APRIL 1971 15p

STUDIO SOUND

ELECTRONIC MUSIC: THE FINE ART OF VOLTAGE CONTROL

FILM SOUND TECHNIQUES

AROUND THE STUDIOS: HOLLICK & TAYLOR

UHER 4000L SERVICING ■ STUDIO DIRECTORY

Drop in a top studio recorder

London made

Hollick and Taylor, Birmingham have stopped looking for a compact eight-track with absolute modular construction, flexible sync routing and designed with the operator in mind.
The new Leevers-Rich 8-track machine is also already making big money in Basle, Brussels, Paris and Jo'burg.

LEEVERS-RICH

EQUIPMENT LIMITED

A Member of the MCP Group

Nick Nichols at our London Office knows the scene. Ring him at **01-874 9054**

Remember there are over 1200 Leevers-Rich professional ¼ inch recorders installed in London alone

319 TRINITY ROAD · WANDSWORTH · LONDON SW18 · 01–874 9054 · CABLES LEEMAG LONDON SW18

Hampstead High Fidelity for the highest quality microphones

STC

STC MODEL 4038

The design patent for this microphone is held by the B.B.C. and is made to their demanding specification by STC.

Bi-directional substantially flat. From 30-15,000 Hz.

Impedance 30 OHMS.

AKG

AKG K180 HEADPHONES

A new addition to the AKG headphones range. Infinitely variable auditory volume. Transmission range 16-20 kHz. Maximum volume at 1 kHz 125 dB. Weight: about 600 grams.

STC

STC MODEL 4104
BIDIRECTIONAL

Noise cancelling microphone
60 Hz - 12 kHz.
Impedance: 30Ω or 300Ω.
Output: 70 dB ref. IV at 300 Ω.

AKG

STC

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Superb cardioid microphone.

From 15-12,000 Hz.
Impedance 30 OHMS or 50,000 OHMS.

AKG

D 224

AKG's top studio dynamic microphone employs two way cardioid principle.

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We have in stock in addition to the above the full range of AKG and STC Microphones, Stands, Adaptors and Headphones.

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Tel. 01-435 0999 & 6377.

SCOPETRONICS

1151 TAPE RECORDER

Wow and Flutter; <06% RMS @ 15 IPS ·14% 7.5 IPS.
Deck hinged at rear for easy access inside cabinet.
Illuminated push button control.
Variable speed spooling.
Full remote control facility.
Wrap round fail safe brakes.
Fader can stop and start mechanism.
Rewind time 2400ft. 75 seconds.
Electronic delay circuit.
Speed consistency better than 2%
One piece spool retainers
Light beam auto stop
Plug in head bridge
NAB 10½" spools.
Time counter.
3 motors.

Sensitivity 45 MV for tape modulation of 40 MM per millimetre Line 'Out' 600 Ohms floating. Delivers + 8dB across 600 Ohms at maximum level. Up to 16dBm with less than 0.3% distortion
Level control calibrated in 1dB steps –3dB to +7dB
0dB equals +8dB out
Frequency response 15 IPS 30 HZ to 15,000 KHZ ± 1dB
7.5 IPS 30 HZ to 12,000 KHZ ± 1dB
Pre-fade listen and line 'in' line 'out' comparison
Line 'in' impedance 50,000 Ohms floating
Overall noise level – record gain at minimum, tape running in record mode=54dB
Built in monitor amplifier and loudspeaker
Pre-set playback gain sets maximum fader output
Offset control (stereo models only) in ½dB steps
Stabilised power supply
100 KHZ crystal oscillator
Plug in modules
mono or stereo
The design of the operating panel is flexible.

Referring to the editorial leader in the February issue of this magazine, we feel that the 1151 more than fulfils the desirable features the editor feels is lacking in British recorders

SCOPETRONICS LTD.

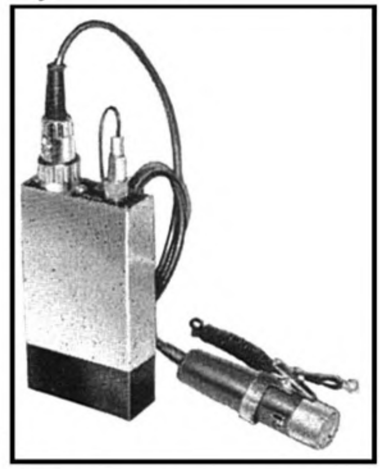
CROWN WORKS, CHURCH ROAD, KINGSTON UPON THAMES.

01-546 1275 01-546 4135

AUDIO

professional radio microphone systems

as used in leading film and TV studios, in theatres, places of public assembly, etc.



Of the range designed and made by Audio Limited, Receiver RMS 7 with Transmitter AU.18 find particular favour where total concealment and maximum freedom of movement are essential. **AUDIO TRANSMITTER AU.18** has a frequency from 100MHz to 175MHz, crystal controlled, with an audio response from 30Hz to 15KHz ±2dB overall from transmitter to receiver output. Distortion at maximum modulation is appreciably less than 1%. Suitable for moving coil or ribbon microphones, effective audio compression is incorporated to avoid overall distortion. The unit measures approximately 4½" × 2¼" × ⅞" excluding plugs; a free hanging length of wire serves for aerial.

audio RMS 7 receiver

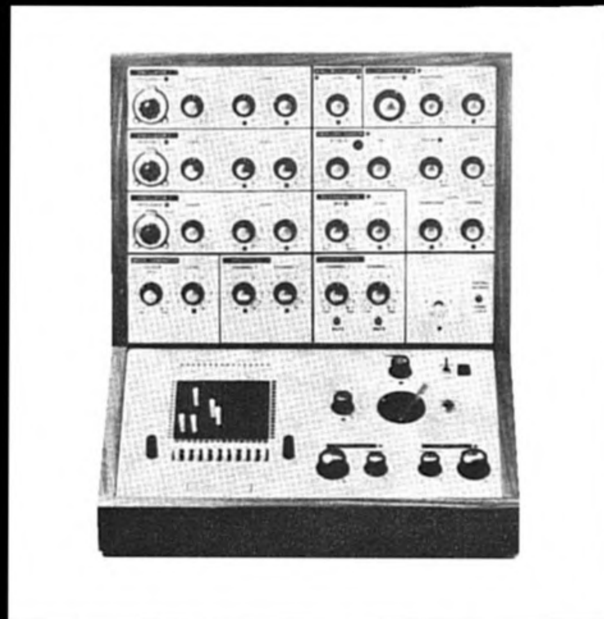
is unusually compact and efficient. The plug-in flexible "whip" aerial provided serves for use indoors and out. Signal, tuning and battery indicating meters are incorporated. Excluding plugs, the elegantly satin chrome finished case measures approximately 7½" x 3½" x 1". The Audio Units featured here are particularly popular with professional users and are available for prompt delivery. High standards of manufacture and performance make the AU.18 and RMS 7 very competitively priced and can be relied on under the severest operating conditions. Other systems from £115 complete are also available. Descriptive literature on request.

★ **Audio Limited radio microphone systems conform strictly to Post Office broadcasting regulations and can be readily adapted to those of other authorities if necessary. A Post Office licence is required to operate in the U.K. Audio Limited will be pleased to advise, demonstrate and quote on request.**

audio limited

46 PENTONVILLE ROAD, LONDON, N.I.
Tel. 01-278-1020

think of a sound... now make it.



VCS3

Designed for the exacting standards of electronic music, the VCS 3 is also ideal for a general purpose audio test instrument and for teaching and demonstrating all aspects of sound phenomena. Why pay for elaborate and expensive laboratory instruments when for only £330 you can make any audio signal from pulse trains to sine waves, and process it from filtering to modulation or reverberation. Everything is voltage controlled, with extremely good signal to noise ratio and high stability. There are three multiwaveform oscillators (.05 Hz - 20 KHz) single sweep of 1000 : 1, three filters, a ring modulator, noise generator, scope output and trigger input, a joystick control for any two parameters, cordless pin patching, and many more facilities.

No studio musician, whether technician, teacher, composer, performer or engineer, can afford to be without this amazing instrument, with its tremendous variety of sound effects, and which is a direct spin-off from the most advanced computerised music studio in the world.

Write or phone for details and free brochure to :

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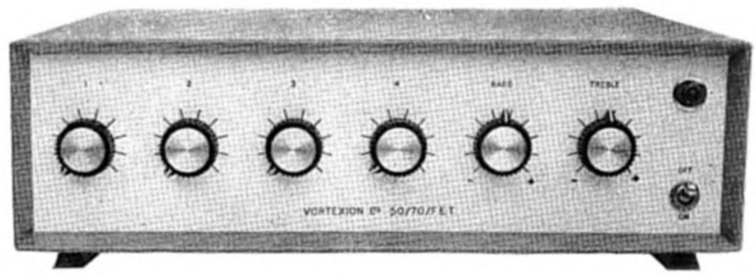
LONDON S.W.15
Telephone : 01-874 2363

Vortexion

This is a high fidelity amplifier (0.3% intermodulation distortion) using the circuit of our 100% reliable 100 Watt Amplifier (no failures to date) with its elaborate protection against short and overload, etc. To this is allied our latest development of F.E.T. Mixer amplifier, again fully protected against overload and completely free from radio breakthrough. The mixer is arranged for 2-30/60 Ω balanced line microphones, 1-HiZ gram input and 1-auxiliary input followed by bass and treble controls. 100 volt balanced line output or 5/15 Ω and 100 volt line.

THE VORTEXION 50/73 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4.WAY MIXER USING F.E.T.s.



100 WATT ALL SILICON AMPLIFIER. A high quality amplifier with 8 ohms-15 ohms or 100 volt line output for A.C. mains. Protection is given for short and open circuit output over driving and over temperature. Input 0.4 V on 100K ohms.

THE 100 WATT MIXER AMPLIFIER with specification as above is here combined with a 4-channel F.E.T. mixer, 2-30/60 Ω balanced microphone inputs, 1-HiZ gram input and 1-auxiliary input with tone controls and mounted in a standard robust stove-enamelled steel case. A stabilised voltage supply feeds the tone controls and pre amps, compensating for a mains voltage drop of over 25%, and the output transistor biasing compensates for a wide range of voltage and temperature. Also available in rack panel form.

200 WATT AMPLIFIER. Can deliver its full audio power at any frequency in the range of 30 c/s–20 Kc/s ±1 dB, less than 0.2% distortion at 1 Kc/s. Can be used to drive mechanical devices for which power is over 120 watt on continuous sine wave. Input 1 mW 600 ohms. Output 100-120 V or 200-240 V. Additional matching transformers for other impedances are available.

CP50 AMPLIFIER. An all silicon transistor 50 watt amplifier for mains and 12 volt battery operation, charging its own battery and automatically going to battery if mains fail. Protected inputs and overload and short circuit protected outputs for 8 ohms-15 ohms and 100 volt line. Bass and treble controls fitted.
Models available with 1 gram and 2 low mic. inputs, 1 gram and 3 low mic. inputs or 4 low mic. inputs.

20/30 WATT MIXER AMPLIFIER. High fidelity all silicon model with F.E.T. input stages to reduce intermodulation distortion to a fraction of normal transistor input circuits. The response is level 20 to 20,000 cps within 2 dB and over 30 times damping factor. At 20 watts output there is less than 0.2% intermodulation even over the microphone stage at full gain with the treble and bass controls set level. Standard model 1-low mic. balanced and 1-auxiliary input.

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Telephone: 01-542 2814 and 01-542 6242/3/4 **Telegrams: "Vortexion, London S.W.19"**


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professional recording tape
EMI
Just add sound
A simple statement, but to the many professional audio engineers using EMITAPE it means flawless recording. EMITAPE provides the qualities of low modulation noise, good dynamic range and signal-to-print ratio so essential in professional sound.
Of course you don't have to be a professional to appreciate EMITAPE quality: it is inherent in all types of EMITAPE in reel and cassette.
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audix

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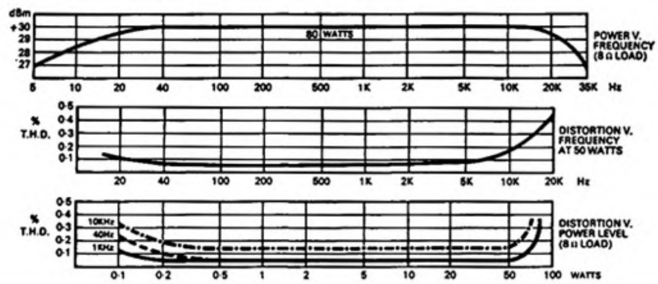
POWER OUTPUT:	Max 80W into 8 ohm.
POWER BANDWIDTH:	5 Hz to 35 KHz at 80 W.
FREQUENCY RESPONSE:	+ 0 dB − .5 dB 20 Hz to 20 KHz.
TOTAL DISTORTION:	Less than 0.05 at 1 KHz.
SIGNAL TO NOISE RATIO:	Better than–95 dB below maximum output.
POWER SUPPLY:	100/120–200/250 A/C 50-60 Hz.



The "Studio 80" Power Amplifier has been produced to high performance standards for Studio and Laboratory applications.

Its proven characteristics puts it in a class beyond anything yet available in power, performance, and price, and is the ultimate in economic functional engineering design – Write for full details of guaranteed performance specification.

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AUDIO DEVELOPMENTS

A PORTABLE MIXING CONSOLE BUILT ON THE MODULAR SYSTEM

SPECIFICATION:

INPUTS:	12 input channels each having 600 ohm microphone input, switched attenuator and 10K ohm line input. 2 echo return channels.
EQUALISATION	All input channels have Baxendall H.F. and L.F. controls, HI and LO pass filters, and presence lift of up to 10 dB. at: 150, 300 and 600 Hz. 2, 3, 5 and 8 kHz.
GAINS	Maximum gain of unit in standard form 80 dB.
NOISE:	Microphone input unit with all equalisers set flat, better than –125 dB.
OUTPUT and DISTORTION:	Maximum output +20 dBm. Distortion 0.05%
MONITORING:	Built in 20w. per channel stereo amplifiers. 4 PPMs and PPM for echo send.
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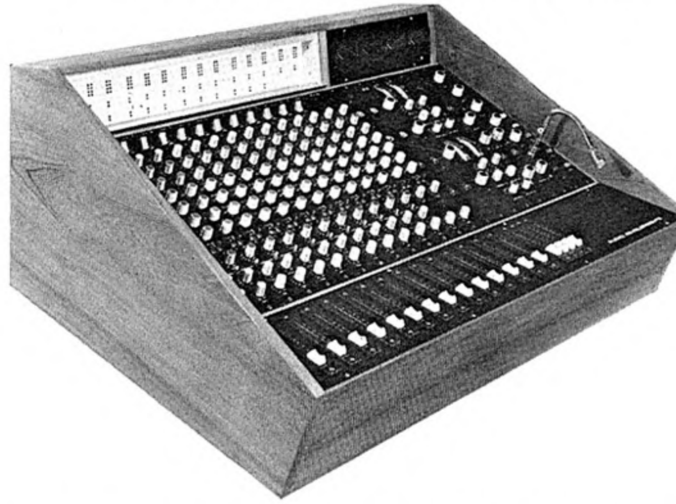
OUTPUTS:	4 Groups 600 ohm Balanced 2 Echo send 600 ohm Balanced 2 Fold-back 600 ohm Unbalanced 2 Monitor Speakers 8 or 15 ohm 1 Talk back Speaker 8 or 15 ohm
FADERS:	All faders are Penny & Giles slide type.
TALK-BACK:	Built-in microphone and talk-back amplifier.
ROUTING:	By unique matrix system.

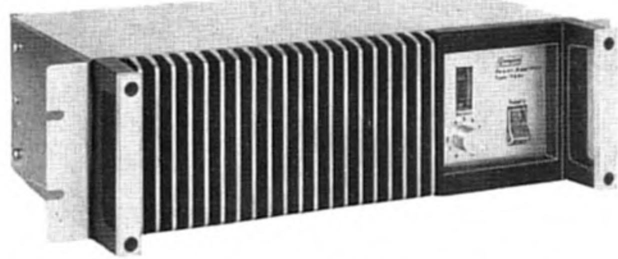


PRICES AND DETAILS ON REQUEST TO

AUDIO DEVELOPMENTS, HALL LANE, WALSALL WOOD, STAFFS. BROWNHILLS 5351

ANNOUNCEMENT
by
Grampian

POWER AMPLIFIER
SOLID STATE
100 watts Type 744
50 watts Type 743



The first of a special range of equipments with built-in **USER VALUE.** Engineered to the highest technical specification and setting a new standard for the reliability requirements of professional and rental use. An Amplifier of great distinction, to set a standard by which others will be judged.

For its complete specification to I.E.C. 268-3 and for information on other amplifiers, microphones, studio equipment and loudspeakers write to us at . . .

100 watts continuous R.M.S. 4 hour I.E.C. Test.

A new technique of assembly using flexible printed wiring, interchangeable modules, and providing access from the front.

The most complete protection systems available.

Die cast machined front panel heatsink. No separation needed for stacking on racks. No ventilation problems.

Grampian
SOUND EQUIPMENT

GRAMPIAN REPRODUCERS LIMITED
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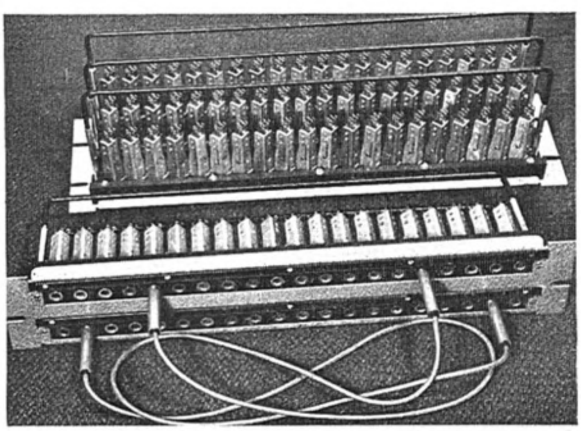
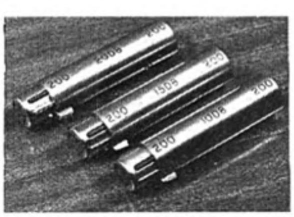
Telephone: 01–894 9141.





JACKFIELDS AND ACCESSORIES
XLR COMPATIBLE IN-LINE ATTENUATORS

HIRSCHMANN 4mm Banana Plugs, Sockets and Accessories

FUTURE FILM DEVELOPMENTS LTD.
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LEVEL CONTROL EQUIPMENT
Superb Performance—moderate cost

7 700-M Compressor-Limiter

The new F700 Compressor provides a range of compression slopes from less than 2:1 to greater than 25:1; switched attack control for special effects; switched release control from 25mS. The threshold level is switched with compression slope to provide a constant level of output for 17dB reduction. Normal output level (unattenuated) +8dBm. Noise better than –75dB below Limit level Distortion: 0.1% for 25dB reduction.

also available

F600 Limiter/Compressor and E800 Equaliser

Audio & Design (Recording) Ltd
10 Lower Rd., Cookham Rise, Maidenhead, Berks.
Tel: Bourne End 22231 (STD..6285-22231)

Another revolutionary recorder has been developed by AKAI. It's the world's first stereo cassette recorder capable of automatic continuous reverse recording/playback! This *CS-50 Stereo Cassette Recorder* incorporates AKAI's unique "INVERT-O-MATIC" mechanism which makes this possible. Almost unbelievable in the cassette field. Yet, it's true. Of course, manual reverse is also possible. Up to two full hours of hi-fi stereo recordings can be made. Sound quality is superb. Frequency response of 30 to 16,000Hz at 1⅞ips is almost equal to open-reel performance. Wow/flutter is within 0.16 to 0.2%. This top-grade cassette recorder also boasts automatic stop and automatic shut-off. *The CS-50D Stereo Cassette Tape Deck*, perfectly matched with the *SW-30 Hi-Fi Stereo Speaker System*, is also available.

Audio & Video

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AKAI ELECTRIC CO., LTD.
Ohta-ku, Tokyo, Japan

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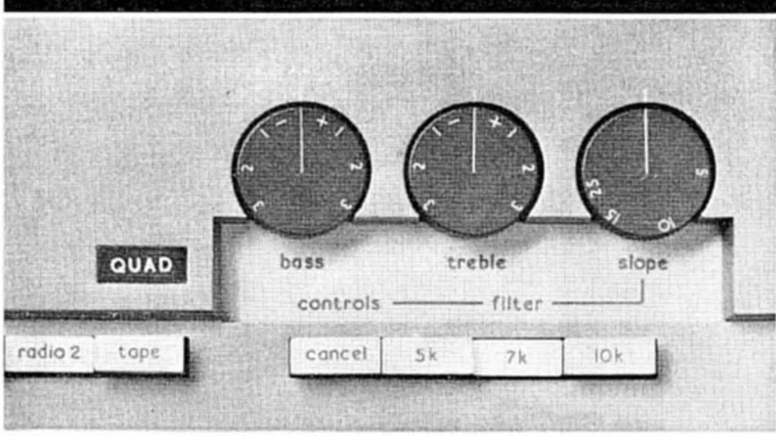
numbers

Set up a QUAD 33 with +1 on the treble control, and you will obtain a response precisely defined; readily and accurately repeatable. This response has a shape rather different from most run of the mill tone controls and there are, as you may guess, good reasons for this.

Then as the listener is not expected to know just what a given response curve does to the signal off the record, we provide a button marked 'cancel'. This enables him to make a direct comparison with the original and so learn just which recording defects need what correction. A QUAD user gets the best out of every record – every time – and enjoys the music to the full.



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See and hear QUAD at SONEX '71 -
Rooms 1001/2, Skyways Hotel,
(Nr. London Airport) 31st March - 4th April

QUAD

for the closest approach to the original sound

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Studio Sound

APRIL 1971 VOLUME 13 NUMBER 4

INCORPORATING
TAPE RECORDER
AND SOUND & CINE

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Telephone: 01-686 2599

COVER PICTURE

The gradual evolution of mixing desks—increasing numbers of channels and facilities—has tended to increase their sideways dimension. Since this has yet to be matched by the evolution of long-armed balancing engineers, the Hollick & Taylor decision to build upwards is an obvious alternative.

SUBSCRIPTION RATES

Annual UK subscription rate for *Studio Sound* is £1.80 (overseas £2.10, $5 or equivalent). Our associate publication *Hi-Fi News* costs £2.82 (overseas £2.65, $6.30 or equivalent). Six-month home subscriptions are 90p *(Studio Sound)* and £1.41 *(Hi-Fi News)*.

Studio Sound is published on the 14th of the preceding month unless that date falls on a Sunday, when it appears on the Saturday.

RESPONDING TO Michael Gerzon's article 'Why Coincident Microphones?' (March issue), Angus McKenzie advocates the allocation of a couple of tracks, in multitrack classical sessions, to a carefully positioned stereo pair (page 177). The idea is that later comparison between two tracks and the multimike premix would show the relative advantages of the two recording techniques. We have often experienced a similar wish, when attending multimike sessions, to try making a Blumlein stereo recording for comparison with the final stereo master tape.

In most cases, however, the use of coincident microphones has been rendered impractical by the habit of sprawling performers over an unnaturally large area to obtain multimike separation. Such an orchestra, recorded Blumlein fashion, would by the nature of that microphone technique sound what it is: an orchestra occupying an unnaturally large area. For this reason, any multimike engineer prepared to experiment with simultaneous coincident mikes is likely to obtain disappointing results which would do little to promote a revival of commercial Blumlein recording.

A few weeks back, we were asked to tape an amateur performance of a piano concerto. The pianist, who had commissioned the tape, fluffed several bars of the work and departed feeling very depressed. Immorally, perhaps, we spliced the relevant few bars of a gramophone recording into the appropriate part of the tape. The disc claimed to be stereo, yet was multimiked in such a fashion that the switch from Blumlein, across the edit point, left us wondering whether the disc deserved to be called stereo at all. The instruments occupied discrete positions across the soundstage, perhaps too discrete, but lacked any semblance of co-ordination with the reverberation.

Supporters of multimike technique sometimes proclaim the larger-than-life quality achieved by closemiking: clearer transients, greater presence, and pinpoint instrument location (through pan-potting). Records produced in this style apparently enjoy consistently higher sales (and generally more encouraging reviews) than Blumlein productions, despite the special exceptions mentioned by Michael Gerzon. The reason seems obvious—most records are reproduced on relatively cheap gramophones, which, even with their tone controls at maximum, equalise the larger-than-life quality down to a pale reflection of reality. By this reasoning, there seems little chance of a reversion to Blumlein until the average standard of domestic listening equipment is improved. Will the move to cassettes hasten or delay this improvement?

Bob Auger is one of the few engineers prepared to defend multimike/multitrack classical music recording in print, and has our highest respect. Other engineers who have disputed pro-Blumlein attitudes seem reluctant to explain their own preference for multimiking. Their attitude tends to be a fatalistic 'Why argue with established practice?' They take for granted the need to work in conditions of high background ambience—the Kingsway Hall and its trains, St. Paul's and its traffic, the Albert Hall and its ventilators. Certainly these conditions can rule out Blumlein recording, but do they have to be tolerated?

Jerry Bruck, the American engineer interviewed last December, mentioned a rather pathetic human point: that many musicians consider themselves in safer hands when surrounded by microphones than when confronted by a solitary Blumlein pair. Does the case against Blumlein rest on problems like *that* or are there other aspects we have overlooked? We would welcome readers' views on this subject—both inside and outside the industry—and promise to disguise the name of any contributor disagreeing with his employer!

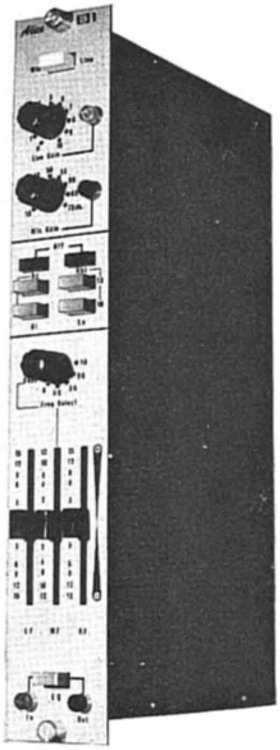
FEATURE ARTICLES

REGULAR COLUMNS

EQUIPMENT REVIEWS

Alice **BUILDS MODULAR MIXERS—**

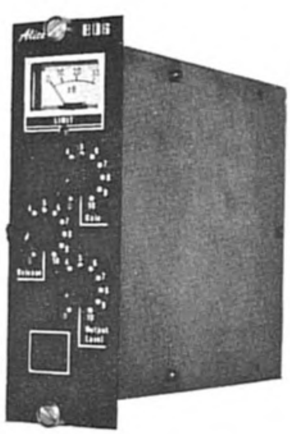
and shows two modules from the BD range



BD1 CHANNEL AMPLIFIER—The basic module of the BD range, this one module combines the functions of microphone amplifier, line amplifier, High and Low pass filters, Top, Mid and Bass equalisation and line drive amplifier with a selection of outputs.

Microphone inputs 200 ohm or 50 ohm (3.3 K or 600 ohm actual impedance inputs). Line inputs 10 K ohm bridging, all floating balanced. Outputs balanced or unbalanced. Height 12", width 1.85", depth 6".

A variety of panel finishes and colours are available to match existing equipment or proposed decor. The mounting system is our own—simple but extremely strong and positive using gold plated connectors and positive locking module fasteners.



BD6 LIMITER AMPLIFIER—A peak limiter with fast attack time and variable release. Limit ratio exceeds 25/1 and overshoot is held to fine limits. Developed for use in a future noise reduction system the circuit is remarkably free of unwanted modulation effects and distortion normally associated with a limiter with this type of action. Input and output nominal 0 dBm balanced or unbalanced. Max gain 16 dB can be supplied in stereo pairs to special order.

Height 6", width 1.85", depth 6".
Price £76 each delivery ex stock.

We also make routing systems, Line amps, equalisers, Complete mixers, large and small.

For further information on modules or mixers ring Ted Fletcher or Jack Keene at:

Alice **(STANCOIL LTD) 15 SHEET ST. WINDSOR BERKS. WINDSOR 61308**

Events

NOISE-CANCELLING CAPACITOR MICROPHONE

A NEW ADDITION to the Calrec range of capacitor microphones, to be shown at the APAE Sound '71 exhibition this month, is the *CM655*. This employs twin cardioid capacitor capsules and rejects sounds from sources more than a few centimetres from the microphone. The *CM655* incorporates a polyurethane foam windshield and encapsulated transistor preamplifier. It is claimed to be practically indestructible and carries the normal Calrec two year guarantee. Improvements in the performance and styling of the *1000* series are announced, the finish now being pearlised nickel with a redesigned slotted head. A new omni-directional microphone is being marketed in this series, the *CM1001*. Calrec are also commencing the production of portable and desk mixers.

SCOTCH MARKETING NAB 203 REELS

SCOTCH 203 LP Dynarange tape is now being supplied in 1090 m lengths spooled on 27 cm NAB metal reels. These are being distributed through audio retailers and are designed for use on NAB-capacity domestic equipment. Retail price is £6.32.

UNAUTHORISED ALBUM

RECORD RETAILERS have been advised by Polydor not to stock the Jimi Hendrix album *Live Experience 1967-68*. The album, which has been offered for sale around London, is largely taken from radio and TV broadcasts in which Hendrix participated.

ZONAL AWARDED BBC CONTRACT

ZONAL FILMS (Magnetic Coatings) Ltd, the Redhill subsidiary of Ilford Ltd, have been awarded a contract for the bulk of the BBC's 6.25 mm tape requirements for 1971. The contract involves the supply of 1 000 km of tape manufactured to BBC specification.

AGFA-GEVAERT MOVES

MOVEMENTS OF several Agfa-Gevaert divisions up and down the Great West Road have resulted in a change of address for the Motion Picture & Magnetic Tape Division. This is now Unity House, Great West Road, Brentford, Middlesex.

VTR EXHIBITION

AN EXHIBITION of video tape recorders and related equipment will be held on Wednesday April 14 and 15 at the London Hilton Hotel. Opening times are 10.00 to 18.00, admission free. The exhibition is being organised jointly by Rank Audio Visual Ltd and Fraser-Peacock Associates Ltd. The new 625-line 6.25 mm Akai battery VTR will be demonstrated (videotape cost is £4 for 24 minutes), together with a low-cost projection TV system.

B & O REORGANISE GUARANTEE ARRANGEMENTS

RESPONSIBILITY for maintaining the 12 month labour-free guarantee on Bang & Olufsen audio equipment has been passed to B & O retailers as part of a new scheme to improve dealer/consumer relations. Dealers are given a 2.5% service fee on each unit purchased, with the exception of loudspeakers. B & O consider that their failure rate makes this a generous allowance. The scheme was implemented on February 1.

FIRST BASF RECORD RELEASES

SALES OF BASF cassette records and discs began on March 1, when 347 titles were introduced to the German market. UK sales are expected to start in spring 1972. To provide such a large selection at relatively short notice, BASF have taken over the distribution facilities of MPS Records GmbH (Musikproduktion Schwarzwald).

SOUND '71

PREPARATIONS HAVE been finalised for the Association of Public Address Engineers annual exhibition at Camden Town Hall. Sound '71 will take place from March 16 to 19 and will be supported by the following exhibitors: AKG, APAE Sales, Astronic, Audix BB, Beyer Dynamic, Calder Recordings, Cass Electronics, CTH Electronics, DJ Electronics, Eagle International, Goldring, Grampian, KF Products, Douglas Lyons, Lustraphone, Jim Marshall (Products), Millbank Electronics, Keith Monks (Audio), Pye Business Communications, Radio London (BBC), Reslosound, Rola Celestion, Shure Electronics, SNS Communications, STC (Footscray), Teletronics, Vitavox, Vortexion and Westrex.

EEL PIE INSTAL NEVE

A NEVE BCM10/2 standard mixing console has been installed at Eel Pie Studios, Twickenham. Delivery and installation occurred within two weeks of the order being placed. A second order for a 16 channel eight track desk has been awarded to Neve, for installation in a new studio opening this spring.

SONEX '71

THE SONEX '71 exhibition of domestic audio equipment will be held at the Skyway Hotel from March 31 to Sunday April 4. Tickets are available free from audio equipment retailers. A preview of the exhibition will appear in the April issue of our associate publication, *Hi-Fi News*, published on March 27. This issue will also carry a free ticket.

NEXT MONTH

A SURVEY OF studio monitor loudspeakers and a review of the Spendor transistor power amplifier will appear in the May issue. Angus McKenzie describes his experiments in quadraphonic recording and Michael Naylor covers the construction of a low-cost four channel recorder.

Developed to a BBC specification, the Scopetronics *1151* incorporates several features not normally available on studio recorders. These include fader start, prefade monitoring and a crystal locked bias oscillator. The 38 and 19 cm/s transport employs a direct drive Papst capstan motor, and hinges open for servicing. Illuminated mode selectors, accessible plug-in heads, variable speed spooling and a time calibrated tape length counter are among other features. Basic price is £495.

An IC Transformerless microphone amplifier

BALANCED input microphone amplifiers usually incorporate transformers, the disadvantages of which are cost and bulk, as well as their susceptibility to picking up stray hum fields. Obviously any method by which the transformer could be dispensed with would be welcome, especially when it can reduce the cost of components by 60% or more and the size by 50%.

The answer to this prayer is manifested in the shape of the integrated circuit operational amplifier, which is capable of directly accepting differential signals such as produced by a balanced microphone line. The op-amp selected was the *709*, which is marketed by several manufacturers. It is also available from Texas Instruments as a 14 lead DIL package containing two separate amplifiers, the designation of which is *SN 72709 DN.* An abbreviated specification is given in **Table 1,** which gives typical test figures.

The ideal operational amplifier displays the following properties: infinite gain; infinite input impedance; zero output impedance; perfectly flat frequency response from DC to infinity; perfect common mode rejection.

In practice none of these is realised but, for our purpose, sufficient accuracy can be obtained in calculation of overall parameters by making the assumption that they are true.

Assuming the input impedance is infinite, no current will flow into terminals 1 or 14. As pin 3 is assumed to be at zero impedance, then I_3 effectively flows through R_3 to earth.

Therefore if R1=R2 and R3=R4 then

$$I_1=I_2 \text{ and } I_3=I_4$$

and the overall gain of the amplifier is given as

$$V_{out} = \left[V_{in}(2) - V_{in}(1) \right] \frac{R3}{R1}$$

Note that, as the two inputs are inverted with respect to each other $V_{in}(2) - V_{in}(1)$ should be written

$$[V_{in}(2)] - [-V_{in}(1)]$$
$$= V_{in}(2) + V_{in}(1)$$
$$= V_s$$

$$\therefore \quad V_{out} = V_s \frac{R3}{R1}$$

As we assume that no current flows into 1 or 14, then the potentials at these points (called the summing point) are at zero volts with respect to the zero volt line.

Therefore the input impedance of the circuit is given as:

$$Z_{in}(1) = \frac{V_{in}(1)}{I_1} = R1$$

Similarly $\quad Z_{in}(2) = \frac{V_{in}(2)}{I_2} = R2$

As the operational amplifier has a very high bandwidth, HF instability can occur unless the frequency response is curtailed. In this circuit, input compensation is provided by C1 and R5, and output compensation by C2.

Ideally, if two identical in-phase signals are applied to R1 and R2, complete cancellation of the signals should result, giving no output. Again, as nothing is perfect, complete cancellation does not occur but the ratio of the

FIG. 2

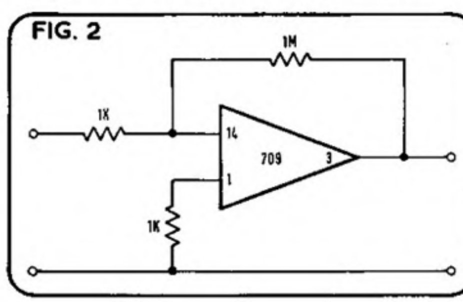


FIG. 3

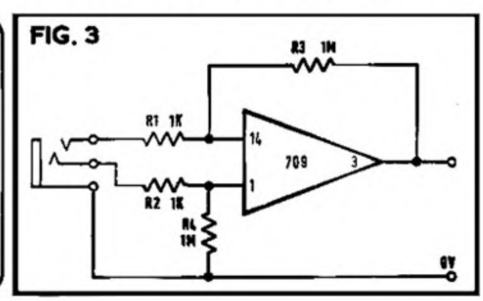


FIG. 1

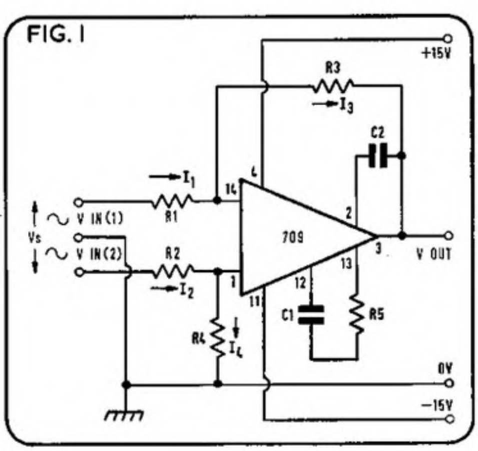
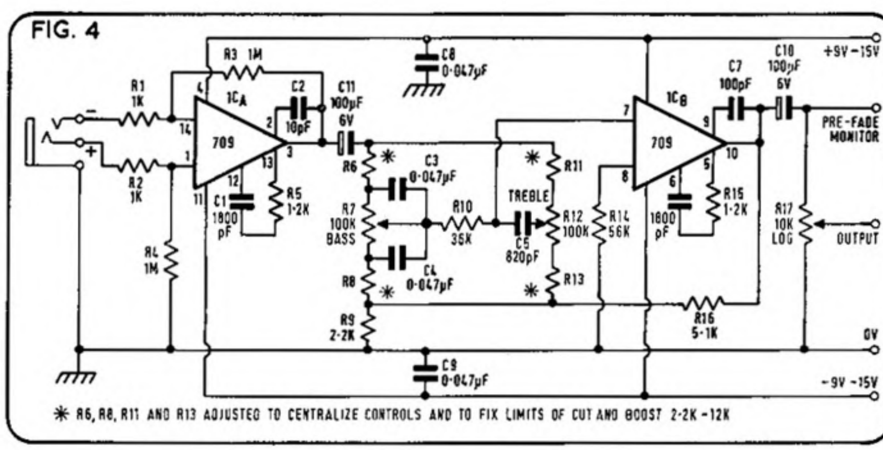


FIG. 4



An IC Transformerless microphone

amplifier

by C S Conduit

cancellation (called the common mode rejection ratio, or CMRR) is still very high by audio standards. To obtain the maximum CMRR, it is obvious that the input impedance and sensitivity must be exactly matched and this implies that R1 and R2 must be identical in resistance. In practice 1% metal-oxide resistors are used, which ensures high rejection of hum picked up on long microphone cable and low thermal noise in the resistors themselves.

Coming to practical applications of the operational amplifier, the requirements for the microphone amplifier first stage are as follows:

Z_{in} (1) 600 ohm
Z_{in} (2) 600 ohm } In practice this is made 1K with respect to 0 V in each case
V_s - 1 mV maximum
V_{out} - 1 V

The input impedance fixes R1 and R2 at 1 K. Thus, for a gain of 1 000, R3 and R4 are 1 M.

The frequency compensation components are C1, 180 pF; C2, 10 pF; R5 1.5 KpF.

For unbalanced inputs, R1 should be equal to R2, R2 being disconnected as shown in **fig. 2.**

This is very convenient because, if the input is wired as shown in **fig. 3,** the insertion of a single circuit jack shorts R2 to 0 V. The fact that R2 and R4 are in parallel is immaterial because R4 is considerably higher in value than R2.

The circuit of the completed microphone amplifier is shown in **fig. 4.** The first stage, which has already been discussed, is fed into the second stage which comprises the bass, treble and level control. The circuit is a straight forward Baxandall configuration in the feedback loop of IC B. This stage gives an overall gain, including volume control, of two, with the tone controls central and the volume control at maximum. As will have been noted, the operational amplifiers require two power supplies, at +15 V and −15V with respect to signal earth. Should such supplies not be available, a 30 V supply can be used which is split as shown in **fig. 5.**

As mentioned earlier, the operational amplifier has a very wide frequency response and care must be taken to ensure that parasitic oscillation does not occur. The frequency compensation components and RF decoupling capacitors across the 15 V rails go a long way to ensure that this does not happen, but good layout is essential if trouble is to be avoided, especially in the very high gain first stage. Input and output components must be kept separate and lead lengths must be short. The prototype was built on standard 0.1 inch pitch Veroboard and considerable trouble was experienced with HF instability until all the unused lengths of track were broken.

The performance of the amplifier is as follows: frequency response: ± 1 dB, 10 Hz to 30 kHz. Sensitivity for 1 V out (V_s): 500 μV. Input impedance: 1 K. Signal-to-noise ratio (1 mV i/p): 65 dB. Bass Control: ±10 dB at 100 Hz. Treble Control: ±8 dB at 10 kHz. Common mode rejection: 58 dB.

TABLE 1

SPECIFICATION OF SN 72709 DN	
Power requirement:	+ 15 V and −15 V DC maximum
Input current:	0.3 μA
Input voltage range:	± 10 V
Max output voltage range:	± 14 V
Input resistance:	250 K
Output resistance:	150 ohm
Common mode rejection ratio:	90 dB
Supply voltage rejection ratio:	25 μV/V
Large signal open loop voltage gain:	93 dB
Total power dissipation:	200 mW maximum

FIG. 5

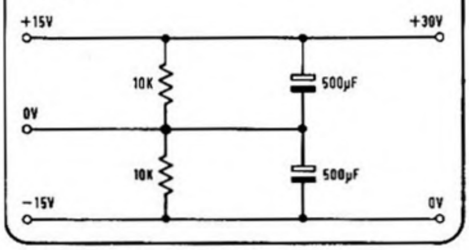


FIG. 6 MICROPHONE AMPLIFIER FREQUENCY RESPONSE

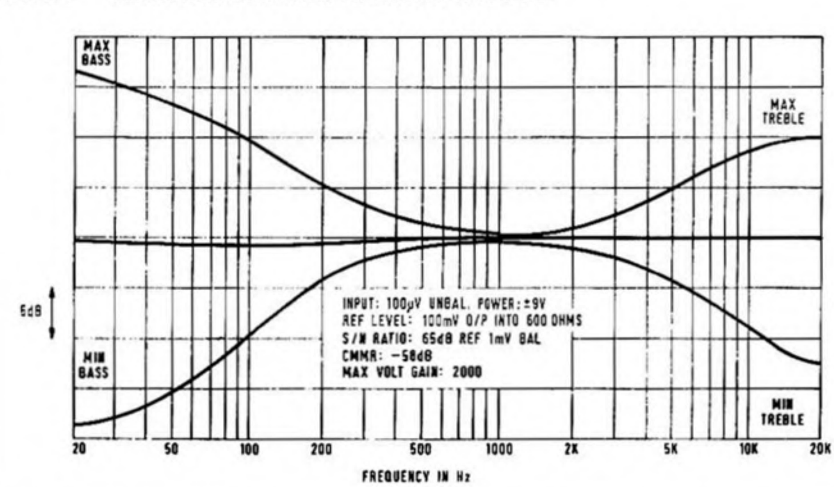
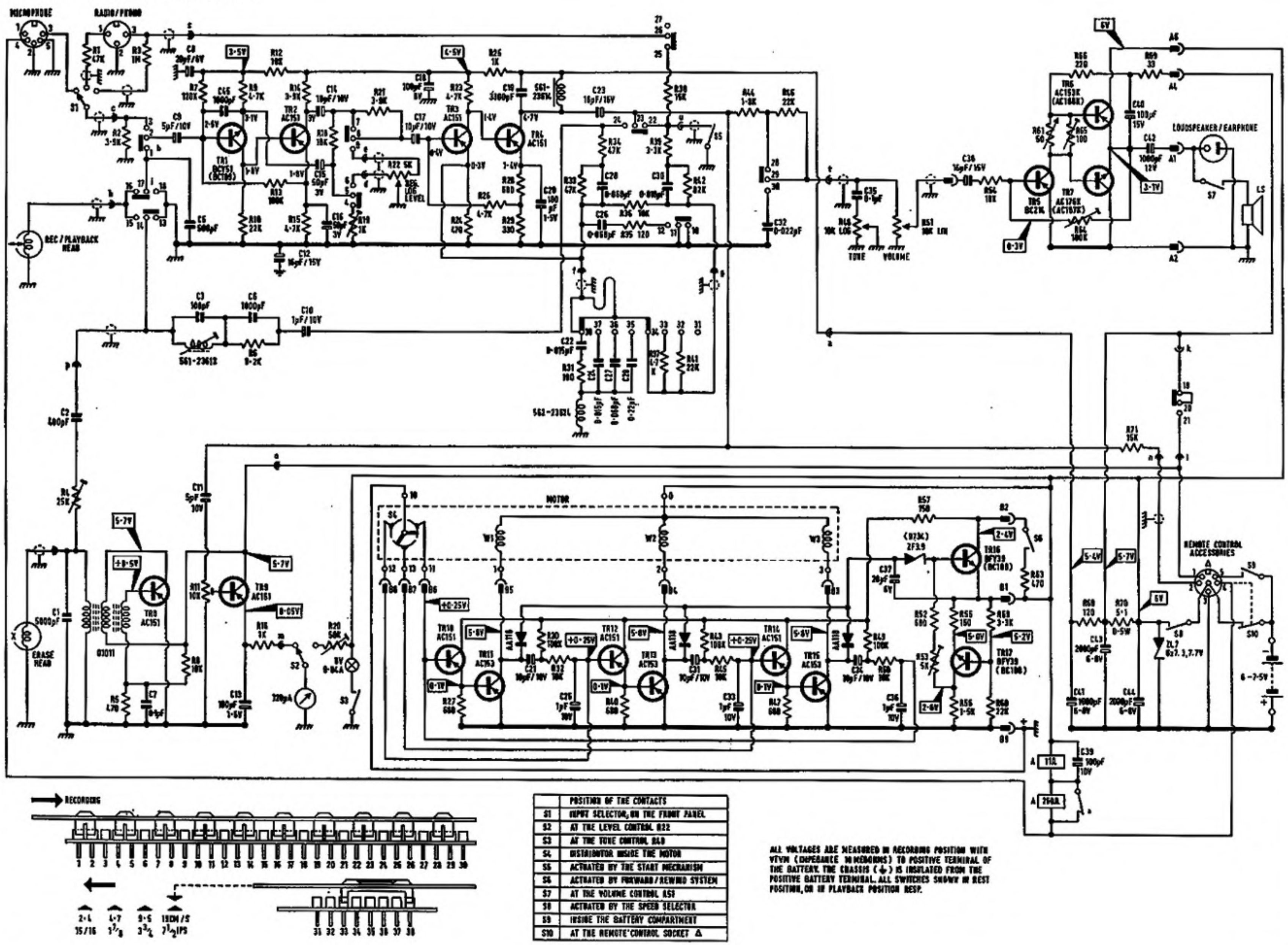


FIG. 1 UHER 4000L CIRCUIT DIAGRAM



	POSITION OF THE CONTACTS
S1	INPUT SELECTOR, ON THE FRONT PANEL
S2	AT THE LEVEL CONTROL R22
S3	AT THE TONE CONTROL R40
S4	DISTRIBUTOR INSIDE THE MOTOR
S5	ACTUATED BY THE START MECHANISM
S6	ACTUATED BY FORWARD/REWIND SYSTEM
S7	AT THE VOLUME CONTROL R51
S8	ACTUATED BY THE SPEED SELECTOR
S9	INSIDE THE BATTERY COMPARTMENT
S10	AT THE REMOTE CONTROL SOCKET △

ALL VOLTAGES ARE MEASURED IN RECORDING POSITION WITH VTVM (IMPEDANCE 10 MEGOHMS) TO POSITIVE TERMINAL OF THE BATTERY. THE CHASSIS (⏚) IS INSULATED FROM THE POSITIVE BATTERY TERMINAL. ALL SWITCHES SHOWN IN REST POSITION, OR IN PLAYBACK POSITION RESP.

IT is a wonder, with the postal strike in deadlock as I write, that the contributions to *Studio Sound* are being received, edited and printed at all. Only by subterfuge, good luck, and travelling friends, have we been able to get the text subbed and printed. Even then there had to be a casualty, and this was the drawing that should have accompanied the last article, giving the complete circuit of the *Uher 4000 Report L* and a layout diagram of the position of the various presets mentioned in the main body of the article.

This is fortunate, for we must begin this month's episode with a look at the motor and its control system. The armature windings, W1, W2 and W3 are static, with a rotating permanent magnet—not shown—encased in a cylindrical iron body. Belt drive is taken from both ends, one belt coupling with the capstan assembly which propels the flywheel by its edge contact. The other belt, the shorter one, drives the rocker assembly that moves the spool carriers. Various adjustments are possible here, and we shall return to this section.

Depending on the position of the rotor when the motor is at standstill, so the distributor mechanism switches its control link through one of the three arms, grounding the base of the appropriate transistor, Tr10, Tr12 or Tr14. One advantage of this system is that the distributor—or commutator—only has to switch very small base currents as the motor runs up to speed. This immediately reduces one of the bugbears of motor control systems (sadly, still present in some quite expensive gear and made worse now that inbuilt microphones are coming along): the radiated switching noise of a motor. In fact, as Alec Tutchings was quick to point out in his review of this model, the motor control system was one of the most important modifications made to the *4000* series, when the suffix *L* was introduced. 'Radiated motor noise is almost negligible as there is no governor to handle intermittent splashes of heavy current, and the commutator current is measured in micro-amps rather than fractions of an amp.'

Switched out

Very true, but what is even more significant is that this commutator is switched out when the motor runs up to speed. The control is then by rectified pulses through each of the windings, compared with the zener reference, setting the mid-rail voltage of the T16, T17 pair, to put it crudely. I make no apologies for begging the question here, as we are not so much interested in the design concept of the servo system as the servicing procedure related to it. Here, we have only one preset, R53. This can pull back an 8% deviation, we are told, and should be set with a 19 cm/sec test tape loaded. I would add that the setting of this control can be done too casually. If it does not take up an on-speed position within the middle third of its arc, you had better begin looking for trouble. The position of R53 can be seen in **fig. 2**.

If the range is such that the speed only pulls in at the extreme setting of R53, before digging too deeply into the electronic circuitry take a look at the drive system. Watch particularly for hardened black deposits on motor and belt-run pulleys. Age takes its toll and neglect has to be paid for. Many a second-hand, erratic

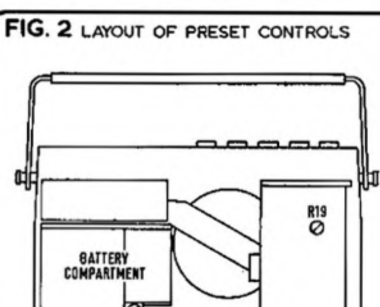
UHER 4000L (CONTINUED)

BY H. W. HELLYER

Uher has cost its new owner no more than a good clean-up and a careful lubrication. I remember talking to Alan Heather of the South Devon Tape Recording Club some years ago on this subject and picking up some useful tips, the result of his personal experiences with the Uher. We agreed then that more money had gone down the drain by unwarranted motor replacement in battery tape recorders than could ever be justified. The position is even worse now, and I shudder to think how many of the good little Philips *EL3301* series have been scrapped because the brains of Eindhoven decreed that a new type of regulated motor had henceforth to be fitted.

Again I digress. Not without purpose, I hope, for the subject leads to the various torques that can be imposed on the drive system, and I take leave here to include yet another drawing, this time a copy of the first figure in the Uher manual, lettered according to their system. Some of the letters we shall not require at present but I leave them in the drawing and may have to refer back to them in subsequent articles.

FIG. 2 LAYOUT OF PRESET CONTROLS



The motor A has two belts, the longer of which, B, drives the stepped pulley. The appropriate diameter of this pulley engages with the flat lower rim of the flywheel. The view in **fig. 3** is, of course, from below with the keybar side of the machine to the bottom of the diagram. The speed selector sets the ramping position, which is spring-aided. First point we come to is the setting of this pendulum bearing. In the 9.5 cm/s speed position there should be about 1.5 mm clearance between the edge of the flywheel and the next largest step on the pulley. This is the easiest way to check and is better than measuring the amount of overlap or the bracket position relative to the deck supports, as some authorities have recommended. If you can slip a triple thickness of postcard between the 19 cm/s step face and the edge of the flywheel, that is about right.

Some day, someone is going to compile a reference list for us—a scale of comparative measurements of engineering dimensions and domestic articles, alternatives and equivalents to feeler sizes. What's the width of a hairpin, Joe?

Clearance between the driving surface of the 9.5 cm/s diameter stepped pulley and the flywheel, when these are disengaged, should be one postcard thick, by this scale. Uher tell us 500 μm, but be very chary of overdoing this setting. Too great a clearance can give us slow-running troubles. The adjustment for lateral position of the pulley-bearing bracket is by moving the lever on which this is mounted. This is not shown in our fig. 3 but, relative to this drawing, comes below the bearing bracket. It can be identified by the angled end, the spring-loaded rod and its nipple. Two screws are used, and the mounting lever can be slid to achieve the necessary 1.5 mm clearance. Don't be tempted to alter those two screws above the bracket. The other clearance is not quite so straightforward. It involves bending the end of the forked lever that goes under the take-up clutch, where this lies under the end of the pulley bracket. This alters the limiting action. As this speed selection and drive assembly is also linked to the equalising switch, alteration could affect switch action. Alter this setting only if you must, and then check switch action afterwards.

The other belt depicted is easily got at for cleaning or replacement. Where turntable drive troubles are reported, this should be the first line of approach. Its action should be clear from the diagram. It drives a pulley on a rod which is coupled to another pulley, the latter driving the feed spool turntable for rewind when the rocker assembly is made to pivot on its axis. The degree of pivoting is very little, impelled by the lever system via those tooth-like cutouts we can see at the lower edge of N in the diagram. The most important adjustment of all is to get this seesaw bracket parallel with the chassis when the mechanism is at neutral. Look for the slider rods that come forward and depress the seesaw arm, check that these withdraw at least 1 mm when neutralised, and then bend the tabs (those jutting portions of the aforementioned teeth) to achieve a solid

(*continued on page 165*)

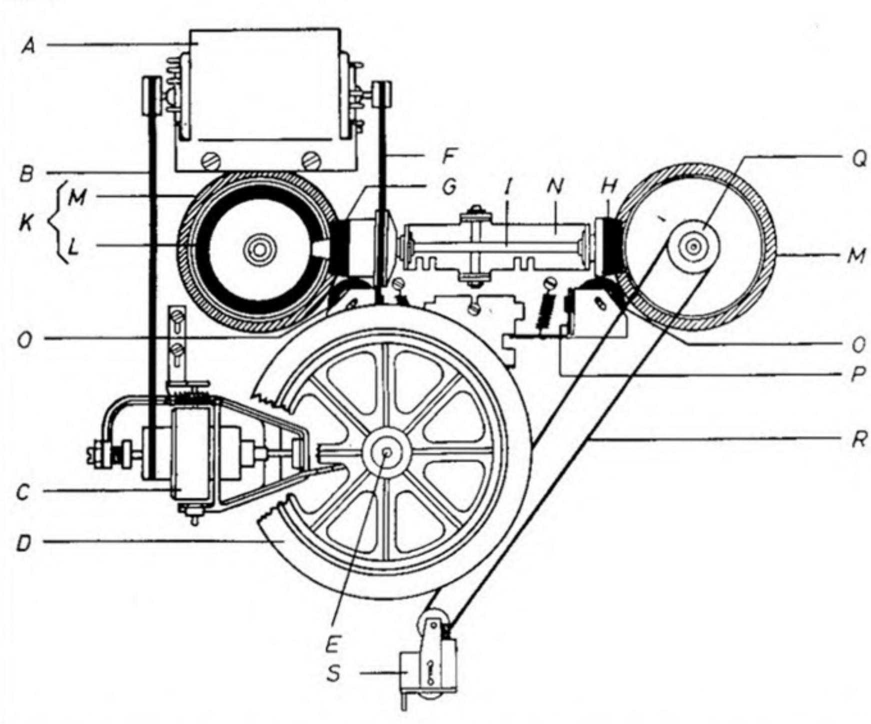
engagement of the conical rubber wheels with the turntable lower faces.

Between the rocker and the deck there are two spring blades carried forward by the lever action. These determine the amount of drive for fast winding either way. Unfortunately, to get at these properly to bend them, so that the correct angle of depression is obtained, one must first take off the seesaw. So adjustment here is very much a trial and error affair. I strongly advise against making this adjustment until all other avenues of approach have been explored.

Drive for the felt-lined friction disc is from the conical extension of the pulley G. The disc L is sprung against the pulley and, because the spool is held to the turntable by the famous Uher securing device (infamous when you lose the tiny circlip that secures it!); gravity plays no part in this clutch operation. It is, in fact, remarkably constant from beginning to end of tape (but the *4000L* does not like double-play tape, be warned). I shall not bore you with spring tension tests for correct clutch torque—I do not think we shall need them. There is only one vital adjustment once the rudimentary cleaning has been done.

Funnily enough, this adjustment is done in the fast forward mode. If we inspect that clutch closely, we shall see that there are two alternative drive methods, rubber pulley to turntable upper section, and metal cone to underside of the friction disc. In the fast forward mode, the rubber is engaged and that vital cone should have 500 µm clearance from the friction disc. To set the drive, go to the other end of the forked lever, where a tab can be seen, shooting off in what looks like the wrong direction. We bend this, very slightly, what looks like the wrong way! By the time you have finished, adjustment should be perfect, and Uher tell us that in this condition the take-up should commence when the start key is only two-thirds depressed.

FIG. 3



Finally, this month, brakes. From fig. 3 we can see the way the brake rollers O engage with the edge of the turntable. We can also see the shape of the brackets in which these rubber rollers are held, the lever P on which the end-pieces are mounted, and the small springs which aid engagement.

This gives us the clue, for the brakes merely clamp on and rely for their efficiency on the rotation friction, depending on the direction the turntable is turning. So we have a limited kind of differential action, and must maintain it by keeping the brake rollers clean, their pin suspensions free in their slots, and the inner end of the pivoted bracket assembly free in the slot of the actuating lever when the machine is at stop. These arms should then be bent if necessary to get a 2 mm clearance of brake roller when the appropriate mode of drive is selected. Finally, another bent tongue can be seen, to the operator's side of the brake tabs, and this has to be carefully set so that the brakes come off just before the pressure roller engages when start is selected.

I have not dealt with the pressure roller, head gate, or head adjustment, leaving this for next month when we shall be taking a look at the *4200* stereo portable.

by Peter Bastin

ROLAND Prognoss, writing in *Hi-Fi News*, says the following: 'Full marks to the brilliant young William Brandling . . . for an original stroke in his current presentation at the Festival Hall. Briefly, the idea is to gather a group of live musicians together with a wide variety of instruments . . .' How very refreshing (and encouraging to the Musicians' Union) to gather together a group of live musicians instead of dead ones.

TAPE RECORDERS have their own individual characteristics, just like editors. Sony machines give a sepulchral groan when turned on. Tandbergs set up a fusilade of small-arms fire when the function switch is changed and other machines rewind at two different speeds, one equivalent to getting up after the alarm has gone, the second resembling the resultant rush to the office. I've had machines which burp, click and stammer, none of the faults being very serious and a few being useful. Take the starting squeak of an Akai *4000D:* close-miked and halved in speed it makes a passable impersonation of a lift.

THE AMERICAN *Stereo Review* for December carried a large postbag of readers' letters about the merits or demerits of Tom Jones. A young lady from Florence, Alabama, greatly in support of the Welsh Warbler, credited him with 35 superlatives, ranging from the 'the best' to 'outasite' via sexy, gorgeous and angelic. She ended her letter with '. . . who has ever (nine times) lived'. Well, it takes all sorts.

LEAK'S NEW Sandwich *200* and *300* loudspeakers incorporate 'grills (sic) of simulated stainless steel'. As used on the original Tay Bridge? The press release is headed 'New hi-fi looks as good as it sounds' which, in these days of cassettes, can be taken two ways.

THE EDITOR of the American magazine *Audio* ponders the future of that subject. This was no doubt brought out by his inspection of the Panasonic mini-screen TV with built-in AM/FM radio, a battery-operated portable TV colour set and a talking clock which announces the time when you press a switch. Then there is the neural hearing concept where sound is transmitted direct to the nervous system, by-passing the ears entirely. The head becomes the dialectric element between two plates of a capacitor, the signal being detected by a complex process involving the cochlea and the nerves themselves. The frequency range of the system is 20 kHz down to 30 Hz. Guaranteed not to dissolve the brain?

A HIGH QUALITY MIXER

David Robinson

PART 11

CONSTRUCTORS' QUERIES

THIS article will quote some of the more common questions that I have been asked about the mixer, and I hope the answers given will help those who may have had similar problems but have not found time to write in. The first question is dealt with in greater detail than the rest since it will be of interest to experimenters.

There are no integrated circuits in the mixer—are they not to be recommended?

No integrated circuits are used since they are more expensive than discrete components and in many cases not as good. In the design of the new mixer I experimented with many ICs and concluded that the present generation left much to be desired. One device in common use is the *709*, made by many manufacturers. **Fig. 80** shows the circuit diagram and pin connections. What goes on in the 13 transistors is not really important; the device should be regarded as a two-input differential amplifier with a voltage gain of 45 000 and a 30 V maximum supply. This amount of gain is unusable as such and the device is normally heavily fed back to provide stable gain. One problem with ICs is that the frequency capabilities of the transistors are very high, so the device is prone to parasitic oscillations. Compensation components have to be added to make the device stable at all gain settings. Second generation devices such as the *741* types have built-in compensation but in these circumstances the full bandwidth capabilities cannot be attained. Three circuits were investigated: microphone amp, mixer, and output amplifier. To do this, a board was designed to carry the IC, power supply decoupling and compensation components, with the idea that this would be the same in all applications. External components would determine the gain. This board was also used as the heart of the IC compressor experiment described last month.

Fig. 81 shows this board design. R1 and R2 provide a half rail voltage; ICs often use positive and negative supplies so that they can be used as DC amplifiers; then for O V input there is O V output. Here we have only a single-ended supply, and furthermore only need an AC output. Biasing resistors R2 and R3 are taken to the inverting and non-inverting inputs; negative feedback is applied via R6 and R5 to the correct terminal. By connecting different resistor values between pins 7 and 4, and between 3 and 1, the gain of the module can be altered over wide limits. The frequency compensation (anti-oscillation) is provided by R8/C2 and C3. R7 provides protection against the output being short-circuited.

The first amplifier to be built was an output stage for driving balanced lines; **fig. 82** shows this. Performance was quite good; signal-to-noise ratio 73 dB, maximum output +20 dBm, distortion at +8 less than 0.01%.

By feeding into the +ve terminal, the input impedance is high; actually 33K due to R2 across the internal 100K, R13.

The next amplifier was the mixer amplifier, shown in **fig. 83.** Here the –ve input terminal is used, and a virtual earth or null-point amplifier is produced. The performance gain is good, the signal-to-noise ratio is 87 dB, and the isolation is excellent: 100 sources faded from one extreme to the other cause less than 1 dB change in the output due to one constant input source. Frequency response is –1 dB at 10 Hz and 25 kHz.

The most difficult and least successful of the amplifiers is the microphone amplifier, which falls down on noise performance. **Fig. 84** shows this circuit. Here the +ve input (high impedance) is used, and switched gains are provided to give a coarse gain adjustment. The overload performance and frequency response are good; the noise figure is some 10 dB which compares unfavourably with the discrete component version. However, for non-stringent applications this may be satisfactory.

The last amplifier to use the module is the (*continued on page 169*)

FIG. 82 IC OUTPUT AMPLIFIER

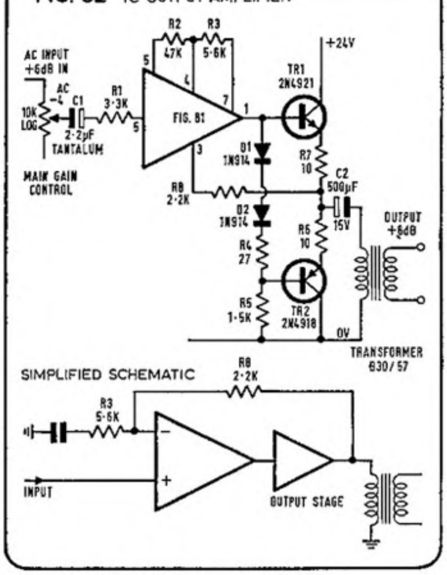


FIG. 83 IC MIXER AMPLIFIER

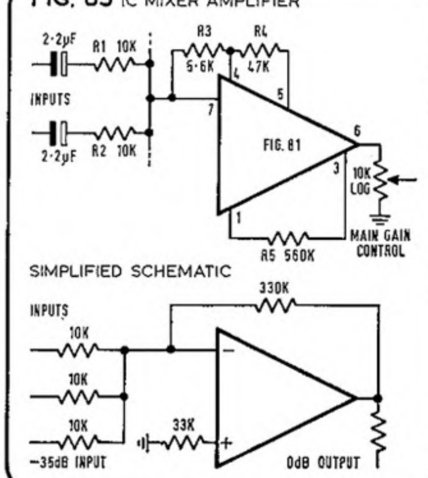


FIG. 81 INTEGRATED CIRCUIT MODULE

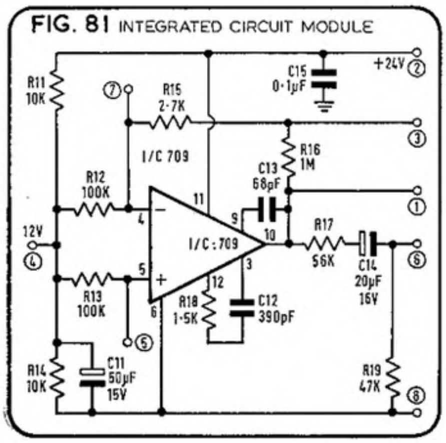
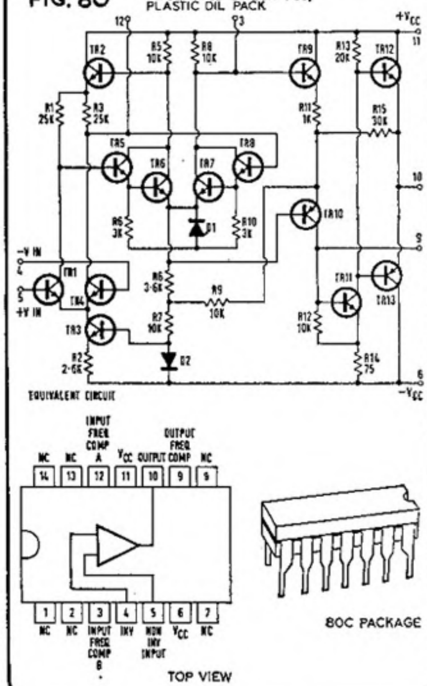


FIG. 80 INTEGRATED CIRCUIT 709, PLASTIC DIL PACK



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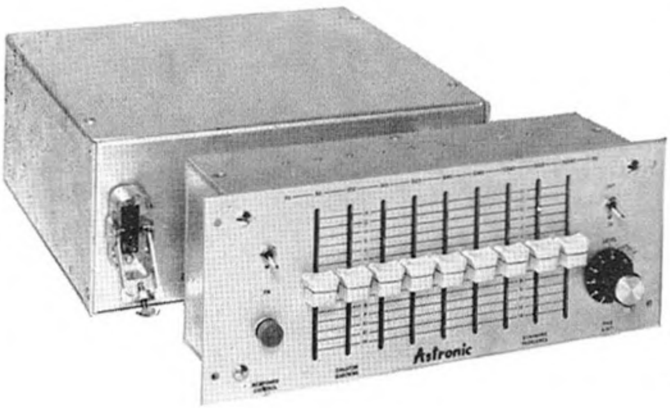

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Reel	4″	5″	5¾″	7″	3″	4″	5″	5¾″	7″
ft.	300	600	900	1200	210	450	900	1200	1800
BASF	—	£1·00	£1·30	£1·55	44p	88p	£1·25	£1·43	£2·05
BASF round pack	44p	£0·76	£1·01	£1·18	34p	68p	£1·01	£1·12	£1·74
BASF low noise	—	—	—	—	—	—	£1·45	£1·65	£2·35
EMI	48p	£0·90	£1·23	£1·50	43p	63p	£1·23	£1·53	£2·10
PHILIPS ...	—	£0·92	£1·23	£1·40	40p	68p	£1·03	£1·30	£1·83
SCOTCH ...	—	£0·80	£1·05	£1·33	35p	55p	£1·05	£1·33	£1·90
SCOTCH Dynarange	—	£0·98	£1·30	£1·66	—	—	£1·27	£1·61	£2·26

	DOUBLE PLAY					TRIPLE PLAY				
Reel	3″	4″	5″	5¾″	7″	3″	4″	5″	5¾″	7″
ft.	300	600	1200	1800	2400	450	900	1800	2400	3600
BASF ...	54p	£1·00	£1·40	£2·02	£2·45	85p	£1·20	£2·00	£2·45	£3·05
BASF round pack	43p	£0·76	£1·18	£1·74	£2·18	68p	£1·01	£1·74	£2·18	£2·79
BASF low noise	—	—	£2·10	£3·00	£4·65	—	—	—	—	—
EMI ...	63p	£1·08	£1·80	£2·40	£3·30	98p	£1·63	£2·80	—	—
PHILIPS...	53p	£0·95	£1·48	£2·13	£1·98	65p	£1·53	£2·50	—	—
SCOTCH	64p	£0·95	£1·58	£2·10	£2·83	93p	£1·50	—	—	—
Dynarange	70p	£1·13	£1·80	£2·36	£3·34	—	—	—	—	—

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compressor circuit shown in fig. 75 last month; examination of this with fig. 81 shows how the module fits into the compressor.

One word of warning: the IC modules possess a very large open loop gain; even with frequency compensation there is the possibility of oscillation when many are strung together in a mixer chain. Keep input and output leads well separated. It may also be necessary to decouple the power supply rail several times in its progress round the mixer with 0.1 μF capacitors to ground near each IC block.

The big advantage of the IC concept is that it is truly modular—the same active device assembly is used throughout, and this obviously helps from reliability and replacement aspects. But, for the most critical applications, discrete components are to be preferred from performance and cost criteria.

FIG. 84 MICROPHONE AMPLIFIER

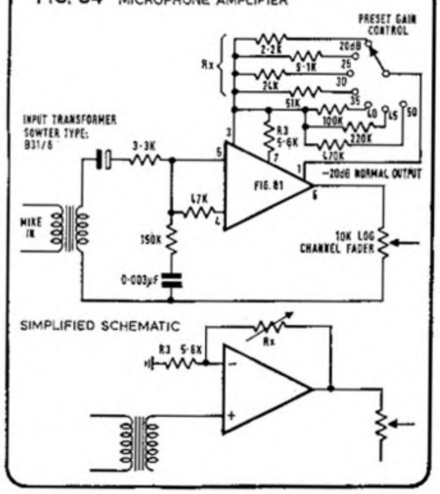


FIG. 85 AMPLIFIERS FOR POSITIVE AND NEGATIVE SUPPLIES

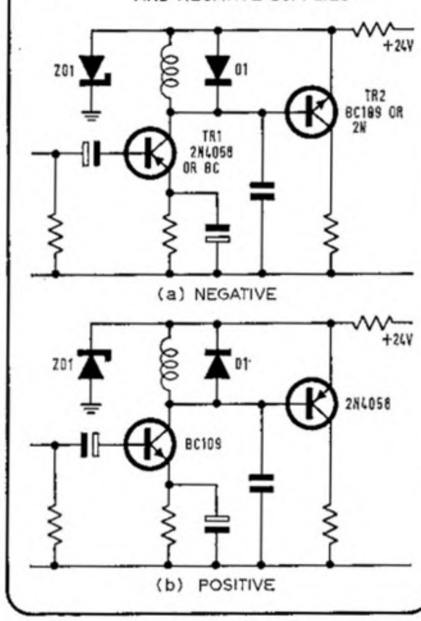
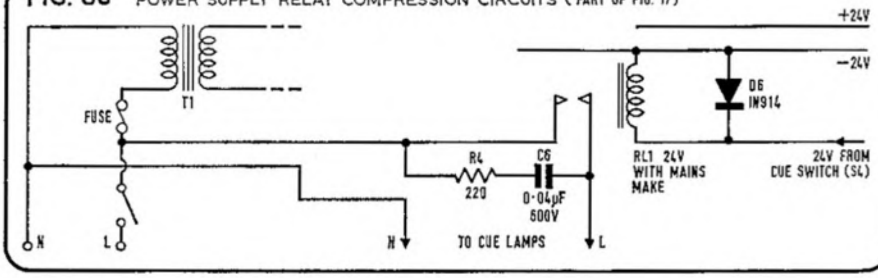


FIG. 86 POWER SUPPLY RELAY COMPRESSION CIRCUITS (PART OF FIG. 17)



The board is available to experimenters—it plugs into the same eight-way edge connector as the existing interior plug-in amplifiers. It is slightly smaller than the interior cards.

Can I use the new circuits directly with the 1964 design?

Yes, provided that a few simple rules are followed. The 1964 design used germanium transistors which were commonly available only as *p-n-p* devices—so requiring a negative supply voltage. Nowadays the most common silicon transistors are *n-p-n*—hence the +24 V supply in the new design. **Fig. 85** shows the conversion; all polarity-conscious components are reversed. In replacing the transistors, the two main types can be interchanged—*BC109* for *2N4058* and the reverse. However, the former is a *TO18* device, the latter plastic encapsulated with differing lead configurations. If printed circuits are being used, then it would ease confusion if devices of opposite polarity but the same physical form were used (if they can be obtained). For *BC109* use *BC179*, for *BC108* use *BC178*, and for *2N4058* use *2N3707*. Thus the new circuits can be converted to work in the old mixer design.

What is a BC109C as opposed to a BC109?

Both *BC108* and *109* transistors are available from the manufacturers, graded for current gain: *A* lowest gain, and *C* highest. However, since the h_{fe} of a *BC109* is over 100 at the minimum, any *BC109* is suitable in these circuits. If the C type is available, it should be used.

Part Two mentioned components C6, R4, and D6 in the power supply for click suppression but these did not appear on the diagram. Where should they go?

Fig. 86 shows where. D6 prevents the induction EMF (generated as the relay is switched off) from rising over 0.6 V instead of 100 V or so. R4/C6 damp out the spark across the mains contacts on the relay.

How should the earthing of the various modules and chassis be arranged?

All O V points should be connected to the O V of the power supply and to the metal chassis of the mixer but in a correct sequence to avoid earth loops. The chassis is connected to the input sockets (if not automatically connected by the socket construction) close to these sockets. The power supply O V line comes into the mixer via a socket and a wire goes from this to the input sockets. All the earth pins of the front panel plug-in amplifiers are strapped together, as are those of the interior plug-in units, and wire from each is taken separately to the input sockets. Earth sides of potentiometers are taken to the earth point nearest to them, e.g. channel and main faders are returned to the interior plug-in earth strap.

Not all voltages are given in the circuit diagrams.

No but all can be deduced from an examination of the circuit. For example, take fig. 34. If the base of Tr1 is at 2.7 V, then the emitter is approximately 600 mV less, or 2.1 V. The emitter of Tr2 is connected to 24 V, so the base is at 0.6 V less, or 24.4 V. The output stage emitter resistors are only 100 ohms so that the emitter of Tr3 must be at 11.5 V, the base therefore at 12.1 V . . . and so on.

Not all capacitor voltages are given. How do I decide what to use?

The same argument as above applies; it can always be deduced. Fig. 23 is a good example. The emitter of Tr1 is at 4.4 V, so that C1 must be at least this voltage working, say 6 V. C6 is between a 14 V point and earth, so that a 16 or 25 V capacitor would be suitable. The method used to designate capacitors is to write an 8μF capacitor, 25 V working, as 8/25.

What value are the resistors associated with C5 and C7 in fig. 54?

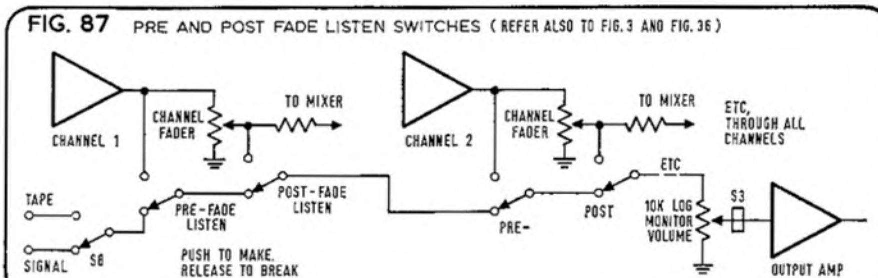
Sorry—these values were omitted. The value of R14 (from C5 to 0 V) is 10 K; R15 (C7 to earth) is 15 K.

How can I wire up pre-fade and post-fade listen switches to the mixer?

The operation of these switches should cut

(continued on page 196)

FIG. 87 PRE AND POST FADE LISTEN SWITCHES (REFER ALSO TO FIG. 3 AND FIG. 36)



The Dolby 360 Series

Nearly a thousand of these new units are already in use.

Each Series 360 unit is only 1¾ inches (44 mm) high. 16 channels therefore require only 28 inches of rack space.

Full compatibility with the A301

Models 360 and 361 are single-channel A-type (professional) noise reduction units which process signals identically to the two-channel A301. The new units are small in size and are designed for simplified installation and use of the Dolby System with 16-track recorders. The cost of the 360 series is somewhat less than that of the A301 for an equivalent number of channels.

Automatic record/play changeover in the 361

The Model 360 is a single-channel noise reduction processor unit. The Model 361 is identical to the 360 in size and appearance, but contains facilities for automatic record/play changeover controlled from the recorder. In the new series, the operating mode is set and clearly displayed by illuminated push-button switches.

Internal oscillator An internal "Dolby Tone" oscillator is provided for establishing correct operating levels. The characteristic modulation of the tone also identifies Dolby-processed tapes. All oscillators in a multi-track installation can be controlled by a single switch.

High stability The circuit is highly stable and does not require routine adjustment. A removable front panel allows input and output levels to be adjusted from the front of each unit. The panel also provides access to relays and the noise reduction module.

Single-module design The noise reduction circuitry is contained in a single module which can be purchased separately. Should failure ever occur, plug-in substitution will restore operation of the system in seconds with no adjustments necessary.

Prices, delivery information and complete specifications are available from

DOLBY LABORATORIES INC

333 Avenue of the Americas New York NY 10014
(212) 243-2525 cables: Dolbylabs New York

UK and International
346 Clapham Road London SW9 .
(01) 720-1111 telex: 919109 cables: Dolbylabs London

ACORN RECORDS

Address: 2 Eynsham Road, Oxford, OX2 9PB.

Telephone: 86-2459, or STD 086-76-2459.

Directors: Colin Sanders and D. M. Sanders.

General Information: Acorn are in the process of moving to new studios where they should be operational by 1 March 1971. Details will be announced in *Studio Sound* as soon as they are available.

ADVISION

Address: 23 Gosfield Street, London W1P 7HB.

Telephone: 01-580 5707.

Directors: K. S. Hibberd, Andy Whetstone, C. Colvington, Mrs B. Hibberd.

Studio Director: Roger Cameron.

Engineers: (Recording) Roger Cameron, Marton Rushent, Eddie Offord; (Film Dubbing) Andy Whetstone, Graham Middleton.

General Information: Formerly in New Bond Street, Advision moved to Gosfield Street about a year ago. The premises are well equipped and luxuriously furnished. Much of their time is spent recording pop music.

Studio: 14 x 11 m, and 6 m high. It holds 60 musicians quite comfortably. There are two separation booths, one 4.5 m square, and the other 3 x 2 m, both 2.5 m high. Microphones used are mostly Neumann and AKG. A projection screen is available for film work. Control Room: 7.5 x 3.5 m, and 3.5 m high. The mixer, which has 22 inputs and 16 outputs, was designed by Dag Felner and built by Advision staff. Limiters used are Audio & Design, Spectra Sonics, and Pye. Echo is from EMT plates. Monitoring facilities consist of J B. Lansing speakers driven by Radford amplifiers. The recorders, which are Scullys, range from mono to 16 track. Dolby 361 noise reduction units are available when required.

Reduction Area: This comprises a 9 x 5 m reduction room and 5 x 3 m overdubbing booth, both 2.5 m in height. About six people can be accommodated in the booth. A 16 channel Neve console is equipped to do quadraphonic work, and four J. B. Lansing monitors are used.

Film Equipment: Advision have comprehensive facilities for synchronised recording, dubbing, magnetic and optical transfer, and editing.

Music Services: Piano in the studio. For electronic music, there is a separate studio, measuring 6 x 4 m, which houses a Moog Synthesiser and a multitrack Scully recorder.

Sound Effects Library: Various effects available for copying.

Disc Cutting: Lyrec-Ortofon mono cutter.

Mobile Recording: The limited equipment available for this purpose includes a Nagra with sync facilities, and an eight track Scully.

Catering: Drinks, available from a vending machine and from the kitchen, may be consumed in the spacious lounge/reception area.

Parking: No private facilities.

Hourly Rates (Tape):

Recording, up to eight track	£30
Recording, 16 track	£32
Recording to picture	£35
Electronic Music Studio, eight track	£25
Electronic Music Studio, 16 track	£32
Reduction, up to eight track	£20
Reduction, 16 track	£28

Editing:

Copying, mono or stereo	£10
Copying, multitrack	£20

Tape charges (per NAB reel):

6.25 mm	£6
12.5 mm	£10
25 mm	£16
50 mm	£26

Hourly Rates (Film):

Music Recording	£35
Commentary Recording	£20
Mixing and Dubbing	£20
Magnetic Transfer, 35 mm, 17.5 mm, or 16 mm	£10
Optical Transfer, 35 mm	£10
Cutting Room hire, 35 mm	£1

Disc Rates (Acetates):

33 RPM 30.5 mm 13 p per minute plus charge per disc	£2.10
45 RPM 18 cm single-sided SP	£1.40
45 RPM 18 cm double-sided SP	£1.90
45 RPM 18 cm single-sided EP	£1.90
45 RPM 18 cm double-sided EP	£2.40

Disc Rates (Masters):

33 RPM 25 or 30.5 mm	£7.75
45 RPM 18 cm SP	£6.13
45 RPM 18 cm EP	£7.0

Other Charges: After 18.00 hours, the additional hourly overtime charges are £3 for a first engineer, £2 for a second engineer. Cancellation rates are 100% for notice given within 24 hours of a session, 50% for notice of between 24 and 48 hours. All locked groove masters are subject to a £1.50 surcharge. Library effects transferred to acetates are charged at normal disc prices with a surcharge of £1.50 for the first effect, plus 75p for each additional effect.

ALAN-GORDON STUDIOS

Address: 32 and 71 Markhouse Road, London E.17.

Telephone: 01-520 3706, or 01-527 5226.

Partners: Dave Lyon and Alan Ward.

General Information: A demo studio which started in a very small way five years ago. The business has been built up successfully more by good will than by advertising. Dave, a bass player, and Alan, former lead guitarist with the Honeycombs, specialise in helping relatively inexperienced musicians to produce impressive demos.

Studio: 4.5 x 3 m, and 2.5 m high; accommodates up to eight musicians. Beyer studio microphones are used.

Control Room: 2.5 x 1.5 m, and 2.5 m high. The mixer which has 10 inputs (eight microphone, two line) and two outputs, was based on a David Robinson design published in this magazine. There is one Audio & Design compressor/limiter; echo facilities comprise of a Grampian spring unit and Baby Binson magnetic drum system. Tannoy *Gold* 38 cm speakers in Lockwood cabinets are used for monitoring. Recording equipment consists of a full-track TRD, a stereo Revox and stereo Ampex.

Music Services: Free use of grand piano, string bass, and various guitar amplifiers.

Disc cutting: Can be arranged for customers. No cutting equipment on the premises.

Catering: Light refreshments available to order.

Car Parking: No problem.

Hourly Rates:

Recording	£5.50
Reduction	£3.50
Copying	£3.50
Editing	£3.50

Tape Charges: 6.25 m NAB £5.25

ART RECORD PRODUCTIONS

Address: 134 Seaforth Avenue, Motspur Park, New Malden, Surrey.

Telephone: 01-942 1412.

Directors: John S. Astor, Vernon A. Dias.

Studio Manager: John S. Astor.

Engineers: Vernon A. Dias, John S. Astor.

General Information: The studio has been going about a year and a half, doing mainly demo work, although a few masters have also been made.

Studio: 4.5 x 3.5 m, 3 m high, holding up to 6 musicians, Microphones by AKG, STC and Fi-Cord.

Control Room: 3.5 x 3 m, 3 m high. The mixer by Darburn Ltd, has eight input channels and two outputs. Alice Electronics limiter/compressors, a Grampian spring echo unit, and a Selmer tape-loop echo repeat unit, can be patched to the channels as required. Recorders are stereo Vortexions, and for monitoring there is a pair of Goodmans units fed by 15 W Leak amplifiers.

Music Services: Piano and drums are available free of charge. John Astor is an independent producer, and the studio have their own record label, **Art.** In conjunction with the Robert Stigwood Organisation, the studio also have a music publishing company called **Motspur Music,** which started at the same time as their record label at the end of summer 1970. In addition, the services of writers and arrangers can be obtained and a backing group is available.

Disc Cutting: No facilities on the premises, but cutting can be arranged for clients.

Mobile Recording: For this work, a Vortexion mixer is used in addition to the normal studio equipment.

Catering: Light refreshment available.

Parking: No problem.

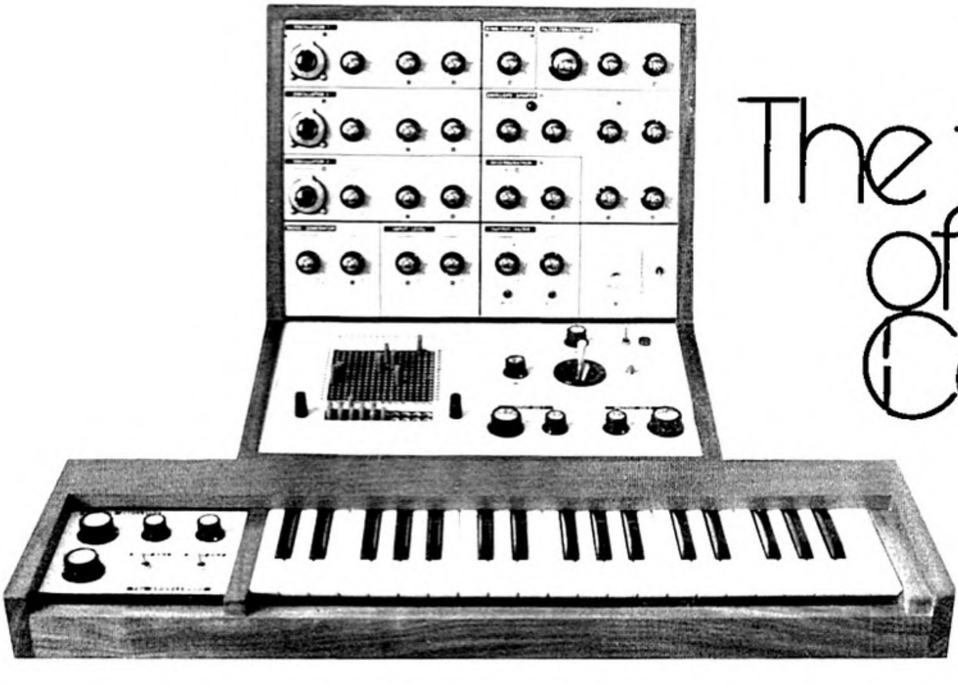
Hourly Rates:	£
Recording (Mono/Stereo)	3.50
Recording (Mono/Stereo), speech only	3.00
Editing	1.00

Tape Charge: Per 18 cm reel, approximately 2.50

Disc Rates (Acetates):

$33\frac{1}{3}$ r.p.m. 25.5 cm, single-sided	2.25
$33\frac{1}{3}$ r.p.m. 25.5 cm, double-sided	2.90
$33\frac{1}{3}$ r.p.m. 30.5 cm, single-sided	1.75
$33\frac{1}{3}$ r.p.m. 30.5 cm, double-sided	3.50
$33\frac{1}{3}$ r.p.m. 18 cm, double-sided mini LP	2.25
45 r.p.m. 18 cm, single-sided SP	1.20
45 r.p.m. 18 cm, double sided SP	1.60
45 r.p.m. 18 cm, single-sided EP	1.60
45 r.p.m. 18 cm, double-sided EP	2.10

Other Charges: Rates for pressings, mobile recording, and other facilities are available on application.



The fine art of Voltage Control

David Kirk field tests the VCS3 electronic music synthesiser

MANUFACTURER'S SPECIFICATION. Voltage controlled electronic music/sound-effects generator. Power requirement: 220 to 240 V or 105 to 115 V, 50 or 60 Hz. Battery operation possible. Internal sources: *Oscillator 1:* 1 Hz to 10 kHz sine and ramp, *Oscillator 2:* 1 Hz to 10 kHz square and ramp, *Oscillator 3:* 0.05 Hz approx to 500 Hz square and ramp. Filter when set to self-oscillate supplies variable frequency sinewave. Trapezoid signal produced by envelope generator. Noise generator with amplitude and coloration controls. **Internal treatments:** Envelope (attack/decay generator), reverberation spring unit, bandpass filter and IC transformerless ring modulator. **Input sensitivities:** Two 5 mV AC into 600 ohms, One ±50 μA into 500 ohms; ±2.5 V DC or 1.8 V AC into 50 K. **Outputs:** Two 10 V into 50 ohms (headphones), Two 2 V into 600 ohms (line), and DC control output. **Internal monitors:** Side-facing loudspeakers driven by 1 W amplifiers. **Finish:** Solid afrormosia cabinet. Slide-out bottom and rear panels. Plastic on heavy gauge aluminium, taking temporary wax pencil marks. **Dimensions (HWD):** 438 x 444 x 419 mm. **Weight:** 10.2 kg. **Manufacturer:** Electronic Music Studios (London) Ltd, 49 Deodar Road, London SW.15.

IMAGINE a series of audio frequency oscillators, each capable of modulating the pitch and level of the others. Imagine also a filter, the cut-off frequency of which may be controlled by the output of an oscillator or by any audio or subsonic signal. Imagine an envelope shaper with variable attack/sustain/decay/off times, a noise generator, a reverberation unit, and a comprehensive linking system by which any signal sources may be connected to any processors. There, in perhaps a confusing nutshell, you have the *VCS3*.

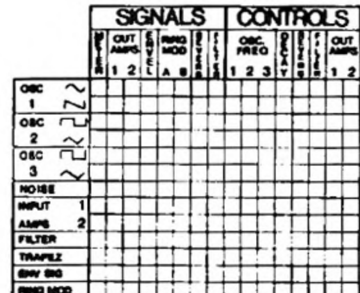
The letters *VCS* represent Voltage Controlled Studio. A simple example of voltage control technique is the rapid pitch variation obtained when an alternating voltage is applied to the base of a transistor wired in an Eccles-Jordan multivibrator. I found nothing as familiar as a plain flip-flop in the *VCS3* circuits, which proved complex enough to dispel any thought of building my own.

Fig. 1 shows the patch panel adopted by EMS in preference to the jack sockets and cables employed on the essentially similar Moog Synthesiser. Signal sources and 'treatments' are labelled down the left-hand side of the patch board. These may be connected in any permutation to the signal inputs and control inputs listed along the top of the board. The link is made by inserting a pin not unlike a sub-miniature jack plug. Reference numbers and letters are printed opposite the sources/treatments (1 to 16) and signal/control inputs (A to P). A pin in 1A joins *oscillator 1* sinewave to the meter. The meter may be switched to read control voltages or signal level. Position 1B links the sinewave to Channel 1 output, which can if desired be monitored on the left of the two side facing internal loudspeakers. Position 1C connects the sinewave to Channel 2, all resulting in fig. 2.

Moving the pin to 1D connects the sinewave to the signal input of the envelope shaper but you hear nothing until you push a further pin into 12B, connecting the envelope output to the Channel 1 monitor output (fig. 3). The sound heard now depends on the attack/sustain/decay/off times determined by rotary control on the steep-sided control panel. These are calibrated 0 to 10. Zero attack and sustain ('on') settings, with a 7 decay setting, sounds not unlike an electric guitar. Raising the attack setting to 7 produces a sound closer to a mouth-organ. I should mention that the unit is *not* designed to imitate acoustic instruments and is not particularly good at such imitations.

Moving along to 1E connects the sinewave to one input of the ring modulator. A pin inserted at 13B joins the ring modulator output to the Channel 1 monitor but nothing is heard until a modulating signal is connected to the second input of the ring modulator. A link at 4F feeds a triangular wave from *oscillator 2* to the second input of the ring modulator. The resultant sound is the sum of the levels of the two tones (fig. 4). If one oscillator is reduced to a subsonic frequency, the other set at say 1 kHz, the result is a 1 kHz tone rising and falling in level like an enraged sputnik. If the subsonic oscillator is raised to an audible pitch, heterodynes introduce an altogether different tone through the beating of one oscillator with another.

Clearing the patchboard, we now place a pin in 1G, joining the sine oscillator to the spring reverberation unit. A pin at 14B feeds the reverb output to the Channel 1 monitor. Reverberation may be mixed in manually though its effect on a constant tone is of little interest to the ear. If the pitch is varied,



The fine art of Voltage Control

however, the interference of the sliding tone with the delayed signal begins to acquire a musical value. We can slide the pitch by hand, or set a separate oscillator to do the job automatically. A pin at 6I joins the triangular output of *oscillator 3* to the frequency-control input of *oscillator 1*. *Oscillator 3* operates over a fairly low range of frequencies (0.05 Hz to 500 Hz) and is a more versatile source of control voltages than the 1 Hz to 10 kHz *oscillators 1* and *2* (fig. 5).

Again clearing the patchboard, we connect *oscillator 1* sinewave to the signal input of the filter. A pin at 10B joins the filter output to the Channel 1 monitor. Varying the filter frequency control alters the timbre of the sinewave. This variation may also be automated by connecting, for example, a subsonic triangular wave from *oscillator 3* to the filter frequency control input, 6N (fig. 6). Depending on the triangular wave level and the manual frequency control positions, the resultant sound can be varied from a rhythmic pulse to the effect obtained with a 'wah-wah' device (a commercially produced pedal-operated tone control which I gather shifts from maximum bass and minimum treble to maximum treble, minimum bass, at the swing of a foot).

A pin inserted at 1I joins the sine output of *oscillator 1* to the frequency control input of *oscillator 1*. If any link is going to blow the fuses, this (fig. 7) should be the one. Happily the fuses remain intact and, remarkably, the oscillator remains stable. Nothing is heard until a pin at 1B feeds the sinewave to Channel 1 output. A rotary knob on the *oscillator 1* control panel allows the sinewave level to be increased. A constant-pitch sine tone increases in level and, at about calibration 5 on the 0 to 10 scale, begins to reduce its own pitch.

A more appropriate arrangement is the use of a subsonic sinewave from *oscillator 1* to control the frequency of *oscillator 2*. This is accomplished by pins at 1J and (to hear the *oscillator 2* squarewave output) 3B. If the regular rise and fall in squarewave pitch is monotonous, it can be rendered more interesting by altering the sine shape. Similarly, the squarewave mark/space ratio can be manually controlled. Still travelling across the top patch board row, a pin at 1K connects the *oscillator 1* sinewave to the frequency control input of the *oscillator 3*, identical to *oscillator 2* except in its frequency limits. Two or more oscillators can be frequency modulated by a single control voltage, as in fig. 8.

I thought I had explored the *VCS3* fairly thoroughly before starting this report but the 1L connection proved a totally new effect. Winding the *oscillator 1* sinewave down to 1 Hz,

(continued on page 175)

Fig. 1 Photo and diagram of the patch panel showing the output rows 1 to 16 and input rows A to P.

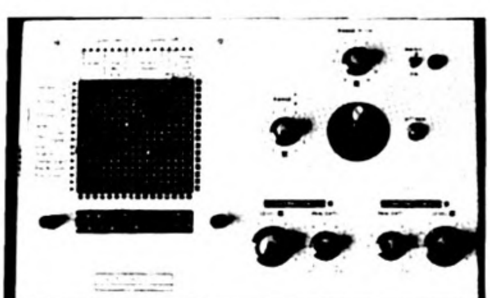


FIG. 2

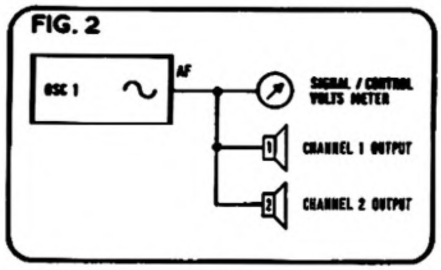


FIG. 3

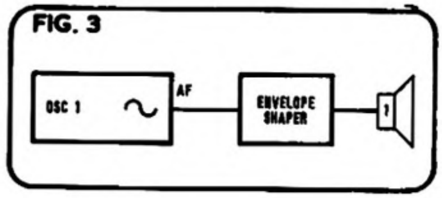


FIG. 4

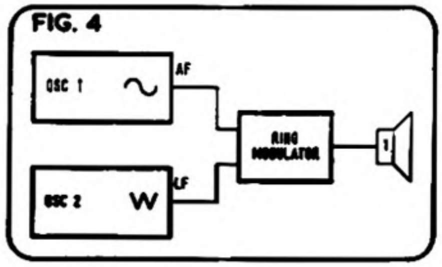


FIG. 5

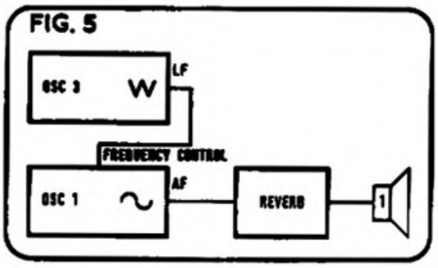


FIG. 6

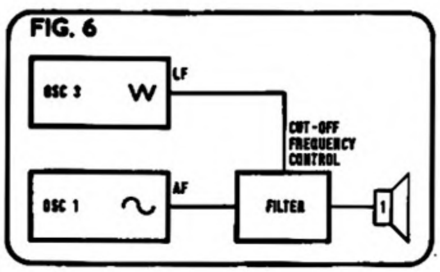


FIG. 7

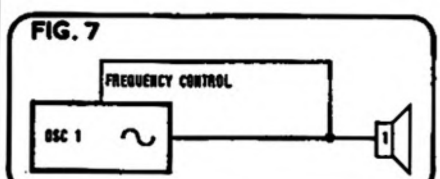


FIG. 8

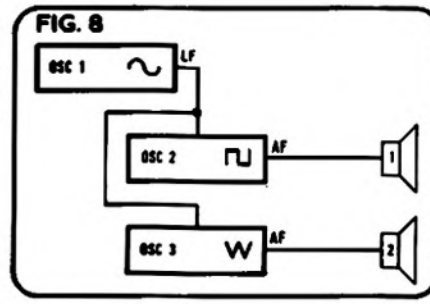
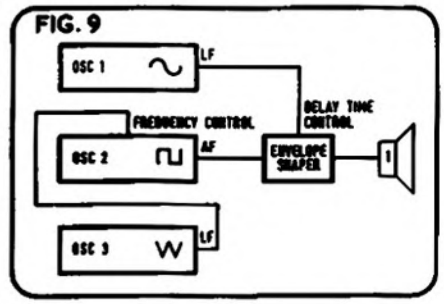


FIG. 9



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this connection controls the decay time of any tone fed through the envelope shaper. Inserting pins at 3D (*oscillator 2* squarewave to envelope input) and 12B (envelope output to Channel 1 monitor) produces a rattling alarm clock tone when attack/on/decay/off times are at zero. As the decay control is increased to calibration 6, this resolves to the effect of fingers drumming casually on one note of a piano. A linking pin at 6J modulates the squarewave pitch, thus our drumming 'pianist' runs his fingers up and down the keyboard (fig. 9). The *oscillator 3* wave-shape control governs the speeds at which the notes rise and fall in pitch.

Clearing the patchboard, we now join the sinewave output to the reverb mix control input, position 1M. A further join in 1A allows us to set a healthy low-frequency meter swing. We connect the squarewave oscillator to the reverb signal input, connect another oscillator to modulate the squarewave pitch, then connect the squarewave output to Channel 1 and the reverb output to Channel 2. Channel 1 now carries the 'dry' squarewave, rising and falling in pitch, while Channel 2 carries the same signal plus a 'laughing' cycle of dry and full reverberation (fig. 10). The 'laughter' can be increased into a bubbling warble by raising the still subsonic frequency of the reverb-mix control sinewave. The reverberation facility is one of the few non-foolproof devices on the *VCS3*. Care should be taken to avoid mechanical feedback between the monitor loudspeakers and the reverb spring.

Patch position 1N joins the sinewave oscillator to the filter frequency control input, working in the manner already described.

Connection 1O and 1P result in the Channel 1 and 2 output levels being modulated by a sinewave.

The signal sources and treatments listed on the left-hand side of the patchboard should be clear from fig. 1. *Oscillators 1, 2* and *3* each have two basic waveforms and all six shapes may be used as signals or control voltages. Noise (hiss to the unenlightened) has little obvious value as a control voltage but is invaluable for one real-life imitation the *VCS3* can do admirably: wind, rain and sea effects.

Two input channels are incorporated and may be routed through the patchboard: tape machine, a microphone, an electric guitar, or perhaps a second *VCS3*. EMS produce a monophonic (in the musical sense) three-octave keyboard oscillator to feed the *VCS3*. This provides an extra tone source, a control voltage, or both. The keyboard is sensitive to depression speed—the faster (or harder) a key is pressed, the louder the note. This facility may be over-ridden if not required. The dynamic voltage can be used to control the frequency of an oscillator so that, the harder you press any one note, the higher the pitch. If you wish to extend a 6% frequency change (one semitone) over the entire keyboard, this is easily accomplished. Similarly, an octave may be compressed into a very narrow portion of the keyboard if a *VCS3* player wishes to depart from musical convention.

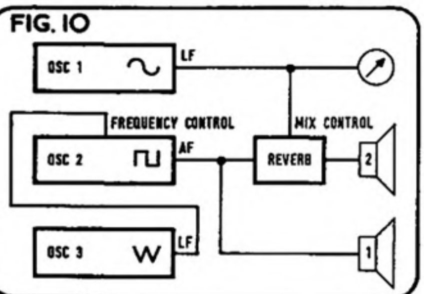
The filter output, labelled below the two inputs, has its value as a signal/control voltage treatment and as a tone source. If a subsonic control waveform is producing undesirable clicks, these can be removed by means of the filter. The filter converts into a variable frequency oscillator when the 'response' control is turned fully clockwise. Then the filter frequency control input becomes another oscillator pitch control.

Yet another signal source is the trapezoid waveform generated by the envelope shaper, not to be confused with the envelope signal.

At the end of the list of 'treatments' are the ring modulator and reverb outputs, either of which may be monitored or used to control

(*continued overleaf*)

FIG. 10



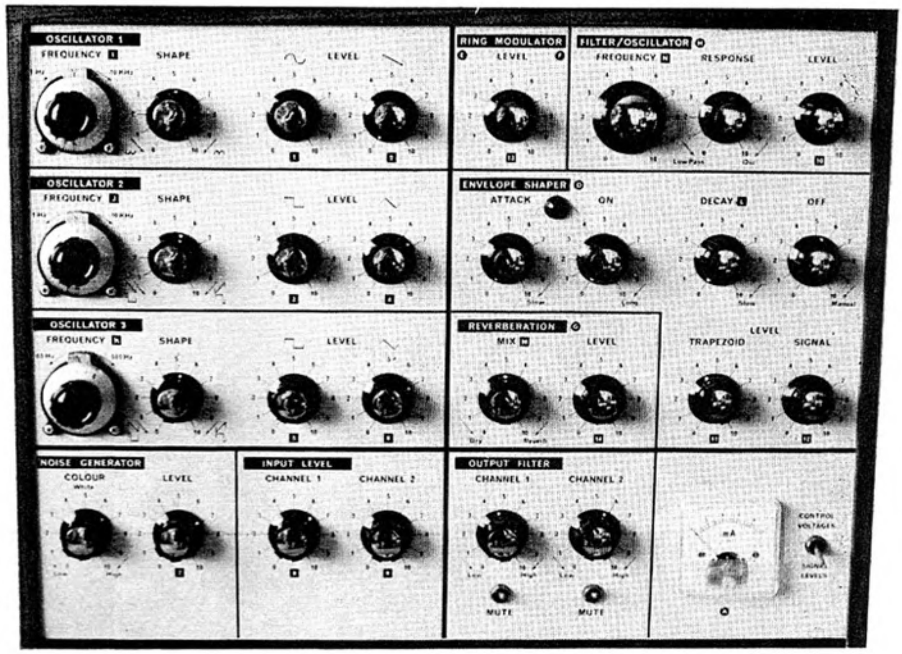
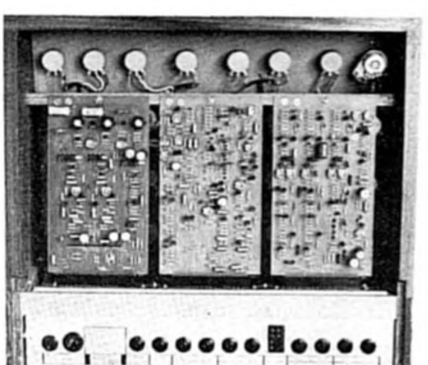
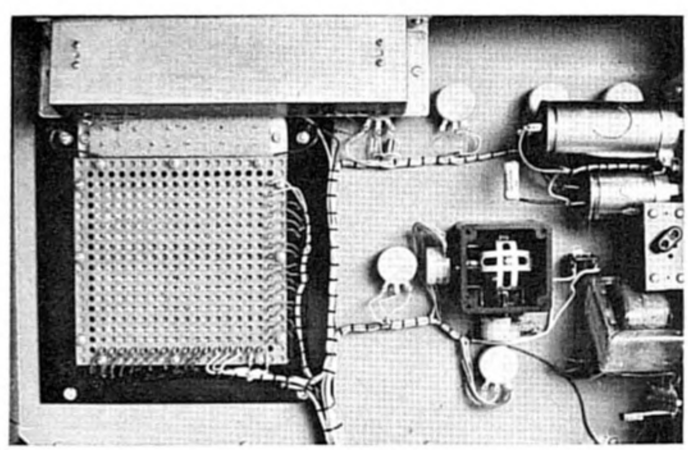


Fig. 11 (top right) Close up of main control panel.
Fig. 12 (right) Rear view, cover removed, showing the three main circuit boards and input/output sockets.
Fig. 13 (far right) Base removed to show patch panel wiring, reverb spring container, power supply and joystick mechanism.





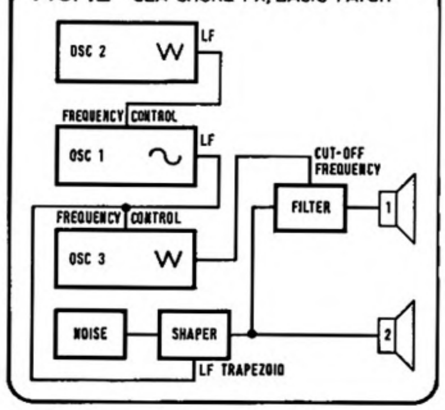
another signal. Two methods of manually controlling *VCS3* circuits have been combined in a joystick, situated to the right of the patchboard. Lateral and vertical movements respectively operate one of two potentiometers, their voltage ranges governed by separate presets. Pins at 15I and 16J would result in lateral stick movement controlling the pitch of *oscillator 1*, and vertical movements the pitch of *oscillator 2*.

The above description should show that, by any standard, the *VCS3* is a remarkably flexible piece of electronic apparatus. Yet it is only when you try to picture the number of simultaneous interacting patch pattern permutations and control positions that the full capability of this unit can be understood.

Fig. 11 shows the layout of the main control panel. Three of the 29 rotary controls on this panel have slow-motion gears, these being the frequency controls of the three oscillators. Tuning of the *VCS3* proved very stable during the month of tests, the control voltage/frequency ratio being virtually constant throughout the 1 Hz to 10 kHz range. Thus two or more oscillators controlled by a single keyboard voltage remain in tune right across the keyboard. To be sure of this facility, it is necessary to align presets inside the basic £330 *VCS3* following the instructions in the Operator's Manual; or pay an extra £20 for a factory-aligned unit.

The role of the various controls should be obvious from the panel labelling. A red bulb between the attack/on envelope shaper controls provides a visual indication of the envelope beat. If the envelope off control is turned fully clockwise, the start of each attack/decay cycle requires a manual signal, either from the attack button next to the joystick or from an external signalling device. The keyboard provides such a signal each time a note is pressed. If the keyboard is employed as a control voltage source (controlling one or more oscillators in the *VCS3*), initial tuning is accomplished by turning the Channel 1 input level control (adjacent to the noise generator panel). Fingering the middle octave of the keyboard, the control is turned until the two notes occupy the desired interval. The setting is fairly critical and, if you ever hear a badly tuned *VCS3*, the blame probably lies with whoever set this control.

FIG. 12 SEA SHORE FX, BASIC PATCH



Two terminals near the pin storage panel allow the connection of external equipment. Alternatively one can break a pin and run leads straight into the patchboard. Before taking such steps, however, try the row of 6.25 mm jack sockets at the rear. These comprise two microphone inputs, two line inputs, two line outputs, a control voltage output and high level (stereo headphone) output. Connection to the keyboard is made through a multipin umbilical.

A set of dope sheets is supplied with the *VCS3* to record the control settings and pin positions of successful projects. Each sheet is simply a drawing of the instrument face, with ample space for calibration numbers and so on. Each control has a dope sheet code number (1 to 39) and it would be quite easy to convey the contents of a sheet by telephone. The Operator's Manual contains several example sheets, demonstrating a variety of effects obtainable by an experienced performer. One of my own permutations carries the title 'Self-generated melodies' and places the *VCS3* into a state which burbles to itself in a pleasant pattern of notes taking something like a minute to repeat. Another is an effective stereo sea-shore synthesis, again taking a fairly long period to repeat (**fig. 12**). Visiting EMS some time ago, I heard a realistic storm which I have been unable to imitate successfully.

Setting up to match the keyboard requires a different approach to the 'playing itself' technique. The keyboard oscillator produces a triangular wave which one might choose to pass through a filter, the filter frequency being modulated by a very slow sinewave. Or use the keyboard to control the apparent pitch of filtered noise. There seem to be a hundred ways of imitating a Woolworth's organ, all of them tiring to the ear. When you increase the patch complexity, however, things begin to happen. There have been occasions in the last month when I wondered whether I was testing the *VCS3* or it was testing me. In the first few days I often convinced myself that one or more units was faulty, only to find that one control or pin was in the wrong position. I developed the habit of confusing the adjacent Ring mod and Reverb patch outputs, reading only the first R of each label. My one criticism of *VCS3* ergonomics is that reverb and filter output rows on the patch panel should be transposed. Which is my way of saying I cannot fault the unit. The *VCS3* is well designed, very well manufactured, and provides invaluable facilities to the composer, music and physics teachers, and the recording studio.

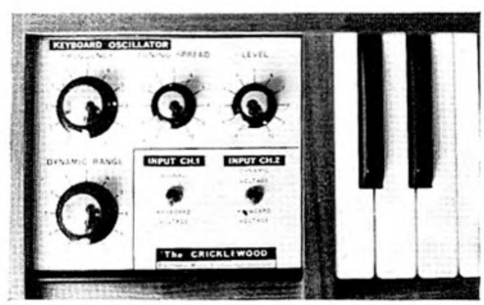


Fig. 14 Keyboard close-up. Frequency, tuning spread and level controls affect the internal oscillator. The dynamic range control varies the loud/soft touch sensitivity.

RECORDING STUDIO TECHNIQUES

PART SIXTEEN—STEREO MICROPHONE TECHNIQUE *by Angus McKenzie*

IN the course of a lecture on stereo microphone technique I gave recently at the Northern Polytechnic, I played an excerpt from a recording of a symphony which had been taped using multimike and coincident techniques. The audience was not told initially which recording was which. The first was the multimike (eventually issued) and the second was coincident. Both were Dolbyed. Only 30% preferred the multimike recording whereas 70% preferred the unissued coincident one. The recording was made in a large hall which was fairly reverberant. It was obvious, from the sound of the two recordings, that better results would have been achieved if the coincident microphones had been set to a crossed hypercardioid pattern rather than a crossed bi-directional one which tended to pick up too much reverberation. Approximately half those who voted for the multimike version admitted they would have voted for the coincident if there had been less reverberation pick up. This is rather a condemnation of multimike technique.

At a later date I played the same excerpts to a group of friends in my listening room. Almost the same percentage voted in favour of coincident recording. The audience at the Northern Polytechnic lecture were very surprised when told which recording was which. It was generally agreed that the bass end was considerably cleaner and better defined in the coincident recording, and the positioning of the instruments, especially at the back of the orchestra, much more realistic.

It is only fair to add that those who preferred the multimike recording claimed the closer technique sounded more exciting and brought out some of the parts more clearly. This, however, is a debatable point. Of course close miking will make the instruments closest to the mikes in question come over more clearly but instruments in between mikes will be subjected to serious phase differences which will tend to make their sound wander. This is particularly so at the bass end. Another comparison was made of two balances produced in the BBC's Maida Vale One studio. The first was a simple coincident pair with one or two extra mikes bringing in the sides of the orchestra. The second used 19 microphones and the studio reverberation was replaced largely by tape-delayed stereo plate reverberation, the echo sound channel being fed to a tape recorder running at 19 cm/s and the output of this recorder to a stereo EMT plate. The output was mixed with the main desk output to provide a controlled reverberation. Although the excerpts were of different pieces of music, the two items were chosen to have similar orchestras. In this case, only one member of the audience preferred the coincident mike technique. The others all agreed that the studio reverberation gave more coloration to the sound. A number of other excerpts were played to show the faults of different microphone techniques, such as two spaced mikes giving an enormous hole in the middle.

Another interesting example was that of an over wide and too close technique employed in recording a harpsichord. The excerpt played was a copy of a current LP recording. The harpsichord sound stretched across the entire width of the loudspeakers, giving the listeners the feeling that their heads were inside the instrument.

Difference channel

Dolbyed coincident piano recordings were played, one recording being with crossed hypercardioid and the other bi-directional directivity patterns. It was generally felt that the hypercardioid recording was more pleasing, although less reverberant. The pure Blumlein crossed bi-directional tended on this occasion to make the piano sound too wide. However, the sound of the latter recording improved dramatically when the difference channel gain was reduced in a sum and difference channel amplifier employed in the playback circuit. This proved the importance of having this facility in a recording chain, allowing the use of a technique with a complete control on the width of sound.

It was generally agreed, in many cases with surprise by engineers who had not previously even considered coincident mike techniques, that this gave superb results when the reverberation characteristics of the hall or studio were favourable. In general, the smaller the ensemble to be recorded, the more suitable was this technique. A typical example of this is once again the BBC's Maida Vale One studio which is used almost entirely by chamber groups and very small orchestras that can sound excellent with only one stereo microphone.

One member of the audience at the lecture brought up the point that chamber music should be recorded in conditions similar to those used for the original performances. For instance, much baroque music sounds best in domestic locations or small halls, whereas other such works can sound magnificent in a church. A location with a magnificent acoustic for chamber groups and small orchestras is St John's, Smith Square, used regularly by the BBC, Argo and Decca. The acoustics are particularly suitable for coincident mike techniques, as used in the Monday lunchtime stereo broadcasts. Almost always the engineers use just two *C12A* or a single *C24*, and the sound produced is some of the finest broadcast. If the room has too dry an acoustic, an extra mike for reverberation pick up may well be an advantage. This may make an unsatisfactory ambience even more noticeable, however. Since it is difficult to take satisfactory reverberation devices on mobile recordings, it is probably better to select the echo send components to the third and fourth channels of a multitrack tape recorder, allowing these to be added later in the studio.

Another engineer made the point that he had previously been biased towards multimike techniques simply because, with the facilities of multi-track tape recorders, everyone strives to get maximum separation between instruments and instrument groups. I suspect from this that many engineers asked to record classical works have relatively little experience of hearing these works live rather than on disc. They consequently tend to have distorted views of how the classical orchestra should best be reproduced, striving for more presence and more excitement, taking the orchestra to pieces and rebuilding it bit by bit. I would go so far as to suggest that the actual stereo techniques employed by many companies were better 10 or 15 years ago than they are now.

I would conclude by suggesting that, rather than abandoning multimike techniques overnight, a coincident pair should be set up in as good a position as possible and the outputs separately taken to two tracks of a multitrack machine so that they can be played back independently. Many engineers are already convinced that this should be done.

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Denys Killick, May 1970 *Tape Recording Magazine*

Recording system 2-track monaural recording and playback.
Power requirements AC: 110, 120, 220 or 240V, 50 or 60 Hz; DC: 12V (8 x HP2 batteries or car/boat battery).
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Reel capacity 5 inch.
Tape speeds $7\frac{1}{2}$, $3\frac{3}{4}$, $1\frac{7}{8}$ and $\frac{15}{16}$ i.p.s. (19, 9·5, 4·8 and 2·4 cm/s).
Frequency response 30 – 18,000 Hz at $7\frac{1}{2}$ ips; 30 – 13,000 Hz at $3\frac{3}{4}$ ips; 30 – 7,000 Hz at $1\frac{7}{8}$ ips; 30 – 4,000 Hz at $\frac{15}{16}$ ips.
Speaker $3\frac{1}{8}$ in x $6\frac{1}{4}$ in.
Power output 1 watt.
Input jacks External microphone, 600 ohms, 0·19 mV; Auxiliary input, 100k ohms, 0·062V.
Output jack Monitor earphone, 8 ohms or 10k ohms, 0·775V at 10k ohms.
Battery life Up to $6\frac{1}{2}$ hours in continuous recording.
Dimensions $12\frac{1}{4}$ in. (w) x $4\frac{13}{16}$ in. (h) x $10\frac{1}{4}$ in. (d).
Weight 11 lb. 13 oz. including batteries.

Supplied accessories Microphone F–26S, reel R–5A, magnetic earphone ME–20A, connecting cord RK–69, 8 Sony super batteries, demonstration tape, AC power cord, head cleaning ribbon.
Recommended optional accessories Telephone pick-up TP–4S, car battery cord DCC–2AW, foot switch FS–5, carrying case with shoulder strap LC–8B, voice-command microphone F–83.

Battery/mains portable tape recorder, model TC-800B
Recommended retail price £86·75

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STUDIO DIARY

BY KEITH WICKS

ISLAND STUDIOS, just round the corner from Portobello Road, report that they are building a new reduction room. Their 20 channel four output desk is by Helios Electronics, who also built the desks for Island's two studios. Associated with the reduction room will be a small overdubbing booth, accommodating up to four people.

From Barcelona, Senor Pepiña of the **Compania del Gramofono-Odeon** reports that their studio is undergoing modifications, details of which will be announced shortly.

More news of Continental activities, this time from the Danish engineering firm of N. P. Petersen, who announce that they have recently delivered an advanced mixing console to the leading recording studio in that country, Metronome Records. Again, further details of the project have been promised, and it will be interesting to see how fast the record industry is expanding over there, compared with the state of affairs in this country.

This leads me to wonder about the exact state of the British recording industry at the moment. The first hint that business was becoming slack reached me when I was woken one morning by a session musician, telephoning to ask if I knew why he was out of work. Hesitating to suggest that he might not be a very good musician, I listened while he told me that he used to have regular work in studios but that lately things had become very slack. At the time I knew nothing of this but, since then, a few studios have made similar comments. At the time of writing (February) most of the major studios seem to be as busy as ever. **IBC** for example, have had numerous sessions booked by Leon Henry Productions, featuring Glenn Weston, Christine Holmes, Manfred Mann, and more work by the New Seekers. All these were produced by Dave Mackay and engineered by John Pantry, who has also been busy continuing with a Brass Monkey album for Egg Productions, co-produced by Doug Flett and Guy Fletcher. Meanwhile, Mike Claydon has been occupied at the desk with a Bee Gee's album for the Robert Stigwood Organisation, a Long John Baldry album, and more work on Graham Bonnet's A & M Records' LP, produced by Trevor Gordon. For the Harold Davidson Agency, Barry Ryan and producer Bill Landis have been doing some work engineered by Brian Scott. Other work at IBC includes an album of Rosetta Hightower, produced by Ian Green for CBS, and an album called *Sing Children Sing* by Lesley Duncan. This was produced by her husband Jimmy Horowitz, who also produced a single by French singer Virginia Vee. John Pantry, having been busy for some time with a Peter E. Bennett album for RCA produced by Chinaman Tokknam Aw, is just starting some 16 track sessions for a Leon Henry Productions album featuring the Mixtures, the Australian group who have had so much success with their Pushbike song.

The disc channels have also been active, among other things cutting 60 stereo masters for Polydor.

On the technical side, news from IBC is that their vocal and reduction suite, with a new 16-track Ampex *MM 1000*, should be fully operational by mid March. They will then start the installation of a new desk in Studio A.

Another studio being re-equipped is EMI at Abbey Road. Studio manager Gus Cook tells me that they are up to their eyes in work installing a new mixer in Studio Three, and completing the rebuilding of Studio One's interior. New equipment at EMI will include a 16 track Studer.

Also going 16 track is **Recorded Sound.** Their recent activities encompass many fields: a number of jingles have been recorded, and the group Tin Tin put together an album produced by Maurice Gibb and engineered by Eric David Holand. A press reception was held for Julie Ege. Julie recorded her song *Love* at these studios earlier this year. Victor Sylvester recorded 12 numbers for Pye in extra-quick time, taking just two three-hour sessions, and Philip Swern put down some album tracks for Pinpoint Record Promotions. The Fantastics have been in. Jack Bavestock has started an album for Stud Records, and Dave Cash has recorded the group Sky for Groovy Music.

At the moment Dave is a regular visitor to Recorded Sound. Along with Tommy Vance, he records disc jockey shows for Radio Monte Carlo International, which started broadcasting on 205 m last November. All English language DJ shows for this station are produced from Recorded Sound using a pair of Garrard turntables, and the reduction room desk.

Also doing DJ work is **Squire Sound** in Charlbert Street, NW8, believed to be the first studio of its kind in Britain. Measuring only 3.5 x 2.5 m. and using only one microphone (AKG *D202*), the studio was designed by managing director Roger Squire. It provides all the facilities necessary for DJs wanting to produce demonstration tapes or finished programmes, and can also be used for such things as commercials and trailers. The idea of the studio was conceived by Roger as being a logical development of his mobile discotheque activities. The project looks like being a great success, judging by the people who have taken an interest during its first weeks. Dave Cash is interested in using Squire for some of his work, and DJs Chris Grant and Nicky B. Horne were recently making a demonstration tape. This will eventually be presented to Station 77 WABC New York City in the hope that they will want regular programmes of this kind. Chris Grant explained that the modern British DJ's approach was appreciated in the States at the moment, so they may do well in this field, especially if they can maintain the very high standard of production I heard when I was at the studio. Chris and Nick are developing their own style, and presenting themselves as a duo, Horne and Grant. Horne is the intelligent character, and Grant (in his own words), is 'the public school thickie'.

The fact that people who have used the studio are so pleased with the results is proof enough that this set up, although very small, can adequately do the job for which it was designed.

The studio was first soundproofed by incorporating double doors, a false ceiling, and blocking in a window with two sheets of plate glass, hardboard, felt, carpet, and foam rubber. The insulation is now very good and is sufficient to deal with low flying aircraft which are evidently common in that area.

The microphone, an AKG *D202*, is suspended at one end of the room over a couple of turntables by Russco of California. To the right is a third gram unit and, on the left, a Spotmaster 500 C cartridge machine for jingles. Other equipment includes a Ferrograph *Series 7* (mainly for tape inserts into programmes), and a pair of Revox stereo recorders. At the back of the room is a six channel mixer made to Roger Squire's specification by Alice Electronics under the supervision of the firm's chief engineer, Ted Fletcher. The grams are fadable by the DJ, while the microphone has a simple on/off switch. In the event of having no producer or engineer at the desk, the studio can still be operated by the DJ alone, levels being taken care of by limiters incorporated in the desk. This system of working means that it is not necessary to provide a level meter for the DJ.

Roger Squire's next move will be to visit a number of commercial stations in the States, with the idea of selling them prerecorded programmes. *(continued on page 181)*

AIR are as busy as ever, work continuing on albums for Procul Harem, Stan Getz, Cilla Black, T. Rex and the Strawbs. Others at the studio have included Roger Cook, Onyx, Badfinger, Barry Ryan, Quatermass, Laurie Marshall, Chet Atkins, a new group called Young & Renshaw, and a very new group called the Sensations. Other work has included jingles for Airy Dell, and Bible reading by Sir Lawrence Olivier. Obviously no shortage of work at AIR.

At **De Lane Lea's** Dean Street premises, John Stewart engineered Rose Garden for the New World, a Grist Brothers album for Capitol, and an album for Curtis Muldoon and Mike Hurst. David Stock has been doing a Lee Lynch album, and music dubbing for a film called *Forever More*, while Louie Austin has been engineering a Barry Ryan single.

Louie has been working at the company's Kingsway studios, doing an album for a Continental group called Main Horse, and some work for a Gordon Guiltrap LP. The latter was co-engineered by Martin Birch who also did a Fleetwood Mac album and single, albums for Gary Farr, Peter Green, Rock Workshop, and Gin House, and a single for Deep Purple.

To put the record straight, the name of the studio manager at **Trident** is Malcolm Toft. In the past I have written his name as *Malcombe* and gone to great lengths to ensure that this spelling, obtained from a well known year book, was not de-*be*-d. After my spelling lesson, Malcolm filled me in on the studio's recent activities.

The group Legend has been in with producer Tony Visconti, the sessions being engineered by Roy Baker. Robin Cable worked on an album produced by Roger Bain featuring Indian Summer, and on a Spring album produced by Gus Dudgeon. Engineer Ken Scott's tasks have included laying down album tracks for Linda Lewis, Dogfeet, and Arthur's Mother.

As well as doing studio work, Trident went mobile to the Lyceum Ballroom, covering the three hour Baker-Jones drum battle with two 16 track machines. Twenty-four microphones were set up and fed to a couple of Neve mixers supplied by Granada, one having 16 channels, and the other eight. As these desks had only four outputs each, echo and foldback facilities were used to route some sources to tracks, so that all 16 tracks were utilised. Monitoring units consisted of four Lockwood cabinets with Tannoy *Red* speaker units, which Malcolm, like many other people, prefers to the *Golds*. (The reasons he gives is that their response is better, and they don't blow so easily.) Engineer at the Lyceum affair was Roy Baker who apparently felt that 16 tracks were not quite enough for that particular session.

Mixing desk

Final news from Trident is that they have just put a mixing desk in their tape copy room. Designed and built by studio staff, it has six channels with full equalisation and two outputs. This means that comprehensive copying facilities are now available at a more economical rate than when copying was carried out in the studio suite.

At **Marquee**, Judas Jump has been recording a new single for the Aquarius label with ex-Stones producer Andrew Oldham. Ian Fisher flew over from France to record a Jug Band single for Mussin Music. This session was engineered by Colin Cauldwell, and took place before an invited audience in order to get a 'gocd party atmosphere'. As at most good parties, abundant booze helped things along. Also at the studio has been Mark Wirzt of Teenage Opera fame, working on a single, and Doris Henderson's Eclection have been laying down tracks for a new album under the musical direction and production of Jimmy Horowitz. Jonathan King has been trying out new tracks for the Weathermen, and Dr Moog has been demonstrating his electronic music synthesizer for the benefit of the press, groups, and other interested parties. Ex-Bonzo Dog, Roger Ruskin Spear, was at Marquee recently. To anyone familiar with this band, the list of instruments on Roger's session will be regarded as nothing out of the ordinary. They included an electric trouser press, electrically amplified tailor's dummy, electric bed spring, and members of the press. Anyone mystified is recommended to experience this kind of performance as a description would convey very little. Engineer Phil Dunne remarked that it was a change from the usual lead guitar, bass and drums.

Spot Productions have also been deviating from the run-of-the-mill material and go down in the history books as having carried out, on behalf of EMI, the first stereo recording for Pakistan. Vocalist Alam Lohar had an instrumental backing which included such unusual things as tabla, bongos and harmonium. Although the sound was rather strange, it was much liked by the studio staff. Two tracks had additional female vocal accompaniment, and the whole album, which consisted of a dozen numbers, was laid down in three three-hour sessions all on the same day.

Judy Stevens, star of ATV's *Girls About Town*, recorded the title song of the play, *After Haggerty*, which opened recently at the Criterion. The song was written by Judy's husband, actor John White, and the recording, produced by Knightsbridge Theatrical Productions, is played at the end of each performance.

Other work at Spot has included a number of children's records for Avenue Recordings, and a Derek Nimmo single, *Hip Hip Hooray*, made on behalf of Lynton Maitland Associates. With a smile, Derek admitted making a flop of a single some time ago, and was rather modest about his latest effort. It is, however, a very pleasant number in the *Grandad* category which his connections think may go right up the charts. Backing on the session consisted of two trumpets, trombone, bass guitar, piano, electric guitar, drums and celeste.

Finally a short item from **Art Record Productions** of Surrey. They have recorded *Please Don't Step on my Feet* by Agapus, and the studio hope to release this soon on their own label.

book reviews

HI-FI IN THE HOME. By John Crabbe. Second edition, revised and updated. 330 pages, 94 line and half-tone illustrations. Price £2. Published by *Blandford Press Ltd*, 167 High Holborn, London W.C.1.

JOHN Crabbe's book, one might well call it a *vade mecum*, was first published in 1968. It has proved so popular that the second edition is with us already. Only minor changes have been made; recent developments in tape cassettes and four-channel stereo are now covered, while the typical budgets and list of suggested recordings have been updated. The ease of reference, a feature of the book, has been further increased by the adoption of itemised page headings in chapters dealing with equipment, and by the expansion of the glossary and bibliography.

To summarise for those who may have missed the original review (by John Fisher, *Tape Recorder*, February, 1969), the book sets out to provide the music lover, who may be completely non-technical, with a commonsense, comprehensible guide to the better reproduction of music in his home, through the intelligent choice and proper installation of the appropriate equipment. In my view, it succeeds admirably, steering the reader through the whole subject (and round many pitfalls) in a logical and painless manner, avoiding gratuitous jargon, and explaining technical terms where they necessarily crop up. Any reader who wants to delve farther into technicalities is given a good start, and enough references to see him on his way.

As the title indicates, the emphasis is domestic, and the author excludes, reasonably enough, such activities as serious live recording. The current *Studio Sound* readership includes many professional sound engineers, who may well think that such a book is hardly for them, True, perhaps, but even they will find it a useful reference to suggest to the occasional enquirer after knowledge—who always seems to pop up in the middle of a panic, wanting far more information than can be given at the time. And —who knows?—a copy left casually on the dining room table might help to explain the *real* facts of life to your wife! **Trevor Attewell**

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*recommended retail price

Around the Studios

HOLLICK AND TAYLOR

by David Kirk

WHEN John Taylor invited me to see the Hollick & Taylor studios in Birmingham I found myself disinclined, like many of his potential customers, to make the long haul north. It would take a day to get there, a day to look round, and probably a further day to get back. A patient Brummie explained that, by rail, Birmingham is only 90 minutes from London. He under-estimated by two minutes and forgot to mention that the taxi journey from station to studio takes an extra 10 minutes. Yet the journey was so fast and so comfortable that I can understand why Birmingham has a growing population of London commuters. The return trip from Euston is about £2.10 which includes the taxi fares.

Hollick & Taylor claim to be the best equipped studio in the Midlands, having multitrack tape, 16 mm film production, and 35 mm projection facilities. The product is wrapped in an unlikely box: a large Victorian house in a residential suburb of the city. Mr Taylor lives upstairs with his family. The equipment lives at ground and basement levels, the control room occupying a room at the rear of the house while the main studios extends from the front right through to the back.

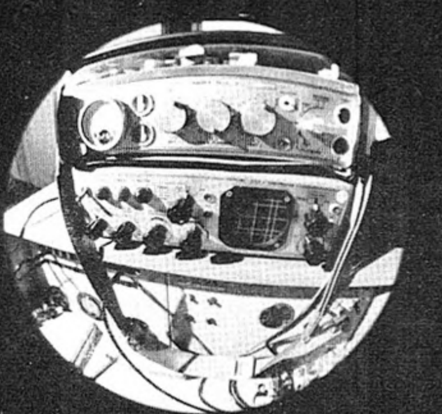
Fig. 1 shows the relative positions of studio and control room. A double-glazed window connects the two, talkback and monitor facilities being provided by Westrex monitor loudspeakers. Beneath them in the control room are two *A62* Studers. One of these was used during my visit to produce the sound track for a two-minute advertising film; to this end the timing had to be practically exact. When the duration was right, the producer considered the accentuation to be out, but after a number of retakes a successful recording was transferred to magnetic film.

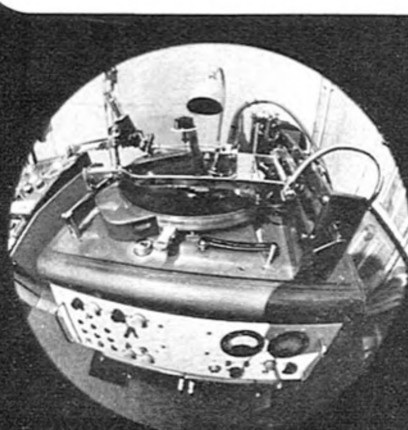
The 20 input mixer (see cover) is based on Audio Developments modules and employs a pinboard routing system involving 183 relays. Above the desk, in a forward slanting rack, are five Pye compressor/limiters, two Astronic graphic equalisers, and an additional filter unit. Eight PPMs register the outputs to an eight-track Leevers-Rich positioned adjacent to the mixer. Reverberation can be derived from an EMT plate, Fairchild reverb unit or Klemt Echolette.

All three recorders are connected for remote starting from the mixer. The small Studers can be removed from their racks for stereo location

(continued overleaf)

Top: Drummer in isolation cubicle.
Upper left: General view of studio.
Lower left: Control room. Close-up of eight track Leevers-Rich.
Bottom left: Nagra 4L and film synchroniser.
Bottom centre: MSS cutting lathe.
Bottom right (and cover): John Taylor at his mixing desk.





recording. During these events the *A62* is joined on the back seat of the Taylors' NSU saloon by a portable six-input mixer, again using Audio Developments modules.

The studio is equipped with a Challen grand piano and Gulbransen *Paragon* organ, the latter more flexible than most divider instruments. An isolating booth in one corner is employed for percussion. Sixteen and 35 mm projectors are situated in a corridor outside the studio, beaming on to the studio wall. A mirror reflects a view of the screen into the control room. A third of Hollick & Taylor's work requires film facilities and there is no shortage of related equipment. RCA op/mag and four-channel Gaumont Kalee 35 mm magnetic film transports are housed in the film dubbing room, again feeding Westrex monitors. Two 19/9.5 cm/s Revox *736* recorders live here, modified to accept GPO jacks, alongside a mono EMI *BTR4*. A Nagra *4L* and synchroniser are to hand for location film sound recordings. An MSS (BBC *Type D*) disc cutter provides one-off demo facilities, with a Thorens player for gram reproduction. A recently acquired Steenbeck film/sound editor is situated in the basement.

Permission to expand the studio and control room has been granted by Birmingham Corporation, following a canvassing of local opinion by Mrs Taylor. One local resident objected to the idea of so close a studio but relented when he learned that the studio had been there for years.

The good rail and (M1) road links between London and Birmingham have proved a mixed blessing. The prospect of increased custom was offset by the ease with which London record companies can send mobile equipment to the Midlands. In some respects, John Taylor admitted, he envied Craighall their Edinburgh position. A bigger worry for him was the declining public interest in pop music, which he attributed to Radio One.

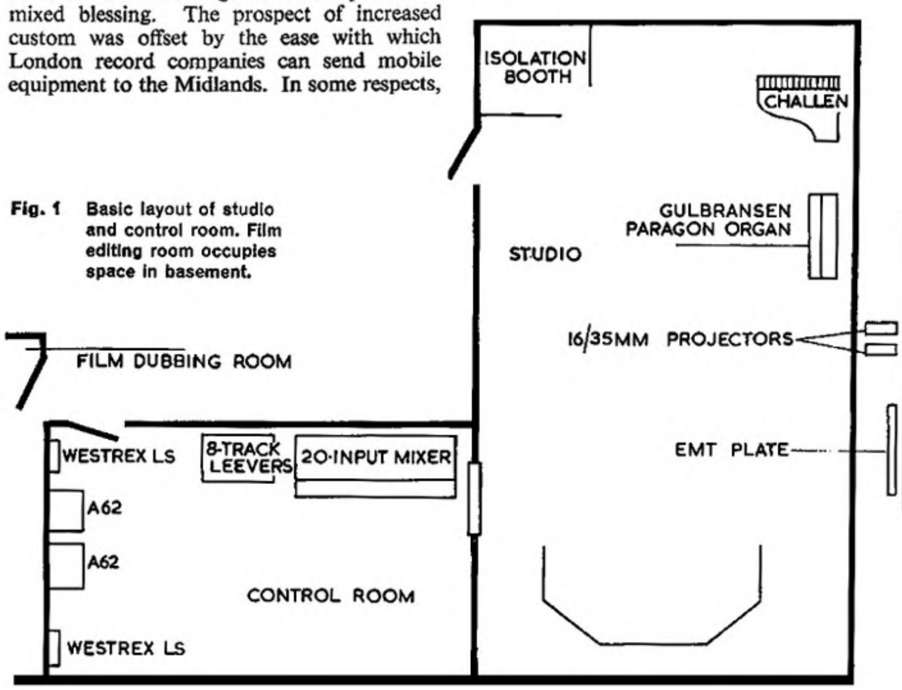


Fig. 1 Basic layout of studio and control room. Film editing room occupies space in basement.

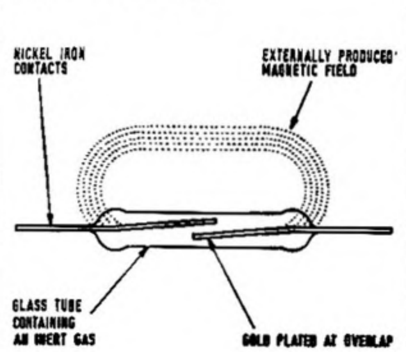
THE INVISIBLE SWITCH

M. G. Skeet describes possible applications of reed relays

IN its simplest form, a reed relay insert comprises two nickel iron strips held rigidly apart in a glass tube as fig. 1. In the presence of an externally produced longitudinal magnetic field (by coil or magnet), unlike poles are produced where the gold plated contact ends overlap. Unlike magnetic poles attract, giving a reliable *make* action. Other contact actions are possible but are not so common.

If the reeds are mounted behind a non-ferrous alloy panel, then various facilities including control or signal level can be provided by using a suitable magnet on the panel front.

FIG. I TYPICAL REED



Two uses for the basic reed arrangement have been investigated. One is essentially practical and provides a speedy method of pre-fade monitoring on a multichannel mixer. The other may appeal to people who like gimmicks.

Prefade monitoring allows a check to be made on any mixer channel prior to that channel being pushed up. It boils down to following the switching by a high input-impedance amplifier (megohms). Any coupling capacitor to this amplifier will be small in value and, if it is held charged, clicks are not likely to occur when the circuit is switched to any channel. A factor here is the signal level through the mixer at the monitoring points. In the typical mixer (fig. 2) the mixing is done at high level, implying signals in excess of 100 mV. Microphone signals will have preamplification prior to mixing.

The complete headphone circuitry (fig. 3) comprises a buffer amplifier (some 2 M input impedance with the 4.7 M input resistor), level control and headphone drive amplifier. The latter circuit suits headphones of 150 to 600 ohms impedance and is from David Robinson's article in January *Studio Sound.*

The reeds are mounted side by side (fig. 4) on a piece of stiff filing card. The contact ends are passed through holes in the card and bent over. If the panel is vertical to keep the operating magnet in the required position, two strips of tin plate are then stuck on the inside of the alloy front panel.

The card with the reeds attached has the reed side built up with rubber strip. When it is stuck to the alloy panel, the reeds are against the tin strips. The contact area of the reeds must be central to the gap between the strips.

A cylindrical Eclipse magnet (12.5 mm diameter by 9.5 mm) from the local iron-mongers provides the operating magnetic field. It is mounted in a light decorative wooden holder that can be readily gripped. Care must be taken to mount the magnet so that there is a longitudinal passage of flux down the reeds. The outside of the alloy panel is marked to indicate where the magnet should be placed.

For the second use of reed inserts imagine a chessboard and, under the squares, behind an alloy screen, pairs of reed inserts. Chessmen with magnets in their bases provide the external controlling influence. It is possible, for example, to use a figure up the left hand side of the chessboard to control signal level and to have others for tone control, filter switching and so on, and yet others for programme source selection. This latter could be made to avoid 'breakthrough' by having a parking square for the chessman which 'earths' the

(*continued on page 187*)

FIG. 2 PRE-FADE MONITORING CIRCUIT (OTHER STEREO CHANNEL NOT SHOWN)

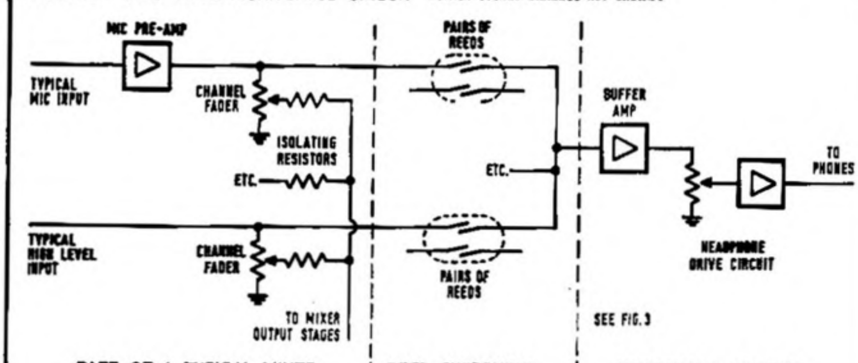
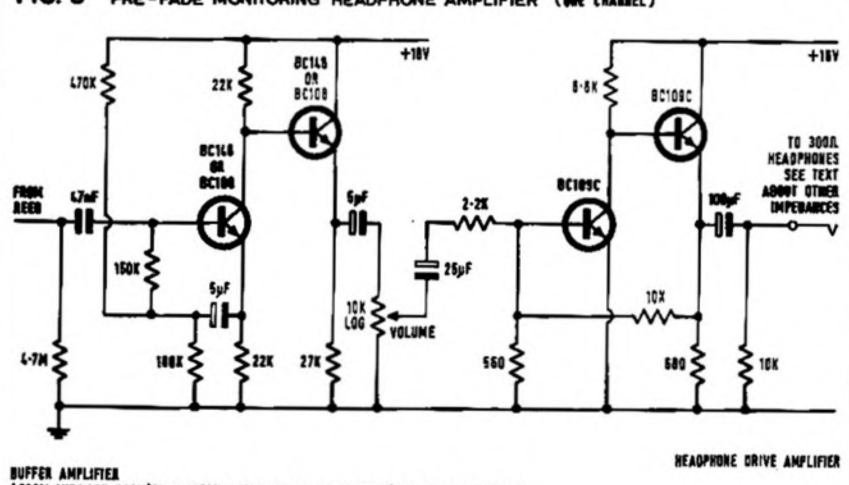


FIG. 3 PRE-FADE MONITORING HEADPHONE AMPLIFIER (ONE CHANNEL)



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TURNTABLE

A column of readers' problems and correspondence

HEADPHONES

From: G. N. Tughan, Tape-Music Distributors Ltd, 11 Redvers Road, London N.22.

Dear Sir, Mr Tony Waldron states in his February article 'Headphones' that foam cushions are used in many designs but liquid filled rubber is more effective. Since this is a Koss patent, we feel that some of your readers might assume from the article that other products are similarly fitted. We would also like to point out that Koss are the first manufacturers to produce a self-energised electrostatic headphone.

Yours faithfully

MAKING IT STICK

From: D. A. Hendon, 'Copthorne', Wix Hill, West Horsley, Surrey.

Dear Sir, Visiting the 'hi-fi' department of a local store, I saw enacted a scene which may be of interest to some of your readers.

The gentleman in front of me had brought back to the shop a tape editing kit. He explained to the assistant that he couldn't 'make it stick'. Picking up a length of magnetic tape he had already prepared, and the reel of splicing tape, he was about to demonstrate his technique when the assistant helpfully explained that this tape was (in his opinion) leader tape, similar to the green and red reels also provided. He extracted a self-adhesive paper label intended for labelling tape spools and showed the customer how to stick the tape together with it. He explained how this was to be folded over to cover both sides of the tape so that it stuck properly. Neither of them noticed that the 'splice' was now half as wide again as the rest of the tape. The customer, apparently enlightened, apologised for his ignorance, thanked the assistant for his help and before I could recover from my astonishment he had gone.

Yours faithfully

STEREO FICORD

From: M. G. Skeet, 2 Roche Gardens, Bletchley, Buckinghamshire.

Dear Sir, As the contributor of the article 'A Stereo Fi-Cord' in August/September 1969 *Tape Recorder*, I am anxious to know if any reader has been spurred on to attempt a similar *1A* conversion. I would like to hear of successful or otherwise attempts, either by letter or tape, and will reply by the same method.

Yours faithfully

ADHESIVE LABELS

From P. J. St. Clair, 34 Ferrers Road, Streatham, London, S.W.16.

Dear Sir, In case anyone may be interested, I have found some adhesive labels that are ideal for applying to leader tape for code marking purposes. These are manufactured by the Blick people and have a reference number *532*. Price is 5p for 210 25 mm labels. 50 mm labels are also available, number *760N*. A particular advantage is that, if the leader tape frays, the label can be removed and placed farther along.

I see Brenell have made their *Type 19* transport available at last. Any chance of a review?

Yours faithfully

Brenell are being approached for a review sample. **Ed.**

THE INVISIBLE SWITCH CONTINUED

signal of each programme source. Moving a chessman from that position to another square will take off the earth and, at the other square, switch the signal through. One chessman can provide stereo switching as, with the reeds now available, it is possible to get two reeds diagonally across a 30 mm square.

The reeds could be mounted as already described on individual pieces of card and stuck under the alloy of the chessboard. However, as it will be necessary to screen, say, the main level control from the programme source selector, it may be best to mount the reeds on strips of card covering the whole area over which one particular control operates. Then a screening cover could perhaps be more readily produced to isolate electrostatically each facility.

The writer has proved the workability of the system by making an amplifier level control. This has a nominal value of 125 K but other values are easily produced. It would be possible to have two rows allocated to this control to increase the number of steps.

Fig. 5 shows the arrangement of a 125 K nominal logarithmic potentiometer composed of fixed resistors. The 250 K resistor loads the input of the stage following the switching when none of the reeds are made. This may not be necessary but depends on how well the amplifier being adapted responds to an open circuit.

Adapting existing amplifying systems would pose the problem of long leads to and from the chessboard. These problems would be overcome if the preamp section were built under the chessboard in the form of a flat box.

Reed relay inserts with an overall length of 45 mm, glass tube length of 27.5 mm and glass tube diameter of 3 mm have been successfully used. They have green coloured glass because of the infra-red method of sealing the ends of the glass tube during manufacture.

Smaller reeds with clear glass having dimensions 31 mm, 21.5 mm and 2.5 mm respectively are available. The cheapest supplies noted, of either type has been from Pre Pak Ltd, 222/224 West Road, Westcliff-on-Sea, Essex. Price is 5p each, plus 5p postage and packing per order.

FIG. 4 METHOD OF MOUNTING PAIRS OF REEDS

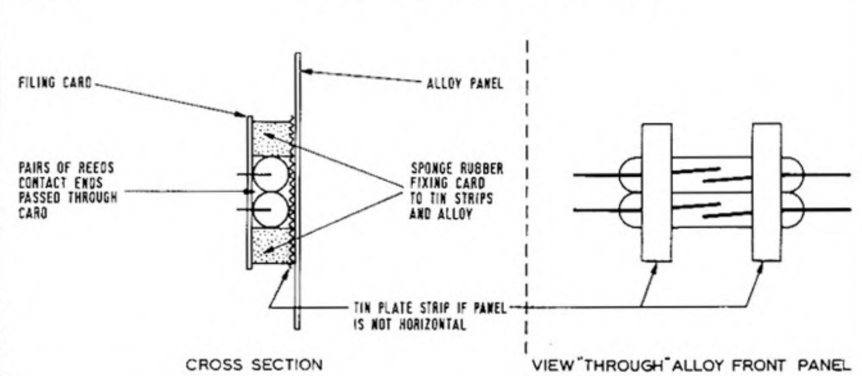
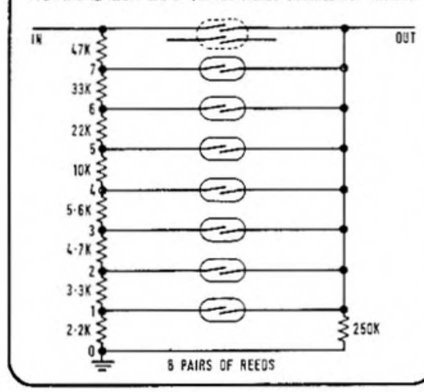


FIG. 5 CHESS BOARD POTENTIAL DIVIDER NOMINAL 125K LOG (OTHER STEREO CHANNEL NOT SHOWN)



first of a series by T. G. Blackham

FILM SOUND TECHNIQUE

THIS series of articles aims to give an overall view of the stages in production of a feature film soundtrack, illustrated by the methods used on the musical *Fiddler on the Roof*. The Mirisch Company is currently completing shooting of this at Pinewood Studios after just under five months on location in Yugoslavia.

Subsequent articles will deal with the actual techniques used for this production, starting here with a general outline of current methods. I am trying to confine the limits of the article to the methods most frequently used in full-scale feature films. For example, when I refer to recordings made on sprocketed tape (magnetic film) the system described will be 35 mm. Other dimensions are used (16 and 17.5 mm), but the principle is the same.

In the case of normal film drama, recording starts at the same time as photography, being that of associated dialogue. Most of the time the microphone is on the move. This and the vital factor of lip sync are two problems which radio and disc producers do not have to face.

Until the advent of magnetic tape, the camera and recorder were locked in sync electrically (except where sound and visual action are recorded on the same piece of film).

During the fifties, magnetic film (sprocketed magnetic tape) took over from the optical medium. This was in turn superseded by 6.25 mm tape with a recorded synchronising pulse derived from the camera motor speed, giving electronic 'sprocket holes'. The 6.25 mm recording is transferred to sprocketed tape and the sync pulse on the tape used to control the speed of the sprocket recorder motor. In the case of sprocket recorders with mains sync motors, the reproduced sync pulse is locked to the mains and the 6.25 mm replay machines varied in speed to keep the mains and the sync pulse in step.

The sync pulse from the camera can be the mains frequency (in the case of a camera with a mains sync motor) or may be obtained from a small AC generator driven by the motor. The most modern systems use a camera motor whose speed is locked exactly to the divided-down output of a crystal oscillator. The sync pulse at the sound recorder is derived from an oscillator of the same frequency. This then eliminates cable or radio links between the camera and recorder.

The clapper board provides visual identification of slate (shot) and take numbers and, when clapped, the start mark. Slate and take numbers are called out and then the board clapped. When the sound has been transferred to sprocketed tape, the start of the clap sound is marked on the tape and on the related part of the *action* (i.e. the film). With the action laced in a projector, the start mark in the gate, and the tape start mark on the replay head, projector and reproducer are locked together and run. The action can be then viewed with synchronised sound-rushes.

The picture and its associated sound are edited together and if necessary original sound replaced by new 'post-synchronisation' recordings. Extraneous noise and poor readings of lines are typical instances of the need for post-synchronised sound. There are two main post-sync techniques: looping and rock'n roll. Looping involves the action and its associated sound being made into a loop. The loops are then run together, the new recording being made on a third blank loop of sprocketed tape. The artist is fed the original sound on headphones whilst watching the action on the screen. He reads his lines using the original (guide) track to give him his cues for lip sync. The loops are run until a satisfactory recording has been made. It is then played back through the record head to maintain sync. The action can be watched and the new recording monitored to check the sync.

With rock'n roll, action and guide tracks are made into rolls and a third roll used for post-sync recording. Again, as many re-takes as necessary can be made but, instead of running all the time, the machines are reversed back to the start after each take. As before, playback is through the record head to maintain sync. This way, after a roll has been completed it can be viewed, whereas with looping all the loops have to be broken down and joined together again. Before they are broken, however, the missing spot effects are added to the post-sync dialogue.

When the film has been cut and the sound assembled, it is ready for the composer to view prior to composition of the score. The music is recorded and edited into its place, then all the sound sources are ready for dubbing.

In the dubbing theatre all the components are mixed to form the final soundtrack. With most productions, each reel will comprise of many separate rolls of film. This is due to the fact that each artist usually has a reel to himself so that the mixer can treat each different source of sound separately from the viewpoints of equalisation, echo and level. A mixture of original and post-sync dialogue also entails separate reels, even though they relate to the same artist.

The film is dubbed a reel at a time, usually in four stages: three premixes and the final dub. Each premix (dialogues, music and effects) is made on a separate roll, then the final mix is made. Dialogue, music and effects are combined and transferred to optical for the native-tongue version of the film. A copy is made of the music and effects for use when making foreign language versions. The above is the case in films for mono-only release. The musical is the most complex form of soundtrack undertaken by the film industry, involving a vast number of recording and editing hours before the cameras begin shooting.

The above shows briefly the main stages of a film sound production. I will now explain some of the terms and techniques used in the context of making a musical. Here, the process is a reversal of my original description: the music is prerecorded and then played back during shooting. *Playback* is the normal method of producing any action in time to music. A sequence could, however, be shot to clicks of appropriate tempo. The music would then be recorded with the action projected on a screen in the studio and the same tempo tape fed to the musicians on headphones.

The recording mediums used for prescoring are magnetic tape or sprocketed magnetic tape. Sprocketed tape has the same basic dimensions as 35 mm picture film stock. The running speed used in the film industry is 27.42 m/s which is the speed of film in a camera running at 24 f/s. This gives 96 perforations per second. For TV use the perforation speed used is 100 per second, giving a camera speed of 25 f/s.

Track configurations are one, three, four or six, between perforations. At least one manufacturer (Sondor) has an eight track machine available. As far as I know, no eight track machines are in use in this country as the track positions accepted here are those laid down by the SMPTE in the relevant American Standards. Their maximum number is six.

The normal approach to pre-scoring is to record the orchestral portion first and any vocals at a later session, having selected the best take or edited between a number of takes. The master recordings are held intact, any editing being of copies (transfers). To maintain sync, the copy must be exactly the same length as the original. This of course can be achieved mechanically and there are machines with two or more sprocket mechanisms driven from a common motor. The more flexible and more frequently used systems employ electrical interlock. Selsyn and Syncrostart are two examples. This is a subject in itself which I hope to deal with at a later date. Start marks occupy the area of one frame, the centre line corresponding to the position of the mark on the head gap. The number of the music piece is written on the tape near to the start mark so that a roll can be wound through and a particular section found without having to lace up and wind through the sprocket drive. The disadvantage of this is that there is no aural indication of how far into a roll one has wound. In some machines the length counter is inoperative when winding outside the sprocket. Hence the practice of writing take numbers on the tape, useful to the editor for quick identification.

For recording and reproduction, the tape is held in contact with the heads by sprung rollers or tape tension balances similar to Studer tape machines. This gives a tight loop; fast wind can be expensive in terms of head wear unless the tape is lifted from the heads.

The edited copy can be used as a tempo guide track when recording the vocal component. The copy is set up on a reproducer with its start mark on the playback head, as was the master when it was copied. The vocal master recorder is loaded with a blank tape, the start mark on the record head. The two are then run up locked together and the vocal recording made. After each take, the reproducer is rewound, the start mark reset on the playback head, and a fresh start mark put on the master (at the record head). When a satisfactory take has been made and playback is required, both machines are rewound and the start marks set on the replay heads. The machines are then run together in lock, resulting in a full playback as if both components were on the same tape.

Copies of the chosen vocal takes are then made, the masters kept intact as in the case of the orchestra masters. Any editing that may be required can be done at this stage. The advantage of the vocal being on a separate piece of tape is that edits between different takes, and corrections in timing, can be made. A late vocal entry could be moved forward with respect to the orchestral component and the length of tape removed in front of the vocal put in after it.

In this way, track after track can be added and, with enough reproducers, the result can be monitored and mixed down. As in the case of dubbing, if there are not enough reproducers, a premix can be made and mixed with the remainder. The flexibility of sprocketed tape and interlock is only limited by finance and hiss levels!

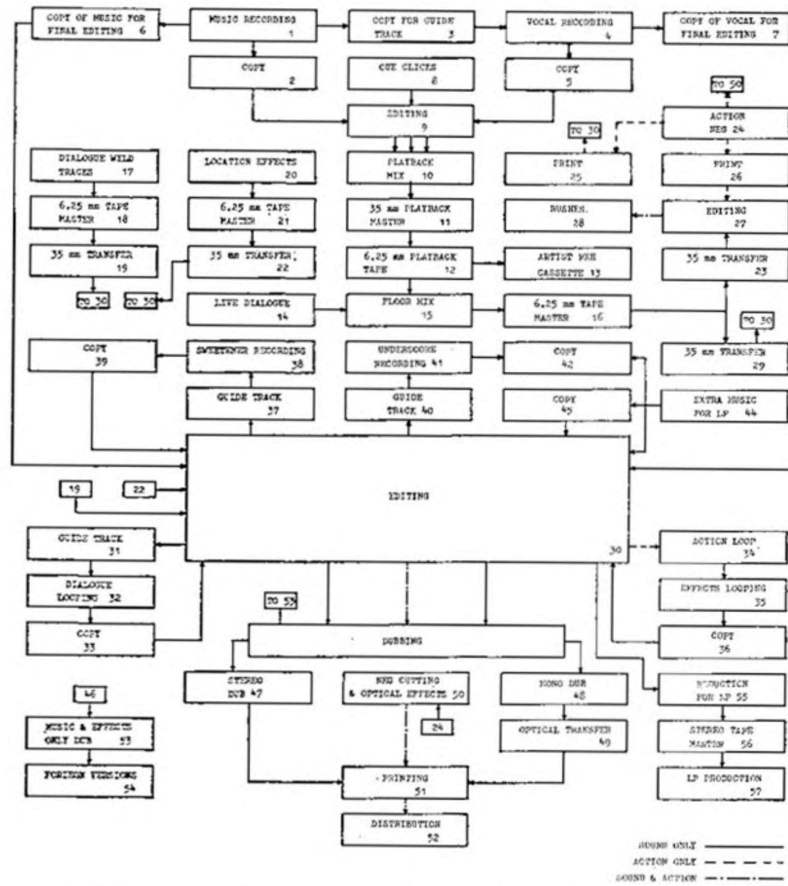
The edited orchestral and vocal components are mixed and cue clicks (*klix* in America) added. These cue the artist at the exact point of a vocal entry, or where a sustained note ends, so that lip sync can be achieved when filming to playback of a prerecorded number. This master playback mix is recorded on sprocketed tape and, as with all other stages, interlocked into the original timing. A 6.25 mm tape copy is then made to be used for playback when shooting in the studio or on location. A sync pulse derived from the speed of the master playback machine is recorded on the tape.

Conventional multitrack tape can be used for original recording using accepted multitrack methods. A sync pulse can be recorded on one track and transferred to the playback tape made for shooting. The sprocketed tape machine speed can be locked to the frequency of the sync pulse on the multitrack tape, or the multitrack tape machine varied in speed so that the reproduced sync pulse is locked to an external standard. This can be a sync pulse generated by the recorder or the mains if the recorder has a mains sync motor.

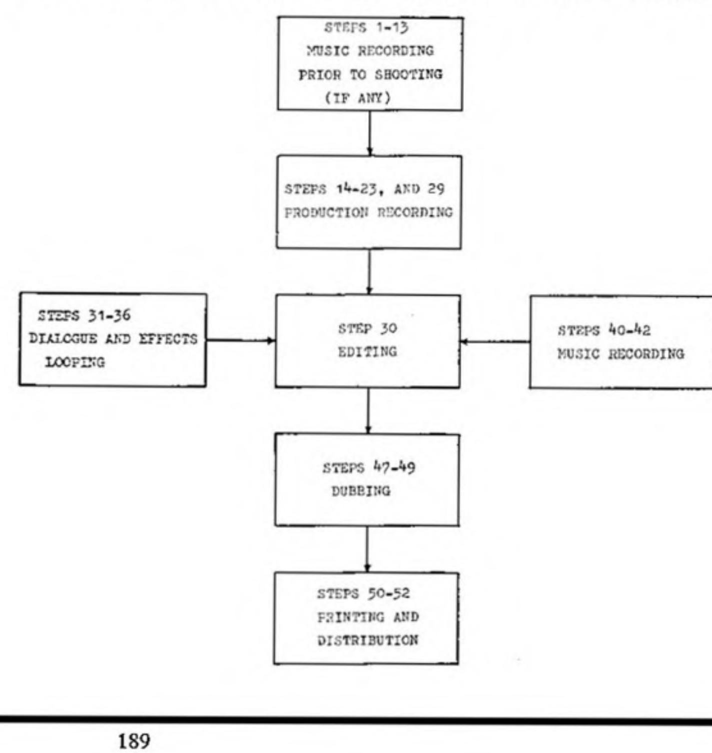
Multitrack tape lacks editing flexibility and is therefore usually restricted to single numbers and TV work.

To be continued

BLOCK DIAGRAM OF STEPS IN PRODUCTION OF FILM MUSICAL SOUNDTRACK



BASIC STEPS IN FILM SOUNDTRACK PRODUCTION



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A Stereo Capacitor Microphone

Part Two — Head Amplifier

BY JOHN FISHER

As has already been stated, one of the factors that made the idea of building a capacitor microphone attractive was the recent increase in the range of FETs available. That and the remarkable drop in prices over the last three years, coupled with good noise performance. Experiments have suggested that picked samples of the popular general purpose *2N3819* could be quite suitable, leaving rejected samples for other projects. The author experimented with various Semitron samples and concluded that *C96E* FETs would be particularly suitable. Characteristics throughout a sample dozen were remarkably close, allowing the devices to be interchanged without need for rebiasing. This made it particularly easy to be fussy over choosing devices with minimal noise and gate leakage. It is particularly important to keep gate leakage currents to the very minimum, otherwise the resistors can contribute a significant amount of noise to the output. It is hard enough to get low noise resistors in these values anyway. The *C96E* seems to be particularly good in terms of leakage but, even so, some samples fell below others.

These junction FETs are electrically symmetrical, or apparently so. This means that it is possible to interchange the source and drain leads and use the device the other way round. It can *sometimes* happen that the noise or leakage is better the 'wrong' way round, and this is worth trying if either prove troublesome and one has few devices to pick from. There seem to be no ill effects in the circuits to be considered.

The capsule dynamic capacitance is of the order of 70 to 80 pF, say roughly 100 pF all told, including the leads. This means that an amplifier input impedance of about 200 M would be ideal (100 M would for most purposes introduce negligible loss at the bass end). The prototype uses 1 000 M resistors as these were more easily obtained at the time of construction. The author experienced considerable difficulty in obtaining physically small high-value low-noise resistors at anything but a high price. Some Erie general-purpose 1 000 M resistors were found to be usable, provided the gate leakage could be kept very low so that noise from current flowing in the resistor was kept to a minimum. However, an exchange of letters with another capacitor mike enthusiast, John Penty, led to a source of Welwyn glass encapsulated low noise 1 000 M types that, although slightly larger, proved rather more suitable and were used in the final version. They are rather expensive new, and it is worth trying to get them on the surplus market provided they have not been used and are in good condition.

The high-value resistors should be handled as little as possible, as should the body of the FET and Veroboard near it, otherwise there is a risk of introducing a noisy leakage path to the gate. If the component bodies are inadvertently handled, they should be wiped with a clean dry cloth or with a clean cloth moistened slightly in meths (not surgical spirit). The inner surface of the final wrapping of polypropylene film should also be handled as little as possible for the same reasons; the capsule should of course only be handled by the support pillar—apart from the risk of noise, handling the capsule body is likely sooner or later to be disastrous ! The choice of amplifier design will be considered briefly. The first circuit tried was a simple source follower (**fig. 4**). This worked adequately and was used for experiments to choose the resistors and FETs. However, with less-than-unity gain the output level is rather low for long unbalanced lines, and the author wanted to avoid including transformers in the mike because of cost and bulk. The output impedance is typically about 1 K or a little less. Adding a low-noise emitter-follower (**fig. 5**) reduces the output impedance somewhat. This arrangement could probably be used but, with the output level at less than 1 mV, it seemed worth going for some voltage gain.

In order to keep components to a minimum and provide DC feedback to stabilise the DC conditions of the circuit, the stages must be DC coupled. This is made easier by using a low-noise *p-n-p* bipolar transistor with the *n*-channel FET. This suggests **fig. 6**, which gives voltage gain with a low output impedance. There are some constraints on the voltage gain and output impedance achieved, however, and the circuit will not work with just *any* FET as the offset voltage (source-gate) required for the current at which the device is operating may make the DC conditions impossible in view of the relatively low supply voltage. Consideration was therefore given to a rather more complex feedback-triple circuit which is somewhat more tolerant and gives a very low output impedance coupled with an appreciable voltage gain (**fig. 7**). The final form of the circuit, which includes refinements such as the small RF-spoiler capacitors to limit the HF response of the circuit beyond the audio range (and so avoid picking up, as a broadband 'mush', half the transmitters of Europe simultaneously !) is given in **fig. 8**.

A high input impedance and some gain are

(*continued on page 193*)

FIG. 4 SIMPLE SOURCE-FOLLOWER AMPLIFIER

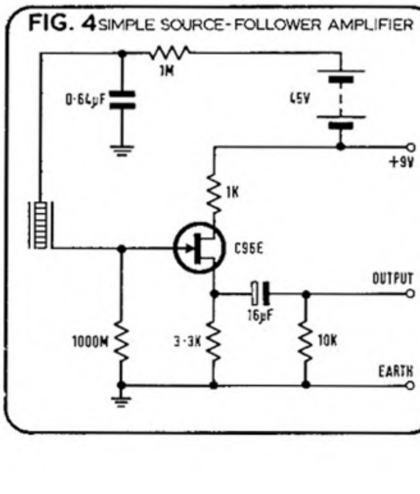


FIG. 5 DITTO WITH EMITTER FOLLOWER

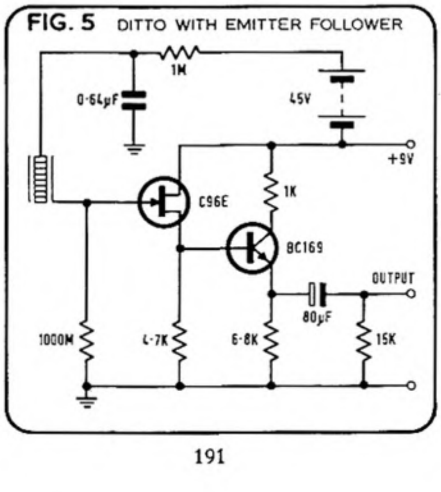
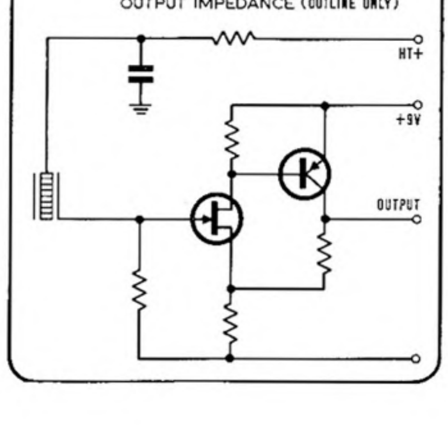


FIG. 6 TWO STAGE DESIGN GIVING VOLTAGE GAIN AND LOW OUTPUT IMPEDANCE (OUTLINE ONLY)



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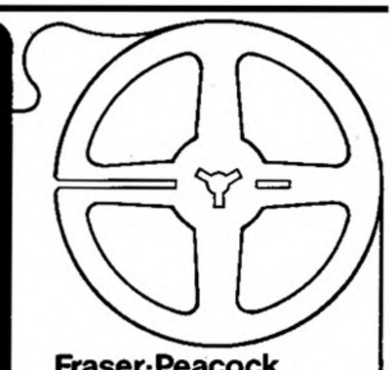

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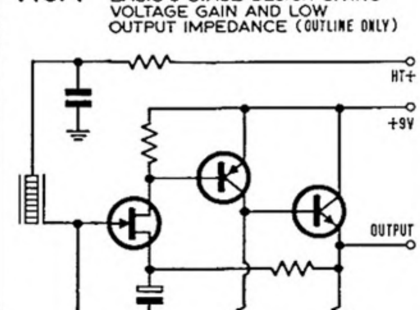
provided by the FET (which operates at a very low drain current. It is directly coupled to the base of the low-noise *p-n-p* silicon transistor which provides voltage gain (choose high-gain specimens) and which in turn is coupled to the low noise emitter-follower output stage. The *p-n-p* transistor is run at about 100 μA with a fairly high value of collector load ; this means the transistor will produce a large voltage gain before feedback, is running at about optimum collector current as regards noise, and is being fed from a lower impedance than its own input impedance at this collector current. DC feedback and source bias are provided by R5, which is partially decoupled at AC to provide voltage gain from the circuit. The source-gate voltage of the FET determines the DC sitting point of the output stage emitter. Due to the DC feedback, this determines the voltages around the rest of the circuit. The voltages given in the circuit were typical with the author's selection of *C96E* devices but may well vary. The considerable AC feedback ensures a high degree of linearity up to the clipping point.

The HT decoupling components are included in the head amplifier to reduce the chance of RF or noise pick-up in the leads and to effectively earth the centre plate of the capsule at the amplifier. In the very unlikely event of capsule breakdown, the HT current is limited by R7. Damage to the FET could occur from the charge stored in C6 and C7 producing an excessive forward bias current, as there is no isolating capacitor to protect the FET if the capsule breaks down. Breakdown is fairly unlikely, however and there is an equal risk with an isolating capacitor of breaking down the gate due to excess reverse bias, (a IM resistor in series with the capsule centre plate would give protection, provided it did not introduce hum pickup). On the whole, junction FETs seem to be more rugged than insulated-gate types. Current ones seem to stand more in the way of maltreatment than did earlier types. It is wise, however, to keep the FET leads shorted until the device is finally in circuit. Unplug the soldering iron while making soldered connections as it has been known for stray voltages (caused by the insulation of the element or leads breaking down) to damage the FET.

The components C8, R8 and R9 are conveniently mounted in the battery pack where space is less at a premium. The other components are mounted on 0.1 inch pitch Veroboard, five strips wide, with the amplifiers staggered. Components are mounted on both sides of the Veroboard, to make the most use of space, and the amplifiers are insulated from the case by two layers of Polypropylene wrapping film. Connections are brought out (with wire links where appropriate) to the copper strips at one end of the component board, and connected with fine flex, as used for electric model racing cars, to the DIN socket. With the exception of the 1 000 M resistors, all other resistors are 5% 0.125 W miniature carbon film low noise types. The larger value capacitors are miniature Mullard electrolytics. It is important that the microphone body and capsule shield be well earthed to avoid hum and RF troubles, and the RF spoiler capacitors must not be omitted. When checking the DC conditions of the circuit without the capsule connected a dummy source (80 pF capacitor) must be connected between the FET gate and earth, otherwise the open circuit input picks up enough noise to produce a clipped signal and shift the DC conditions. With the dummy load on the input, it should be possible to short the input without any detectable shift in voltage at the emitter of the *BC 169*. If there is a change, either the bandwidth of the circuit is still too high, the amplifier is in a large noise field, or—and this is particularly important—the FET gate may be 'leaky' although the leakage current may be so small that in most other applications it would be of no consequence. The amplifiers must be screened by the case for AC tests.

FIG. 7 BASIC 3-STAGE DESIGN GIVING VOLTAGE GAIN AND LOW OUTPUT IMPEDANCE (OUTLINE ONLY)



In the prototype, leads were made long enough for the amplifiers to be withdrawn completely from the case without unsoldering the DIN socket. The capsule leads should be as short as possible, just long enough to enable the mike head to be detached from the case to allow the amplifiers to be withdrawn. The components are a tight fit and care must be taken that they do not strip insulation as the amplifiers are slid in and out.

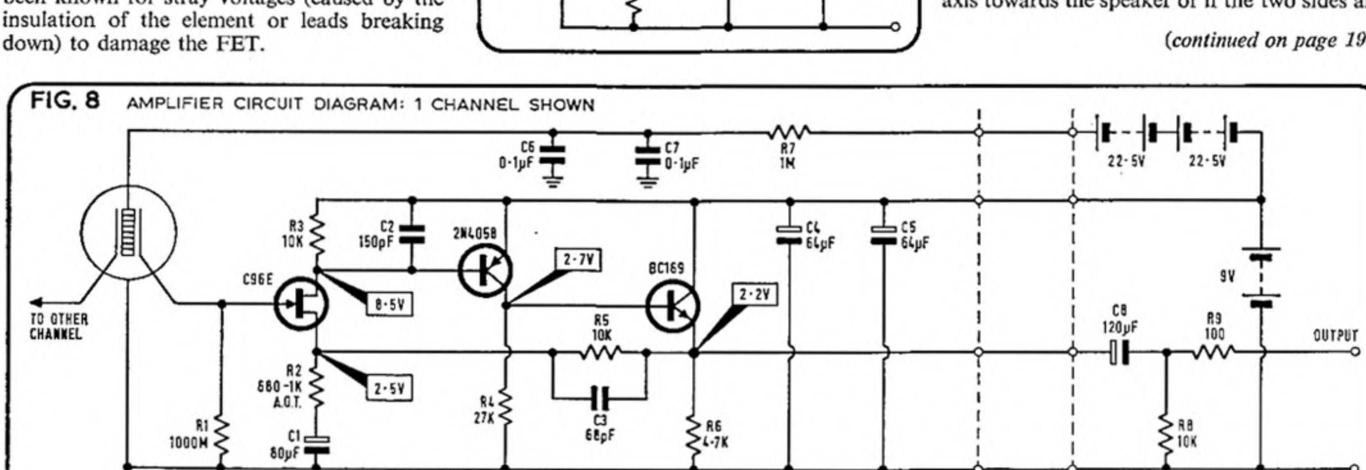
Balancing

Ideally the two halves of the capsule should have identical outputs and, using 5% or better resistors, the amplifier gains should be within 1 dB. However, as mentioned earlier in the article, there may be some overall imbalance and it is as well to measure this and correct for it at an early stage. The simplest way of correcting would be to incorporate a balance control in the battery box and make a preset adjustment after completing the microphone. However, this is likely to mean unequal output impedances and loads on the mike outputs (neither normally serious). Since it seemed neater to produce a mike with equal outputs from both channels, the author chose instead to adjust the feedback resistor ratio by adjusting R2 on one channel ; to correct the initial imbalance on one of the capsules to within 0.5 dB, respective values of 680 ohms and 1 K were used on the two channels.

Without access to a dead room and other elaborate equipment, the simplest method is to balance using white noise in a well furnished and curtained room. The mike is placed on the axis of, and about 60 cm back from, a small speaker such as the *Maxim* which is fed with noise. If you don't have a generator, most detuned FM tuner provided a suitable source of hiss. The mike is fed, via preamp if necessary, to an expanded scale dB meter, VU meter or valve voltmeter. The outputs of the two channels are then compared, and adjusted as necessary. With ideal capsules, identical results should be obtained as regards balance, whether the mike is used with its main axis towards the speaker or if the two sides are

(*continued on page 195*)

FIG. 8 AMPLIFIER CIRCUIT DIAGRAM: 1 CHANNEL SHOWN



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equipment reviews

TELCON TELSHIELD

MANUFACTURER'S SPECIFICATION. Mu-metal foil for magnetic and electrostatic screening. Supplied in 3.63 m rolls of 152 mm width and 50 μm thickness. **Price:** £2 per 30 cm² 50 um. **MANUFACTURER: Telcon Metals Ltd, Manor Royal, Crawley, Sussex.**

FOR a few decades the remarkable properties of Mu-metal (or permalloy as it was originally named by its discoverer, G. W. Elmen of the Bell Telephone Company in the US) have encouraged its use in applications where a substance of extremely high permeability has been required. Elmen in fact discovered the material when looking for a high permeability core material for use with loading coils in telephone circuits. Permalloy allowed the size of the loading coil to be considerably reduced, originally by two thirds, and now to only a fraction of the original. The alloy contains approximately 79% nickel, 20% iron and 1% various other elements, and has the remarkable property of screening very effectively magnetic induction. It is necessary to anneal the metal at a high temperature, so screening cans or shields have to be formed and drilled *before* this process. Bending, drilling or imparting any severe shock seriously diminishes the magnetic properties, which makes the material difficult to use for small production runs.

For some time Telcon Metals of Crawley, Sussex, has been developing an interesting form of Mu-metal known as *Telshield* which appears to be the electronic engineer's dream in that it can be used very easily by carefully bending it around the circuits or components to be screened. The material is normally supplied in rolls containing 3.63 m of 152 mm width, and only 50 μm thickness. Because it is so thin it can be bent carefully without destroying much of the magnetic property, although its manufacture is difficult in that it has to be cold rolled, which of course takes a considerable time. For this reason, and also because of the high price of nickel, it is not cheap, normally costing about £2 per 30 cm² of 50 μm material thick and proportionately more for greater thicknesses, available to special order.

Telcon have submitted several samples for assessment, and a number of experiments were carried out to prove how useful the material can be, particularly to the recording engineer.

I had always heard that a reasonable thickness of Mu-metal was necessary to get adequate magnetic screening, and a thickness of only 50 μm seemed almost ridiculous.

A 500 μH unscreened air cored loudspeaker crossover inductance was soldered to two pins of a screened DIN socket mounted at the end of an Eddystone die cast box. A screened locking DIN plug and cable carried the output from the coil to the input socket of a B & K spectrometer with the chassis of the Eddystone box connected to the screen of the cable. A 2.5 mH air cored choke of very heavy gauge wire and of 76 mm diameter was connected via a variable resistance to the 6 V secondary of a heavy duty mains transformer, and a current of approximately 3 A was allowed to pass. The Eddystone box was held vertically with its coil at a carefully controlled distance above the 76 mm coil and the output measured on the B & K meter. A Telshield cylinder 152 mm long and 90 mm in diameter was then held round the box, and the output of the coil was reduced by as much as 27 dB. Winding a second layer of Telshield around the cylinder improved the screening by only a further 3 dB, showing that the remaining magnetic induction probably leaked from the ends of the cylinder.

The effect of Telshield was then tried round a tape recorder replay head that had previously picked up a rather high hum field since it did not have a Mu-metal screen. Making a dog kennel structure over the head, ensuring that no corner had a radius of less than 6 mm or so, gave a considerable hum reduction, although perfection was only achieved when a further piece of Mu-metal was held in front of the gaps.

The manufacturer claims that Telshield may be cut with scissors, and can also have holes punched in it with a decrease of magnetic performance only around the area of the cut or hole. On the other hand, I find that dropping a piece of Telshield on a hard floor or allowing the material to become kinked, seriously reduced the magnetic properties.

The inadequacy of magnetic screening around gram motors has often worried me and it would seem possible to reduce the hum field greatly by using Telshield on the motor board. We made two semi-circles of Telshield into a turntable mat and found that the hum fell by approximately 8 dB near the centre of the turntable which already had a pretty low hum field, namely the Thorens *TD 125*. Because of the shape of the haphazardly cut segments, however, a very slight variation in induction was noticeable as a join went under the pickup. A Mu-metal turntable mat would therefore be a worthwhile manufacturing proposition.

The use of bias rejection coils in tape replay amplifiers is fairly common. For applications such as this, Telshield proves very suitable in that it can be easily stuck into position lining a very small Eddystone die-cast box in which the coils can be connected in series with the replay head output leads. Normally it is almost impossible to get away with rejection coils in this part of the circuit. It is also possible to stick Telshield to plastic sheeting and envelope a troublesome mains transformer, dramatically reducing the external field. The extraordinarily high peak permeability of 50 000 for the material of course is reduced as the radius of a Telshield cylinder is decreased, but little harm is done to the material with cylinders made to as little as 40 mm radius. The material can also be spot-welded although, in the neighbourhood of the spot, the magnetic properties will be diminished. Telshield is available under a different brand name in the US but should not be confused with another product being offered, a copper impregnated adhesive tape which has very different electrical and magnetic properties.

Telcon, incidentally, is apparently the largest user of nickel in Britain, and can supply Mu-metal screens, pots and cans to any shape required.

I would like to see Telshield made easily available to the public by inclusion in such useful catalogues as Radiospares and Tape Recorder Spares. **Angus McKenzie**

STEREO CAPACITOR MICROPHONE
CONTINUED

turned alternately to the speaker; if there is a marked difference, the capsule is unlikely to be really suitable for stereo, though it is worth experimenting further (possibly with a compromise balance) if the difference is small.

Noise is used rather than tone as it gets round the problem of reflections and standing waves in a room fairly neatly. A further check could be made using bands of filtered noise, if suitable equipment is available. Given a reference mike, the frequency response can also be conveniently measured using third-octave bands of filtered noise. For most people, obtaining a balance will be enough since there will not be a great deal they can do about the frequency response.

Provided the capsule is carefully made and its housing does not introduce serious resonances, the frequency response of the mike should be comparable with many studio designs. The HF resonance (inevitable) is well damped and not obtrusive, the transient response is excellent and coloration minimal. The design is prone to rumble, however, in common with many cardioids. Apart from suspending the mike resiliently, it is worth limiting the LF response by either using a lower value of gate-leak resistor than the 1 000 M or reducing C1 to 16 or 25 μF, thereby increasing the feedback at low audio frequencies —or both.

out the normal monitor feed and substitute only the signal present in the selected channel, either before or after the channel fader. The switch is often a biased pushbutton type; press to hear, release to normal. **Fig. 87** shows how.

For how long will printed circuits be available?

Until publication of this series of articles starting in June 1970, I was still receiving requests for boards for the 1964 design. Stocks now kept are small so delivery is extended—but they will be still available.

Would it be possible to produce a printed circuit panel for the 18 dB/octave filter (fig. 52)?

In the face of many such requests, I have managed to use the same filter card (ref. 122) for all three filters (figs. 51-53). If you can find three ganged potentiometers it can even be made variable.

What is the output impedance of the plug-in front panel amplifiers?

It varies from unit to unit, with 4.7 K as the highest value (fig. 23) and very low as the lowest (fig. 27). In general it is the value of the collector resistor when the output is taken from the collector, lowered if there is any feedback taken from the collector; e.g. in fig. 28 the output impedance is considerably lower than 4.7 K. In all cases, however, quite long leads can be taken from the breakjack outputs to external circuits.

What type of coils are used in the tone control, the film industry filter, and the notch filter?

All circuits use the same inductor, 18 mm Mullard coil *LA2500*. The assembly comprises the ferrite pot core *LA2500*, with former *DT2178*, clip assembly *DT2399*, and mounting board *DT2359*. (Note slight difference in number from those given in Part Three, page 350, which refer to older parts now superseded.) The number of turns for a given inductance can be calculated from the formula $n=52.5\sqrt{L}$ where L is inductance of coil in milliHenries. It is important to fill the former well to preserve a good Q, and the following table gives typical numbers of turns for the former.

swg wire	typical turns
32	200
36	400
40	1 000
44	2 000
46	3 000
50	16 000

The range of coil adjustment using the core provided is about $\pm 8\%$.

Is it possible to make linear slider faders in a similar manner to the quadrant types described?

For the answer to this I am indebted to Mr Brian Algar who has sent me a detailed set of drawings showing how he approached and solved this problem (**fig. 88**). The arm still moves in a radius but it is only slight. For a 75 mm travel the centre rise of the knob is less than 4 mm, which is not too noticeable. Suitable gears can be obtained from the same source as the prototype gears.

Are there any alternative transistors or diodes which can be used?

None of the transistors has any special requirement; the *BC109* is a low-noise, high-gain, low-current device—like the *2N930*, *BC169*, *2N3391A*, and many others. The *BC108* can be replaced by *BC168*, or *2N2926*. The only point to watch is that the lead configuration may change from device to device. The *1N914* diode is a general purpose silicon diode, and *8A200* or similar types can be used here.

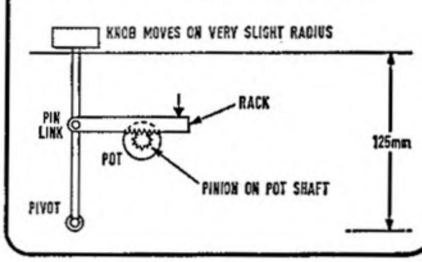
What wattage are the resistors used in the circuits?

In all cases save one, 250 mW types are satisfactory; in many cases 125 mW will do. The exception is the current trip in the power supply which should be calculated as $P=I^2R$. Five per cent types are the best to use, and carbon film types are now the most common available resistors. The Iskra, Piher or Beyslag ranges are ideal. In the microphone amplifier, metal oxide resistors can be used for R1, R3, and R7 to 11 if the ultimate in noise performance is required.

This list represents the more common questions I have been asked, but it is by no means exhaustive. I am still receiving queries about the 1964 design, so I am resigned to problems cropping up in 1975 on this one!

Next month will be the final part and will tidy up any loose ends which may come to light. It will also show how some readers have interpreted the concept, with photos showing their versions of the mixer.

FIG. 88 LINEAR HOME-MADE FADER



COMPONENT SUPPLIES

Printed circuit ref. *213* 30p
Filter card ref. *222* 30p
} from the author, c/o Link House. Cheques etc, should *not* be made out to Link House.

Transformers

BBC mike amp (fig. 22) Type *3128* £2.50 each
IC mike amp (fig. 84) Type *3106* £2.85 each
Output transformer for IC or discrete component amp (figs. 34 and 82) Type *3057* £3.40 each
from E. A. Sowter Ltd, 7 Dedham Place, Fore Street, Ipswich, Suffolk. Prices are for one off (discounts for quantity), including UK postage. *708* integrated circuit, each, from Quarndon Electronics Ltd, Slack Lane, Derby DE3 3ED. Texas Instruments type *SN72709 N* 70½p each, postage extra. £1.50 minimum order.

Mullard coil parts:

coil and adjuster	*LA2500*	30p
former	*DT2178*	2½p
clip assembly	*DT2399*	1½p
mounting board	*DT2359*	2p

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Gears and rack system: S. H. Muffet Ltd, Mount Ephreim Works, Tunbridge Wells, Kent.

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