of the unit. The ratio is actually about 80dB, and the background noise should be completely insignificant provided the unit is not used with a very low level signal. The circuit can take a maximum input level of about 2 volts RMS at most frequencies without serious distortion being produced. The circuit has an input impedance of about 50k and an output impedance of approximately 350 ohms.

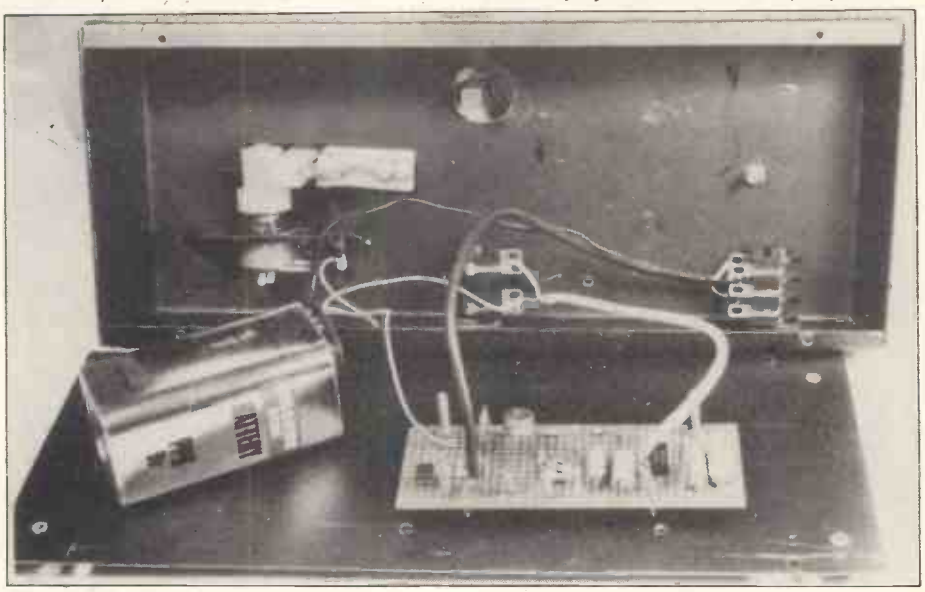
The Circuit

Figure 1 shows the complete circuit diagram of the Volume Pedal, and IC1 is the Hall effect sensor. This is not one of the usual Hall effect switches but is a linear device, of recent origin, which has differential outputs.

IC2 is an operational amplifier used in the inverting mode.
gives an output voltage swing that is sufficient to give a wide attenuation range from the VCA, and a single resistor and diode chain in the feedback network of IC2 is adequate to give the desired tailoring of the amplifier's transfer characteristic.

The VCA is based on IC3 which is the well known MC3340P device. This can provide a voltage gain of about 13dB, but in this application a maximum gain of only unity is required and this is achieved by using R7 and R8 to provide about 13dB of attenuation at the input of IC3.

The current consumption of the circuit is about 12mA, and it is switched on automatically by insertion of the input jack.



View inside the pedal.

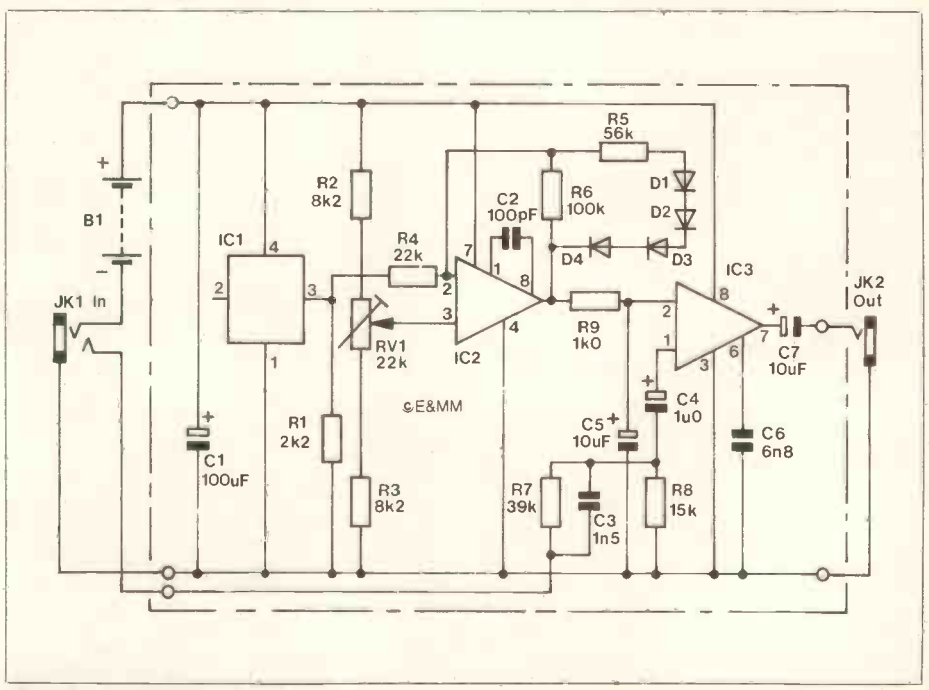


Figure 1. Circuit of the volume pedal.

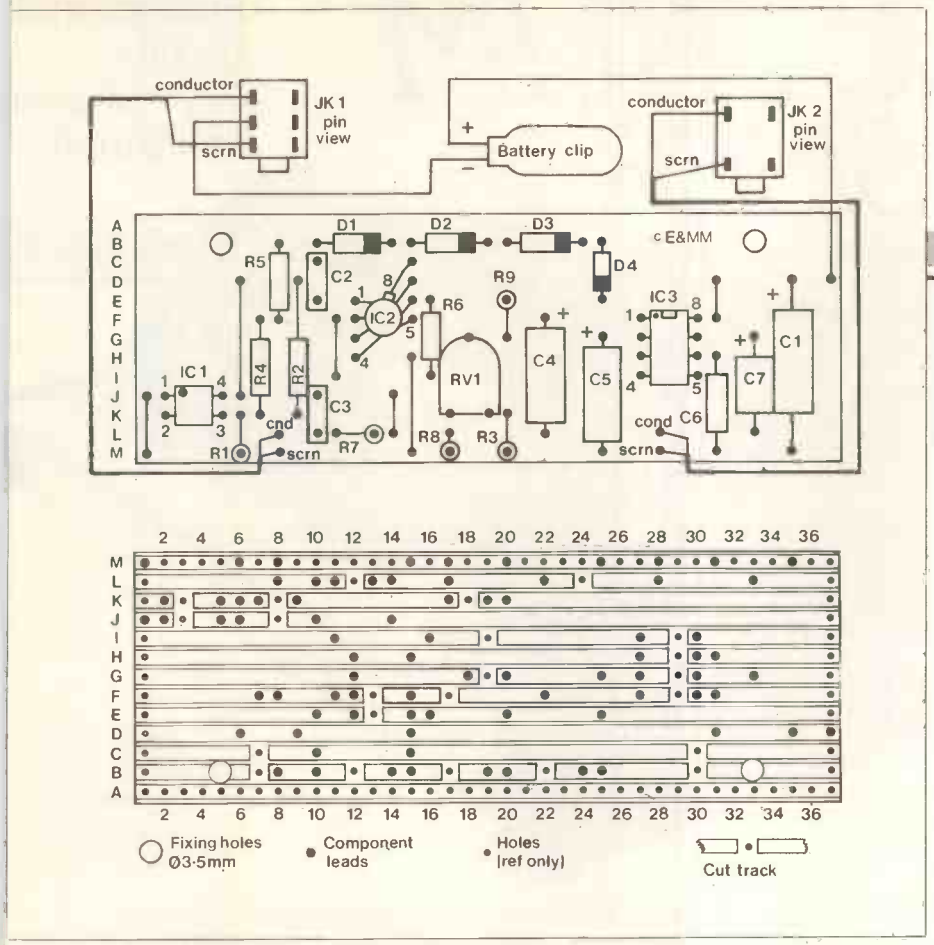


Figure 2. Veroboard layout and wiring of the volume pedal.

Construction

A 0.1" matrix stripboard measuring 37 holes by 13 copper strips accommodates practically all the components, and Figure 2 provides details of this board and wiring of the unit.

IC2 is a CMOS device and requires the normal MOS handling precautions to avoid possible damage by static charges.

The pedal itself is a modified Maplin volume pedal. The output lead should be removed, but retain the potentiometer to give friction to the pedal mechanism. Open out the recessed hole on the right hand side of the case to 11mm, and drill another the same size nearby to accommodate the jack sockets.

The magnet passes through a hole about 18 to 20mm in diameter which is made in the top panel, midway along and about 75mm out from the side of the case on which JK1 and JK2 are mounted. The magnet cannot be fitted direct to the underside of the pedal as it is too short to reach down into the case. Therefore a piece of timber or chipboard about 18 to 20mm thick is glued to the underside of the pedal immediately above the hole in the top panel of the case, and the magnet is then glued to this. A good quality adhesive must be used, and an epoxy type is probably the best choice for this application.

However, it is essential to mount the magnet the right way up or it will produce an output voltage of the wrong polarity from the Hall effect device. Probably the easiest way of finding the correct polarity for the magnet is to first wire the component panel to the off-board components. Connect the battery, and connect the unit into a signal path. It should be possible to control the gain of the circuit by adjusting RV1, and this component is adjusted just far enough in an anticlockwise direction to severely attenuate the signal as it passes through the unit. Apply each end of the magnet to IC1 in turn, and note which end produces an increase in gain from the circuit. The other end of the magnet is glued to the piece of timber or chipboard on the underside of the pedal.

The component board is mounted on the base panel of the case, and it must be positioned so that IC1 is aligned reasonably accurately with the magnet. The easiest way of achieving this is to hold the component board in position with IC1 over the magnet, and then measure the positions of the two mounting holes in the board relative to the sides of the case, and drill the mounting holes in the base panel of the case accordingly. Spacers a quarter of an inch long are used over the mounting bolts for the panel so that when the pedal is in the down position the magnet is in close proximity to IC1. If necessary, one or two extra nuts or some washers can be used to give further spacing and reduce the minimum gap between IC1 and the magnet, but do not use so much spacing that the two come into contact when the pedal is fully in the down position as this could possibly result in damage occurring.

The setting of RV1 controls the maximum amount of attenuation that the unit can provide, and it will probably be possible to obtain a maximum level of around 90dB. This is more than is normally necessary, and a lower level of around 60dB should be more than adequate and would give more precise control of the attenuation level. The magnet will have a slight effect on the unit even with the pedal in the fully up position, and to allow for this RV1 should be adjusted for a few dBs more attenuation than is required (since RV1 cannot be adjusted while the base panel is in position). **E&MM**

PARTS LIST FOR THE VOLUME PEDAL

Resistors — all ¼W 5% carbon unless specified			
R1	2k2		(M2K2)
R2,3	8k2	2 off	(M8K2)
R4	22k		(M22K)
R5	56k		(M56K)
R6	100k		(M100K)
R7	39k		(M39K)
R8	15k		(M15K)
R9	1k		(M1K0)
RV1	22k sub-min horizontal preset		(WR59P)
Capacitors			
C1	100uF 10V electrolytic		(FB48C)
C2	100pF ceramic plate		(WX56L)
C3	1.5nF ceramic plate		(WX70M)
C4	1uF 63V electrolytic		(FB12N)
C5,7	10uF 25V electrolytic	2 off	(FB22Y)
C6	6.8nF polycarbonate		(WW27E)
Semiconductors			
IC1	634SS2		(QR55K)
IC2	CA3130T		(QH28F)
IC3	MC3340P		(QH49D)
D1-4	1N4148	4 off	(QL80B)
Miscellaneous			
JK1	Stereo jack socket		(BW79L)
JK2	Mono jack socket		(BW78K)
B1	PP6 battery		
	PP3 battery connector		(HF28F)
	Bolts 6BA 1in.		(BF07H)
	Nuts 6BA		(BF18U)
	Spacers 6BA ¼in.		(FW34M)
	Volume pedal		(XY28F)
	0.1 matrix Veroboard		(FL08J)
	Large bar magnet		(FX72P)
	Wire, solder, etc.		

The SPECTRUM SYNTHESISER

Professional Quality Monophonic Instrument

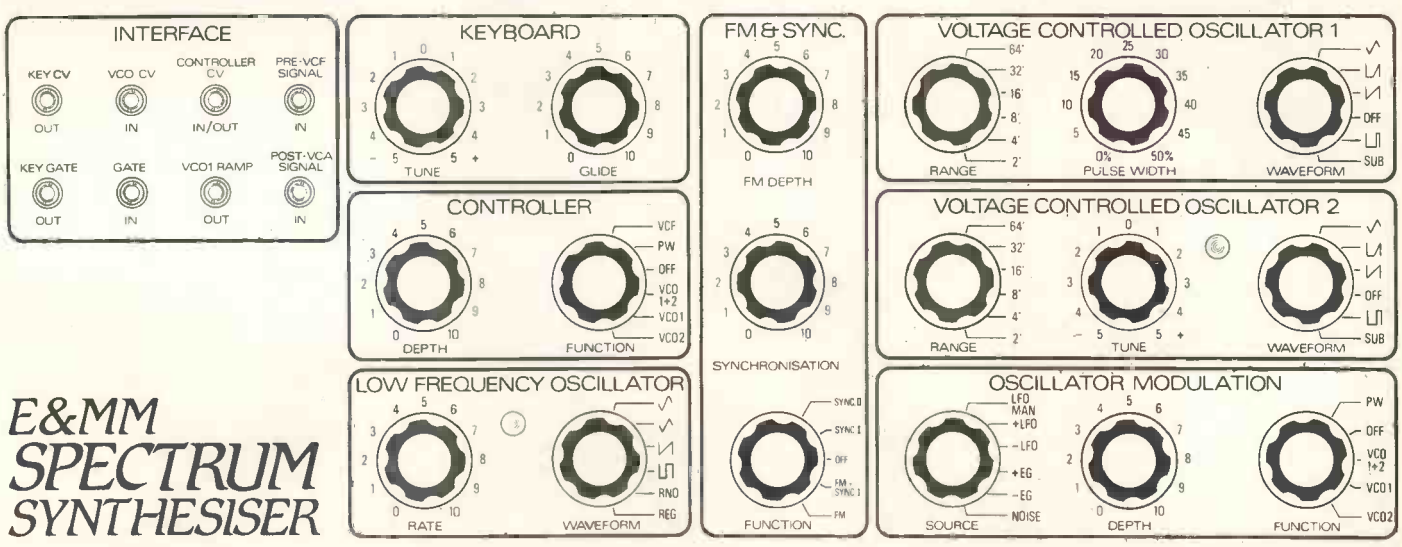
- ★ Low Cost
- ★ Easy to Construct
- ★ FM and Sync.
- ★ Stereo Outputs
- ★ Sequencer Effects
- ★ Interface Facilities
- ★ Four Octave Keyboard
- ★ Performance Controller

RECORDED ON CASSETTE NO. 6

Since publication of the Spectrum articles was delayed earlier this year, many improvements have been made to the original design. The synthesiser can still be built for around £200, plus cabinet, yet offers features found only on expensive commercial instruments.
For the benefit of newcomers to the magazine, and to bring our regular readers up to date with the improvements that have been made, we will be reprinting some of the original material.
The project will be published in two parts, containing sufficient information to enable experienced constructors to build the Spectrum. PCB track layouts and component overlays, cabinet drawings, a wiring chart and more comprehensive circuit descriptions are available in the Spectrum Synthesiser book, available from Maplin Publications for £1 plus 24p postage.

The Spectrum is a monophonic two oscillator switch-linked synthesiser featuring advanced specification, constructional simplicity and low cost. Modulation, timbre control, and interface facilities not found on any comparable synthesiser make it extremely powerful and versatile for keyboard playing, sound effects and many other home, stage, or studio applications. Construction is simplified by the use of integrated circuits that each perform major synthesiser functions with few external components. No gluing of contact blocks or bending of gold wires is needed to assemble the keyboard contacts; a new contact system only requires soldering of the contacts and drilling of the chassis to mount the contact PCB.

Figure 1 shows a block diagram of the synthesiser and the front panel legending is reproduced below. Modulation routing is accomplished by source and function switches and depth controls, rather than the usual method of providing each source with its own depth for each controlled function found on some small synthesisers. Switching is most suitable for a large number of sources as here, and allows fast selection of source and selection of modulation effects with preset depths, in favour of simultaneous modulation of one parameter by more than two signals. Six modulation signals are available: keyboard, controller, low frequency oscillator (LFO), envelope generator, noise generator



E&MM SPECTRUM SYNTHESISER

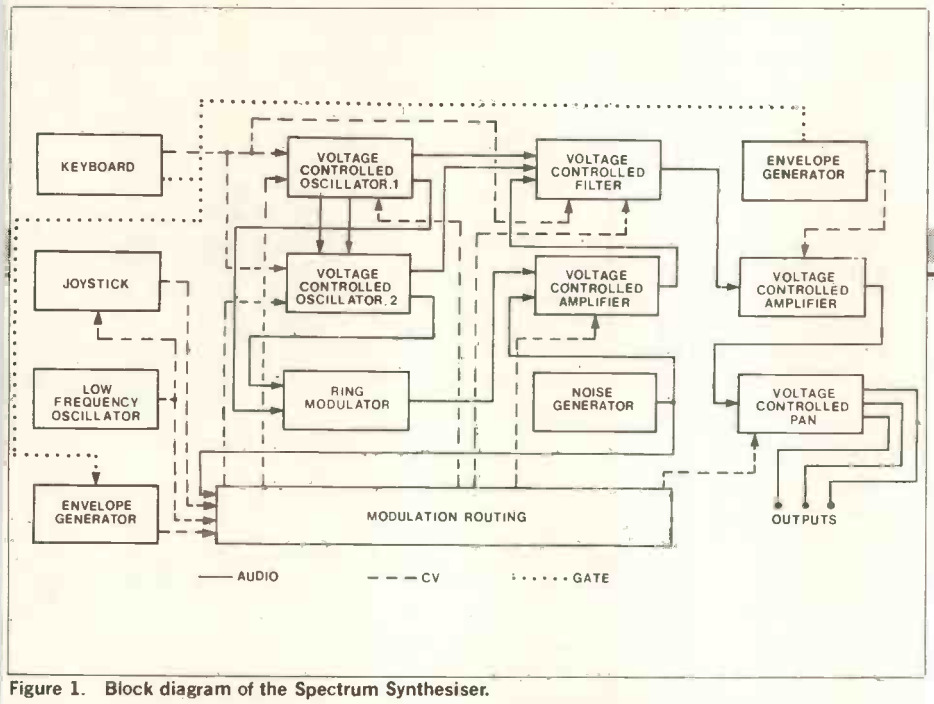


Figure 1. Block diagram of the Spectrum Synthesiser.

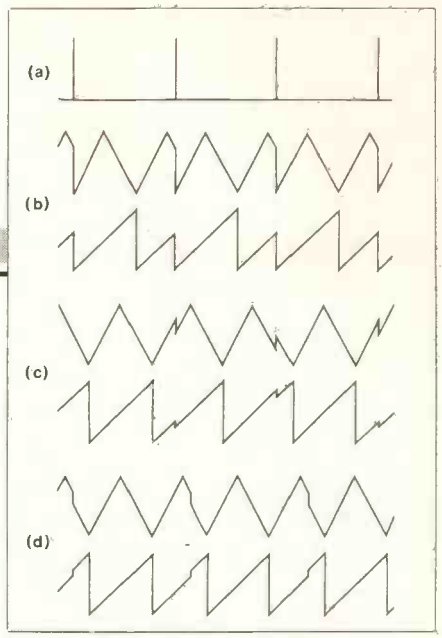


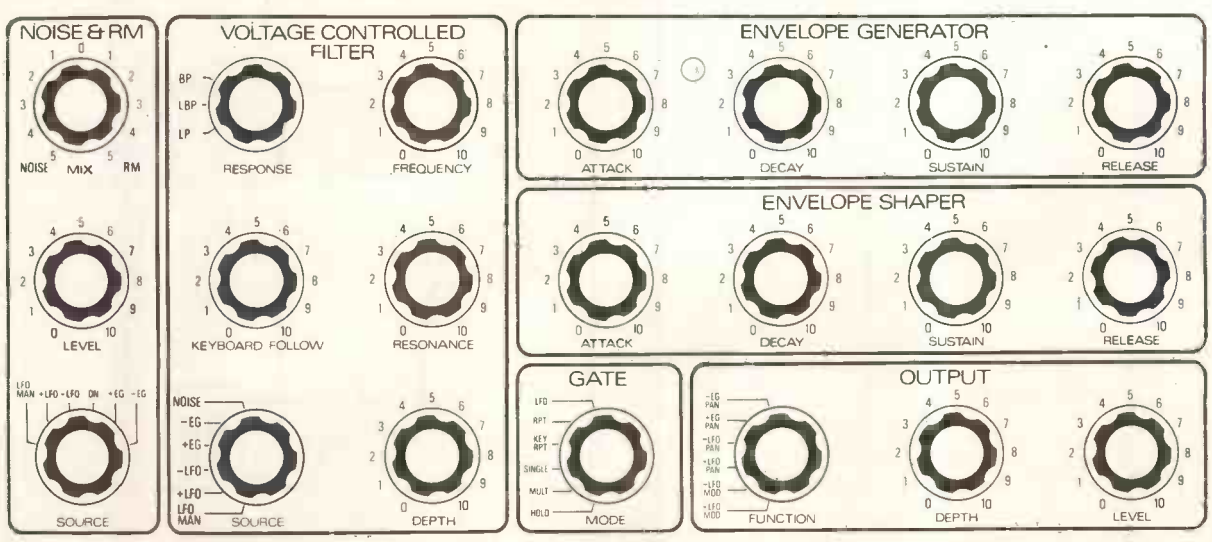
Figure 2. Sync. waveforms. (a) Sync. pulses. (b) Sync. I. (c) Sync. II. (d) Sync. II with decreased VCO1 frequency.

and external. The keyboard is of the highest note priority type and has a glide which always completes even after the key is released — this makes the keyboard much more useful as a controller for effects sounds. The joystick controller routes a voltage dependent on the side-to-side position of the stick to various voltage controlled circuits, allowing it to be used to control the pitch (pitch bend) or timbre. The external voltage fed into the controller jack can override or add to the joystick voltage for control by additional synthesiser equipment, or a pedal can be plugged in and used for control by attenuating a fixed joystick voltage.

The low frequency oscillator generates random and regular sample and hold effects in addition to the four common waveforms. The regular S/H option allows rising and falling scales, rising and falling repeating groups of two, three or more notes, and other sequencer-like effects, with the pattern controlled by the LFO rate. A LED displays the LFO cycle and the joystick's vertical position determines the amplitude at the LFO manual output. The envelope generator is of the exponential ADSR type and, like the LFO, has + and - outputs that can be separately selected for each controlled parameter. The envelope generator shares its gate signal with the envelope shaper, which determines the loudness contour of each note. 'Single' on the gate selector switch causes gating each time a first key is depressed; 'Multiple' retriggers when any new note is played, allowing fast runs without 'missed' notes. 'Hold' keeps the gate high for continuous effects, and 'LFO' causes gating on each LFO cycle. In the 'Repeat' position the envelope generator retriggers at the end of the decay period, acting as an additional LFO with variable symmetry. This allows complex rhythmic effects when used with the LFO, and gives great scope for 'backdrop' sounds based around complex S/H patterns with periodic timbre sweeping effects derived from the EG. 'Key Repeat' brings in the repeat only when a key is held, allowing key-synchronised repeating notes and delayed modulation (the delay determined by the attack time). An LED indicates the EG's attack segment.

The voltage controlled oscillators (VCOs) each have six switched octave ranges and five waveforms. The sub-octave output is a pulse wave with a square wave added an octave below, making the sound fuller and richer. The tuning LED detects the beats between the oscillators, and indicates when the pitches are in simple musical intervals, useful for tuning without sounding a note (e.g. on stage). The pulse width of VCO 1 is variable, and VCO 2 has a tune control with a ± one fifth range.

The VCOs can be used together to provide a vast range of sounds not possible with basic synthesisers having only waveform, shape, VCF cutoff and VCF resonance as the controls affecting basic timbre. This is done by frequency modulation and synchronisation — special features of this design. FM uses the triangle output of VCO 1 to modulate the frequency of VCO 2 up to ± 100% giving a whole range of non-harmonic tones for bell, gong and chime sounds etc. Synchronisation gives various waveforms from VCO 2 (see Figure 2) which have particular bands of harmonics emphasised for strong, voice-box-like sounds. This is achieved by resetting the output of VCO 2 upon each



cycle of VCO 1, so the tones generated are always harmonic. Two modes of sync. are provided: Sync. I is that normally found on rampwave oscillators, the VCO 2 waveform beginning in the same way after each reset; Sync. II is something totally new — the triangle output is set to mid way each time but then carries on in the same direction in the new cycle. VCO 2 locks on to VCO 1 harmonics with the change from one harmonic to the next emphasised by a sharp change in tone. This enables automatic arpeggiation and incredible tone sweeps to be obtained since VCO 2 now is effectively a voltage controlled waveform generator/frequency multiplier. The sync. control attenuates the pulses fed to VCO 2 so that it only resets if the wave form is above a certain threshold, resulting in the oscillators being locked together in musical intervals (3rds, 5ths etc). Simultaneous Sync. I and FM produces harmonic tones with the shape of FM-ed waveforms within each cycle.

The ring modulator uses triangle and square VCO waveforms to provide further complex tones. Its output is mixed with the noise signal and fed into a special voltage controlled amplifier (VCA). This can be controlled by the LFO or EG, and gives the signals their own loudness contours. Hence noise 'chiffs' can be added to notes, or ring modulation set to swell in as a note decays.

The VCA output is fed to the voltage controlled filter (VCF) mixed with the VCO outputs. The VCF offers the two most useful responses, low pass and band pass, plus an intermediate response for bright sounds that remain strong in lower harmonics. Cutoff frequency and resonance controls perform their normal functions and a keyboard follow control determines how the cutoff frequency varies over the keyboard range.

After envelope shaping, the signal is fed to the voltage controlled pan circuit which can modulate the location of the sound in the stereo field by the LFO or EG signals. The stereo outputs can also be used for voltage control of the depth of external effects such as reverb, phase, and echo, by routing one signal via the effects unit and one direct to the amplifier. A mono output is also provided, and the VCA can also be used for additional amplitude modulation with the LFO as source (for tremolo and other effects).

The interface jacks allow connection to external devices such as sequencers, additional VCO banks, waveform processors etc. The Spectrum Synthesiser uses the 1V/octave CV standard, and can be interfaced to any other exponential CV synthesiser.

Keyboard

The moving contacts are silver-plated springs, each fixed at one end and moved at the other by the plunger of the respective key such that the spring makes contact with two palladium bars when the key is depressed (Figure 3). The first bar is connected to the sample and hold circuit which stores the voltage representing the last key depressed, and the second to a circuit which generates a gate signal for the S/H and the envelope generators. The moving contacts connect to the divider chain (see Figure 4). These functions are usually carried out by separate contact pairs, where unless the contacts are precisely set up, note-jumping will occur when the envelope is gated before the S/H receives the new key voltage. The system used here is immune from this since the construction ensures the correct sequence of operation, and no initial setting up is required. The keyboard recommended in the parts list has removable key plungers so that cleaning the contacts is much easier too. Unclipping a plunger allows access to the sides of the bars and springs that meet.

Power Supply Unit

The Power Supply Unit consists of two identical circuits providing the positive and negative supplies, driven by a dual secondary transformer. Each secondary produces about 21V when the AC signal is rectified and smoothed, and is fused for protection in the event of a power supply fault. Regulation is carried out by the well-known uA723 regulator IC which is used with an external power transistor in series pass mode to provide the required current. This current limits at 270 mA when the voltage across series resistor R1 (R2 in the -ve side) reaches 0.6V. RV1 (RV2) allows the rail voltage to be adjusted to exactly 15V, and D1 (D2) protects against reverse polarity, again in the event of a fault. The + 15V regulated output of the side based around IC2 is connected to 0V of the IC1 side, giving the -15, 0, + 15V supply rails.

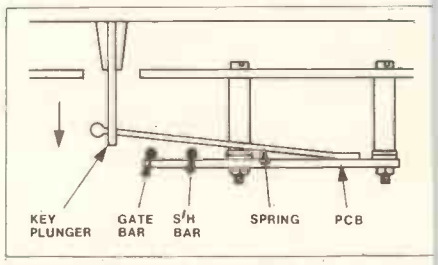


Figure 3. Key contact construction.

Keyboard Controller

Figure 6 shows the circuit diagram of the keyboard controller. Connections 1 and 2 are the bottom and top respectively of the keyboard divider chain. This is arranged in the feedback loop of IC3a, which drives a current of about 1.8mA through the divider chain.

IC3b generates a signal that is used, after processing, to gate the envelope generators and key voltage sample and hold. With no keys depressed, the non-inverting input is held at 0V by R60 and since the inverting input is at +0.83V (determined by R58) IC3b's output is at its negative extreme, almost -15V. When a key is depressed, the voltage at the inverting input rises to between 1.7 and 5.7V since the gate bus-bar is connected to the divider chain by the contact of the depressed key, and the output of IC3b goes high.

TR3 is a FET which acts as a voltage controlled switch in the sample-and-hold circuit around C11. It is normally held off by the negative output voltage of IC3b, via R62 and D14, but upon this going positive it is turned on and C11

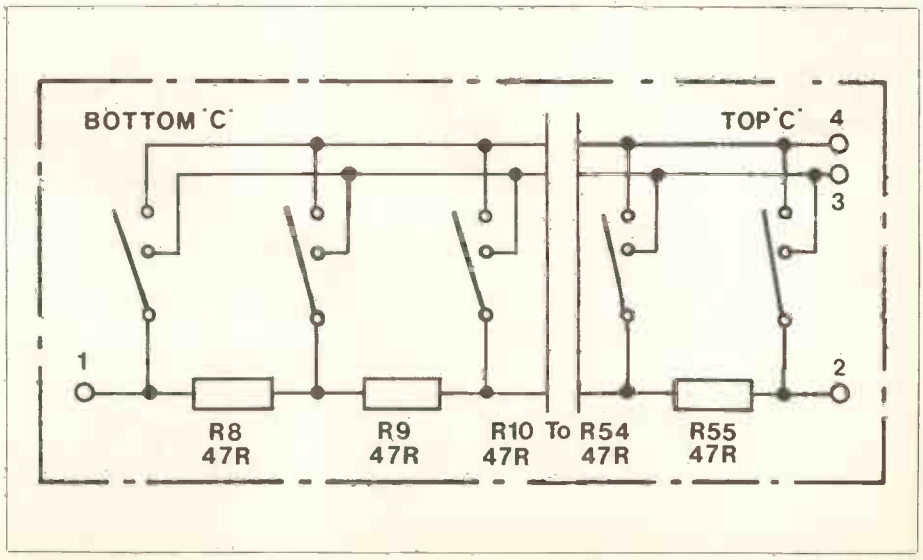


Figure 4. Circuit of key contact assembly.

charges to the voltage on the S/H bus-bar (connection point 3). Since the contact spring makes with this before the gate bus-bar, the new key voltage is always ready for sampling by the time the FET is turned on. IC5 is a FET input op-amp with a very low input bias current. This ensures that when the key is released and TR3 turns off the charge on C11 is retained with the minimum of 'droop'. Even when C11 is a high quality type (as it must be), leakage in this component predominates over the input current of IC5a. On the prototype, it took about 15 minutes for middle A to drift up to A#.

If a new note is played on the keyboard before the previous one is released, a new CV is generated, but since the key gate signal remains high, the EGs will not restart their envelopes. This can be a problem when percussive envelopes are used, fast keyboard runs giving missed notes. The problem is eliminated by detecting a change in CV at the sample and hold output, and generating a key retrigger signal for the EGs. IC4a is a high-gain differentiator that produces a pulse for each change in the value of the CV. These pulses are rectified and squared up by the comparator IC4b, and lengthened by D16, R75, and C12 to a minimum of 5mS.

Contact bounce produces a very ragged CV change when a note is depressed while one is already down, and this in turn produces a multiple pulse at the output of IC4b. The circuit around IC6c generates a clean 500uS pulse from this signal — most important for external devices such as sequencers which count in response to triggers from the keyboard.

The de-bounced gate signal from IC6a is inverted by TR5, which drives the 'key gate out' interface jack. D19 causes the gate out signal to go low in response to the key retrigger signal. TR5 is arranged to pull the output to +15V to generate the gate signal — this system allows gates from different sources to be connected together, providing an OR-function that gates the controlled device if any source signal is high.

The output of the sample-and-hold circuit (TR3, C11, IC5a) is passed to the glide circuit (R74, RV4, C13, IC5b) which produces sweeps between successive notes. The time taken for a new note voltage to be reached is controllable from almost instantaneous to five seconds for one octave by RV4. IC5b is a low input bias current op-amp, avoiding any voltage drop across RV4 that would cause a perceptable pitch error with maximum glide.

Low Frequency Oscillator

The Low Frequency Oscillator (LFO) of a synthesiser provides periodic waveforms for the control of other modules to produce modulation of pitch, timbre, amplitude etc. When the synthesiser is being used other than for simple melodic playing, the LFO is often the main control source, and must have a wide frequency range and a choice of precise waveforms. The Spectrum LFO has a range of over 1000:1, from 0.04Hz (25 seconds per cycle) to about 42Hz. Sine, triangle, ramp, and square waveforms are available, plus two additional step-type waveforms, one giving a new random voltage on each cycle, the other producing a wide range of repeating sequences. A LED flashes to indicate the LFO cycle and is very useful for quickly checking or setting the rate. Particular attention has been paid to waveform precision, and good symmetry is retained over the frequency range. Unlike many other designs, no setting up is required.

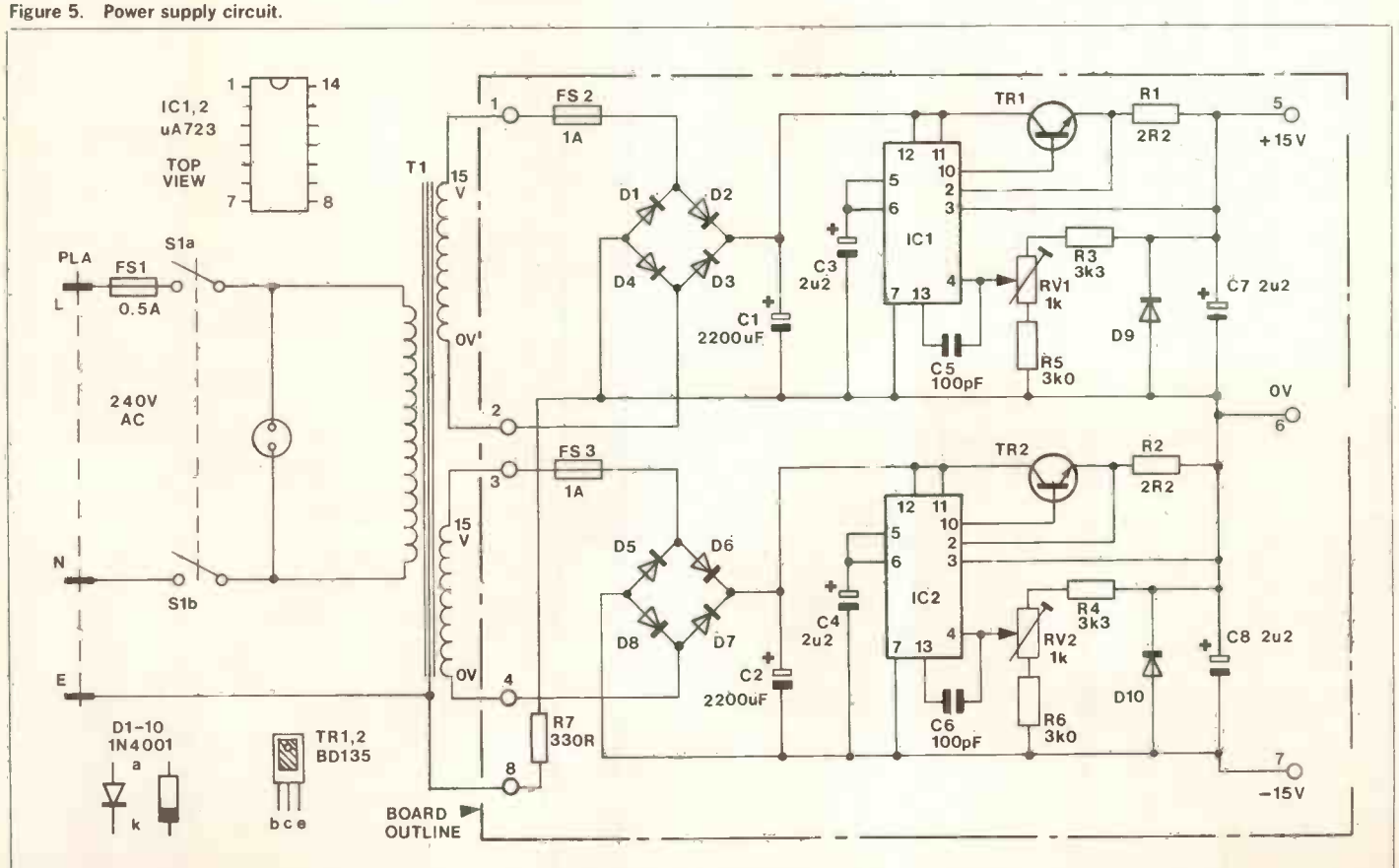
Circuit

Figure 8 shows the circuit of the LFO. It is based around IC8, IC9a, TR8, 9, 16 and 17, which form a precision triangle and square wave generator. IC8 is an integrator driven by the voltage at the wiper of RV6, the Rate control.

IC9a is a comparator which reverses the voltage at the integrator input when its output reaches thresholds set by R100 and 101, so the integrator output ramps up and down between fixed levels generating a triangle wave.

The method of producing the ramp-wave is rather unusual. The triangle and square waves are mixed and half-wave rectified by IC9b. Since only positive output values are allowed, the signal is 'cut off' at zero volts when the square wave is high i.e. when the triangle wave is falling. The result is a positive going

Figure 5. Power supply circuit.



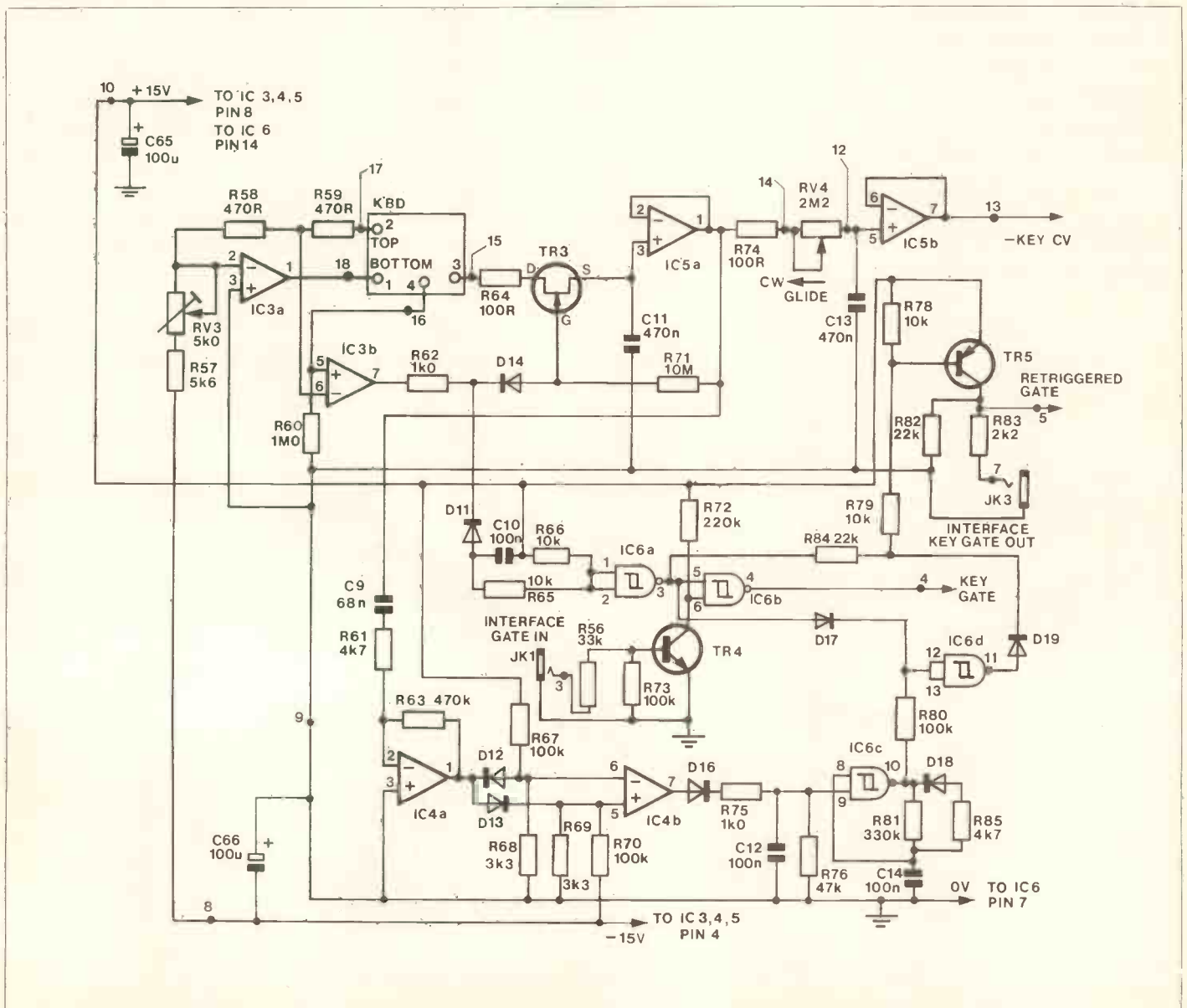
half-wave rectified ramp wave, which gives a complete ramp wave when the triangle wave (and an offset) is added, producing a slope during the 'flat' half cycle and half-cancelling the slope during the other half.

The sine wave is generated by D24-27 and associated resistors. Minimum harmonic content of a sine wave used for control purposes is not as important as smoothness of the waveform — it should have no sharp changes of gradient and should slow down gradually towards the peaks.

The 'LFO MAN' output gives the selected waveform at a level controlled by the joystick y-axis. RV7 is the joystick pot, acting as potential divider fed by +LFO and buffered by IC12b. Since the joystick needs to move in both directions, there will be an indeterminate amount of LFO signal on the wiper of RV7 when the stick is central. RV8 cancels this signal out by introducing the same polarity signal to the inverting input of IC12b. This means that moving the joystick one way will give an increasing +LFO signal on the LFO MAN output, while the other direction will give -LFO.

The regular and random LFO waveforms are step-type functions which change level abruptly at the beginning of each cycle and remain fixed until the next cycle starts. They are produced by the sample-and-hold circuit around C19 and differ in the type of input to the sample-and-hold (S/H). The random waveform has the output of the noise generator as its source, producing a new random voltage in the range ±2.5V every cycle. The regular waveform is more complicated since the source is periodic — a 20Hz rampwave which is synchronised to the main LFO. This is generated by the oscillator around TR6, 7 and C15.

The effect of sampling a constant frequency rampwave at a regular rate is to produce complex repeating sequences of voltages, the sequence length and type being determined by the sampling and sampled frequencies. This is often used to produce note sequences by modulating a VCO with the sample-and-hold output, but suffers from the disadvantage that the slightest change in sampling frequency or the frequency of the sampled waveform changes the effect. In practice it is very difficult to get a precisely repeating sequence, rather than one which has a repetitive 'theme' that steadily changes as a part of a truly repeating sequence with a much longer period. In other words, the results are often too complex and uncontrollable to be useful, and some method is needed to restrict the S/H waveform to shorter repeating sequences. The Spectrum is unique in providing this, and does so by prematurely resetting the rampwave oscillator if it is near the end of its cycle when sampling occurs. Referring back to the LFO circuit diagram, this is achieved by C17 and R99 which couple



pulses from the LFO square wave to base 1 of TR7, the unijunction transistor in the rampwave generator. When the square wave goes low, the reset threshold of TR7 is effectively reduced by about 1 volt, so if the voltage on C15 is above +4V at this instant, the ramp wave is reset early and the sample-and-hold receives the voltage at the start of the next ramp cycle, i.e. -10V. The rampwave generator then runs normally until the next time it falls above +4V on a sample, whereupon it is reset and the sequence is repeated exactly. The time taken for this to occur depends upon the frequency ratio, but since the synchronisation is quite weak, sequences from very short to quite long are easily obtained and very long sequences are terminated when the premature reset condition arises.

VCOs and Associated Circuitry

Figure 9 shows the circuit diagram of the Voltage Controlled Oscillators. The oscillator control circuitry and the sections that combine the VCO signals by frequency modulation and synchronisation are also included.

Each VCO uses the CEM 3340 IC, which is specifically designed for this kind of application, allowing a versatile and precise VCO to be built with great improvements in cost, component count and specification over discrete designs. The CEM 3340 was fully

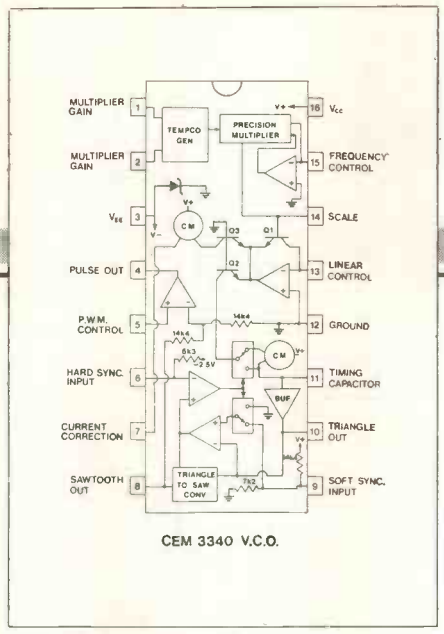


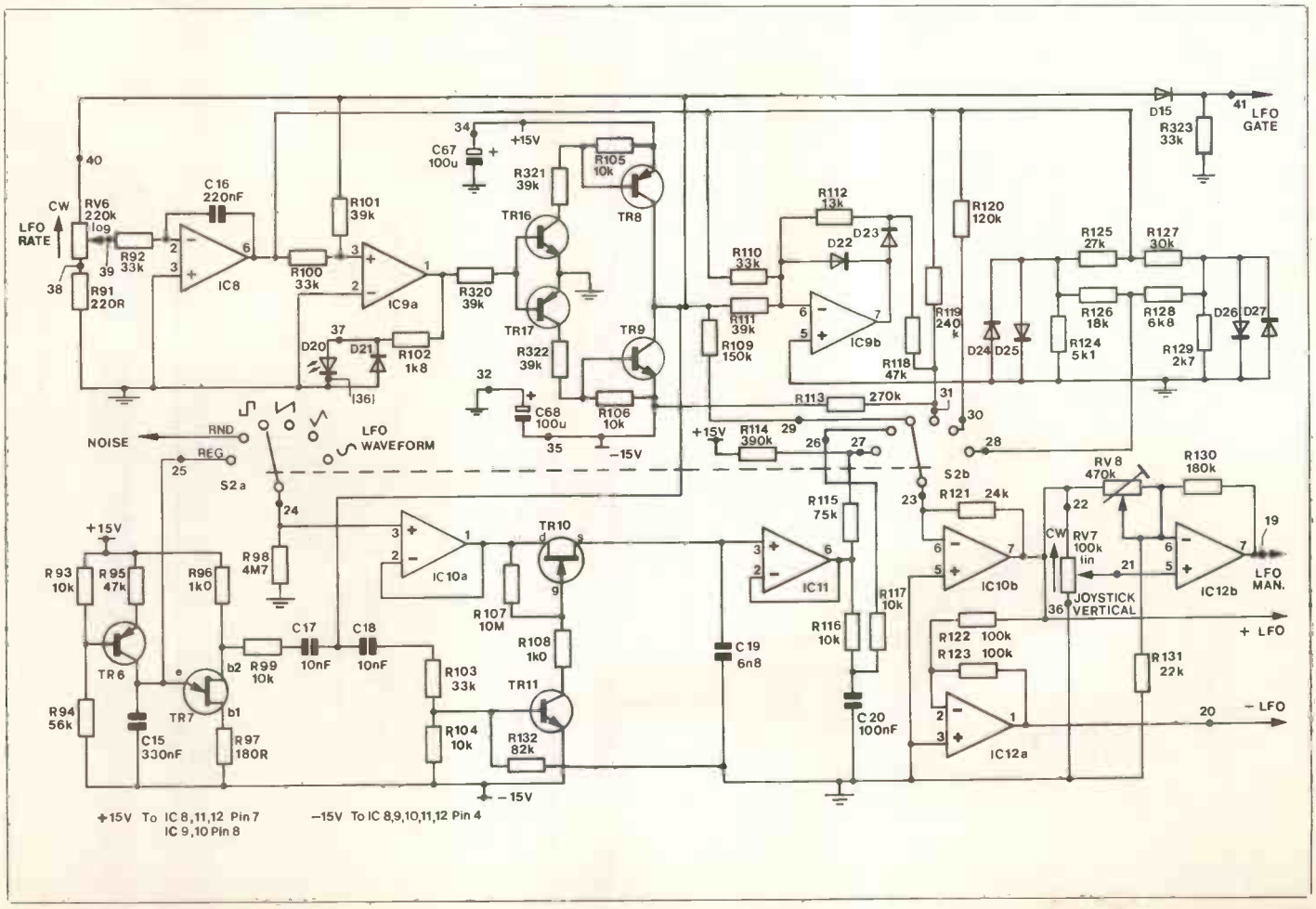
Figure 10. The CEM 3340.

described by Charles Blakey in 'IC's for Electromusic', E&MM March '81, so except where its usage in this design is unusual, we shall not discuss it in great depth here. The internal diagram is shown in Figure 10. The device is an exponential VCO with linear FM, sync, and pulse width control inputs. IC15 and IC16 are the basis of VCO 1 and VCO 2 respectively, and pin 15 of each is the exponential control input. This is a virtual earth summing node so each of the required signals for VCO pitch control are routed to this point via a resistor whose value which determines the control relationship (the amount of pitch change for a given voltage change). With the scale trim presets correctly set, 100k gives the required keyboard control relationship of 1V/Octave.

IC7a inverts the output of the glide circuit, and applies an offset so that the middle 'C' of the keyboard generates a key CV of 0V. This simplifies interfacing with additional equipment. The 'Tune' pot. (RV5) shifts the pitch up to ± 2 semitones.

The key CV signal is fed to VCO1 and VCO2 via R162 and R163 respectively, which are 100k 1% metal film resistors with a temperature co-efficient of better than 100ppm/°C. The precision is not important since the scale is trimmed, but the low temperature co-efficient is required to ensure that the control relationship remains constant with varying temperature. IC15 and IC16 are internally compensated for temperature changes, but stability of external

Figure 8. Low frequency oscillator circuit diagram.



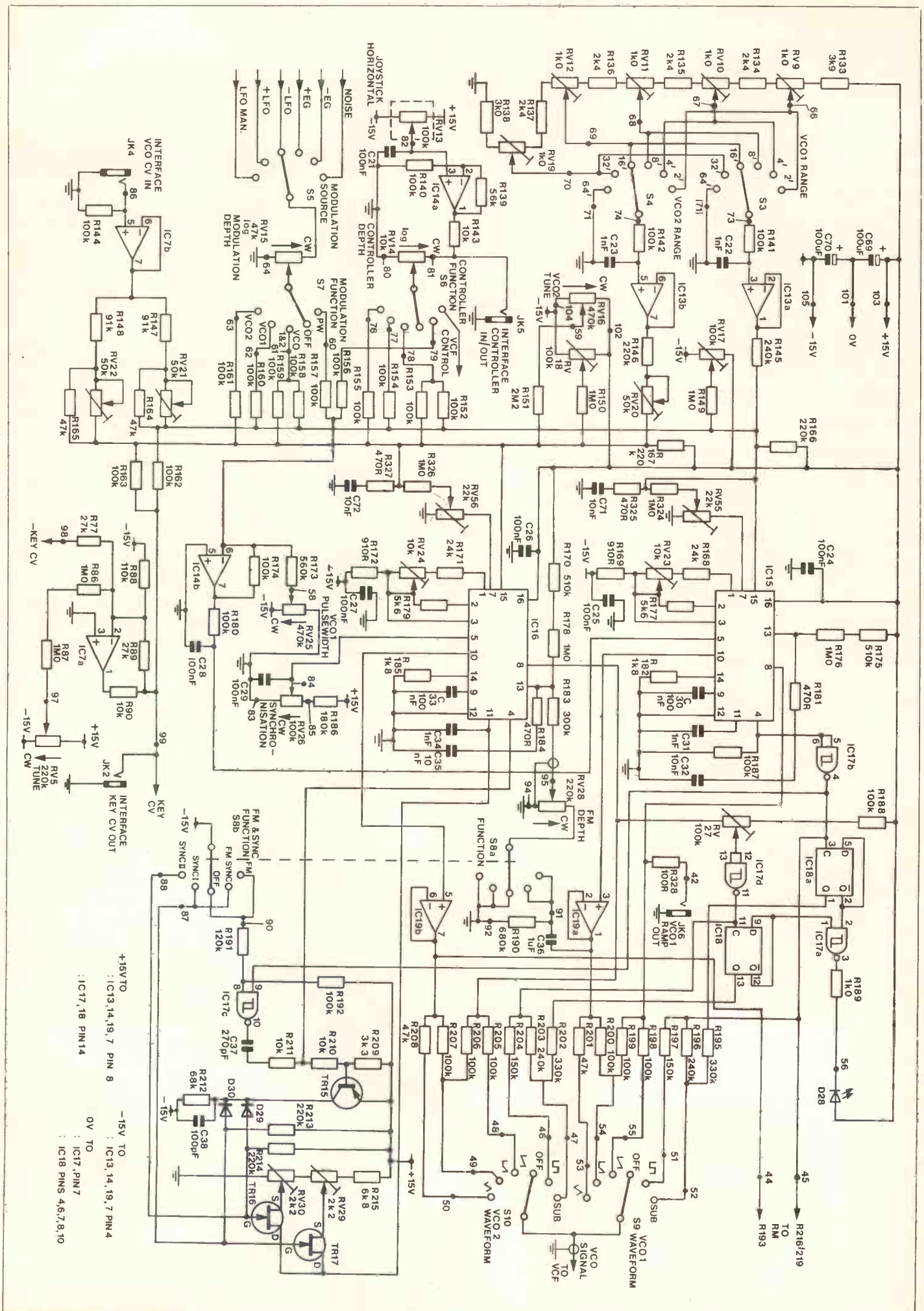


Figure 9. VCOs and their associated circuits.

control signals is just as important where it affects control scale.

The VCO CV interface socket accepts an external voltage from a device such as a sequencer for additional precise control of the VCOs. The voltage is buffered by IC7b and fed to pin 15 of IC15 by R147, R164 and RV21, and to pin 15 of IC16 by R148, R165 and RV22. Though 100k 1% resistors would give a control scale as precise as that for the keyboard, the external CV must match key CV for scale exactly, so RV21 and RV22 are included. S5, RV15, S7, and R157-161 perform the Modulation routing for the VCOs.

The controller enables the joystick or an external device to control either or both oscillator pitches, pulse width, or filter cutoff frequency with variable depth. IC14a amplifies the voltage from the wiper of RV13, the x-axis joystick pot. With the controller in/out socket unused, RV14 controls the amount of joystick voltage modulating the function selected by S6.

Each VCO has a range selector switch which transposes the pitch up or down over a total range of six octaves. The voltages for the different ranges are provided by the potential divider composed of R133-R138, RV9-12 and RV19. The 64' position is connected to 0V, and so adds nothing to the basic pitch for each VCO set by RV17 and 18. Successively higher positions of the range switches S3 and S4 add 2.4 volts per position. R145 ensures the correct current/frequency relationship for VCO 1, while VCO 2's control input may be trimmed by RV20 so that the oscillators remain exactly in tune during octave switching.

The synchronisation circuit appears in the bottom right hand corner of Figure 9. S8b is the pole of the FM & Sync Function switch that controls this circuit. When sync is off (in the 'Off' and 'FM' positions) pin 13 of IC17d is held low blocking the pulse wave from VCO 1, the 'master' oscillator. When sync is selected, the pulse wave is inverted by the NAND gate and the falling edges are differentiated to give 10us wide negative pulses that turn TR15 on. TR16 and TR17 are FETs that provide a low resistance path from C34, the integrator capacitor of IC16, to the potential divider R215, RV29, RV30 when either gate is allowed to go high. Without sync selected, the FETs are held off by R212 via D29 and D30. With S8 in the 'Sync I' or 'FM + Sync I' position, the gate of

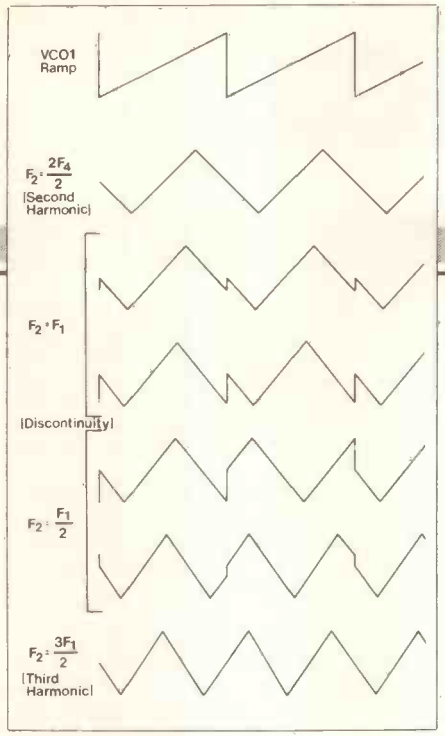


Figure 11. Sync. II.

TR17 is connected to -15V holding it off, but on each sync pulse R214 is allowed to turn on TR16, and C34 discharges to the voltage set by RV30. With Sync II selected TR16 is held off and TR17 discharges C34 to the voltage on the wiper of RV29. Hence, at the end of each cycle of VCO 1, VCO 2's waveform is reset to one of two positions depending on which type of synchronisation is selected.

The synchronisation control uses the pulse wave facility of the CEM 3340 to inhibit reset until the rampwave of VCO2 has passed a certain point in its cycle. Reference to Figure 10 shows that the pulse wave is normally derived from the rampwave by comparing it with the voltage at pin 5, the pulse width modulation input. The output at pin 4 is an open NPN emitter, which is high while the ramp waveform is below the PW control voltage. This output is connected to the junction of R210, R211 in the base circuit of TR15 so for the first portion of VCO2's cycle the TR15 is held off and the sync pulses are prevented from resetting the cycle. The proportion of the cycle for which sync reset is inhibited is determined by the setting of RV26, the synchronisation control, which supplies a variable voltage to the PW control input. With the

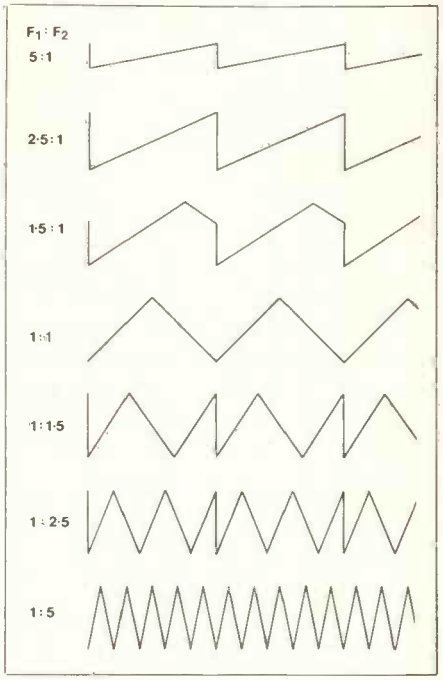
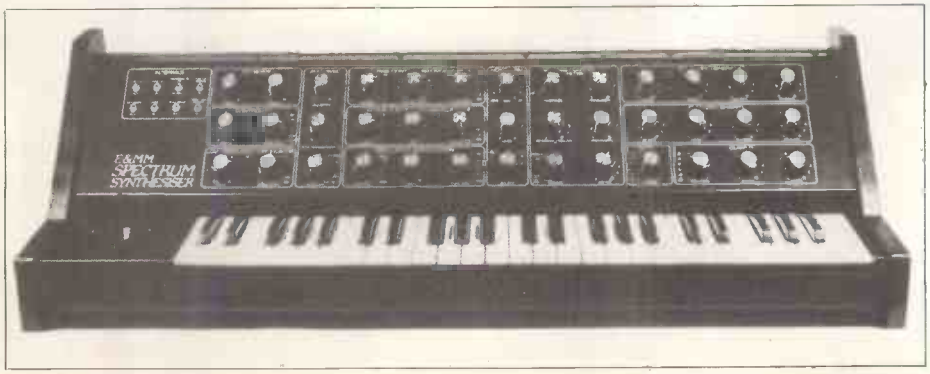


Figure 12. Sync. I.

synchronisation control at 0 (>5V at pin 5) no sync reset can occur. At 10 (0V at pin 5) the PW output at pin 4 has no effect and every sync pulse causes reset (hard sync).

When using soft synchronisation, the PW output of IC16 turns TR15 off as soon as the reset takes the ramp waveform below the voltage on the wiper of the sync control (the dotted line). This would cause the new cycle to begin at some point above 0V (or with Sync II above 2.5V) depending on the point it was at before the sync pulse. C38 is included to keep the FET on for a short time after the reset turns TR15 off, ensuring that C34 discharges to the voltage on the potential divider.

The two sub-octave square waves are NAND-ed to provide the drive to the tuning LED. When the waveforms are out-of-phase, the output is high and the LED off. Advancing phase difference due to slightly different frequencies produces a pulse wave that varies from 100 to 50% width, displaying the beats as fluctuating LED brightness. **E&MM**



America

Tim Schneckloth

Ever since synthesists started synthesising (say that five times fast!) they've sought new and original ways of controlling the sound. For aficionados of various instruments, conjuring up elaborate electronic sounds with their favourite axe has been a long-standing dream. And like all dreams, some come true and some don't.

In the last decade, a lot of attention has been paid to giving wind instrument players a chance to plug in. The Lyricon is one of the best-known electro-wind instruments; it can be heard on records by Tom Scott, Michal Urbaniak and many others.

For a lot of listeners, the film *Apocalypse Now* and its swelling electronic soundtrack provided a first exposure to the sound of the EVI (Electronic Valve Instrument) invented by Nyle Steiner. Over the last few years, Steiner tried to market the instrument himself through his own company. Since that method proved unsuccessful, he recently turned to a large company, Music Technology, Inc., to market his invention. As a result, we can soon expect wider use and recognition of the EVI's capabilities.

What is it? Well, basically it's a wind-controlled synthesiser that gives the player a great degree of — how can I say it? — wind sensitivity. In other words, a skilled wind player, who has learned to shape every nuance of his music with his breath control, etc., can use the EVI as a "real instrument"; it responds in much the same way an acoustic instrument would.

The synthesiser electronics of the EVI are housed in a small control box. The instrument itself is shaped along pitch changes and includes a thumb valve and rotary octave control.

I've heard the instrument played several times by its inventor, not to mention on the *Apocalypse Now* soundtrack (on which it was also played by Steiner himself; he seems to be one of the only true virtuosos of the EVI). It provides a warm, stately sound that should translate well into rock, jazz and experimental contexts. Now that it's getting better distribution, we'll probably be hearing more of it. At least I hope so.

For those of us who are fond of American guitars, Guild has introduced a new solid body electric that reflects that company's high standards of quality. It's the Guild M-80, and it features a solid maple top, with a mahogany back, contoured for balance and playability. The neck is constructed of three pieces of maple, and it offers 24 reachable frets and a 24 ¾-inch scale ebony fingerboard.

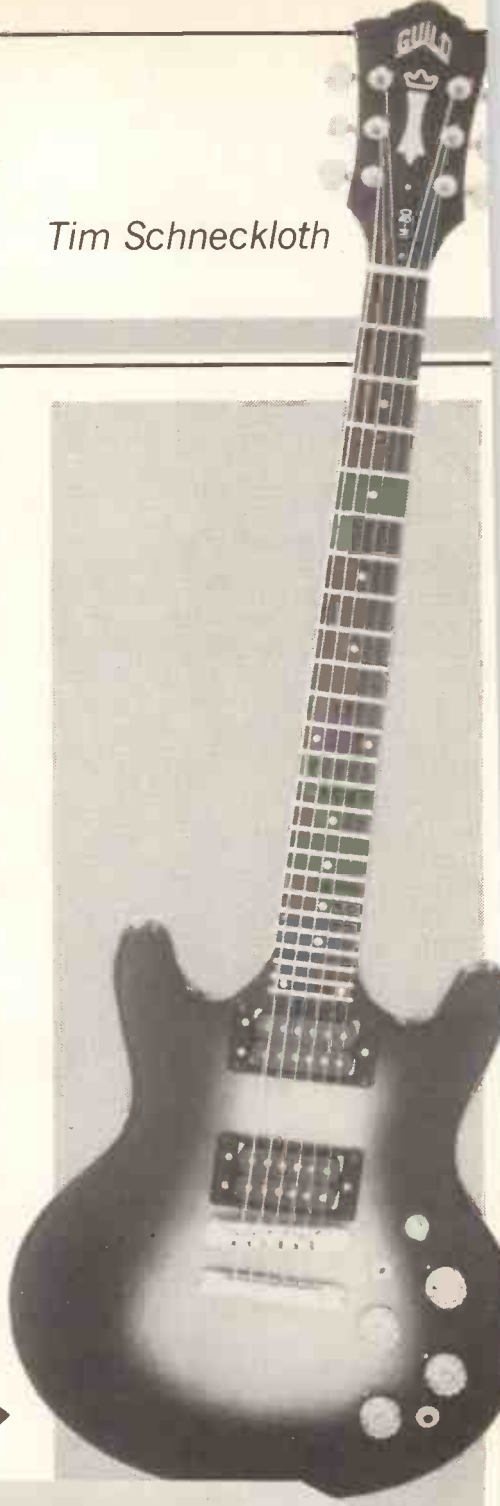
The M-80 is a dual pick-up model, boasting Guild's newly designed XR-7 pick-ups, which, according to the company, have "an advanced magnetic/electronic design" that provides "a versatility of sound that ranges from a raw, wall-shaking power to soft, gentle whispers". Rather like my plumbing.

The guitar's hardware includes Guild's SP-6 quick change tailpiece that allows strings to be changed in about a minute. Also featured are fast control speed knobs, an innovative Guild bridge, and deluxe machine heads.

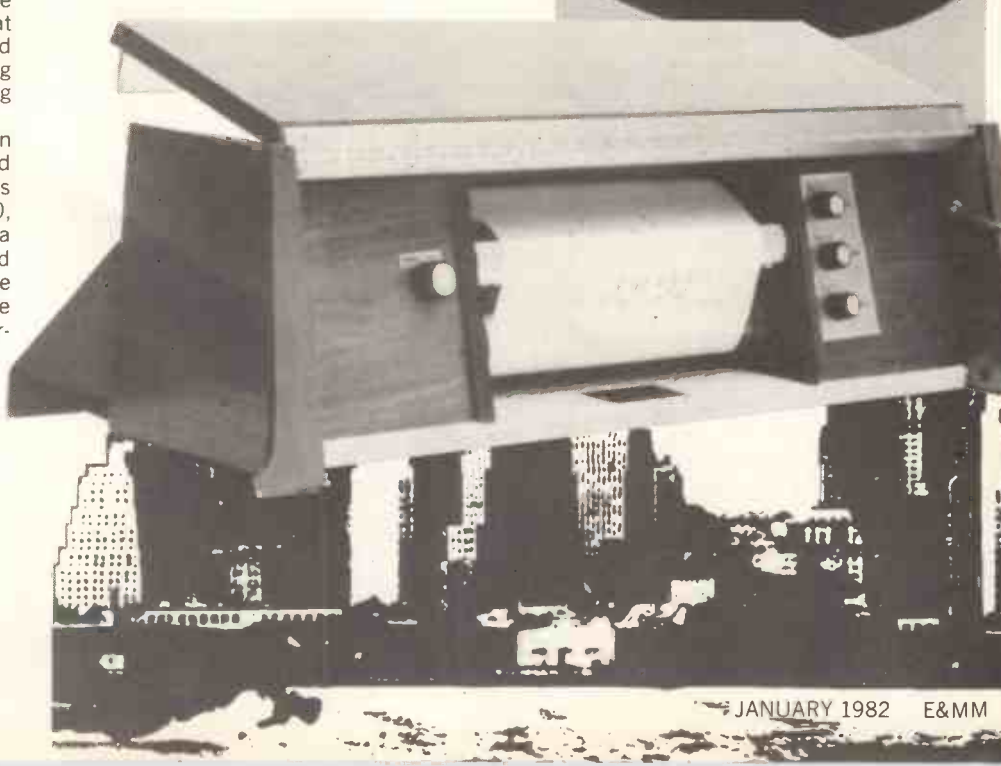
For organ enthusiasts, here's a new breakthrough: the Organ-Matic from Diversified Keyboard. It's nothing less than an electronic organ player that operates with standard piano rolls. I don't know much about it, except that it can operate both keys and pedals and is available in various wood finishes to match nearly any new or old organ. Contact the company for more details.

In the field of sound reinforcement, the hot new item for the month is an impressive line of mixing consoles from Biamp Systems, Inc. It's called the 83 Series and is available in 6, 8, 12 and 16 channel versions. They replace Biamp's 82 Series mixers, which are now being discontinued after three strong years on the market.

The input channels feature trim control, three bands of EQ, effects/reverb send, monitor send and pan control, with the addition of an LED peak indicator for monitoring channel overload. The LED is an integrating-type peak detector which becomes visible with a +8 dBV signal, indicating there is 10dB of headroom remaining. Each channel has a channel patch jack which is post-EQ and pre-fader.



Guild M-80 guitar. ▶



Organ-Matic. ▶

The 1283 mixing console from Biamp.

The transformerless, balanced, variable gain input stage utilises a differential pair of ultra-low noise transistors to perform the high gain (52dB) function. The trim attenuator is variable from 0 to -42dB and the common mode rejection is better than 50dB out to 80kHz, independent of trim control setting. Equivalent input noise is a respectable -127dBV with a 150 ohm input.

On the effects box front this month, we have the Carrotron C821B1 Pre-Amp, available from Analog/Digital Associates in wild, woolly Berkeley, California. The pre-amp, of course, is designed to compensate for power loss when used with high impedance instruments and microphones. The box features a footswitched low-noise active volume control which allows the signal to be boosted up to +20dB, while adding much less noise than would occur if the volume on the power amplifier were turned up. The footswitch is not in the signal path; all that is switched is volume, with no pops or tonal changes. The unit works on a nine-volt battery.

If you're in the market for new performance monitors, you might look into the Bag End TA-12 from Modular Sound Systems. These speaker systems are available in floor wedge or square PA enclosures, and they feature high efficiency and a high power handling capability. Each system includes an E-12 Bag End 12-inch loudspeaker and an ST-350-B Electro-Voice tweeter in a specially designed crossover network. The system also employs the Time Alignment Technique licensed through E.M. Long Associates, making it the first Time Aligned performance system on the market. Suggested retail prices range from $395 to $495, depending on the cabinet.

Carrotron Pre-amp.

And finally, if you're restringing your guitar or bass, you might want to try the new "Performer" strings from Kaman Musical String Corp. They're made from what the company describes as a newly developed material called "chrome steel". It's a material in the stainless steel family and has 8 per cent more magnetic output than conventional stainless 430, according to Kaman. The strings are coated with "Kamflon", a shiny black Teflon-based coating that gives the strings a permanent baked-on finish for more comfortable playing and reduced finger noise.

Companies and manufacturers mentioned:
Music Technology, Inc., 105 Fifth Ave., Garden City Park, NY 11040.
Guild Guitars, Saltmeadows Road, Gateshead, NE8 3AJ.
Diversified Keyboard, Inc., P.O. Box 193, Lakeview, OH 43331.
Biamp Systems, Inc., U.K. distributors: Kitchens, 27/31 Queen Victoria St., Leeds.
Analog/Digital Associates, 2316 Fourth Street, Berkeley, CA 94710.
Modular Sound Systems, Inc., 22N49 Pepper Road, Barrington, IL 60010.
Kaman Musical String Corp., P.O. Box 837, Bloomfield, CT 06002.

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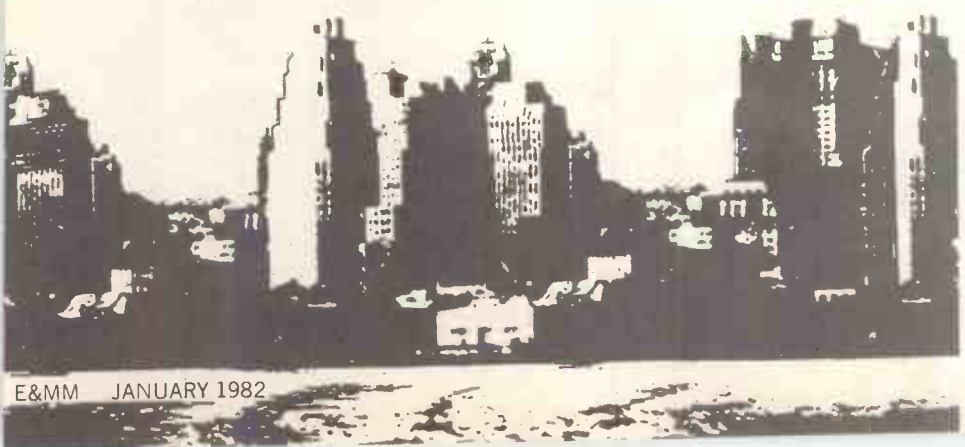

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This special directory is a great way of making contact with other electro-musicians and costs less than any other Classified advertising. The information is presented in condensed form to allow us to insert the maximum number of entries each month.
To fit the maximum information on a line please use the codes listed: Inst. categories (except M&C) imply the use of electronics with inst. specified.

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Rich Wilde, Hull, N. Humberside, 0482 702850, KDV, M, RE, -.
Kev Tweedy, Woolwich, SE London, 01-854 4033, K, M, BERG, -.
David Jones, Bangor on Dee, Clwyd, 0978 780762, K, B, E, -.
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Peter Makin, Bolton, Lancs, 0942 892193, GM, M, PREV, C.

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JUNE Wordmaker ★ Guitar Tuner ★ Hi-Fi/Group Mosfet amp ★ Select-a-Match ★ Fairlight CMI review ★ David Vorhaus ★ Matinée Pt. 4

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SEPTEMBER Partylite ★ Tape-Slide Synchroniser ★ Synpac 9V effects supply ★ Noise Gate ★ PA Signal Processor ★ Digital Keyboard ★ One-handed Guitar ★ Chromascope & Linn Drum reviews ★ Kraftwerk revealed

OCTOBER Harmony Generator ★ Securigard burglar alarm ★ Effects Link Fx-1 ★ Music at City University ★ dbx noise reduction & Blacet Syn-Bow reviews ★ Micro interfacing ★ Disco equalisation and metering

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DECEMBER Rick Wakeman in 1984 ★ Orchestral Manoeuvres in the Dark ★ Bio Music ★ Yamaha CS70M, Vox Custom Bass & Custom 25, Roland CR5000 & CR8000, Alpha Syntauri, Fostex 250 ★ Synclock project ★ Make music with the ZX81

EDITORIAL NOTE: Elka-Orla (U.K.) Ltd tell us that the price of the X-50, reviewed in the December issue of E&MM, includes the legs and pedals.

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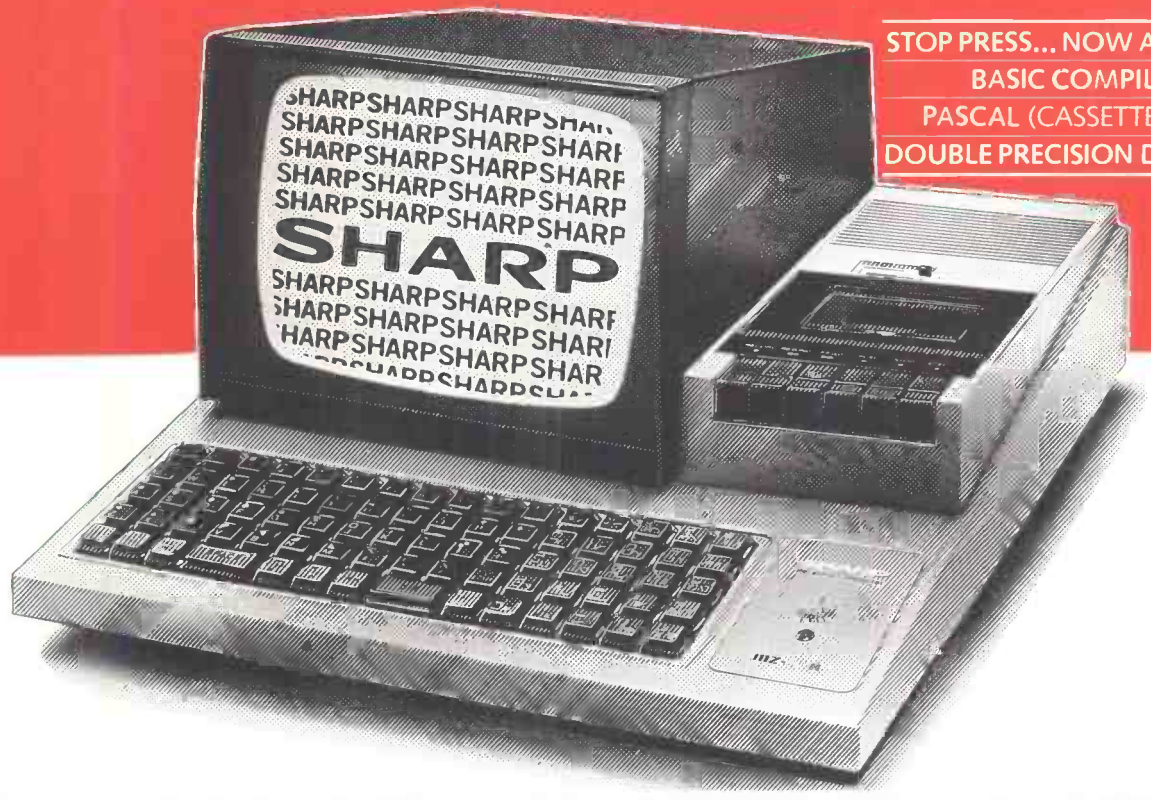

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