July 1972 25p

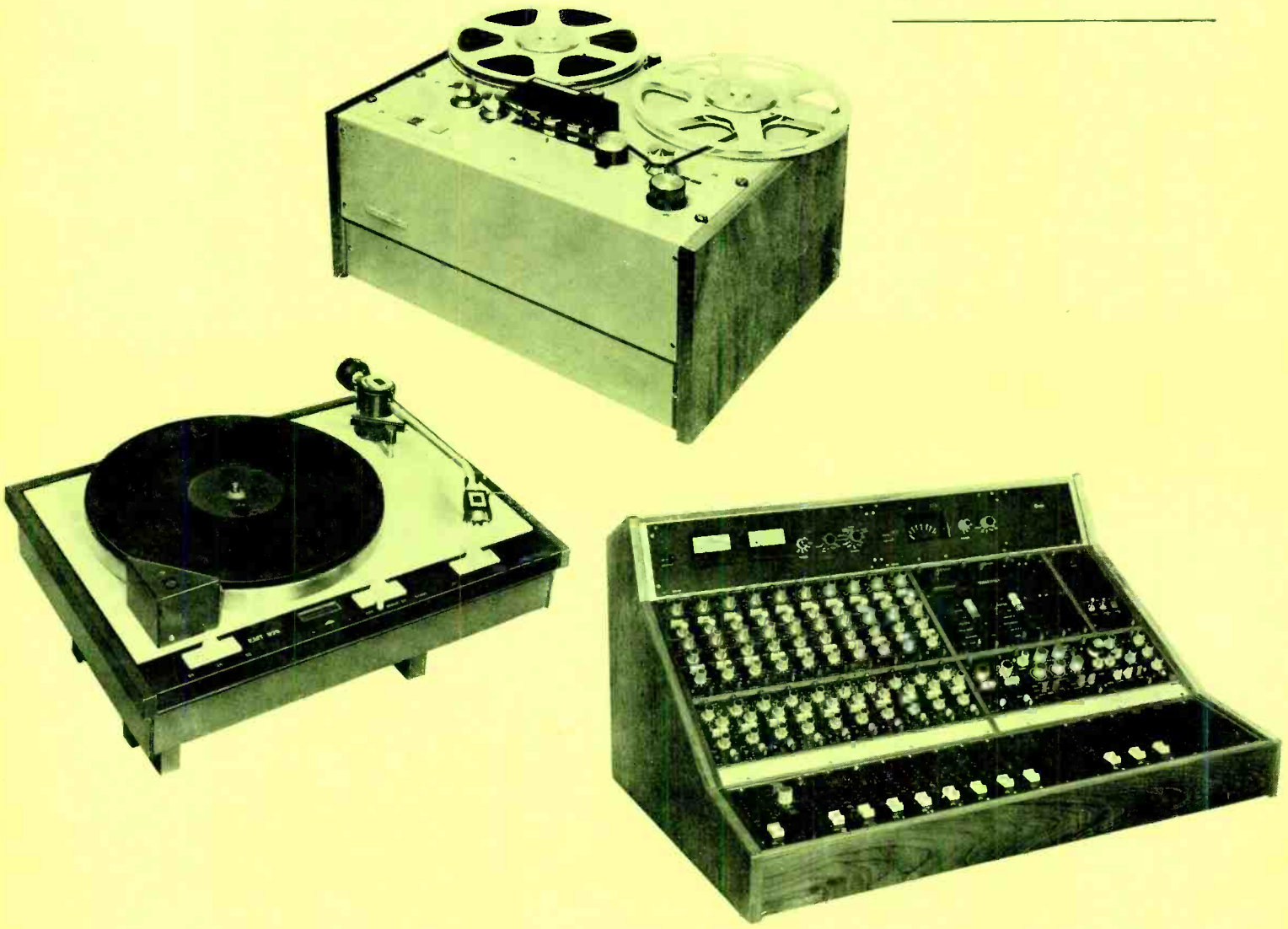
studio sound

APRS 72 PREVIEW

Sound in the theatre

Understanding music synthesisers

Reviews:
Philips PRO 36,
Rogers BBC Monitor,
and
Quad Electrostatic



Hampstead High Fidelity for the highest quality microphones

STC Professional partners

4038
BIDIRECTIONAL
Ribbon
30 Hz - 15 kHz
Impedance: 30Ω or 300Ω
Output: —80 dB ref IV at 30Ω

4104
BROADCAST QUALITY
COMMENTATOR'S NOISE
CANCELLING LIP
MICROPHONE
Sensitivity —84 dB ref. IV
Impedance 30 or 300Ω

4021
OMNIDIRECTIONAL
Moving coil
40 Hz - 12 kHz
Impedance: 30Ω
Output: —80 dB ref IV/dyne/cm²

4037 A & C
OMNIDIRECTIONAL
Moving coil
Frequency response:
30 Hz - 12 kHz
Sensitivity: —84 dB ref IV
Suitable for interviewing

MAIN STC DISTRIBUTORS

hHI FI

HAMPSTEAD HIGH FIDELITY

91 Heath Street, Hampstead, London NW3 6SS

Telephones: 01-435 0999 and 435 6377

Professional terms available

65/1B
LIGHTWEIGHT STUDIO
MOVING COIL HEADPHONES
Omnidirectional
Frequency Response
50 Hz to 15,000 Hz
Impedance: 300Ω per earphone
Sensitivity +45 dB ref.
V/dyne/cm²
Weight 11oz. (300g.)

studio sound
INCORPORATING TAPE RECORDER

JULY 1972 VOLUME 14 NUMBER 7

EDITOR DAVID KIRK

ASSISTANT EDITOR JOHN DWYER

CONSULTING EDITOR JOHN CRABBE

AUDIO GROUP ADVERTISEMENT MANAGER ROBIN WELLS

ADVERTISEMENT MANAGER TONY NEWMAN

Editorial and Advertising Offices: LINK HOUSE, DINGWALL AVENUE, CROYDON CR9 2TA. Telephone: 01-686 2599

FEATURES

COLUMNS

REVIEWS

THE NEXT step in the progressive adulteration of sound recording techniques was revealed at the 42nd Audio Engineering Society Convention in Los Angeles—to be reported in detail next month. Those London stragglers who have finally caught up with 16 track may now find themselves pushed into and beyond 24 track operation. A UK company, Amity Shroeder (pronounced Orange), has already announced a 24 track recorder using 50 mm tape which in terms of track width is the equivalent of working three tracks on 6.25 mm tape. This might be regarded as halfway between industrial and domestic standards. Alas, the wedge does not stop here. The small print on an Amity advertisement (June STUDIO SOUND) proceeds to offer 16 tracks on 25 mm and 32 tracks on 50 mm 'with surprisingly good results'. In the United States. one manufacturer has gone still further by offering 40 tracks on 50 mm. This machine is based on a 3M *Isoloop* transport and more or less represents five track working on 6.25 mm.

Absurd? Perhaps not. We recently condescended to play with a $\frac{1}{4}$ track *Chilton* recorder and were agreeably impressed by its performance. We had hitherto regarded 19 cm/s $\frac{1}{4}$ track operation as a joke, albeit a better class of humour than that other joke—the compact cassette. In this case, however, the combination of low noise tape and an almost V-shaped head contour resulted in remarkably low levels of noise and dropout. Whether this format would stand up to the rigours of continuous studio working is a separate question; only the smallest studios have any serious use for four track 6.25 mm.

50 mm is evidently regarded as the maximum practical tape width for audio recording. It is interesting to see 76 cm/s as a standard speed on the new 24 track 3M recorder. Raising the speed in this way may compensate for the hiss and dropout inherent in narrow track operation though it will not necessarily reduce spreading or tape weave. Still, to quote the old get-out, there's always Dolby.

CORRESPONDENCE AND ARTICLES

All STUDIO SOUND *correspondence should be sent to the address printed on this page. Technical queries should be concise and must include a stamped addressed envelope. Matters relating to more than one department should occupy separate sheets of paper or delay will occur in replying.*

Articles or suggestions for features on all aspects of communications engineering and music will be received sympathetically. Manuscripts should be typed or clearly handwritten and submitted with rough drawings when appropriate. We are happy to advise potential authors on matters of style. Payment is negotiated on acceptance.

SUBSCRIPTION RATES

Annual UK subscription rate for STUDIO SOUND *is £3 (overseas £3.80, $8 or equivalent).*
Our associate publication Hi-Fi News *costs £3.24 (overseas £3.66, $8.64 or equivalent). Six monthly home subscriptions are £1.50* (STUDIO SOUND) *and £1.62* (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.*

PAST ISSUES

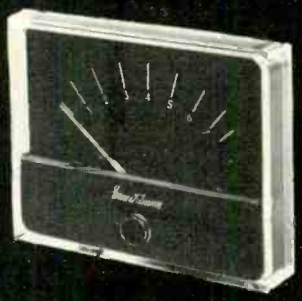
A small number of certain past issues may still be purchased from Link House, price 31p each including postage.

Photostat copies of any STUDIO SOUND article are available at 25p including postage.

BINDERS

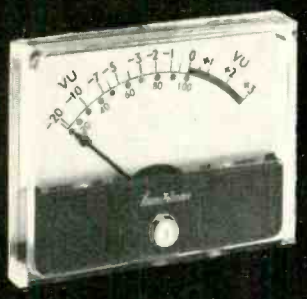
Loose-leaf binders for annual volumes of STUDIO SOUND *are available from Modern Bookbinders, Chadwick Street, Blackburn, Lancashire. Price is 85p. Please quote the volume number or date when ordering.*

PEAK PROGRAMME METERS to all B.B.C. specifications



AND **VU METERS**

TO THE BELL SPECIFICATION



OVERSEAS AGENCIES

R. Schmidt	Copenhagen	Denmark
OyChester	Helsinki	Finland
Theal N.V.	Amsterdam	Holland
Vianello	Milan	Italy
Rieck	Bergen	Norway
Eltec	Lisbon	Portugal
Nordstrand	Stockholm	Sweden

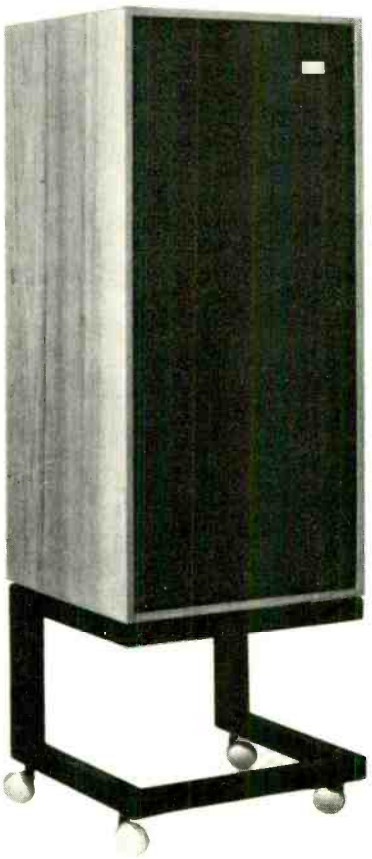
Ernest Turner

ELECTRICAL INSTRUMENTS LTD

CHILTERN WORKS
HIGH WYCOMBE
BUCKS
ENGLAND

spendor

Studio Series



"A new standard in loudspeaker design"

Types BCI and BCII

Size	25in. x 11¾in. x 12in.
Weight	31lb.
L.F. Unit	SPENDOR 8in. plastic cone
H.F. Units	Celestion HF 1300 S.T.C. 4001G
Nominal Impedance	8 ohms
Frequency Range	45 Hz to 25 kHz (±3 dB, 60 Hz to 14 kHz)
Power Rating BCI	40 watts programme
BCII	50 watts programme

Types BCIA and BCIIA

Specification as above but with SPENDOR power amplifier M.208 (20 watts) or M.508 (50 watts) fitted into the back panel. The amplifiers can be provided with either balanced or unbalanced input.

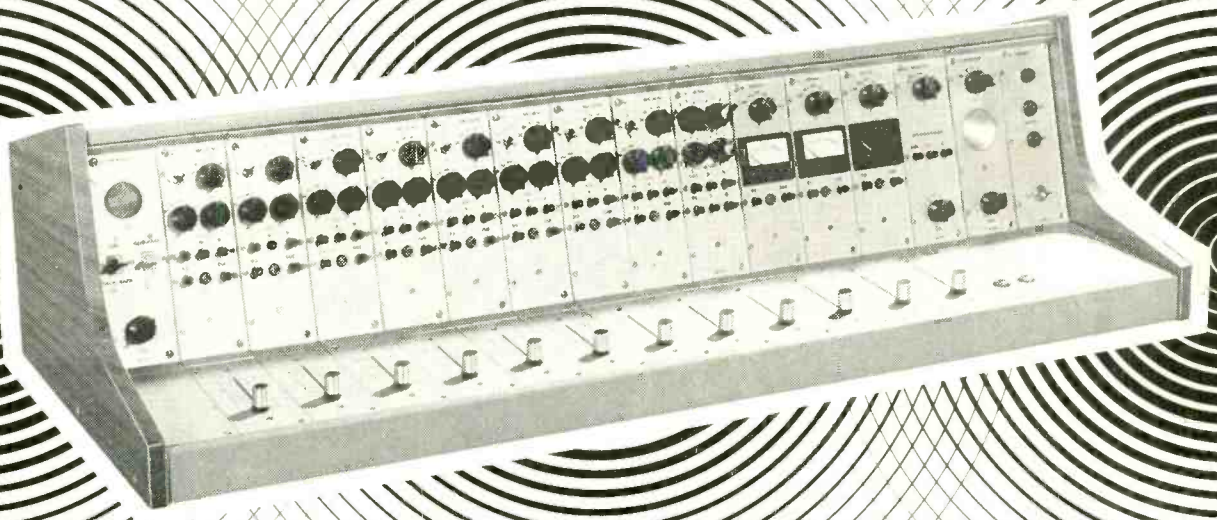
Prices from **£72·31** Trolleys **£8·50** each

Spendor Audio Systems Limited

3 Station Approach Redhill RHI INX

audix
SOUND SYSTEMS AND ELECTRONICS

MODULAR AUDIO MIXER



SERIES MXT-800

The MXT-800 series of audio mixing modules can be supplied to form compact 2 or 4 group mixers suitable for use in local broadcast and the smaller recording studios. Each mixer is custom built and can incorporate P.P.M. or V.U. metering, and additional master output group, limiter, talkback, monitor, echo, oscillator, pan, and line equaliser modules.

Overall mixer specification:–

Frequency response:–	±0.4dB 20Hz–20KHz including input and output transformers.
Distortion:–	Typically 0.02% at normal levels. Less than 0.1% 20Hz–20KHz at +18dBm.
Noise:–	Microphone channels:– noise factor less than 2dB ref. 600 ohms. All other inputs:– –75dBm.
Gain:–	Maximum system gain, microphone 100dB. Line 20dB.

audix

MANUFACTURERS OF SOUND SYSTEMS AND ELECTRONICS

AUDIX BB LIMITED
STANSTED · ESSEX
TELEPHONE: STANSTED 3132/3437 (STD 027-971)

COMMUNICATION ACCESSORIES & EQUIPMENT LIMITED

77 AKEMAN STREET, TRING, HERTS, U.K.

G.P.O. Type components on short delivery

JACK PLUGS — 201, 310, 316, 309, 404
JACK STRIPS — 310, 320, 510, 520, 810
JACK SOCKETS — 300, 500, 800, B3 and B6 mountings
PATCH PANELS — made to specifications
LAMPS & LAMP STRIPS — SWITCHBOARD No. 2 LAMP CAPS 10 way PO 17 20 way PO 19 BALLAST PO No. 11 HOLDER No. 12
CORDS, PATCHING & SWITCHBOARD — made to specifications
TERMINAL BLOCKS DISTRIBUTION — 20 way up to 250 way
LOW PASS FILTERS — type 4B and PANELS, TELEGRAPH 71 (15 x 4B)
UNISELECTORS — various types and manufactures both PO and miniature
LINE TRANSFORMERS/RETARDATION COILS — type 48A, 48H, 49H, 149H, 3/16, 3/216, 3/48A, 3/43A, 48J, etc
FUSE & PROJECTOR MOUNTINGS — 8064 A/B 4028, H15B, H40 and individual 1/2
COILS — 39A, 40A and 40E, etc
PO TYPE KEYS — 1000 and PLUNGER TYPES 228, 279, etc
19" RACKS — VARIOUS SIZES

Telephone: Tring 3476/8 STD: 0442-82 Telex: 82362 Answerback: Batey UK Tring

TEAC R-340 Series Tape Decks bring you the ultimate in professional performance. Frequency response is as wide as 30 to 20,000Hz at 15 ips with a variation of only 2 dB, and wow and flutter is a surprisingly low 0.03% at the same speed. Signal-to-noise ratio is 60 dB on full-track and 56 dB even on the 4-track version. Variation of tape speeds does not exceed 0.3%. 2,400 ft. tape can be spooled in less than 100 seconds.

TEAC®
R-340
PROFESSIONAL TAPE DECK

Tape Deck R-340 Series **£450**
Amplifier AR-15 **£140**

For full details of TEAC equipment, write to sole U.K. distributors:

ACOUSTICO ENTERPRISES LTD.
6-8 Union Street, Kingston-upon-Thames, Surrey
Tel. 01-549 3471/3 (3 lines)

The Quietest Revox

One of the most compelling reasons for buying a Revox is the sounds it doesn't make.

No spurious pops or clicks. No wavering, fluttering tones. No distracting hum. And best of all, virtually noise-free electronics.

Take our new A77 Mk III for example. We manufacture it to such close tolerances and with such exacting attention to detail, that it is generally regarded as one of the quietest tape recorders ever made.

Unfortunately, no matter how quiet our electronics are, there is still the inherent problem of tape hiss.

And that's where our new Revox A77/ Dolby B recorder comes in.

By now, the virtues of the Dolby Noise Reduction system are too well known to require any elaboration on our part.

Suffice it to say, for all practical purposes the last major stumbling block to quality, noise-free recording has finally been eliminated.

Listening to tapes on the new Revox/Dolby B is a revelatory experience. Tape hiss is virtually non-existent. The music seems to emerge from a background of velvety silence. And at 3-3/4 i.p.s. the absence of extraneous noise is truly startling.

But no mere description of the Revox/Dolby B can adequately convey the experience awaiting you the first time you listen to a tape made on this remarkable machine.

The Revox/Dolby B

Your nearest Revox dealer will be delighted to audition the Quietest Revox for you. Once you've heard it, you'll understand why we say...

Revox delivers what all the rest only promise.

Revox at Lamb House, Church Street, Chiswick, London W4 2PB
Revox Corporation in USA; 155 Michael Drive, Syosset, N.Y 11791 and 3637 Cahuenga Blvd. West, Hollywood, California 90068
Revox Sales and Service in Canada; Montreal P.Q

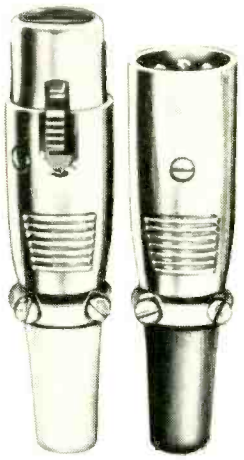
Audio Connectors

Speaking of Audio Connectors, we have them in stock . . .

Also Cannon, Smart & Brown and Kings solder and crimp types BNC, TNC, N and SMA series.

In addition, we can supply connectors of varying types, including Rack & Panel and Circular in standard and miniature configurations.

If the component you need is not in our stock, we can identify it and supply it quickly.



Why not telephone us now?

We'd like to demonstrate just what PSP Service and technical know-how can do for you

PSP Electronics (London) Limited

Members of the Association of Public Address Engineers

228, PRESTON ROAD · WEMBLEY · MIDDLESEX
TELEPHONES: 01-904 9521 (FIVE LINES)
ITT CANNON AUTHORISED DISTRIBUTORS

NEW!

from Crown International

D60 POWER AMPLIFIER DUAL CHANNEL

With the introduction of the D-60, Crown International have again produced a power amplifier of a quality and performance unequalled in the field of audio amplifier design! Equally at home in the Studio, Laboratory, or domestic system, the D-60 offers 'DC-300 type' excellence at a lower power level, and at a price which brings it within the range of many more budget-guided users. The Crown 3 year warranty applies of course.

Power Response:	±1 dB 5 Hz—30 kHz at 30 watts into 8 ohms
Power at clip point: (per channel)	64 watts RMS into 4 ohms. 41 watts into 8 ohms. Over 100 watts into 8 ohms as mono amp
I.M. Distortion:	Less than 0.05% 0.01 watt to 30 watts level
THD:	Below 0.05% through band. Typically 0.0005% 30 watts at 1 kHz
Damping Factor:	Greater than 200 (zero to 1 kHz at 8 ohms)
Hum and Noise:	106 dB below 30 watts level
Load Impedance:	4 ohms or greater
Dimensions:	17″ wide. 8¾″ deep. 1¾″ thin
Weight:	10 lb
Price:	**£97**

Sole Agents:

MACINNES LABORATORIES LTD.
Stonham, Stowmarket, Suffolk
TEL. STONHAM 486 **IP14 5LB**

Alice . . .

HAVE A QUIET WORD WITH US AT THE **APRS** EXHIBITION

ALICE (Stancoil Ltd.), 15 Sheet St., Windsor, Berks. Windsor 61308

MEET THE FAMILY.

We've been in the microphone business for over 40 years now.

And in all that time we've built up quite a family.

Ribbon mikes, moving coil mikes, headphones, stands, accessories, the lot.

Over 50 in fact.

All these products, made to the same high acoustic quality that has set standards all over the world.

All these products are shown and explained in detail in the Beyer Dynamic Catalogue.

Which, if you are at all interested in better equipment, is something you should send for.

To: Beyer Dynamic (GB) Ltd., 1 Clair Road, Haywards Heath, Sussex.
Telephone Haywards Heath 51003

Please send me full particulars and illustrated brochure of the Beyer Dynamic products.

Name .....

Address .....

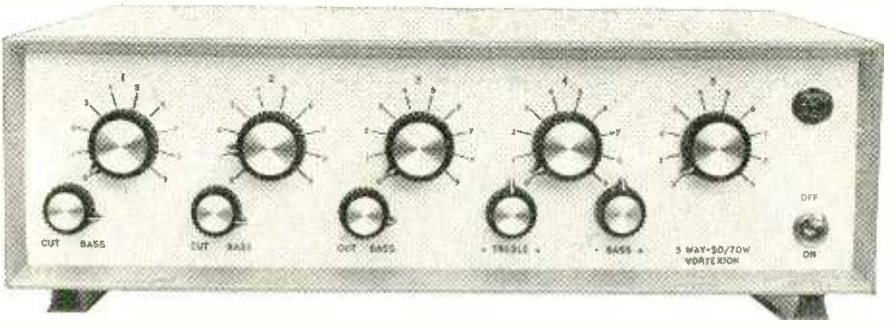
.....

BEYER DYNAMIC

Vortexion

50/70 WATT ALL SILICON AMPLIFIER

WITH BUILT-IN 5-WAY MIXER USING F.E.T.s



THIS is a high fidelity amplifier with bass cut controls on each of the three low impedance balanced line microphone stages and a high impedance (1·5 meg.) gram stage with bass and treble controls, plus the usual line or tape input. All the input stages are protected against overload by back to back low self capacity diodes and all use F.E.T.s for low noise, low intermodulation distortion and freedom from radio breakthrough.

A voltage stabilised supply is used for the preamplifiers making it independent of mains supply fluctuations and another stabilised supply for the driver stages is arranged to cut off when the output is overloaded or over temperature. The output is 75% efficient and 100V balanced line or 8-16 ohms output are selected by means of a rear panel switch which has a locking plate indicating the output impedance selected. The mixer section has an additional emitter follower output for driving a slave amplifier, phones or tape recorder, output ·3V out on 600 ohms upwards. Price £84·00

50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4-WAY MIXER

(0·3% intermodulation distortion) using the circuit of our 100% reliable 100 Watt Amplifier 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 2-30/60Ω balanced line microphones, 1-HiZ gram input and 1-auxiliary input followed by bass and treble controls. 100 volt balanced line output or 5/15Ω and 100 volt line. Price £77·00

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 0·4V on 100K ohms.
Price £80·00

THE 100 WATT MIXER AMPLIFIER

With specification as above is here combined with a 4 channel F.E.T. mixer, 2-30/60Ω 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. Price £115·00
Also available in rackpanel form.

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 2dB 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 input and HiZ gram. Outputs available 8/15 ohms OR 100 volt line.

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.

200 WATT AMPLIFIER

Can deliver its full audio power at any frequency in the range of 30 c/s—20 Kc/c±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 100-120V or 200-240V. Additional matching transformers for other impedances are available.
Price £135·00

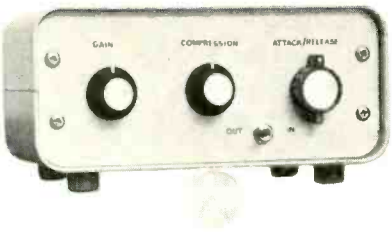
F.E.T. MIXERS AND PPMs

Various types of mixers available. 3, 4, 6 and 8 channel with Peak Programme Meter. 4, 6, 8 and 10 Way Mixers. Twin 3, 4 and 5 channel Stereo, also twin 4 and 5 channel Stereo with 2 PPM's.

VORTEXION LIMITED **257-263 The Broadway, Wimbledon, SW19 1SF**

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

CUT YOUR LEVEL PROBLEMS DOWN TO SIZE; WITH A CHADACRE ELECTRONICS AUDIO COMPRESSOR TYPE 9521



Almost every audio source can benefit from a degree of compression, that is to "tame" the dynamic range of the programme.

Compression will tend to increase the density of the sound, this is due to the fact that the low and medium levels are increased, relative to the maximum levels.

"The Ratio" of the compressor will determine the density, i.e., the rate at which the gain increases: e.g., a ratio of 6:1 simply means that for a 6 dB increase of input signal the resulting output will only rise 1 dB.

The speed at which the compressor reduces the level is termed attack "time", and the optimum attack time for a compressor lies between 1 and 10 Ms.

The rate at which the compressor takes to restore its gain back to normal is termed the "release time".

Both of the above time characteristics are adjustable on the 9521 compressor. They are fast attack/fast release, medium attack/medium release, special attack/slow release. Specially designed for automatic level control of a tape recorder. These "time constants" are selected via a 3-position switch. Also adjustable: input gain control, compression control, compressor in/out* for comparing the uncompressed signal and on/off control* to disconnect the supply.

The uses the 9521 compressor may be put to are very comprehensive. Below are listed just a few.

In a mixing console, where it may be inserted in individual channels between the microphone amplifier and line amplifier. Used in this sphere it will prevent overload distortion of the following stages, and may also be used to create special effects, which may suit the artistic requirements of the programme.

In conjunction with a discotheque system, to give a constant level, with the peak level; the compressor will make the R.M.S. value appear as a constant peak level, thereby packing the maximum "punch" for this type of application.

It may also be used in public address work, where it will compensate for poor microphone technique. Intelligibility may be improved and enable the amplifier to be used at a lower gain setting, with the consequential risk of acoustic feed-back howls greatly reduced.

The world of radio communication may also reap the advantages of the compressor. By applying the 9521 in this field, the "talk power" or intelligibility over a noisy channel is greatly improved, it is preferable to speech clipping, as it does not introduce harmonic distortion.

Finally, it can be effective to the hard of hearing, who may need to listen to the radio or television at an uncomfortably high volume (to others) in order to hear everything. If, however, the dynamic range of the material is compressed, the annoyance factor caused to others by the peak sound levels is reduced.

The 9521 compressor is available either as a Module mounted on a Painton 15-way plug; order 9521/M. Or built in an attractive robust case. The input and output connections are terminated on a Din socket.

The power requirements may be either satisfied from internal batteries† (ample space provided) or an external power supply may be fed into the two banana sockets provided. Order 9521/C.

** Available an cased units only.* *† Two type PP9.*

9521—SPECIFICATION

Power requirements: 18v/4·5mA—30v/6mA.
Input impedance: 50kΩ. Output impedance: 600Ω. Ratio: continuously variable, 1:1 through 6:1. Unweighted noise level: 90 dB. Fast attack/fast release: may be pre-set anywhere between 1Ms and 10Ms, normally set for 10Ms at factory. Medium attack/medium release: 0·5 secs. Fast attack/slow release: attack approx. 3Ms, release approx. 7 secs.*
** Longer release times available on request.*

PRICES

	Quantity	Price	Quantity	Price	Quantity	Price
9521/C	1-4	**£28·50**	5-10	**£26·50**	11-25	**£24·00**
9521/M	1-4	**£19·50**	5-10	**£15·50**	11-25	**£13·50**

CHADACRE ELECTRONICS LIMITED
(AUDIO DIVISION)
43 CHADACRE AVENUE, CLAYHALL, ILFORD, ESSEX **TELEPHONE: 01-550 7119**

Video Spray 90 cleans tape heads- in operation

A quick squirt of Video-spray 90 and your tape heads and gaps are rapidly cleaned. And you can use Video-spray 90 whilst the machine is in operation. It dissolves even hardened dirt by simultaneous physical and mechanical action.

99.8% pure, Video-spray 90 can be used safely with any video or sound recording machine. The spray doesn't attack plastics, is electrically non-conductive and is not inflammable.

Supplied in 2.5 oz and 6 oz. cans. Available through your retailer or direct from:

Special Products Distributors Ltd.
81 Piccadilly, London, WIV 0HL. Tel. 01-629 9556

Rycote Windgags

for Sennheiser 805's 405's

are light weight **POLYTHENE** almost indestructible

and other capacitor microphones

Write to **RYCOTE,** POOLHEAD LANE, TANWORTH-IN-ARDEN, SOLIHULL, WARKS.

or leave your name and address on our recorder on Earlswood 2339

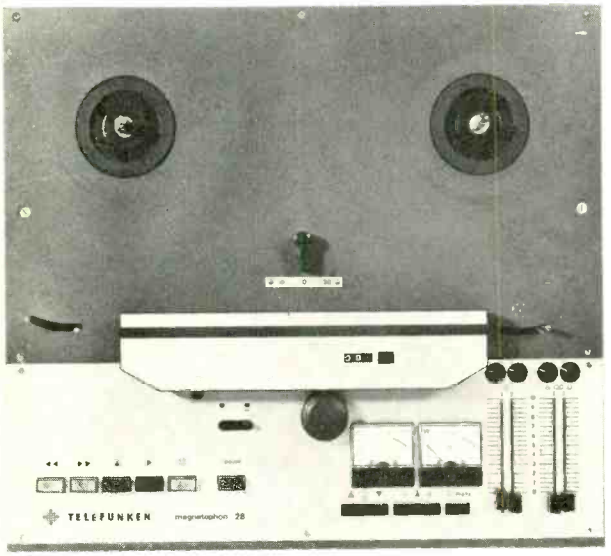
STUDIO INSTALLATIONS

T. B. Technical, *Audio Systems Consultants,* can provide engineers for planning, installation, and maintenance of all professional audio equipment.

Also
Audio Test Equipment Hire

T. B. TECHNICAL LTD.
90 Wardour Street, WIV 3LE
01-437 1892/3

TELEFUNKEN M28A £633



MAGNETOPHON M28A professional tape recorder by Telefunken, the company who made the world's *first* tape recorder.

● **Three-motor tape transport** at 3¾ and 7½ ips ensuring maximum speed constancy.
Fully comprehensive mixing facilities.

● **Solid state electronics** are used throughout. Modular construction ensures trouble-free maintenance and replacement of parts.

● **Relay operated transport control** operated by illuminated push buttons requiring only fingertip operation.

● **Two-channel monitoring and VU-meter amplifier** can be switched to two modes. In the 'before-tape' mode the amplifier is connected to the output on the mixer, while in the 'after-tape' mode it is connected to the output of the replay amplifier. Two large VU-meters calibrated to international standards are provided.

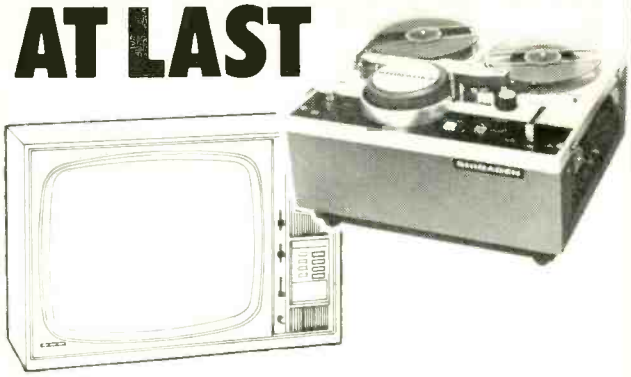
● **Interchangeable head assembly** comprising half-track, stereo, erase, record and playback heads, is mounted on a single rigid plate fixed to the main chassis. It is normally not necessary to replace or adjust heads during the normal life of the machine.

Broadcast studio versions. Models 28B and 28C are provided with tape speeds of 15 and 7½ ips, but have no mixing or monitoring and VU-meter amplifier. Model 28B is equipped with full-track heads.

Model 28C has two-track heads and track selector switch.

A.E.G. Telefunken
A.E.G. House
2-4 Clerkenwell Green,
London EC1
Tel: 01-251 0244

AT LAST



A COLOUR PACKAGE DEAL

★ that's based on the new E.I.A.J. standard

★ is switchable to PAL-SECAM

★ available now, and guaranteed not to date.

The delightful duo in this outstanding colour package are the new Shibaden SV 620 Colour Video Tape Recorder and a 19″ Monitor. The SV 620 produces beautiful high fidelity colour pictures using a very efficient video head with a newly developed HPC ferrite.

The SV 620, which has a playing time of 70 minutes is compatible with other Japanese machines which are being introduced to Europe which means that there should be standardisation between different manufacturers.

The 19″ Colour Television monitor which completes the package is a superbly engineered push-button set designed to give a very sharp colour picture. Fully transistorised, styled in teak. Available as receiver/monitor or monitor only.

That's the perfect colour package. The Recorder weighs only 35 lbs and costs £595. The Monitor weighs 62 lbs and costs £220. Together . . . 97 lbs for only £815.

A 15″ Monitor at £195 is also available.

Live demonstrations arranged in London area immediately or visit our showroom.

AND NOW WE'VE SOLD YOU THAT

we'll show you how to use it to get the best results, and give you the best back-up service in CCTV.

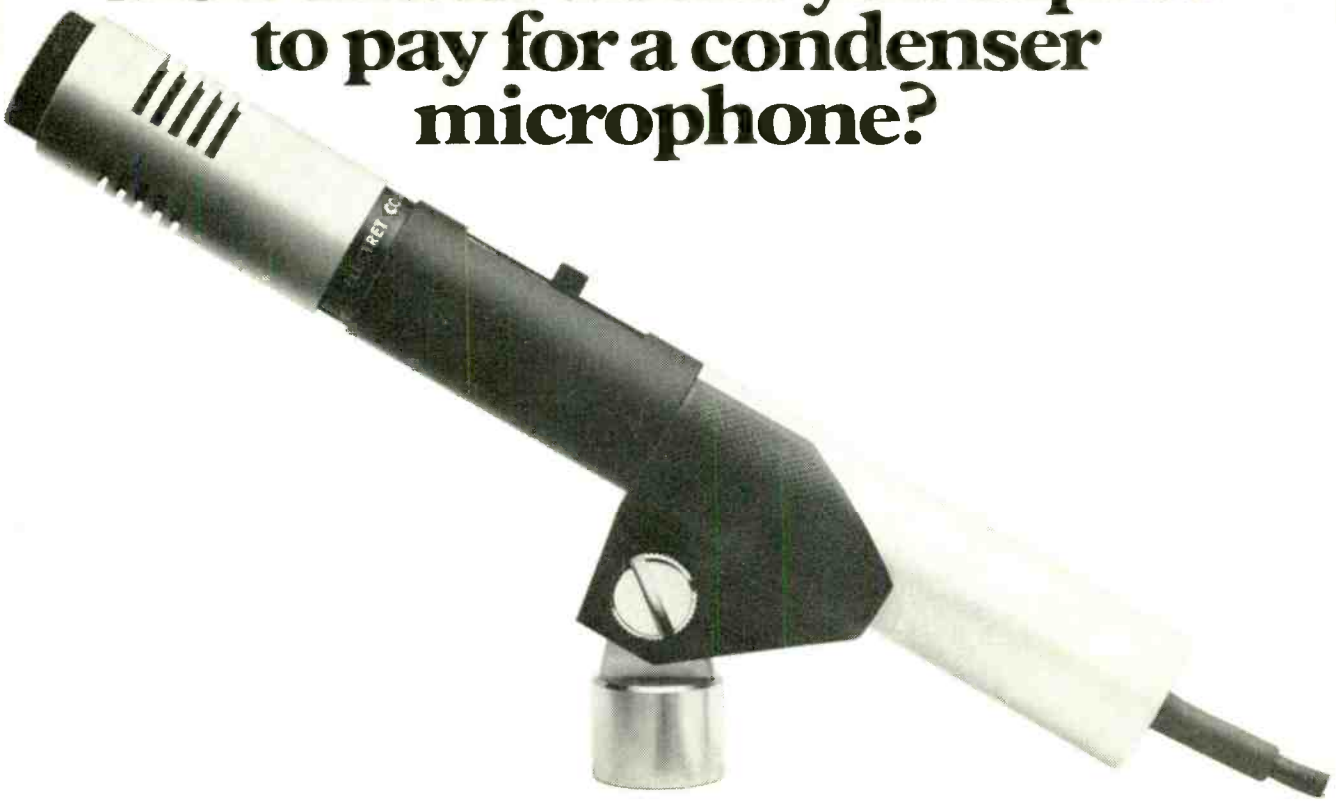
We'll also help out if you need extra production facilities—just call us. We learnt all about CCTV the hard way and being lazy we know the easiest way to get good results. No matter what equipment you've got, or the problems, we can help. And if you want more—or less—than our colour package deal, we can advise you from the simplest set-up to the most complex.

Contact

ACTION VIDEO LTD
45 Great Marlborough St., London W1.
Telephone: 01-734 7465/6/7

PRODUCTIONS • SALES • SERVICE • HIRE

How much would you expect to pay for a condenser microphone?



Our C096 is just £15.*

It's that inexpensive because of what you don't get.

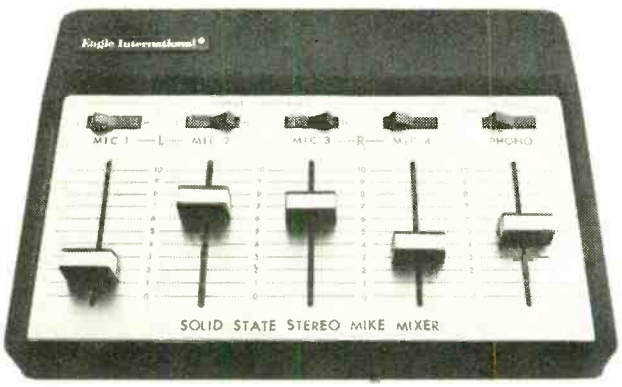
It uses a lightweight diaphragm of polymerized film powered by a single dry cell and built in low noise FET pre-amplifier.

This dispenses with the costly and bulky power supplies usually associated with ordinary condenser microphones.

What you do get is a cardioid response of better than – 20 dB.

You get equally good value from our MP12 Stereo Mike Mixer at £26.40.*

It offers an advanced transistorized circuit incorporating the latest type of silicon transistors for low noise performance from internal batteries.



These batteries will give you well over a month's normal daily use.

Slider controls operate all four inputs independantly and the MP12 is switchable Stereo or Mono.

If you would like more details of other Eagle units, send for our catalogue.

That won't cost you anything.

C096 Specification

Frequency Range: 30 – 16000 hz
Sensitivity: – 70 dB
Output Impedance: 600 ohms.
Power Source: IHP7 Dry Cell or equivalent mercury
Overall Consumption: 800 micro amps
Dimensions: 22 × 108 mm.

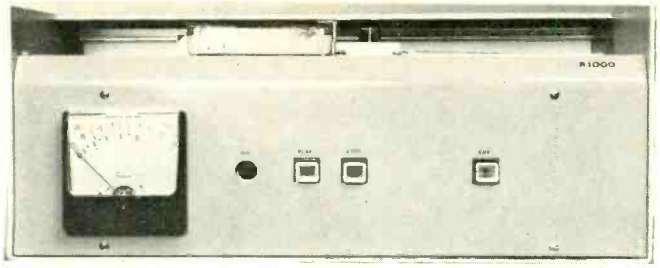
MP12 Specification

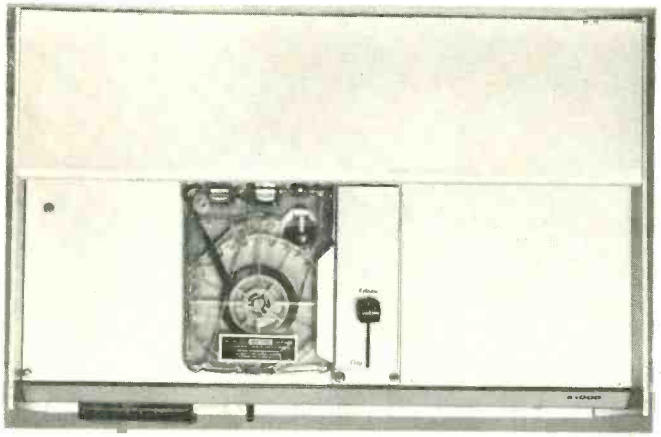
Inputs: Microphone - 4 switched inputs (high or low impedance)
Phono - 1 stereo input (magnetic)
Input Impedance: Microphones - 600 ohm (low) 50 Kohm (high)
Phono - 47 Kohm RIAA
Input Level: Low Impedance - 72 dBV at 1000 hz
High Impedance - 55 dBV at 1000 hz
Phono Stereo - 55 dBV at 1000 hz
Freq. Response: Microphone - High or low Impedance 30 to 20,000 hz ±2 dB
Phono Stereo - 30 to 20,000 hz ± 1 dB (RIAA)
S/N Ratio: Microphone - High or low impedance better than 48 dB (max. volume)
Phono Stereo better than 52 dB (max. volume)
Output Level: 500 mV at 47 Kohm
Batteries: 2 × PP3 or equivalent
Current Consumption: 2.8 mA
Semiconductors: 12 Low Noise Silicon Transistors
Dimensions: 250 mm. wide × 190 mm. deep × 45 mm. high
Net Weight: Approx 1.7 kg.

* Recommended retail price

Eagle International

Dept. P.4., Eagle International, Precision Centre, Heather Park Drive, Wembley HAO ISN Telephone 01-903 0144





broadcast standard cartridge units from £220.00

Using the Telex NAB standard cartridge, and Telex heavy duty transports, the Avcom Sonifex R1000 series have been designed to meet the rigorous demands of continuous broadcast use.

In five basic model configurations, from the R1000P 'play only' to the R1000RPC 'play, record, cue play and record' with 100ms stop/start time, flutter at 0.3% maximum and built-in long term reliability, the R1000 series must be considered for all cartridge applications.

Avcom Systems Limited

Newton Works, Stanlake Mews, London W12 7HA *01-749 2201*

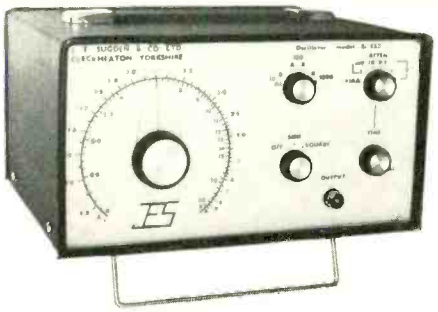
High speed, high quality cassette and reel to reel duplicating

AUDIONICS
160 Ewell Rd Surbiton Surrey Tel: 01-390 0291

AUDIO CONNECTORS

BROADCAST PATTERN JACKFIELDS, JACKCORDS PLUGS & JACKS. QUICK-DISCONNECT MICROPHONE CONNECTORS. AMPHENOL (TUCHEL) MINIATURE CONNECTORS WITH COUPLING NUT. HIRSCHMANN BANANA PLUGS & TEST PROBES. XLR COMPATIBLE IN-LINE ATTENUATORS. LOW COST SLIDER FADERS BY RUF.

FUTURE FILM DEVELOPMENTS LTD.
90 Wardour Street WIV 3LE
01-437 1892/3



JES AUDIO INSTRUMENTATION

Illustrated the Si453 Audio Oscillator

SPECIAL FEATURES:

★ very low distortion content—less than ·03%
★ an output conforming to RIAA recording characteristic
★ battery operation for no ripple or hum loop
★ square wave output of fast rise time

£40·00

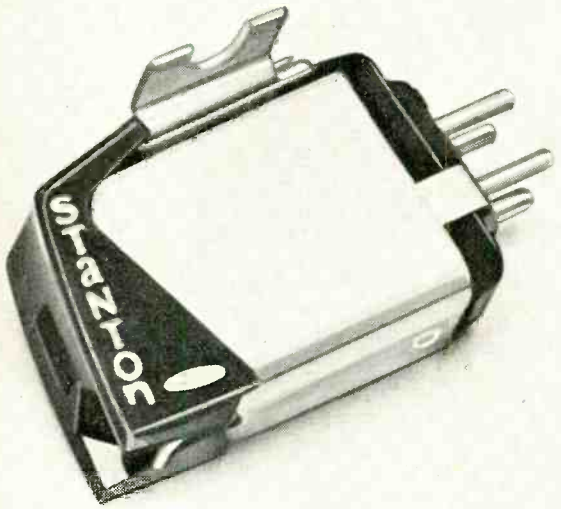
also available

Si451 Millivoltmeter
★ 20 ranges also with variable control permitting easy reading of **relative** frequency response **£35·00**

Si452 Distortion Measuring Unit
★ low cost distortion measurement down to ·01% with comprehensive facilities including L.F. cut switch etc. **£30·00**

J. E. SUGDEN & CO. LTD., CARR STREET, CLECKHEATON, YORKS. BD19 5LA. **Tel: 09762-2501**

STANTON CARTRIDGES:



the starting point of fine hi-fi

Sound reproduction from a record can only be as good as the cartridge which tracks it: with the Stanton 681EE you ensure the best. The Stanton 681EE meets the most exacting requirements of the professional user and the discriminating enthusiast.

The Stanton 681 Calibration Series has an amazingly low-mass moving magnetic system which weighs only 1/5 or 1/10 of ordinary pickups. Its frequency response from 10 to 20,000 Hz is virtually a straight line. Every 681 is guaranteed to meet the specifications within exacting limits and the most meaningful warranty possible – individual calibration test results – comes packed with each unit.

Ask for a demonstration of the Stanton 681EE at your local dealer, or write for details and specifications, plus information about the Stanton 500 Broadcast Standard Series. Trade enquiries welcome.

WILMEX LTD
Stanton Division, 24/26 Ensign Street,
London E1 Telephone: 01-949 2545

Make your own magnetic shields in minutes

Telshield is an efficient, easy to use, ferromagnetic foil which provides a simple, quick and economical answer to shielding components from unwanted and spurious signals. It is easily cut with scissors, formed into cones or cylinders etc., which can be fixed with adhesive tape clips or spot welds to provide a permanent efficient shield.

When formed into a complete enclosure around a device, it carries the stray fields around it because of its high conductance to magnetic flux.

It is especially useful for experimental, small-run, research and development applications which do not merit the tooling involved in the production of fully fabricated shields.

Telshield is supplied in convenient packs in a standard thickness of 0·5mm., in widths of 150mm, 50mm and 25mm, 3·66m in length, costing about £5.00

Telcon have full facilities for fabricating shields to customers' own specifications and also offer a range of standard boxes and cans.

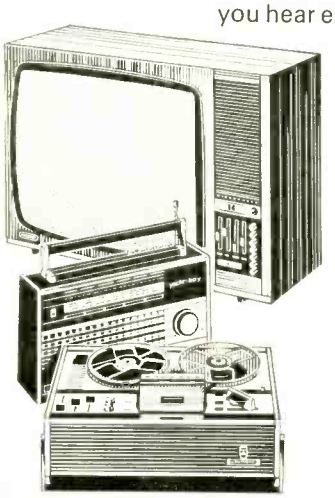
Please send for further information

TELCON

Telcon Metals Ltd
Manor Royal, Crawley, Sussex
Crawley: 28800

Sounds too good to lose

If anything is worth recording it's worth recording well. And that means getting a Grundig to do the job properly. A precision-built reel-to-reel tape recorder with a moving-coil microphone designed and made to hear as clearly as you do. A machine with a recording head precision-engineered to make sure every sound is recorded exactly as it comes in. A machine with a strong steel chassis to protect all that superb circuitry. Slider controls, like the ones you see on big studio consoles, for extra precision in setting. And for playback, a full-sized loudspeaker to make sure you hear exactly what you recorded with nothing missing! In short, a tape recorder designed by perfectionists, built with precision, rigorously tested, right for you for life. Worth while?
Just lean back and listen.



GRUNDIG

The difference is incredible

Precis

ARTICLES PRINCIPAUX

RUBRIQUES REGULIERES

SPEZIALARTIKEL

STANDIGE RUBRIKEN

ARTICOLI SPECIALI

ARTICOLI REGOLARI

ARTICULOS SELECCIONADOS

ARTICULOS DE SERIE

News

IEA Exhibition '72

THERE WERE about 700 exhibitors at this year's Instruments, Electronics and Automation Exhibition. Even so there were few items of interest to those in sound engineering that would not apply to every other branch of electronics as well. The exhibition was held at Olympia between May 8 and 12. Heathkit were showing most of their test gear as well as launching a new £75 desk calculator and demonstrating something from their hi fi range. Heath are now part of the French Schlumberger group.

Livingston Hire put managing director David Rennie's 1925 three-litre Bentley on their stand because the range of equipment they hire out, about 600 instruments, would be 'too large to show'. It includes Nagras, oscilloscopes, wattmeters, B&K test gear, sound level meters and so on.

Jermyn make transistor hardware but none of that was in evidence either. Instead another managing director paraded his plaything, this time a 240 mm gauge model of an LMS 4-4-0 locomotive and tender. Other, more vulgar ways of attracting attention centred around female playthings; one firm offered a girl for a night (sorry, evening) at the Savoy if you bought the lucky ticket. One poor wretch was dressed in restoration costume and made to stand in a phoney Stuart setting next to a barrow of relays. Above her was a sign which said: 'Ask Nellie what she's doing after the show'. It must have been even tougher going than it looked. The last time she was seen she came skidding on to an adjacent stand asking if someone would please give her a drink. Then she disappeared behind a cardboard partition and, to our knowledge, didn't resurface.

New developments being aired on the Mullard stand included a channel intensifier tube originally developed for the army. The device, which has now been declassified, has an optical gain of about 10^5 and is claimed to produce a good picture in starlight. One advantage of the tube is that, unlike cascade tubes, its image does not dazzle or black out in bright light. An image of the scene is formed by an external lens on the photocathode. The electrons thus emitted from the photocathode are focused electrostatically on the channel multiplier plate, just as they are focused in an electron microscope.

Electrons travelling through the channel electron multipliers increase in number and strike a phosphor screen, where they reproduce the scene. The serial number of the tube is *XX1241*.

Sonnenschein launched a new series of rechargeable batteries at the exhibition. What makes the Dryfit PC and ST batteries special, apparently, is that they can be stored, charged or discharged, in any position. The new ST battery is specially designed to work in constant charge conditions, such as in alarms.

The batteries are available from two to 12 volt capacities, with ampere hour ratings from one to 20, and in four different terminations from F. W. O. Bauch Ltd, on whose stand they appeared.

Also on the Bauch stand were examples of the EMT range of audio cables. These are available in two types of shield: a single and a double stage Reusen shield. The first is claimed to be effective up to 50 MHz and is recommended for signals of 0.5V or more. For lower voltages the 500 MHz double shield is recommended. The cable is available, according to the catalogue, in 15 varieties, ranging from single pair to ten pair with a few odd combinations in between.

Also on the Bauch stand was a selection from the Switchcraft connectors they distribute. These are now available with five contacts, on a gooseneck and in microphone cord plugs with an on-off switch.

Penny and Giles were exhibiting some of their conductive plastic precision wirewound potentiometers as well as some pressure and acceleration transducers and some display instrumentation. Naturally enough there was only a small display of slider faders and they had no new products to offer. Penny and Giles do a low cost fader that is available in ten linear and eight log output units and which their brochure claimed were available 'virtually ex-stock'.

On the Radford stand there was a pre-production *Series Three* transistor voltmeter, low distortion oscillator and distortion measuring set. These replace the valved *Series Two* equipment. The oscillator has a frequency range from 6 Hz to 200 kHz and distortion of less than 0.005 per cent from 20 Hz to 20 kHz. The distortion measuring set measures those distortions and noise down to 0.001 per cent of the input signal amplitude over the range 20 Hz to 20 kHz. The voltmeter measures from 0.1 mV to 300V in 14 ranges from –80 to 50 dBm.

Concern for the much talked about but inevident improvement of the 'quality of life' was shown in a number of exhibits. Significantly, the Department of the Environment was represented, with a stand showing methods of measuring to the measurement of water pollution; ominously the Department was in the 'late entries' section of the catalogue. Altogether there were more than 20 entries under 'pollution recorders'.

B & K had three exhibits on their stand, one of which was the noise dose meter. This measures instantaneous sound levels and reads out a figure which represents the equivalent continuous noise level over the period for which the machine has been in use. It is assumed, of course, that the effect noise is produced by the length of time at the equivalent noise level and not by subjection to a series of peaks. The other two items on the stand were an electronic digital event recorder and a hydrophone, which measures sound levels underwater—the only place there seems to be any work these days.

Medway at Thames

THAMES TELEVISION entertained about 200 members of the British Kinematograph, Sound and Television Society on May 3 with a lecture about and demonstration of what they call the 'Medway' sound dubbing system. The name is an acronym for Music, Effects, Dialogue way. The system was developed after Thames' successful sale of television programmes to foreign companies. Dialogue had to be translated into other languages without any change in the music or effects.

They have done it by using a six track sound recorder. Each of the six tracks is allocated a particular part of the sound to be broadcast. Track one is dialogue, two is music, three is effects, four is a composite track, five is miscellaneous and six is for synchronisation.

Dialogue is recorded first, after mixing, when the programme is being made in the studio. The sound and vision are then edited on the vtr. The audio is then recorded on track one of the six track tape machine and the vision is recorded on to a helical scan vtr. A sync generator records a pattern on to track six of the sound machine, the cue track of the vtr and the audio track of the helical scan machine.

Effects, music and miscellaneous tracks are then added, using the helical scan video copy to monitor the vision and synchronising sound and vision with track six. The three tracks are then mixed for level, again using the helical scan monitoring system, and the final sound mix is recorded on track four, the composite track. Dolby processing is used to record on to tracks one, two and three and five and so deprocessing is used before the mix, after which Dolby processing is used again for recording on to track four. The English version is then replayed as a complete programme simply by playing the composite audio track and using track six for sync.

For foreign language broadcasts the music, effects and miscellaneous tracks are remixed with the changed dialogue and cued up from the composite track of the English recording. This is the advantage of the Medway system, that the sound is stored separately and any of its three components can be changed without affecting the others.

AMITY 24 Track TAPE RECORDER on 2" Tape Transport

hear it perform at the **APRS Exhibition on June 23-24**

Stand No. 55

FEATURES

- Built-in Dolby (A) noise reduction systems an alternative extra—spacesaving and much less expensive.
- Variable capstan speed.
- Heavy *cast* alloy deck plate.
- Printed circuit spooling motors.
- Electronically controlled braking.
- Direction sensing.
- Tension sensing (ensuring constant tape tension from end to end of spool).
- Plug in tape logic cards.
- All deck functions can be remotely controlled.
- All electronic functions remotely controlled.
- Separate aural and visual monitoring.
- Console mounted with teak veneered side panels.
- British made and designed throughout.
- No import duty.
- Our organisation ensures immediate service anywhere.
- It is possible to expand the number of tracks and modules from your basic purchase due to the tape recorder's special method of construction.

This is the first time the new multi-track Amity tape recorder is being displayed. The machine is available in mono/stereo 4, 8, 16, 24 and 32 tracks. The transport is completely designed and built by Amity throughout and incorporates many significant features. The basis of the transport is the aluminium alloy casting, extensively ribbed for maximum rigidity, stress relieved after casting, then machined off flat on all mounting faces to ultra precision tolerances. The tape drive in the play and record modes utilises a single hysteresis synchronous capstan motor, the shaft of which is extended upwards to form the capstan spindle, and is ground between centres for maximum accuracy. Tape tension in this mode is held constant either side of the capstan by sensing arms linked to photo-electric devices which automatically control the torque to the relative spooling motor.

The spooling motors are of the 'printed circuit' type. These were chosen for their power/weight ratio and acceleration and braking characteristics. The transport is controlled from a completely solid-state logic circuit, all functions of which can be operated remotely. In addition to the normal logic functions, i.e. play, record, rewind, fast forward and stop, the transport also has the following facilities: a stand-by mode in which the brakes are released and the tape lifters are withdrawn to permit tape loading and hand cueing, speed change switch—mains on/off switch—master electronics monitor buttons (e.g. line-in or replay) and the capstan supply switch to select either fixed or variable speed capstan operation, together with the vari-speed control knob.

The mode of operation of the electronic modules is determined by selection of the appropriate illuminated push button on the front panel. These buttons are of a single shot nature and operate plug-in relays mounted on the rear of the module. Adoption of this system means that the entire tape machine can be operated by remote control. The two upper push buttons on the modules are 1) monitor line in. 2) Replay Channel mode selection consists of 4 buttons. 3) Record. 4) Ready. 5) Safe. 6) Sync. A unique feature is the provision of a local record button on each channel so that channels may be selectively 'dropped-in' to the record mode independently of each other whilst the tape is in motion in the 'play' mode. Alternatively, any number of channels previously selected to 'ready' may be dropped into the record mode simultaneously by pressing the master record button on the tape transport. An additional switch on the electronics modules controls the V.U. meter function independently of the aural monitoring so that the recording engineer may listen to the incoming line but watch the off tape signal on the meters. Positions on this switch represent Bias-Erase-Input-Play. On modules incorporating the Dolby (A) system there is an extra two push buttons for noise reduction in/out and Dolby tone; also a fifth position on the V.U. meter switch for Dolby calibration. All pre-set controls on the modules are mounted on the plug in amplifier cards. These cards carry all the electronic components for each particular channel so that an entire module need hardly ever require replacement. All printed circuit cards and edge connectors, plugs and sockets, and relays employ gold contacts for maximum reliability. Balanced outputs are standard. Plug-in transformers can be supplied should balanced inputs be required.

Write for details to : **AMITY Recording Development, 3/4 New Compton Street, W.C.2**

continued

The synchronisation system they have used at Thames is something they call a Teddington Lock. Generally the machines which Thames have been using will synchronise within a second. They use a ten bit binary code which repeats itself after 2048 clock pulses. With a word frequency of 100 words a second this means the machines have a margin of ten seconds in each direction.

Other features of the system include a cueing number which appears in the picture when the picture is transferred to helical scan and which can be used for reference, and a centre zero meter which tells the engineer how far, if at all, the sound and picture are out of synchronisation.

John Tasker, Thames' head of sound, explained the system with the help of Gunter Kahn, Senior Sound Planning Engineer, and Tom Slowley, Senior Sound Development Engineer. Other staff who participated in the exercise were Ron Ferris, Sound Supervisor, and Roger Holmes, who worked a cctv camera. Leslie Hill was at the piano.

John Tasker explained that the system had been in general use for about a year, and gave us examples of some of the programmes that had been using the system, which was first used for a Sherlock Holmes episode and lately for 13 half-hour Tony Bennett shows from The Talk of the Town. He also played some stereo they had recorded from the shows.

John Tasker also explained what the new system meant to Thames in production terms. Discounting extra tape costs and assuming an average requirement for two dramas and two light entertainment programmes a week, the system saved about 1200 hours a year in vtr time but added about 500 man hours elsewhere at a cost of about £500 a year, so the system seems, by a small amount, to be paying its way. Added benefits, added John Tasker, included giving Thames a definite programme style and a rejuvenated training programme.

The Fiddler wins an Oscar

AN OSCAR was recently presented to David Hildyard and Gordon McCullam for their work on the film *Fiddler on the Roof*. The audio side of this production was described in April to July 1971 STUDIO SOUND by Tim Blackham.

People

ERIC A. SAWKINS has been elected 1972 to 1973 president of the Association of Public Address Engineers. Formally vice-president of the Association, Mr Sawkins is sales manager of the Westrex Audio Communications Division. He lives at Ongar.

Former professional products manager at EMI, Michael Ford has joined Sound Techniques as sales manager. Mr Ford has had 12 years' experience in the audio industry.

Four new appointments have been made within EMI's Central Research Laboratories: J. A. Lodge is now assistant director, audio and television research, while I. J. P. James becomes scientific adviser on television systems. Mr James remains technical director of EMI's Sound and Vision Equipment Division. R. J. Froggatt has become assistant director, systems research, and I. D. C. Burridge is the laboratories' new manager of finance and administration.

R. J. T. (Dick) Brown has retired from Agfa-Gevaert. He is succeeded as manager of the Motion Picture Division by Eric Drew, his assistant for some ten years.

Kilowatt amplifier from Crown

A HIGH POWER amplifier capable of delivering 1 kW rms into a 4 ohm load is now being manufactured by Crown International and imported by Macinnes Laboratories. The *M600* reaches this power within ±1 dB from dc to 20 kHz at 0.05 per cent thd. Intermodulation distortion is better than 0.1 per cent at all levels from 100 mW to 1 kW. The *M600* incorporates a two-speed fan for cooling and costs £730. Further data: Macinnes Laboratories, Stonham, Stowmarket, Suffolk.

Light modulator

UNI-FI ELECTRONICS Ltd, 65 East Hill, London SW18, have introduced a control system capable of modulating three lighting circuits to the relative bass, middle and treble levels of in-going audio. In addition, it may be operated from an internal modulating signal generator varying in light intensity from two fluctuations per second to one every two minutes. Each lighting circuit may be independently controlled. The *Varicolour* produces 1 kW from each output and sells for £85.

Beaverbrook radio seminar

SOMETHING LIKE 300 hopeful commercial radio proprietors, advertising agency representatives and their clients, students and 'other interested parties' attended a seminar organised by Beaverbrook Commercial Broadcasting Ltd on May 2. The event, held at the Grosvenor House Hotel on Park Lane, included a lunch attended by Sir John Eden, the Minister for Posts and Telecommunications, after which he said he hoped to announce the locations of an additional ten stations to the five already announced.

The minister, in his speech, declared that commercial radio would have to be truly local.

There were entertaining moments; a Scots Canadian broadcaster, Jack Webster, described how he did his four hours a day, six days a week telephone 'hot line' programme. The tapes he played, though poor in quality, were well worth listening to.

Those involved in commercial radio are very sensitive about their ability to provide a good news service. Consequently, delegates were treated to excellent hourly news bulletins that were so elaborate as to be almost self conscious. At one point the chairman, Mr Terry Bate, jumped on to the platform to announce, with barely suppressed glee, that we'd all heard about the death of J. Edgar Hoover 40 minutes before anybody else. Hoover couldn't have timed it better. In spite of the expense involved which, with reports from Washington, Vietnam, Hong Kong and Piccadilly, must have been considerable, one was meant to draw the conclusion that it was a foretaste of a typical commercial radio news bulletin. One gentleman nearly spoiled the self-deception by asking, towards the end of the day, if there would really be any need for all this news. The question produced a masterpiece of embarrassed evasion from chairman Dimbleby.

Mr Milt Klein, a producer for an advertising agency, told everyone that the secret of success was to exploit love, honesty, rock music and children. The audience cooed and gurgled over examples, described as prize winning, of Mr Klein's art, which same examples *The Times* called 'excruciating' the next day. Mr Klein, in conjunction with an earlier remark made by Terry Bate, depleted your correspondent's enthusiasm for commercial radio. In the course of a lecture, Mr Bate produced a slide with the words 'compensating salesmen' on it and said: 'This is a terrific subject. I love this one, it's all about money and getting paid.'

Two Ampex *AG 440B* stereo record/replay machines were being used in the news studio. Loudspeakers were by JBL, mixers by Neve, speakers by Lockwood and tape cartridge equipment by Plessey. Mobile radio facilities were provided by Pye. Those contributing to the news facilities were the American Broadcasting Corporation, The Evening Standard, radio station CHQM of Vancouver, Associated Press and, especially, the GPO.

Mock-up of a commercial radio news studio. David Dimbleby at the telephone.

3M cassette duplicating tape

DESIGNED FOR C60 cassette production, Scotch *277* 3mm duplicating tape is now available from 3M on disposable lightweight hubs. A newly formulated back coating minimises the physical distortion which has previously presented difficulties in cassette duplication. Scotch *277* is electrically conductive to prevent static causing dust attraction. Further data: 3M UK Ltd, 3M House, Wigmore Street, London W1A 1ET.

Amalogne department

OUR ADVERTISING people apologise for the misprint on page 17 of June STUDIO SOUND. For *amalogne* read *analogue* in the reference to Alice/Stancoil research into amalogne to digital converters. More forgiveable is an editorial error in our May *News* column; the new telephone number of Macinnes Laboratories is Stonham 486. Apologies to whoever lives at 485.

When only the very best is good enough.

The Koss ESP9 Electrostatic Studio Monitor.

Send for leaflet on entire range of KOSS-prices from £9½ to £69

name .....
address .....
county .....

KOSS TMD Ltd 11 Redvers Rd London N22 Tel-01 888 0152

The Mirisch Production Company presents a Norman Jewison film "Fiddler on the Roof" released through United Artists.

Great Performances

Oscar winning "Fiddler on the Roof" starring Topol is one of the many films made at Pinewood. The award for Best Sound went to G. K. McCallum and D. Hildyard. Below is the new 30 input dubbing console, with 6 output groups, 6 sub groups and 4 echo groups designed and built by Neve for Pinewood and used extensively on this great film.

Neve

Rupert Neve & Company Ltd.,
Cambridge House.
Melbourn.
Royston.
Hertfordshire, SG8 6AU.
England.
Tel: Royston (0763) 60776 (10 lines)
Telex: 81381

Rupert Neve of Canada Ltd.,
7528 Bath Road,
Malton.
Toronto, Ontario.
Canada.
Tel: 416-677 6611

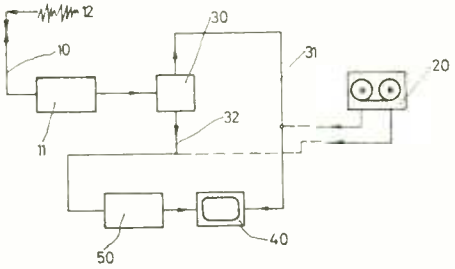
Rupert Neve Incorporated,
Berkshire Industrial Park.
Bethel,
Connecticut 06801.
U.S.A.
Tel: (203) 744 6230 Telex: 969638

Patents

LF video transmission

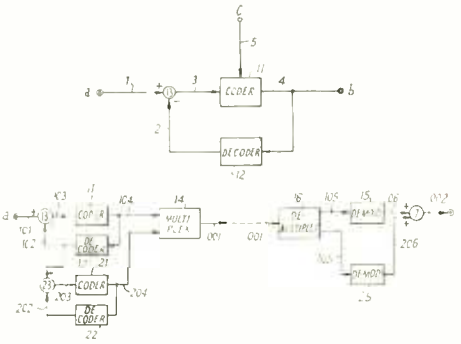
THE MESSERSCHMITT company have patented a method of transmitting still pictures over channels with a bandwidth of only 30 Hz. (BP 1269186) the invention sacrifices a loss in the amount of video information transmitted per unit time in order to achieve this. 26 kHz of the bandwidth is used for video information and the remainder for audio. The domestic receiver has to be provided with image storage units and fast and slow sweep generators in order to receive the pictures.

The image storage units convert the scan rate of the received picture from about one frame per second to about 25 frames per second. The diagram shows what happens to the received signal. The 30 kHz signal is received on a modulated carrier wave in the normal way by the aerial, 10. An hf receiver and demodulator 10 which gets rid of the carrier and the signal is then filtered at 30 and divided into a video and an audio part, 32 and 31. The information can then be viewed on a modified television receiver, or it can be recorded on an ordinary (?) tape recorder, 20. The audio part is fed



directly to the television set but the audio information is passed to the image storage unit 50 and then to the television receiver, with a picture at the normal rate of about 20 pictures a second.

The Nippon Electrical Company have also patented a method of transmitting television pictures with a reduced bandwidth (BP 1269693). There are two methods of modulating a television picture; pulse code modulation (pcm), and delta modulation. Delta modulation is more economical, being less costly in terms of apparatus, but requires a bandwidth about 1.6 times as great. The bandwidth is needed for the abrupt changes in luminance level at the points where white meets black, though there are few places where these occur on any given picture. Also the human eye is more sensitive to moderate changes in luminance level than those where there is sharp contrast. The Japanese invention relies on this fact by allowing 100 or more quantisation steps where there is a



need for them, i.e. in the moderate light level changes, reducing the number at the points of high contrast requiring large bandwidth.

The conventional delta modulator is shown here. The input signal 1 has subtracted from it the output of the decoder 12. The signal 3 is then passed to the coder, which gives out a '0' or a '1' depending on the polarity of the difference signal 3. The decoder 12 is an integrator which produces an analogue signal proportional to the '1' or '0' signal it receives from the output 4.

The Nippon arrangement consists of two such delta modulators, the outputs of which are time division multiplexed at 14. The first delta modulator responds to small changes in levels and has a sampling frequency about half of that required to respond to the most abrupt changes in video level. Arranged in this way, the second delta modulator, which has a quantising step several times larger than that of the first delta modulator, handles those signals which the first delta modulator cannot follow. Thus it delta modulates what could be called the overload component of the signal. At the receiving end, the two signals are obtained separately and then recombined to give the correct luminance signal at less cost in bandwidth.

Tape quality monitor

3M HAVE taken out a patent (BP 1269151) for a method of measuring the quality of tape. The patent refers to videotape but the method could also apply to audio tape. The basis of the system is that the rate and duration of dropouts are measured. Allowance is made for the learning time of the person watching the videotape output (about 16 seconds) and the time over which they forget the last dropout that occurred (about 30 seconds). The dropout has to last more than 5 μs before it becomes visible.

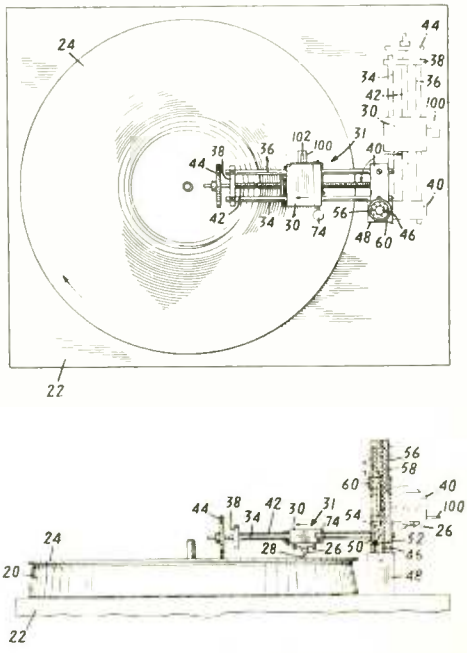
The circuit for the monitor consists of a device which emits a pulse every time there is a dropout of greater than 5 μs duration and integrates the pulses to obtain analogue signal proportional to the rate at which the pulses occur. This is followed by a second circuit which integrates the output of the first circuit with a charging time constant between ten and 20 seconds and a discharging time constant of between 14 and 30 seconds. If the dropouts occur at more than a certain rate, all the integrating circuits are discharged; otherwise they would be continuously charged at a high value. It is suggested that a pen recorder be used with the readout from the second integrator and that any charts made with a particular length of tape should be kept with the tape for future reference. The patent goes on to describe the means by which the readout is calibrated using a pulse signal generator.

An automatic gain control stabilises the input to the detector without affecting signals of the short duration of dropouts. The detector emits the dropout pulses and is designed according to the circuit of BP 1145345. The chart driver circuit contains the two integrators, the output of the last being fed to the chart recorder.

Radial pickup arm

RADIAL PICKUP arms have been an elusive ideal for many years now. The advantages claimed are that they would eliminate tracking error, free the stylus of the burden of propelling the

continued 27



SOMETHING NEW!

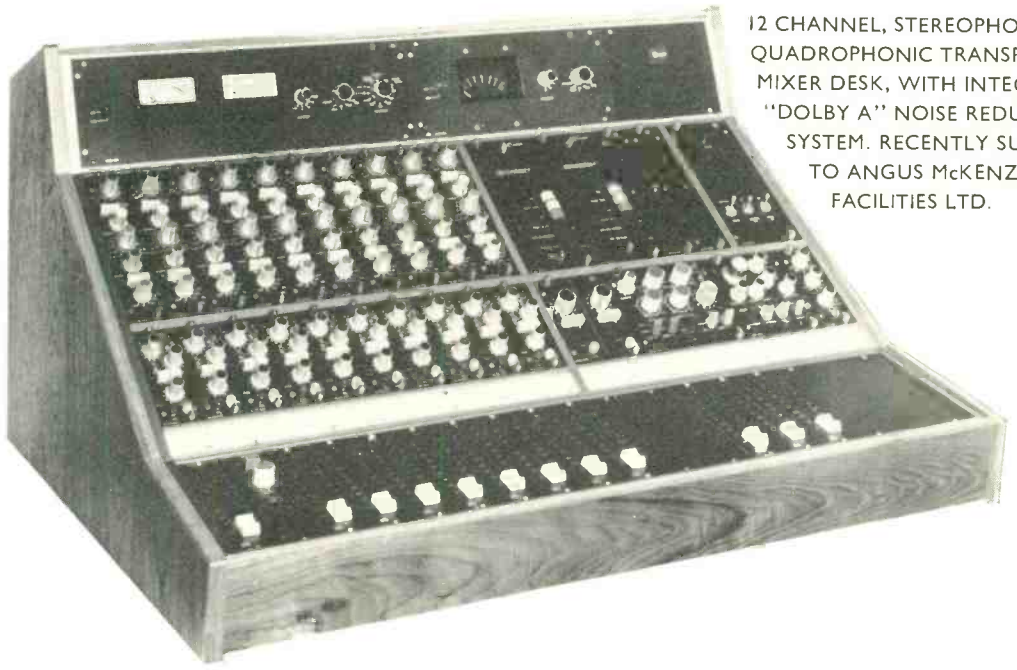
6 INPUT 100 STEREO AMPLIFIER

- ★ All modular construction 19in rack, 3 unit high
- ★ Interchangeable plug-in inputs (gold plated contacts)
- ★ All important pre-set gain (40 dBs variation) accessible from front
- ★ Pan (stereo width) control on each input
- ★ High signal level 'op amp' mixer, with separate Bass and Treble controls for music inputs
- ★ 80 watt R.M.S. modular stereo power amplifier with transistorised short circuit protection
- ★ Circuits designed and produced to professional standards

AREAC +− 1 0 Reg. Trade Mark

AREAC Ltd, Summit Gardens, Halesowen, Worcs

021-550 2868



12 CHANNEL, STEREOPHONIC/ QUADROPHONIC TRANSPORTABLE MIXER DESK, WITH INTEGRAL "DOLBY A" NOISE REDUCTION SYSTEM. RECENTLY SUPPLIED TO ANGUS McKENZIE FACILITIES LTD.

CALREC MIXER DESKS — THE PROFESSIONAL'S CHOICE

CALDER RECORDINGS LIMITED, REGENT STREET, HEBDEN BRIDGE HX7 7DG Phone 042-284 2159

Southern Distributors: **Beyer Dynamic (GB) Ltd., 1 Clair Road, Haywards Heath, Sussex** Phone 51003

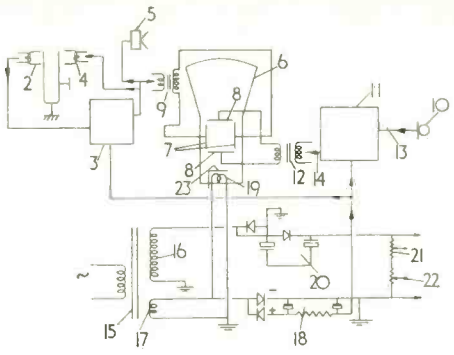
continued

pickup, eliminate the resonance between the pickup mass and the suspension compliance, and make it possible to play records in conditions of vibration or tilt or both.

CBS have patented such an arm (BP 1270369). In their invention, the pickup is mounted on a carriage 30 which progresses along a threaded rod 42. The rod terminates in a wheel 44 resting on the record label. The revolving disc makes the wheel rotate and the threaded rod also turns causing the carriage to move along the rod. The pickup is allowed a certain freedom of movement on the carriage, the movement of which is halted should the stylus travel any distance at a slower speed than the carriage. No allowance seems to have been made for the pickup's moving faster than the carriage so one assumes that the pitch of the thread is always such as to propel the carriage at a greater speed than the pickup. The pickup can be raised and swung off the record by the knurled ring 60 about which the suspension rotates.

Tuning aid

MESSRS JARVIS and Garton have patented a circuit for helping to tune musical instruments. The tuning fork 1 is set in motion its vibrations are maintained by the coil 4. The output of the tuning fork from transducer 2 is amplified by amplifier 3 and applied to the X plates 7 via a transformer 9 and to a loudspeaker 5. A crystal microphone 10 picks up the sound of the musical instrument and amplifies it to output 14. After the transformer 12, the signal from the instrument is applied to the Y plates 8 of the cathode ray oscilloscope 6. If the frequencies of the fork and the instrument are equal, there will be either a line or an ellipse on the screen.



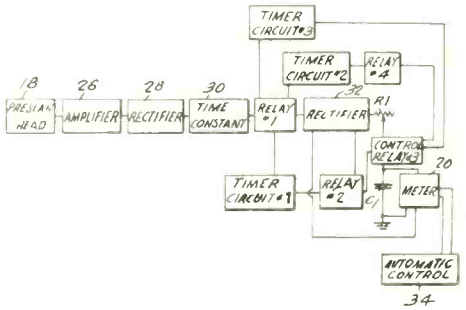
Film recording

A CANADIAN, Mr R. C. Alexander, has patented what he calls a film rerecording aid: a device which senses the beginnings, pauses and ends of narration or dialogue and translates them into a simple visual indication (BP 1271933). In film or videotape mixing and editing, all the various components of the sound track are fed to a mixing console and balanced onto a magnetic tape. The various components of the soundtrack are chosen by the editor with the aid of a footage counter. He notes the length of each section and submits them to the mixer in the form of a cue sheet which has a description of what is on each track. The mixer uses this in conjunction with the footage counter he has in his own studio.

Mr Alexander's invention does away with the need for the footage counters and tells the mixer when the beginning and end of each section is.

The device, as you might have guessed, has two playback heads, one of which is situated a measured distance before the main playback head. A meter is calibrated with three positions marked on it. A light behind the meter comes on a few seconds before the block of voice track reaches the regular pickup head, which supplies the mixing console. When the light comes on, the pointer moves slowly up towards the B position, which it reaches exactly when the block of voice reaches the regular playback head. It continues to point C where it rests, dipping momentarily towards A when there is a pause in the voice track. As the end of the voice track approaches the pointer moves slowly back towards A and reaches it as the end of the block of voice reaches the regular playback head.

The circuit works as follows. When the voice appears at the prescan head it is amplified, rectified and applied to relay 1, via an integrator to make the relay stay closed as long as the voice continues. The relay fires an scr which charges the capacitor in parallel with the meter and turns on the meter light. As C1 charges, the meter climbs up the scale at a rate determined by the value of R1, which is adjusted to make the meter reach B when the voice reaches the playback head. If there is a pause relay 1 opens and starts the timer circuits 1 and 3.



Timer 3 is faster than 1, so 3 activates relay 3 to disconnect the meter and C1 from the charging current. C1 discharges through the meter and the pointer dips. If the pause is short, relay 1 will close again and timer 2 will operate because it is fed through relay 1 from the scr current.

Timer 2 activates relay 4 to unlock relay 3 and reconnect C1 and the meter, recharging C1.

THE FOLLOWING list of Complete Specifications Accepted is quoted from the April issues of the Official Journal (Patents). Copies of specifications may be purchased at 25p each from The Patent Office, Orpington, Kent BR5 3RD.

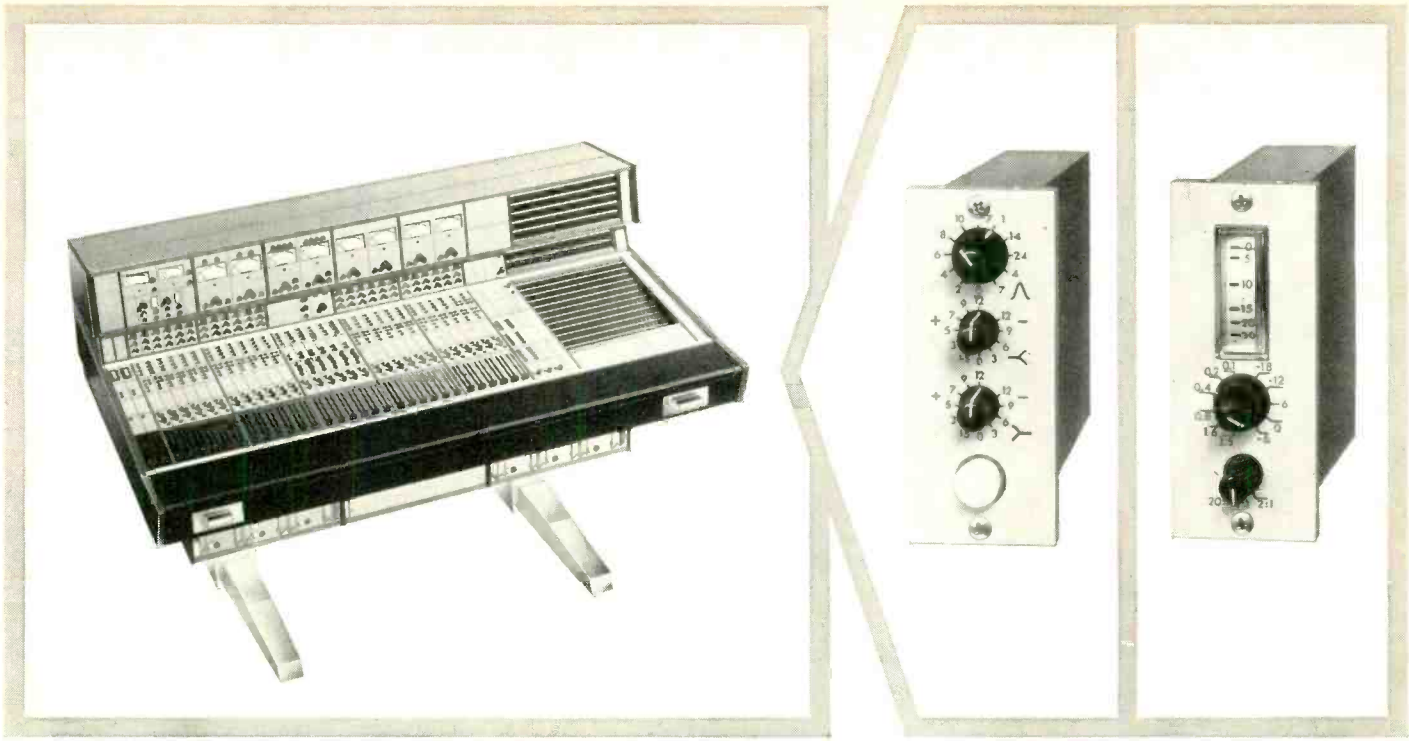
April 6, 1972

1274167
Sherbaum, A and Gottner, H
Mouthpieces for brass instruments
1274191
Kent Ltd, George
Electric controller device having means for stabilising a voltage stored on a capacitor
1274243
Etabs Emile Haefely SA
Wound capacitors having low self-inductance
1274343
Rolls-Royce Ltd
Acoustic linings
1274373
Nordiska Piano, AB
Devices for securing and tightening strings in pianos and like stringed instruments
1274402
Mullard Ltd
Devices for measuring the duration of an electrical pulse
1274463
Kaston, H.
Mute for stringed instrument
1274507
Compagnie Generale D'Entreprises Electriques
Electric power terminal strip assembly including detachable insulating partitions
1274672
RCA Corporation
Operational amplifier
1274708
Svenska Radio AB
Arrangement for automatic tuning of receivers, eg for wireless or for wired transmission of information
1274777
ITT Industries Inc
Electrical connector with an accordian sealing member
1274801
Freeman, A. B.
Electronic chord selection device for a musical instrument
1274859
James, N. A.
Cinematographic sound films
1274914
Tokyo Denki Kagaku Kogyo KK
Endless tape cartridge
1274951
Siemens AG
Optical transmission systems
1274957
General Electric Co Ltd
Telephone line loop-detecting circuits
1274975
Transistor AG
Semiconductor elements having a definite charge carrier lifetime

April 12, 1972

1275031
Ampex Corporation
Magnetic recording media
1275039
Telefonaktiebolaget L. M. Ericsson
Variable frequency oscillator
1275056
Marconi Co Ltd
Adjustable phase shifters
1275079
Standard Telephone & Cables Ltd
Measuring instruments
1275087
Jakubovicz, J.
Musical instrument
1275091
Semiconductor Research Foundation
Transit time diode oscillator
1275093
Marconi Co Ltd
Television equipments
1275104
Nippon Kokan KK
Eddy current test apparatus
1275111
International Standard Electric Corporation
Image reproducers
1275115
RCA Corporation
Recorders
1275122
Trico Products Corporation
Electric motor control systems

continued 29



mm II from Pye TVT

this exciting new modular mixing system brings your sound to you the way you want it

MMII represents the very latest concept in modular audio mixing equipment.
Smooth, positive operation, coupled with unsurpassed reliability through the use of rugged mechanical components and all-solid-state electronics mean that MMII is built precisely to *your* requirements; to do just what *you* want, with ease and versatility.
With almost limitless combinations of modules, MMII offers the broadest range of facilities: for outside broadcasting, radio and TV studios and large theatres, to sophisticated studios for the film and recording industries.
Talk to Pye TVT about MMII ; there's so much more to tell.
Phone or telex. Today.

rely on PYE TVT

Pye TVT Ltd., Coldhams Lane, Cambridge CB1 3JU
Tel: Cambridge (0223) 45115 Telex 81103

APRS 72

visit us at the Pye TVT stands Nos. 11 & 18

Howell Jones David Bott
Bram Potappel Trevor Foxon

PATENTS

continued

1275174
Siemens AG
Directional antenna systems
1275176
Xerox Corporation
Multi-stylus recording assembly
1275183
RCA Corporation
Electrical circuit having insulated gate field effect transistors
1275196
Standard Telephones & Cables Ltd
Gain control circuits
1275222
Fernseh GmbH
Television cameras
1275247
Licentia Patent-Verwaltungs-GmbH
Transistor circuit with an inductive load
1275248
Siemens AG
Circuit arrangements for compensating for the dc voltage components occurring in the demodulation of frequency-switched signals
1275272
Texas Instruments Inc
Solid state scan converter utilising electron guns
1275307
Sony Corporation
Magnetic recording and reproducing system
1275308
RCA Corporation
Tunable microstrip band pass filter
1275310
RCA Corporation
Combined display system and circulating memory
1275391
Marconi Co Ltd
Aerial systems
1275418
Telefunken Patenverwertungs GmbH
Power transistor
1275426
Kokusai Denshin-Denwa KK
Repeating system for digital information
1275452
Vsesojunzny Elektrotekhnichesky Institut IM Vi Lenina
Photosensitive semiconductors
1275522
Transistor AG
Semiconductor elements
1275545
Matsushita Electric Industrial Co Ltd
Semiconductor pulse generator
1275549
Philips Electronic & Associated Industries Ltd
Capacitive store
1275579
International Standard Electric Corporation
Electronically controlled antenna system
1275592
Brown Boveri & Co Ltd
Thyristor forced-communication circuit
1275598
Shell Internationale Research Maatschappij NV
Transistor inverter circuit
1275613
Minnesota Mining & Mfg Co
Isolated solid state remotely controlled switching circuit
1275671
Plessey Telecommunications Research Ltd
Digital to analogue converter
1275678
Marconi Co Ltd
Phase sensitive detectors
1275725
Standard Telephones & Cables Ltd
Solid state scanning systems
1275761
Ricoh KK
Electronic display arrangements
1275790
Columbia Broadcasting System Inc
Video signal recording
1275825
Matsushita Electric Industrial Co Ltd
Electric cells
1275850
North American Rockwell Corporation
High speed digital receiver and transmission system
1275861
Nokia AB OY
Electric capacitor unit with an internal fuse arrangement
1275872
Audio Magnetic Corporation
Vibration processing of magnetic tape

April 19, 1972

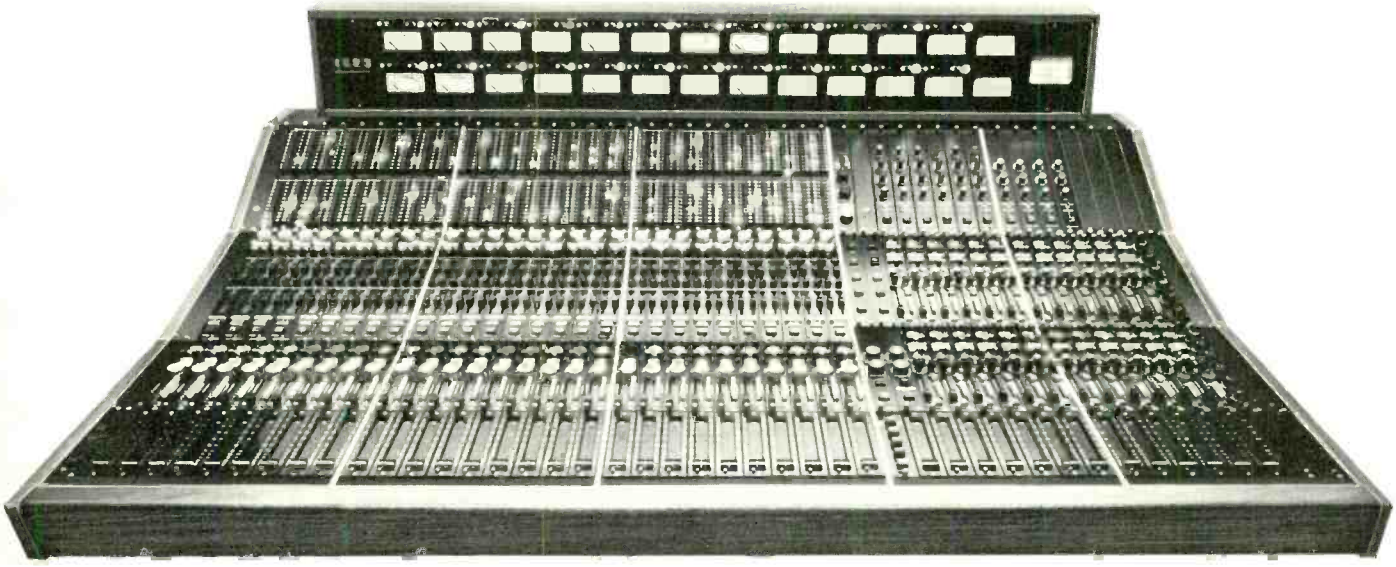
1275906
Barr & Stroud Ltd
Optical projection head
1275929
Sony Corporation
Thermal development processes for electrosensitive recording sheets
1275935
Kavalerov, GI and Others
Analog-to-digital convertor
1275942
Bunker-Ramo Corporation
Electrical socket connector
1275961
Sanyo Electric Co Ltd
Piezoelectric ceramic compositions
1275972
RCA Corporation
Negative effective electron affinity emitters with drift fields using deep acceptor doping
1276004
International Computers Ltd
Magnetic transducer assemblies
1276017
Philips Electronic & Associated Industries Ltd
Method and device for producing three-dimensional images
1276035
ITT Industries Inc
Circuit for amplifier gain control
1276051
ITT Industries Inc
Electric connector interfacial seals
1276104
Danfoss A/S
Connection between sheet-metal sound-absorber and a pipe
1276135
Licentia Patentverwaltungs-GmbH
Control circuit for the controlled semiconductors of an electronically commutated direct-current motor
1276161
Electronic Research Corporation
Recording and reproducing colour television signals
1276183
Decorart & Playart Ltd
Electronic organs
1276196
Philips Electronic & Associated Industries Ltd
Electro-acoustic transducer
1276202
Licentia Patentverwaltungs-GmbH
Light display devices and control circuits therefor
1276220
Nippon Selfoc Co Ltd
Multi-terminal optical cable
1276278
Philips Electronic & Associated Industries Ltd
Frequency divider
1276299
Hawker Siddeley Dynamics Ltd
Amplitude-stabilised audio oscillators
1276375
Motorola Inc
Transistor differential amplifiers
1276489
Wurlitzer Co
Portable music laboratory
1276490
International Business Machines Corporation
Analog digital converter
1276498
Amplivox Ltd
Ear defenders
1276523
RCA Corporation
Liquid crystal display assembly having independent contrast and speed of response controls
1276597
Knecht, N. E.
Voltage rectifier and multiplier

April 26, 1972

1276692
Tokyo Shibaura Electric Co Ltd
Magnetic head and a method for manufacturing the same
1276697
Matsushita Electric Industrial Co Ltd
Electro-photograph apparatus
1276699
RCA Corporation
Logic circuit
1276749/50
Honeywell Inc
Electro-photographic recording apparatus
1276752
Tektronix Inc
Variable attenuation amplifier
1276762
Soc Alsacienne De Contructions Atomiques De Telecommunications et D'Electronique
Memory devices
1276778
Cit-Compagnie Industrielle Des Telecommunications
Circuitry for controlling an electric current in an inductive load
1276789
Nippon Telegraph & Telephone Public Corporation
Television telephone system
1276801
Reliable Electric Co
Line protector for a communications circuit
1276807
Anderson Power Products Inc
Quick acting safety disconnect electrical switch
1276809
Bosch Elektronik GmbH Robert
Image transmission
1276825
Singer, Co
Memory core submodule
1276885
Texas Instruments Inc
Image storage device
1276905
RCA Corporation
Retrieval of holographically recorded data
1276923
Redifon Ltd
Visual simulation apparatus
1276941
International Standard Electric Corporation
Radiotelephonic system
1276969
International Business Machines Corporation
Magnetic disc record drive apparatus
1276986
Philips Electronic & Associated Industries Ltd
Frequency synthesis system
1277023
EMI Ltd
Diaphragms
1277039
Texas Instruments Inc
Image storage apparatus
1277041
Owens-Illinois Inc
Implosion-resistant cathode-ray tube envelope
1277052
RCA Corporation
Semiconductor transducer
1277089
Mullard Ltd
Interface transmitter
1277097
Staar SA
Sound recording and playback apparatus
1277109
United States Atomic Energy Commission
Multiremanent ferroelectric ceramic optical devices
1277119
Martinesco, D. M. and Marsot, C. L.
Audio-visual apparatus
1277160
Ampex Corporation
Means for pressing a magnetic tape against a transducer
1277162
Standard Telephones & Cables Ltd
Microphones
1277172
Hitachi Ltd
Method of making a large integrated circuit
1277177
International Business Machines Corporation
Magnetically recording and reproducing information
1277199
EMI Ltd
Amplitude modulators
1277225
Hitachi Ltd
Commutatorless motor system
1277240
Matsushita Electric Industrial Co Ltd
Colour television pickup device
1277250
Western Electric Co Inc
Filter circuits

Diary

BY KEITH WICKS



WE start this month with a look (above) at the Trident desk built by Malcolm Toft and Barry Porter. This is the basis of a system to be produced on a commercial basis, also to be seen at APRS 72.

MT We have a general policy of changing the mixer every three years or so; that's about the desk life. It's rather like a car—about three years before you get real problems. Then switches go noisy and it would be very time-consuming to change all the switches. You get a recurring fault like a mic gain switch which is always dealing with very low signal levels. They all tend to go at about the same time. In a studio atmosphere there are a lot of cigarettes, coffee and goodness - knows - what floating around.

BP This was aggravated on the old desk by the fact that half the switches are now discontinued and you can't get replacements for them.

MT But the desk's ageing tied in very well with the fact that the engineers needed more facilities anyway and we were a bit short of mic lines from the studio. In addition we were thinking of the advent of 24 track. Also the studio needed redecorating, having seen well over four years of solid use, so we decided to deal with all these problems at once: have the studio redecorated and install a new desk. We found out the facilities we required by having an initial meeting with our sound engineers. For example they wanted six echo routes and four foldbacks, each independently controllable. Having decided we needed a new desk we went to one of the major manufacturers and sat around a table discussing the project for three hours. We told them what we wanted and asked if they could do the job. They said they could do it but that they would be deviating from their standard modules so obviously the price would go up.

MT In general our engineers did not think that the facilities on these desks were up-to-date enough for what they wanted. We went to another firm who came closer to what we required but it still wasn't quite what we wanted.

BP Another point was that nobody could supply us with a desk containing the required number of channels in the available space. For example, to get this amount of equipment on a Neve desk, it would have to be over 3m long, which is too big for our control room.

MT So we came to the conclusion that, with help from our own desk engineers, we could come up with what we wanted. There are some very non-standard items on our desk. For example our pièce de résistance is the illuminated pushbutton routing. On every channel there are 48 illuminated push buttons. These allow you to switch any track to any group and you can, of course, switch across as many groups as you like. You can pan any track to any group. We used rotary pan switches in order to ensure that we get complete compatibility. With ordinary pan pots you always get a rise of the centre image but with stepped pan controls you can get compatibility no matter where the sound is panned to.

MT The cost of making a desk ourselves could have been quite high. In fact everybody said we couldn't do it. We were told that it would take us three years with a staff of six, and a research and development investment cost of about £20,000. Somebody else told us they had spent three years building their own desk and it still didn't work properly. However, we have always had confidence.

MT If we could build a desk for the same figure as we had been quoted by other desk manufacturers then we would still come out of it winning because the knowledge acquired building it ourselves and knowing every part of it would be invaluable. Also we could consider going into production if it turned out well.

On our desk we have reduced balanced circuits to a minimum for two reasons. It's not the cost of transformers but the distortion and phase shift which are important. The use of so many transformers in some desks may be the reason they give such a harsh sound.

BP In some desks you can get the situation where you are going through four or five transformers in one channel. On another channel you may be by-passing some of these so you will get a difference in phase shift between two channels. If you mix these two together, you are going to get cancellation somewhere, either at a spot frequency or at high frequencies.

MT What we have done is use very low impedance line amplifiers. The only transformers in the modules are the mic, line, and the main group transformer which feed the machine. The insert points for limiters all comes out unbalanced because it is a very low impedance drive just going up to the jackfield and coming back. So there really are no problems.

BP During development a lot of time was

continued 33

DO YOU USE COMPACT CASSETTES?

Fraser-Peacock Associates Limited would like to send you details of their new High Speed Cassette Copier

2 cassette copies-2 minutes
Automatic levels
Simple operation
Fast rewind facilities

Blank cassettes any length up to C90 available, details on request

fpa

Fraser-Peacock Associates Limited
94 High Street Wimbledon Village London SW19
01-947 2233
sole UK distributors of Infonics

INDIGO
Sound Studios Ltd

061-834 7001 Multitrack in Manchester

72 Gartside Street Manchester M3 3EJ

ZEL-LA
RECORDING STUDIOS

Air-conditioned studio · Ample car park
4-track facility, capacity for 30 musicians

Please write for studio brochure or telephone 021-455 0645 (24 hour anwserphone)

ZELLA RECORDS (BIRMINGHAM) **LTD.**
"Walker Hall," Ampton Road, Edgbaston, Birmingham B15 2UJ

GRIFFITHS HANSEN (Recordings) LTD.

Specialists in sound and vision equipment hire

Full range of recorders, mixers, amplifiers, mikes, speakers, projectors and screens available for hire.

Public Address and Recording Systems for Conferences and Exhibitions, Tape Duplicating and Specialists in recording Language courses are all part of our complete studio service.

For further details contact:

Griffiths Hansen (Recordings) Ltd., 12 Balderton Street, London W1Y 1TF
Tel: 01-499 1231

continued

taken up by being side-tracked. Various ideas we had were rejected for one reason or another. For example we experimented with differential input ics, hoping that we could use them instead of transformers. These did not, however, prove to be a feasible proposition because of the inherent noise problems.

MT Our desk has 28 inputs and 24 groups. There are 24 main meters which are switchable to vu or ppm. They are standard Sifam meters which we had specially scaled and we drive them with logarithmic or linear amplifiers.

BP The basic meter movement is very fast rising. There are two amplifier cards which look after rectification and time constants. There is also a built-in low pass filter which rolls off very sharply over 20 kHz so that no bias can be picked up. Sometimes all a vu-meter will do is pick up adjacent track bias.

MT When we first started, four years ago, the first bit of track bouncing I did was on adjacent tracks of our Ampex. The vu was reading bias at almost zero level.

BP Some manufacturers don't fit any bias traps on their replay amps. With our system you can have about +20 dB bias and still hardly move the needle. We have Multiturn variable resistors in the meter amplifier circuits so that the meters can be lined up exactly. This also lets us set up the meters to read zero level at any chosen output level.

MT Being switchable our system gets over the controversy of vus against ppms because you can take your pick. A lot of engineers are now going over to ppms because they are finding voices—drums and other sounds with a lot of transients, can easily get distorted. You notice it an awful lot with piano. You can be peaking at only zero but you get terrible distortion using a vu. But if you are looking at it on a ppm, then it may read +15 dB. The arguments in favour of ppms are very valid in a number of cases and engineers are waking up to this. There are two additional meters which can be switched to the echo and foldback feeds. You have the choice of inserting two different kinds of equaliser on push buttons. The equaliser section is different in that you have control over four separate frequencies at one time.

There is a total of 16 different frequencies, four on each section, so you can boost or cut any of four frequencies. Apparently one of the major manufacturers is soon to produce an equaliser of this kind, so we are obviously on the right track. There are also high and low pass filters on each channel. High pass is at 25, 50 and 100 Hz and low pass at 9, 12 and 15 kHz.

Every module has its own stabilised power supply built into it. Unlike most people, we don't rely on having just one very smooth power supply. Our system produces good smoothing and stabilisation.

BP During remixing, the machine comes up on the channels when they are switched to line. If you want to put something quickly on to a channel, you've got no cross-plugging whatsoever. You just turn the module's selection switch on to the mic position. A red light on the channel indicates when this has been done.

MT One thing about our desk is that it is much easier to operate than the old one. in spite of the fact that it has a lot more facilities on it. It has been designed much more logically. It looks complicated without actually being difficult to work. Our four independently controllable foldback systems mean you can give four people completely independent mixes at different levels. This is one facility that the major manufacturers would have to design special modules to cope with.

We can switch any channel on to the monitor speakers only, bypassing the route module. The reason we did this is that we have no echo return channels as such and we didn't have space on the desk to put them in. As we've 28 input channels, even if we are mixing 24 track we can still allow four channels for echo devices. And, by being able to route on to monitor only, you can get phantom echo. In many studios, when you want to get phantom echo you have to mess about with the monitor system and do all sorts of complicated switching. For example, on our old 16 channel desk, positions 17 to 20 on the routing switch selected on to speakers one, two, three or four. So you had to go past the routing to get on to monitors. With our new system, you can have a channel punched up to a group and just cancel it by going on to monitor. If you want to go back on to group, you just press the button and you're back. Another thing we have done is to bring the outputs of the foldback system back on to the jack-bay. If you are not using foldback you can patch them to different echoes and you have independent control on them. In all, there are five independently controllable cue feeds and you can use them for anything you like. The echo can be switched to pre or post fader. Foldback feeds are taken before the fader because that is what our engineers always require. This means you can mess around with a fader on a session without worrying that the musicians will complain about their foldback level changing.

There is pre and post fade monitoring for checking each channel. The monitoring facilities are fairly comprehensive. We've got four independently controllable banks, and six echo buses. Each monitor module has an individual sync switch to throw it into the tape replay position. So, if you are doing selsyncing, instead of throwing the whole desk to monitor tape you throw the individual monitor channels to tape and leave the rest of the modules switched to whatever live tracks are coming up from the floor. This is a rather easy way of selsyncing without plugging up through the channel. We've got equalisation on monitor because we very often get asked for this by producers. The desk is designed with 24 track working in mind because we reckon we may go 24 track around the end of the year. I don't think there is any point in considering 32 track until somebody develops a tape with no noise. Twenty-four track is a cram on 50 mm tape; what's going to happen with 32 tracks?

BP The technical performance of the desk is excellent. When you route a channel to any group, you can switch all the other channels into that same group and the level will not alter one iota. The total unweighted harmonic distortion on each channel is below 0.01 per cent at +20 dB. The typical value is around 0.005 to 0.006 per cent. The noise level on the channels is about −93 dB.

MT And with all 24 inputs switched to one group, the noise level is about −75 dB, which is what one major manufacturer quotes for one input switched to one group.

Mayfair Sound Studios have also installed a new desk they built themselves. In addition, the studio has been rebuilt and a new control room and separation booth completed. The studio remains eight track, for which the hourly charge is £20.

Mobile engineer **Peter Self** commenced trials on his mobile 16 track studio in June. If all goes well, it will be used for recording sessions in July. Peter is working under the name **Counterpoint** and may be contacted at 449 1164.

At **Maximum**, McGuinness Flint has been working on a single and Brewers Droop continued recording an album for RCA. Alan Jones, once a member of Amen Corner, finished a single, and Dennis Coulson has completed his album for DJM Records, all the recording and reduction being carried out within one month. Trombone player Derek Wadsworth blew into the studio to start on an album with his band. Meanwhile, the rehearsal room has been earning a steady £1 hourly from people like Jethro Tull, Long John Baldry, Atomic Rooster, Procol Harum and Manfred Mann.

Sarm engineers Barry Ainsworth and Gary Lyons have been doing freelance sessions for Vickie Brown (Joe's wife), Nashville Teens and Rescue Company Number One. Interviews were recorded with Dave English (of the Temptations) at the Churchill Hotel, and with Clodagh Rodgers in her dressing room at the Palladium. Other work included further sessions for a Butterscotch album, various copying and cutting, and engineering by Barry on a Buddy Greco album being made at Pye Studios. Equipment is now being purchased for Sarm's own 16 track studio which should be open within a few months.

Peter Houghton reports that his **Gooseberry Studio** now has an eight track Brenell recorder with electronics by Richardson. For a few weeks, Peter is making a special offer of eight track recording during the daytime at only £21 cash for three hours. To make a booking, phone 01-437 6255.

At **Theatre Projects**, David Kossof has been making an album for Procaudio on the history of Israel. Music recording has been completed for Scholastic Records and will be used on some children's eps to be issued in the States. Editing and mixing were carried out on a recording of Orson Wells reading *The Prophet*.

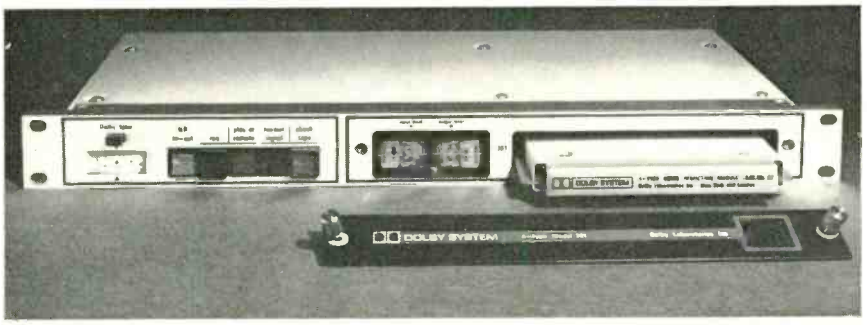
Jackson Recording Studios are looking for a studio manager. He will be completely responsible for the running of the studio, and will look after clients, sound, maintenance and publicity. The ideal person will be under 26 with three or four years studio experience. If this is the job for you, try convincing Malcolm Jackson on 79 72351. Malcolm is already a familiar sight in the West End, pushing his cart from studio to studio, collecting unwanted 16 track recorders. With someone to run his own studio, he will have time to expand this used equipment business which has been doing very well. In the studio, work ranged from promotional material for Smiths Industries and Bluecol *Antifreeze* to a budget album of *Godspell* for Pickwick International.

continued 67

The Dolby Noise Reduction System

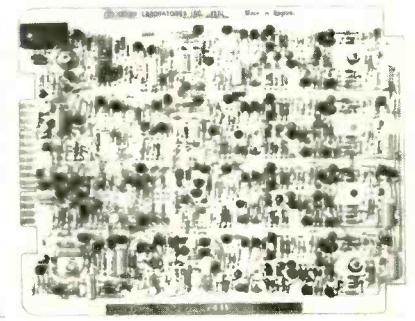
A significant advance in professional audio technology

Model 361 Noise Reduction Unit with cover plate removed, showing remote control relays and plug-in noise reduction module.

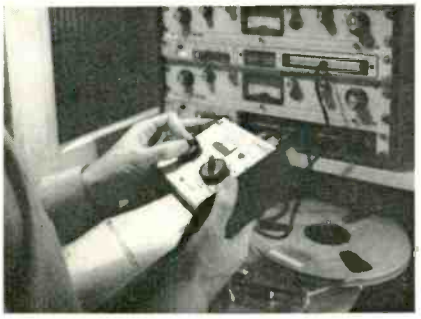


'Dolby' and the double-D symbol are trade marks of Dolby Laboratories Inc

Catalogue 22 circuit board is available in quantity to manufacturers of professional audio equipment.



The Dolby Noise Reduction System can improve the performance of any high-quality audio channel affected by low level noise. The noise may include rumble, hum, crosstalk, clicks, pops, buzzing, hiss, or discrete frequency interference such as television synchronizing pulse crosstalk. All of these forms of noise are reduced by the Dolby System without affecting the overall frequency response or dynamics of the signal.



Catalogue 35 Test Set permits rapid verification of performance without additional instruments or removal of unit.

Although most of the 6,000 channels now equipped with the Dolby System are used in music recording, the system is suitable for use in any situation in which the signal is available for processing at both ends of the recording or transmission chain. The processing operations can be separated by any distance or time duration, since the system parameters are extremely accurate and stable. The system is particularly suitable for applications where excessive overshoot cannot be accepted, or where distortion and noise modulation effects must be inaudibly low. Among current applications are use in land line transmissions, microwave links, VTR sound tracks, and high-fidelity motion-picture sound track recording.

The Model 360 Noise Reduction Unit fits a standard equipment rack and is only 1¾ inches high. The unit is built around one basic plug-in module containing the noise reduction circuitry. Three illuminated push-buttons on the front panel select record or play (encode or decode) functions, and activate the noise reduction circuit. The Model 361, similar in appearance to the Model 360, can be remotely switched. The basic noise reduction module is itself available in quantity for incorporation by manufacturers and large-scale users into recording or communications apparatus.

A simplified Dolby System, designated the Dolby 'B' System, has been developed for consumer applications, and is licensed to manufacturers of home recording and broadcast reception equipment. In addition to its use in recorders and the duplication of tape cassettes, the Dolby 'B' System is also being extensively applied in test broadcasts in the United States as a means of improving reception quality of stereophonic FM transmissions.

Journal reprints, product descriptions and technical data are available upon request.

Among users of the Dolby System in the communications and broadcasting fields are: British Broadcasting Corporation, London. British GPO (Broadcast Landlines), London, Glasgow. Ceskoslovensky Rozhlas, Prague. Ceskoslovenska Televize, Prague. Danmarks Radio-TV, Copenhagen, Soborg. Department of Posts and Telegraphs, Dublin. European Broadcasting Union, Brussels. Iceland State Broadcast-Television, Reykjavik. Institut für Rundfunktechnik, Hamburg, Munich. London Weekend Television, London. Magyar Radio es Telvizio, Budapest. Norddeutscher Rundfunk/TV, Hamburg. Norsk Rikskringkasting, Oslo. N.O.S. Television, Hilversum. ORTF, Paris. Radio Nacional de España, Madrid. RTV Ljubljana, Ljubljana. Saarländischer Rundfunk, Saarbrücken. Sveriges Radio, Stockholm. Thames Television, London. VNIIRT, Moscow. Yleisradio, Helsinki.

Dolby Laboratories Inc
1133 Avenue of the Americas, NY 10036
Telex 125797

346 Clapham Road, London SW9
Telex 919109

Tiger Building 30-7 4-chome Kuramae
Taito-ku, Tokyo
Telex J22498

Recording Studio Techniques

BY ANGUS MCKENZIE

HIGH LEVEL MONITORING

FOR several years many, if not most, recording engineers have been monitoring at increasing levels, particularly when using multitrack techniques. In addition, pop musicians are using amplification equipment with higher and higher output levels. The consequences of these very high levels are not only to increase the difficulty of adequate sound insulation but also to present what may be a serious occupational hazard for those involved in pop music. At some recent recording sessions, I was alarmed by the high monitoring levels used and horrified when I heard a group, who were performing in a BBC studio, use 2 kW of available output power to feed enormous loudspeakers. I therefore decided to investigate the possible hazards of such high sound pressure levels and have made some interesting measurements as a result.

As a general guide to the whole problem, a most useful book has recently been published: 'Occupational Hearing Loss' edited by Dr D. W. Robinson of the National Physical Laboratory. I also obtained considerable information from the BBC and various audio consultants. This article is intended as a guide to the subject and as a warning to musicians, engineers and their employers of the possible serious consequences of being subjected to these high levels over a period of years.

As a start I measured typical peak sound pressure levels in my own listening conditions. I measured all levels in rms, weighted to the dBA curve, with a Bruel & Kjaer *2203* sound pressure level meter. For comfortable quality-control listening I found that, on the average classical stereo programme from any source, peak readings of 90 dBA were obtained using two Spendor *BC1* speakers driven from a Quad *303*. Under similar conditions, but using Tannoy 38 cm *Monitor Gold* speakers in large enclosures, I found myself listening to sound pressure levels about 5 dB louder. In the case of pop music, I obtained equivalent readings about 5 dB higher from the two systems.

I then decided to determine the highest sound pressure level that could be obtained from the two different speaker systems on both classical and pop music. The Spendors peaked at between 98 and 100 dBA before objectionable distortion was noticeable. In the case of the Spendors, this distortion was apparent at bass frequencies. With the Tannoys, the limitation was amplifier clipping. All the levels were measured with the loudspeakers about 2.5m apart with the meter a similar distance away from each loudspeaker and in the position at which I normally listen. Those who helped me in the tests were also used to hearing monitors at high levels but agreed with me that the maximum level obtained of 108 dBA was intolerably loud even in my listening room, which is approximately 10 x 4 x 3m and acoustically treated.

On pop sessions, up to four loudspeakers are employed. Often these are driven by amplifiers capable of 100W drive to each loudspeaker and peak sound pressure levels of 114 dB can be measured when all four channels peak at the same time. Peak monitor levels of 110 dB are experienced under normal circumstances and, although they may seem incredibly high, levels of this order are quite typical. Pop groups may subject themselves to even higher levels, peaking something like 118 to 120 dBA; for many people this is not far off the threshold of pain. To put these levels in perspective I measured, at a distance of 4m, the maximum sound level produced by a sports car which accelerated from standstill. The level was 100 dBA—about the same as a *VC10* flying fairly low overhead at London Airport. Having accepted the above levels as those used in the music industry, the psychological and physiological effects as determined by many experts in the field should be considered.

As far back as 1953, audio consultants reached the conclusion that an average continuous noise level of 90 dBA was the maximum that should be allowed under normal working conditions. Fifteen years later, after some years of research, the Ministry of Labour also recommended 90 dBA maximum advisable noise dosage for a working environment, although this was only reported at lectures and not published at the time. Reference is made in Dr Robinson's book to the hypothesis that between 1,000,000 and 2,000,000 people in the UK are subject to occupational noise hazards, and that approximately ten per cent of these people have already suffered significant or serious hearing loss; at best this has affected their ability to hear normal conversation satisfactorily and at worst almost total deafness. It is reasonable to assume that many recording engineers or their colleagues may hear average noise levels of the order of 95 to 100 dBA for up to 20 hours per week. Monitoring some stereo lps made recently by pop groups, I found that the total dynamic range during a number did not vary much more than ± 6 dB from an average level. It is therefore possible that the average noise dosage heard by these engineers could be around 100 dBA for as much as 20 hours per week and an interpretation of a table in Dr Robinson's book (p. 61) shows that, after enduring these levels for five years, about ten per cent are likely to have suffered a 15 dB hearing loss. After 20 years, some 26 per cent are likely to have reached the same state and during the same period ten per cent will have reached a 25 dB hearing loss, sufficient for the subject to have difficulty in hearing a normal conversation.

For pop groups, the situation may be considerably more serious since the average sound pressure levels incurred can be some 10 dB louder. On the other hand the average time of exposure may be somewhat less than the 20 hours referred to for engineers, although many groups perform almost every night in addition to making recordings during the day. An interpretation of the same table in combination with other established facts shows the possibility that ten per cent of members of pop groups could have a 25 dB hearing loss after five years and 25 per cent would be similarly affected after ten years regular exposure.

These figures all appear serious even though I have tried to interpret them as realistically as possible. Even if the calculations have an error of a factor of two or more, they are still highly significant.

The employer's liability in the event of hearing damage can be considerable, even under present law, and in the event of the matter coming under the proposed Industrial Injuries act, likely to become law in the near future, employers as well as engineers and musicians should take note of the results obtained by Dr Robinson and his colleagues all over the world. In a recent case, a trades union brought an action on behalf of an employee against an employer after serious hearing damage resulted from his exposure to very high sound pressure levels while at work. Even though ear muffs were provided and the employee was encouraged by the employer to wear them, the judge ruled in favour of the employee, awarding damages and costs. He said that the employer should have insisted on receiving written indemnity from the employee to make the employee fully responsible for his not wearing the ear muffs provided. The case is likely to go to appeal but nevertheless it shows the danger and, under the circumstances, it may be advisable for managements to consider indemnifying themselves from the results of engineers or musicians using high monitoring levels.

It is possible too that, since sound pressure levels of 115 dBA have been measured in fairly reverberant halls during pop group performances and in discotheques, some consideration should also be given to absolving managements from responsibility for possible damage to the hearing of audiences. The BBC have already taken steps in such locations at the Paris Cinema to warn audiences that they cannot be held responsible for hearing damage, although I am not sure that a printed notice is sufficient legally for such indemnification.

[*Under the law of contract such a notice, if*

continued over

prominently displayed, is quite adequate. Even should an illiterate member of the audience damage his or her hearing no civil action can be brought, since illiteracy has been established by case law as a misfortune, not a privilege—**Ed.**]

During a case concerning hearing damage in 1968, a judge made the following statement which, in view of its importance, I include verbatim. 'The overall test of the reasonable and prudent employer, taking positive thought for the safety of his workers in the light of what he knows or ought to know, where there is a recognised and general practice which has been followed for a substantial period in similar circumstances without mishap, is that he is entitled to follow it, unless in the light of common sense or newer knowledge it is clearly bad; but where there is a developing knowledge, he must keep reasonably abreast of the risks, he may be thereby obliged to take more than the average or standard precautions . . . If he is found to have fallen below the standard to be properly expected of a reasonable and prudent employer in these respects he is negligent.' Surely this statement applies very forcibly to our industry, although I hope that further investigation may show the situation perhaps to be not quite as serious as it now appears.

In my own case I find that I listen to loudspeakers with a wide, flat frequency response and reasonably low coloration at a lower measured sound pressure level than I do to loudspeakers having more coloration and a tendency to peaks at middle frequencies. It could be that, in trying to hear some sounds at a reasonable level, I make others in the peaky region of the loudspeaker much louder. I also find there is a temptation to increase the volume if a higher sound pressure level is available on the monitoring system. Furthermore I carried out some tests using headphones, and again found myself listening to a higher level of sound than that produced under normal listening conditions. It is therefore possible that, if a single loudspeaker system could be designed capable of producing sound pressure levels peaking perhaps not more than 105 dBA per speaker, engineers might not want to listen so loud. It is also interesting that in any given period of monitoring there is a tendency to increase the listening level if the original levels chosen were already loud. After such a period of listening, the effect produced on my colleagues and myself was that of a slight giddiness and a feeling of claustrophobia which took at least 30 minutes to wear off. During this period it was quite difficult to concentrate on anything requiring a fair degree of mental effort. On the other hand, those who are used to these high levels may well find that the effects we noticed are not so pronounced.

Recently I listened for six hours to recordings peaking not more than 94 dBA for some quality-monitoring work. After a gap of about two hours, I had occasion to replay a master tape recorded a few weeks previously and insisted to my colleague that something was wrong at the high frequency end. The entire system was checked with a test tape but nevertheless I was still worried. It was not until replaying the tape the next morning that I realised that I had been suffering from aural fatigue. Frankly, had I been dubbing at the time I would undoubtedly have added treble boost, which could have disastrous results at a later stage. Such experiences are by no means uncommon, for many other engineers have told me of similar instances.

In view of all this, I suggest that monitor amplifiers capable of more than 50W per channel could create occupational hazards, although in general loudspeakers that show less coloration with a flatter response usually need more drive for a given output than normal.

In conclusion, Bruel & Kjaer have recently announced a noise dosage meter which integrates the sound levels received over a given period and relates this to an average. It would be most interesting to hear any reports of the use of such a meter in control rooms where high monitor levels are incurred. I was told recently of one engineer who measured as high as 98 dB in a middle frequency octave in a control room during a session, thus proving that levels as high as 110 dBA overall can be reached. I trust that, after reading this article, engineers will seriously consider the possibilities mentioned. I also hope that researchers may be able to prove that our industry is not quite so hazardous as it appears to be at the moment.

Sound in the Sun

By Adrian Hope

IF you are one of the anticipated 4,000,000 people taking their holiday in Majorca this year, try and pack a portable fm radio. There is a fair amount of fm broadcasting on the island and it is usually worth listening to because Majorca has a large resident English population, catered for by the English language newspaper *Majorca Daily Bulletin* and the English language hours of local broadcasting.

The *Daily Bulletin* features a lengthy column each day by Riki 'Lash' Lazaar, who is a colourful emigre American living on the island. The Lazaar column is basically a guide to who and what are on the island and it fairly heavily plugs his nightly radio show. This is on the station Radio Mallorca (96.6 MHz) from seven to midnight and Lazaar can usually be relied upon to play good middle of the road jazz or pop music. Lazaar's origin is Los Angeles, where he went out on 20 kW, but in Majorca he has to make do with the 1 kW local transmitter. Being a mountainous island, there are the usual problems of reception but on the whole anyone wanting to pick up the station usually can. It comes over clear as a bell in line of sight Algeria.

What makes Lazaar's nightly radio programmes rather out of the ordinary is that they are not put out from the radio station itself but from his bar overlooking the Bay of Palma. Riki's bar, or *My Own Place* (MOP for short), is in many respects just like any other Majorcan bar except that in the middle of the room there is a small open studio manned by Riki and a girl dj. Twin Garrard turntables are used to play music into the bar and out along telephone landlines to a transmitter for broadcasting. At each table in the bar is a Shure *Unisphere* mic and, between records and commercials, Riki interviews any personalities that he has invited or who have called in for a drink. The programme goes out live but apparently there have so far been none of the obvious problems. Lazaar is an accomplished interviewer with 25 years experience and I wouldn't argue with him when he says that, although he ran a similar station back in Los Angeles, his bar studio is the only one of its kind in Europe.

All Majorcan radio is commercial and the Lazaar commercials are mostly for local hotels and nightclubs. Most of the plugs are prerecorded on cassette and played off a pair of Philips *2202* recorders mounted vertically in the studio wall. The first few hours of the evening's programmes go out entirely off disc and with prerecorded commercials (at the last count they had around 21 prerecorded blocks of them). The live interviews and chat come on towards the end of the evening. The amplifying equipment is all Braun and, not surprisingly, the broadcast programmes have an air of relaxed informality.

The telephone system on the island is inadequate but somehow the hook-up between MOP and the transmitter works and there are no crossed lines. To be fair, the general technical standard of broadcasting on the island is poor, as also is the average Spanish attitude towards good quality sound reproduction. Record players and radios are on the whole nasty so the generally rather low standard of broadcasting is unlikely ever to be noticed. Most holiday island broadcasting is essentially beach or warm-evening-on-the-terrace music so lack of technical perfection tends to matter far less than in our colder climate.

The other two radio stations are Radio Popular (which is a church-backed station) and Radio Juventud (of which there are approximately 50 stations dotted all over Spain and which is the medium of the official Spanish political party, the Moveiento). Radio Popular also puts out some programmes in English and at their studios in rooms off a beautiful Spanish church I met Englishman Jack Webb who broadcasts for an hour every night playing recorded music, mainly 'standards' of the Ray Coniff, James Last type, with classical music on Fridays and sports results on Saturdays.

Jack Webb has been on the island for around six years and, although he has these regular broadcasts (97.5 fm) his main interest is in running Medreco. This is his own recording company, which is based on the island. Before moving down from the Radio Popular building, Jack Webb showed me a few of their studios and on the whole the technical standard generally resembles the better end of British hospital radio. All the taped work is from Ferrographs and a few Brenells. The record library is small but adequate; one problem in this area is that bringing in British discs attracts heavy import duty.

Jack Webb's own studio is in the old part of Palma (capital of Majorca) and, being tucked away in a maze of steps and alleys, needs little or no soundproofing. Few cars come within earshot in this part of the town. The studio itself is small and simple because Webb's main field is location recording. The idea is a good one and it seems to work. When a hotel or nightclub features an interesting regular act, the routine is to produce a 45 rpm ep disc and sell it along with drinks at the bar. Thus for instance when the Brusellas bar featured the jazz piano of Bob Weedon, the Medreco label put out a record of four tracks by 'Mr Bob'. Likewise, when the Palma Guitar Centre wanted to make and sell a souvenir record, they came to Jack Webb. Incidentally, the Guitar Centre (run by American Peter Burr) has some Sony recording equipment of its own and make up demo tapes for local songwriters to send hopefully to the mainland, England or the USA. But where the final product is to be a disc, Jack Webb and Medreco usually undertake the work.

Webb's equipment is all portable and he can pack up all the necessary and load it into a Seat *124* in under an hour. The equipment is a Leevers-Rich batteries/mains portable, an EMI warhorse and a Midas custom-built mixer brought in from the UK. The Midas has nine channels but, by hooking up to a Vortexion, Jack can muster 12 channels in all, each with top and bass lift and cut, pan, echo, limiting, foldback and ppms in the output modules. The mics used are mainly AKG *C28*, *D19* and *D202*. In the studio, playback is through an American Harmon Kardon amplifier and a pair of large Wharfedales. None of the equipment is Spanish and, to be frank, one very seldom ever sees any Spanish-built equipment being used in anything other than purely domestic surroundings. Webb humps the Seat full of equipment out over the island to wherever the recording is to be made and this alone can be a fairly hair-raising experience. The Lluch Boys' Choir (who performed in London in 1971) were first recorded by him at the Lluch Monastery, which is a scary ride away over the mountains towards the north of the island. Nearer home, the best acoustics are to be found in the Auditorium at Palma and the Santa Eulalia church. Webb recorded the local police band in the Auditorium and a programme of organ music in Santa Eulalia but unfortunately the prices now being charged for using the Auditorium look like closing the doors on this as a location studio.

For the 50-piece Police Band in the Auditorium, two capacitor mics were used about 3.5m above the instruments and about 10m apart in line with the conductor. A dynamic mike (*D19*) was used at the music stand for the oboe and piccolo and another *D19* for a few percussion items which were separated from the main body of musicians. This recording was taken up by Polydor in Spain and so will be edited by them and issued (probably with a couple more sessions yet to be recorded) on a Polydor label. Normally, however, Jack Webb edits the tapes (usually BASF *LR56*) in Palma and sends them to Barcelona for transfer to disc. To be honest, the kind of sound quality off the discs that come back from Barcelona is nothing to write home about and tends to be rather boxy by the best British pressing standards. But these little 45s do make happy souvenirs of music heard and sunny times spent on the island. At only 100 pesetas each (about 60p) for a stereo ep, the idea is a good one and makes money.

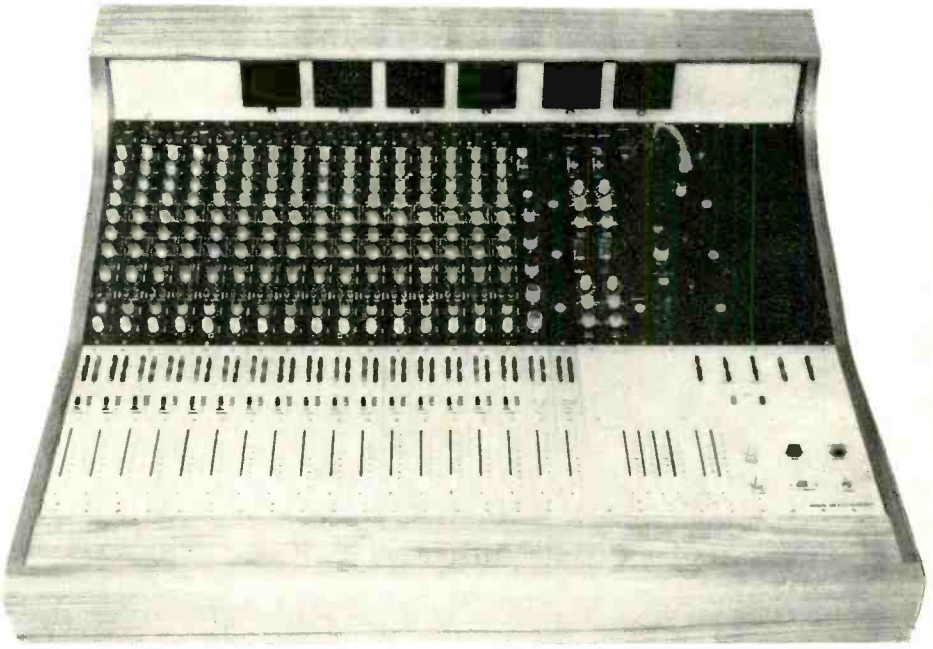
Also sensible is the round-figure price—no 99 pesetas and 'have you any change?' nonsense. Not only are 45 extended plays still being made in Spain but, as I mentioned, they are in stereo. It never seems to have occurred to anyone to make them in mono.

APRS 72 Preview

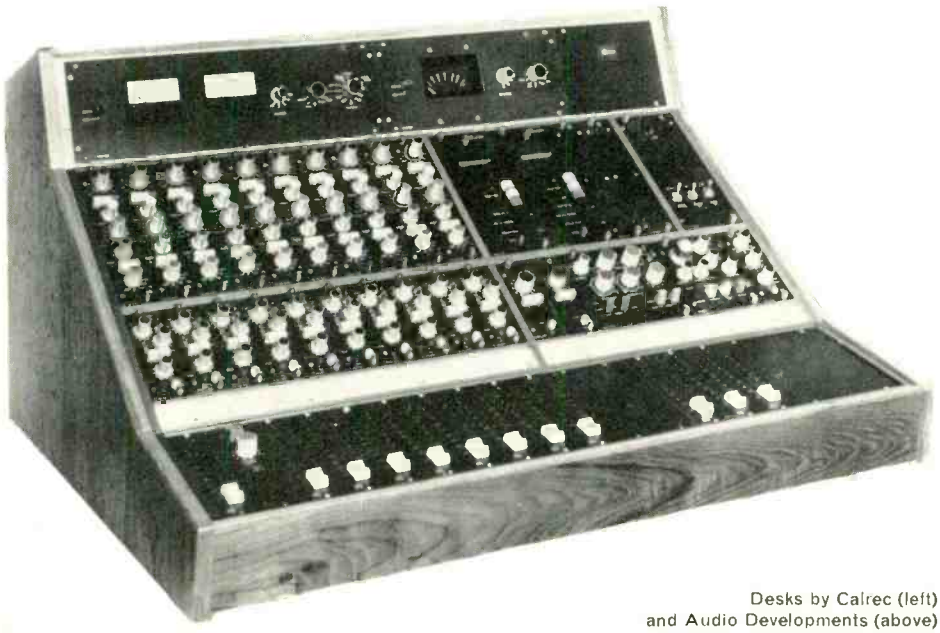
THE annual exhibition of the Association of Professional Recording Studios will this year be held at the Connaught Rooms, Great Queen Street, London WC2, on June 23 and 24. Admission is by trade ticket, available from the APRS Secretary, E. L. Masek, 23 Chestnut Avenue, Chorleywood, Hertfordshire.

Visualise an **AKG** *C451* with an anti-rumble preamplifier and you have the *C451/boom*, described as equally suitable for boom or hand use. This will be exhibited with a miniature quick-release adaptor and two forms of boom cradle. The *BX20* stereo reverberation spring system (shortly to be reviewed) attends its first APRS exhibition Two versions are available, one with 2s and the other with 1.5s minimum decay time. Prices are £975 for the *BX20* and £60.50 for the *C451*/Boom. Representative: Peter Eardley.

Allen and Heath have managed to squeeze a six channel mixer into a space about 20 x 30 x 2.5 cm. The mixer, one of which will be taken from stock for the exhibition, has been built to provide numerous facilities at reasonable cost. Each channel features continuously variable input sensitivity; treble, middle and bass equalisation; foldback monitor output; echo send; stereo panning and flat faders. There are two outputs, each with echo return equalisation, vu metering and a slide fader. Also on the stand will be units from their range of studio mixers and a spring reverberation unit. Details will be available of a new range of semi-modular mixers which Allen and Heath hope to introduce within a month or so.



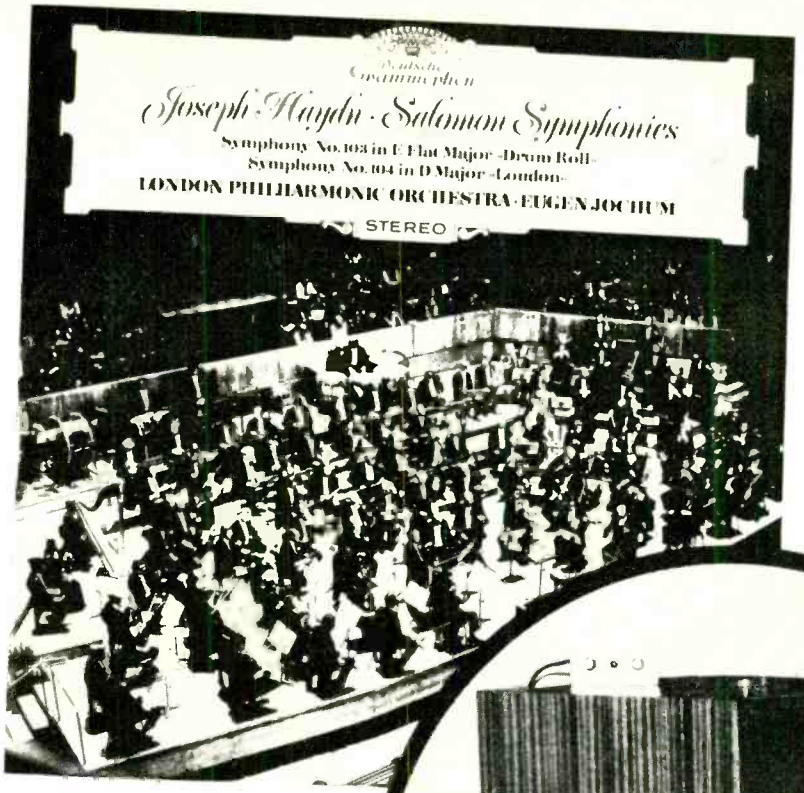
Stands 24 and 25 will respectively house **Alice/Stancoil** and **Alice Developments**, represented by Ted Fletcher, Eric Keene and Byron Davis. Items from the *SM2* series of mixing desks will be displayed. These are available with six to 20 channels and up to four output groups, starting in price at £502. They are available on quick (how quick is quick?) delivery. In the *BD* range of modules, *CNS* is a crosstalk and noise reduction system operating as a frequency conscious low-level expander. *BD6* is a high speed limiter designed to broadcast standards (£78) and *BD7* a limiter/compressor/noise gate (£125). *BD15* is an equaliser with bass, mid and treble cut and lift plus switched-frequency high and low pass filters; £68. *BD24* and *25* are modular power supplies producing stable dc with automatic current trip and reset. Output is 24V negative earth or 24-0-24 split rail for ic applications. Respective prices are £29 and £36. Alice are preparing to produce a new design of modular ic mixing equipment, the *SM2M* series, with prices starting at £535. Finally, the *AD62* six channel stereo mixer will be displayed. Selling at £210, this has been developed for the amateur market.



Desks by Calrec (left) and Audio Developments (above)

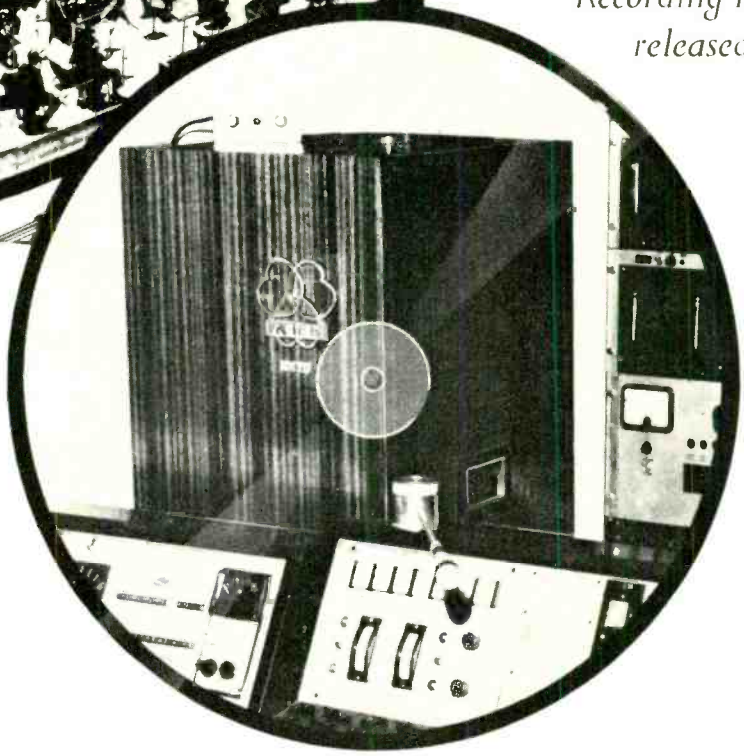
Two mixing desks by SAIT Electronics will be demonstrated by **Allotrope,** probably using material originated by a Triadex *Muse* electronic music generator. The *Muse* will be demonstrated by itself and in multiples, visitors being able to listen on headphones. Malcolm Hodges will be along to demonstrate the Hodges *Edit 900* which provides search, cueing and indexing in addition to comprehensive remote control.

continued 40



ALREADY ON RECORD

[*Record sleeve reproduced by courtesy of Deutsche Grammophon (Great Britain) Ltd. Recording not yet released.*]



THE NEW AKG BX20

STEREOPHONIC STUDIO REVERBERATION UNIT

Price £975 delivered. Hire rate £20 per day. Send for complete technical data on the BX20 and all AKG professional microphones

AKG EQUIPMENT LTD

182-4 CAMPDEN HILL ROAD

KENSINGTON, LONDON W8 7AS

Telephone: 01-229 3695

continued

Audio & Design anticipate showing their range of limiters, compressors and equalisers, including the *S760* peak limiter compressor. They also hope to show the prototype of a phaser which should be in production by August. A new unit combines the *S760* limiter with the *E800* equaliser, which can be switched before, after or into the side chain of the limiter.

Audio Developments, in the persons of Peter Levesley and David Rivett, plan to show a new mobile mixer capable of feeding two, four and eight track tape machines. Features include twin compressors, Ernest Turner concentric ppms, and pin matrix routing. This unit will complement another new item, the TRD *700* series tape machines. These are designed to fill the need for reasonably priced portable recorders with 27 cm spool capacity. Features include switched DIN/NAB equalisation, selsync, linear input and output faders, and twin ppm or vu meters. TRD styling appears to have been pleasantly updated. Deck logic and servo back tension are incorporated on the larger *800*, a console model for 12.5 mm mastering.

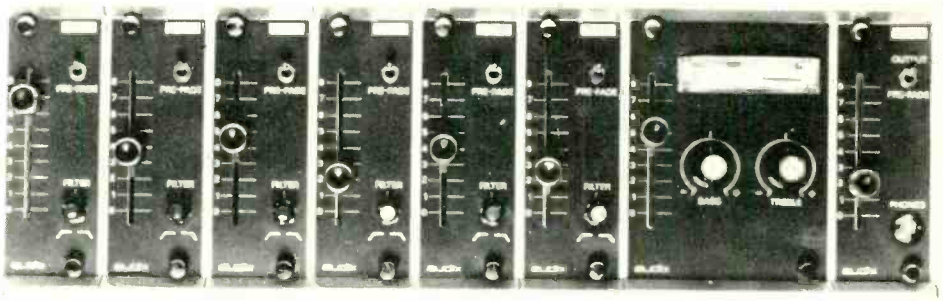
AV Distributors will be exhibiting film equipment, mixers and accessories as well as several versions of the Stellavox *SP7* battery recorder.

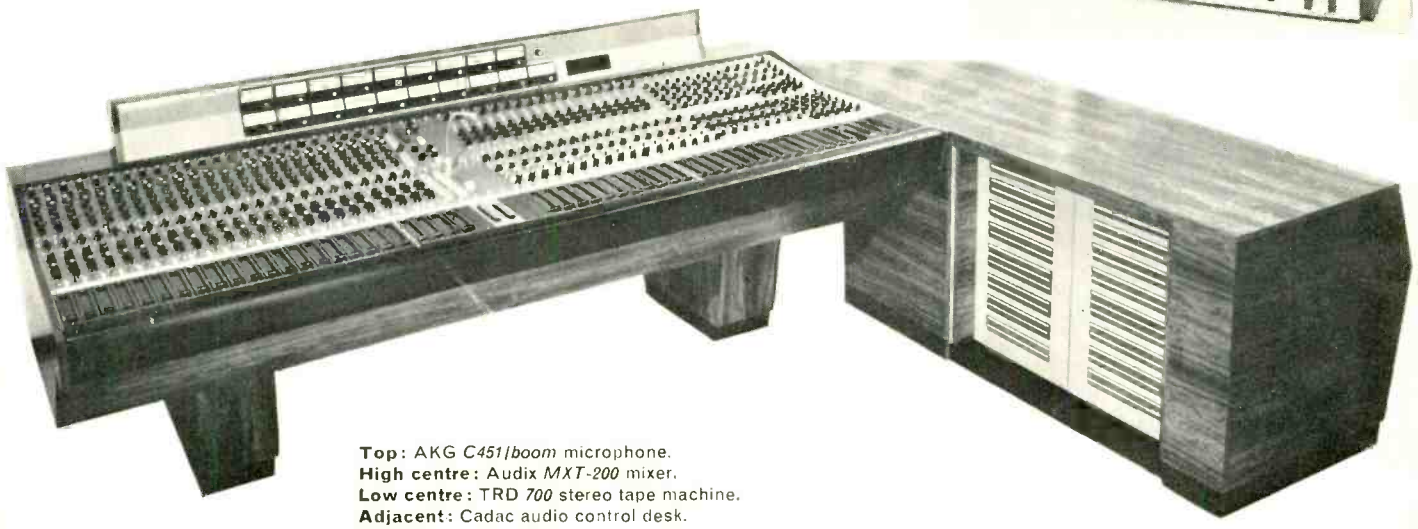
At a time when audio mixers are growing increasingly complex, the **Audix** *MXT-200* combines the advantages of modular construction with extreme ergonomic simplicity. Suitable for mono or stereo working, the system features high and low frequency filtering on each channel plus group bass and treble controls. Up to 16 plug-in channels, each with prefade listen miniature toggle switch, may be connected to a group fader/equaliser. Among a choice of 30 modules are output routing, monitoring, ppm or vu metering facilities. The system is described as equally suitable for recording, broadcasting, theatre and public address applications. For local radio, Audix will display a broadcast mixing console and programme source apparatus such as disc and cassette reproducers.

BASF have patented 'special mechanics' to ensure the running reliability of their C60, C90 and C120 cassettes, available with ferrous or chrome coatings. The latest range of BASF studio tapes will be shown, including matt back *LPR LH* which allows safe fast winding on machines with flangeless hubs.

Among several items of interest on the **F. W. O. Bauch** stand, the EMT *240* reverberation unit was first shown to the trade at AIR Studios on May 2. The *240* is only one fifth the volume of the *140* plate and centres on a 30 cm^2 gold foil. Unlike the plate, the new unit may be operated near speakers in control rooms and in outside broadcast vans. No adjustments are required after transportation. Weight is 60 kg and the case dimensions 67 x 63 x 30 cm. Price: £1,290. A companion to the foil is EMT's *440* electronic delay system. This offers a wear-free and worry-free alternative to running a tape delay machine. Storage time may be varied in 7.5 ms steps up to a maximum of 120 ms (four output version). *928* is EMT's new studio turntable, operating at 78, 45 and 33⅓ rpm. Drive is from a belt coupled three-phase synchronous motor, powered by an ic oscillator with fine frequency adjustment. A *929* arm is incorporated, statically and dynamically balanced in all directions, tracking force being applied by a spring. Basic price is £415. EMT *256* is a small (190 x 40 mm, seating 100 mm) compressor with the properties of the *156*, including programme-controlled release time. It is intended for use in microphone mixing channels and has been simplified for

continued 42





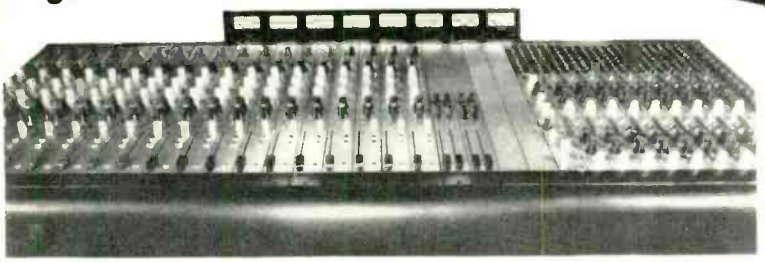
Top: AKG *C451/boom* microphone.
High centre: Audix *MXT-200* mixer.
Low centre: TRD *700* stereo tape machine.
Adjacent: Cadac audio control desk.

From Newcastle to Johannesburg people are turning on to System 12 for multitrack operation

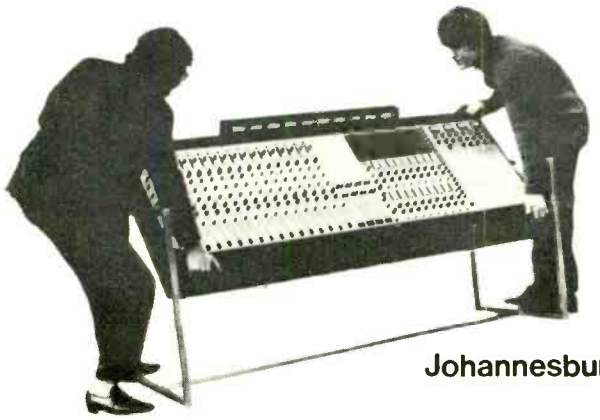
Manchester

London

Kingston Jamaica



Newcastle



Johannesburg South Africa

Above you can see some of the System 12 desks that have been supplied to worldwide users. They realize that with System 12 they can rapidly get down to make 8 and 16 Track Masters without frustration at a down to earth price.

Complete with a free standing console including a 180 hole jack bay, *fully* modular construction, and all the Equalization, Echo, Fold Back and Monitor facilities you need, System 12 enables you to start making 8 and 16 Track Masters as soon as you plug it in.

All this, backed up by our own past six years making desks adds up to value for money second to none. We can probably offer you a System 12 desk to meet your requirements NOW.

System 12 is a 16 track desk.

For further information contact:
Sound Techniques Ltd., Industrial Estate, Mildenhall, Suffolk.
Telephone: 0638-713631 Telex: 81509

Sound Techniques

continued

rapid identification of control settings on elaborate desks.

Bias Electronics are to display their *BE1000* stereo recorder, available with 38 and 19 or 19 and 9.5 cm/s tape speeds. This has all the basic features of a studio machine, including an electronic back tension servo, open face plug-in head block, switchable equalisation, tape time counter and 29 cm NAB, European and Cine spool capacity. Price is £543 with ferrite (£508 with standard laminated) heads. The new *BE370* monitor amplifier will be shown, rated at 70W rms into 8 ohms for one per cent third harmonic distortion. Intermodulation distortion at 20 dB below full output is 0.1 per cent. Free standing or rack mounting units are available, input being 10 kΩ (bridging transformer) through Cannon connectors. Price is £70. Bias have been appointed distributors to the recording industry of Keith Monks Audio products and will display items from the KMAL range of microphone stands. Bias representatives are Peter Lindsley and Tony Costello.

From **Brenell,** on stand 59, an eight channel master recorder using 25 mm tape. Also on show will be a heavy duty solenoid operated tape transport and a four track recorder accepting standard NAB reels.

The **British Homophone Company** will provide advice and quotations to those interested in their tape to disc service. As well as showing examples of their product in its various stages of completion, Peter Shrubsall, John Hale and E. B. Pinnegar will be on stand 13 to answer any questions.

This year **Calrec** are to show further examples of professional sound mixers using the recently extended range of modules. On the stand will be a portable 12 channel stereo/quadraphonic desk, recently constructed for Angus McKenzie Facilities. The outstanding feature of this desk is the inclusion of four Dolby *Cat 22* cards, built into two Calrec modules. Also on show will be the complete range of Calrec capacitor microphones and accessories.

A 30 input 16 group music recording console of the kind currently being supplied to several major European studios will be displayed by **Cadac.** Other equipment on show will include a newly designed quadraphonic panpot and a limiter/compressor. Details of the service offered by Cadac in the design, manufacture and commissioning of studio equipment will be available from representatives Clive Green and Adrian Kerridge.

Trident Studios venture into manufacturing with a desk built by Malcolm Toft and Barry Porter and detailed on page 31. Trident built the prototype for their own studio a year ago and spared no expense to get the best desk they could. They have formed Trident Audio Developments to market a version of the desk. Each is built to customer's specification. Several have been ordered already and you can see examples of Trident expertise on stand six.

EMT *928* studio turntable.

CTH Electronics hope to show a new portable mixer which can be powered from its own batteries or from the mains. The internal batteries are nickel cadmium cells which last 50 hours and which can be recharged in half the discharge time. The six channel mixer comes in a wooden carrying case so that, as Carl Heinlein put it, you can sling it in the back of a jeep.

Dolby are to exhibit their *364* cinema noise reduction unit for the first time in the UK. While intended for the playback of Dolby encoded optical soundtracks, this is said to be capable of improving worn and noisy prints not recorded with the system.

At stand 53, emphasis will be on lacquer discs, of which **EMI** claim to supply over half the world's needs. The range of audio EMI tape will also be available for inspection.

Fraser-Peacock Associates, the Wimbledon company handling Infonics open reel and cassette duplicating equipment, will display a new high speed cassette to cassette copier. This produces two cassette copies in two minutes, two tracks in one pass, through internal agc. The unit may be purchased for £900 or leased over three years at about £7 per week. FPA are now offering blank cassettes of any length up to C90. Competitive prices are claimed and turnround is two to three days.

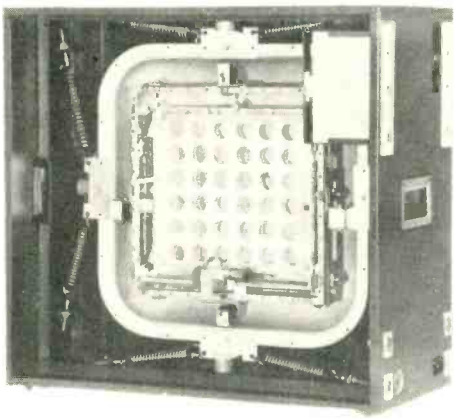
Freehurst Ltd is the name of a company recently formed by John Alcock and Peter Townshend. On stand 23, they will exhibit the *Trackplan* modular mixer developed for studio and PA applications in conjunction with Alice. Ted Fletcher will oscillate from stand 24 to describe the facilities offered by the desk. These include ten to 36 inputs and eight to 24 outputs for integral or external tape machines. Internal power amplifiers and stereo or quadraphonic monitoring are available. Prices and delivery times are described as highly competitive. Freehurst can also supply monitor speakers, studio fitments and decorations.

Stand 28 will be occupied by **Future Film Developments** who specialise in audio connectors and cables. Future Film introduced a range of microphone cables earlier this year, available in ten colours. This will be featured in their display alongside a wide variety of switches.

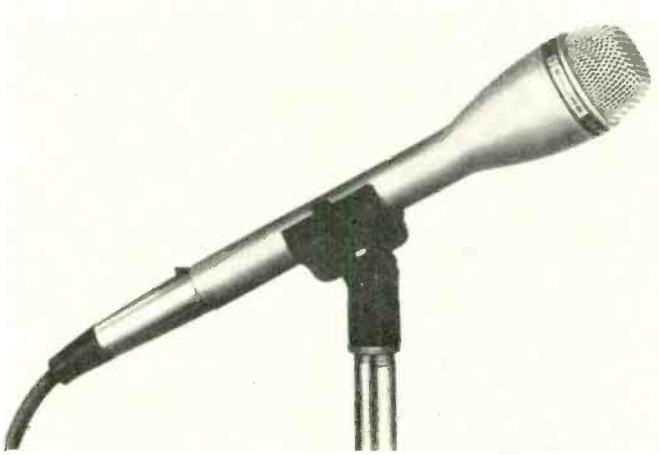
continued 47

Right: Inside view of the EMT *240* reverberation unit.

Below: EMT *256* compressor.



Below: Shure *SM61* anti-shock microphone.



NEW equipment for the professional sound-recording studio from brenell

DESIGNED AND MADE IN THE U.K.

MULTI-CHANNEL EQUIPMENT

We have set a new price/performance standard with our 4, 8 and 16 channel studio recorders offering full facilities for the production of master recordings. PPM or VU meters on each channel. Equalisation to CCIR, NAB and IEC characteristics. Remote control for tape transport and record functions. The equipment is in full production and studio use in both U.K. and overseas.

STUDIO RECORDERS

for 2-channel reducing, field recording and full-track mastering.

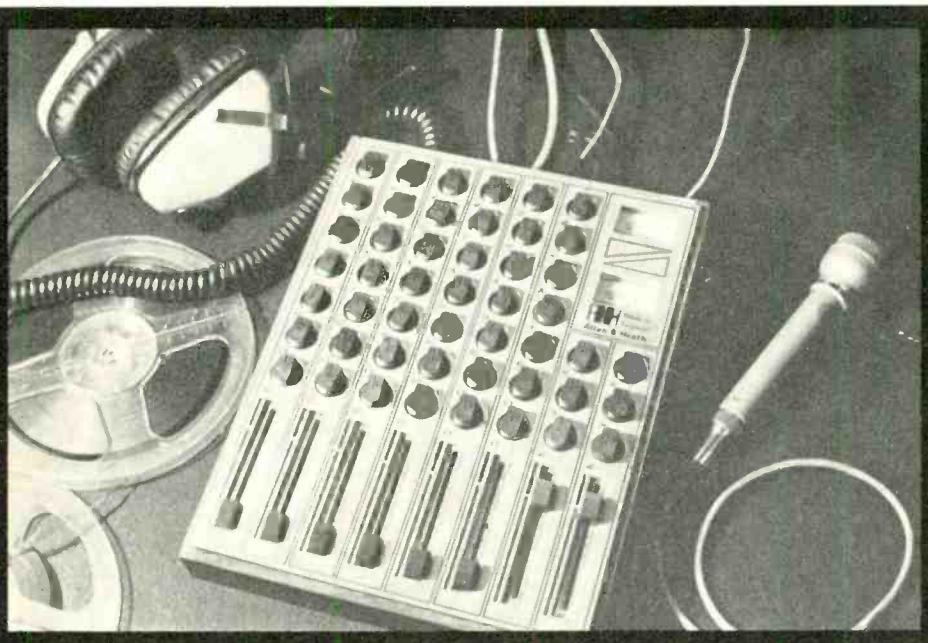
TAPE TRANSPORTS

We offer a widened range of 2 speed and 4 speed models from 15/16 to 60 IPS, $\frac{1}{8}$" to 1" tape width, with heavy duty solenoid operation and remote control facilities.

brenell

★ *See us on Stand 59, at the APRS Exhibition in June, or write for literature.*

BRENELL ENGINEERING CO LTD
231-5 Liverpool Road, London N1 1LY Tel. 01-607 8271 (5 lines)



A SIX WAY MINIATURE STEREO MIXER OFFERING ON EACH CHANNEL

Continuously variable input sensitivity
Treble, mid and bass equalisation
Foldback Monitor output
Echo send
Stereo panning
Slider fader

TWIN OUTPUTS, EACH WITH

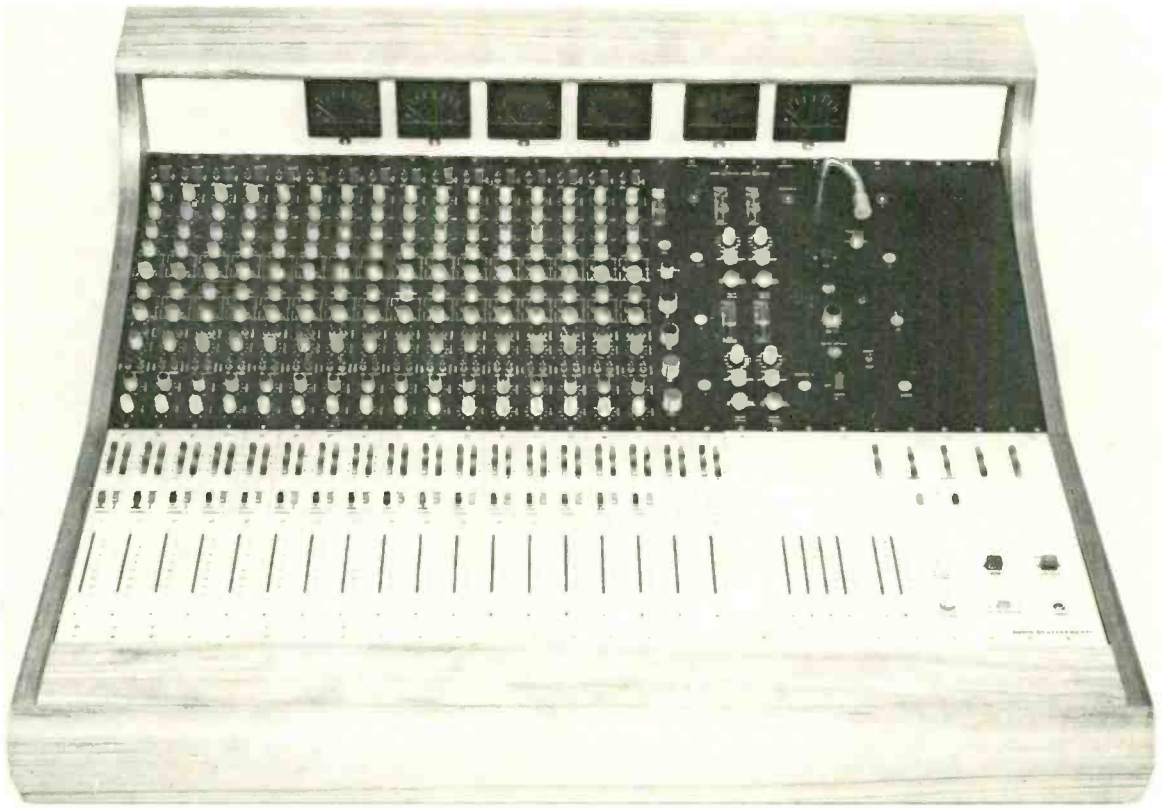
Echo return equalisation
Vu metering
Slider fader

available ex-stock at £100·00

ALLEN & HEATH LTD
PEMBROKE HOUSE CAMPSBOURNE ROAD
HORNSEY LONDON N8 tel:01-340 3291

MIXERS CAN BE LINKED TO INCREASE AVAILABLE CHANNELS

Audio Developments



Custom Mixing to the Highest Standards at Competitive Prices

AUDIO DEVELOPMENTS

HALL LANE • WALSALL WOOD • STAFFS. • ENGLAND **Tel. BROWNHILLS 5351**

Or **TRD SALES SERVICE** · DOG HOUSE · COPLE · BEDS. **Tel. Cardington 404**

TRD
SERIES 800

NEW

LOGIC CONTROLLED ★ PPM OR VU METERING ★ NAB/DIN EQUALISATION
11½" PLATE CAPACITY ★ ½" TAPE ★ 4 SPEEDS ★ SYNC FACILITY
VARIABLE SPEED SPOOLING ★ REMOTE CONTROL

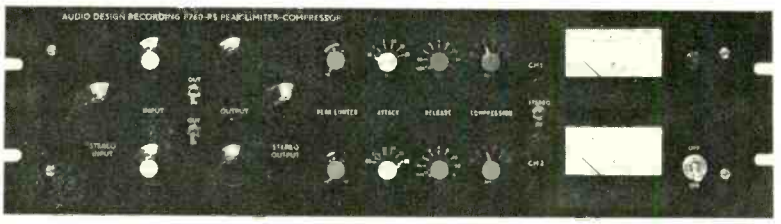
TAPE RECORDER DEVELOPMENTS LTD.
HALL LANE • WALSALL WOOD • STAFFS. • ENGLAND Tel. BROWNHILLS 5351

LEVEL CONTROL EQUIPMENT

Superb Performance—Moderate Cost

To some people, buying the best means *paying* the *most* . . .

If *you're* tempted to do that with Limiters and Compressors, then you haven't *heard* our wide range of units



F760-RS Stereo/Dual Mono Rack Unit

F760-N Module

Of course one of the great things about them is that in normal operation you **don't** hear them—yet they are versatile enough to produce some pretty wild effects when called for.

Units can simply be inserted to suit any operational level from −20 to +10. Line-up takes a matter of seconds and once set any ratio can be selected without change of output level (for 10-12 dB gain reduction) and comparison is possible between direct and processed signal at comparable peak levels.

The F760 Series provides the most effective combination of facilities with separate compressor and peak-limiter. Thus it's possible to have compression on say a 2:1 slope—retaining dynamics—yet still handling those inevitable peaks.

NEW PRODUCTS: We are introducing two phasing effect units—P200 Phaser and the P400 Autophase. The P200 is a manual unit in a 40mm module and provides effective phasing at relatively low cost. The P400 Autophase is a sophisticated design with multiple phasing sections that are automatically controlled from the signal being processed or from an external signal source. Just insert, flick a switch and it's all happening, and what's more the exact effect can be duplicated take after take or at any time. If you run a progressive studio can you afford *not* to have a P400?

APRS 72 EXHIBITION — Stand 41

AUDIO & DESIGN (RECORDING) LTD

St. Michaels, Shinfield Road, Shinfield Green, Reading, Berks. Tel. Reading (0734)-84487

continued

Gulton (Europe), who are distributors for Electrovoice microphones, will be showing items from the Electrovoice range. The *RE20* microphone is a new studio microphone which is claimed to combine the robustness of moving coil construction with the sound quality of capacitor microphones. Robustness is also one of the features of the *635a* microphone, which will also be on display, and Gulton tell us that it can be banged on a table without any ill effect. It is designed for hand or stand use.

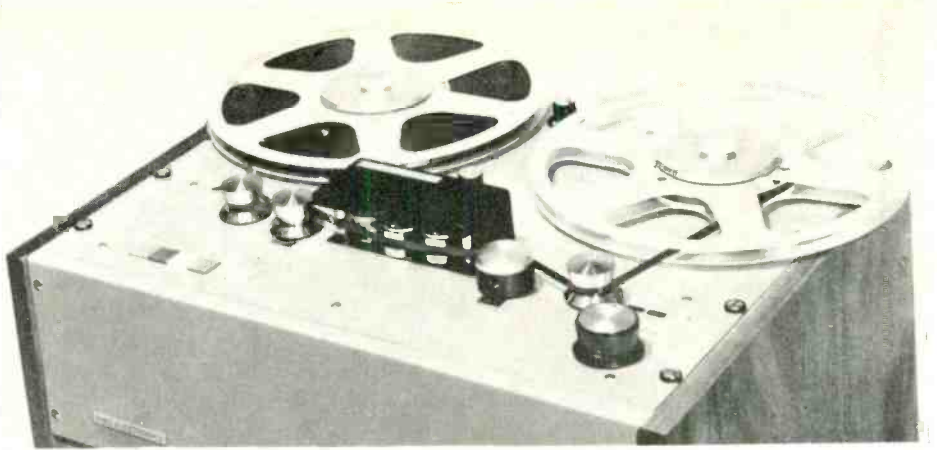
The *RE15* and *16* are dynamic cardioid hand or stand designs. The *RE16* offers, it is claimed, a uniform frequency response irrespective of sound direction. The miracle in question also has a bass cut switch and a blast/pop filter. Other microphones on show will be the *RE20* and the *668* boom microphone, which has been used extensively in film studios.

Gulton will also show the *Sentry 4* loudspeaker, which they claim is entirely free of coloration. All in all the Gulton stand should prove well worth a visit.

Hayden Laboratories plan to show examples of audio equipment by Kudelski, Plessey Australia, Sennheiser and Sondor. Standard and pilotton versions of the stereo Nagra will be seen alongside the pocket-sized *SN*. A Plessey feature will be the *Rapid Q* stereo machine, described as having particular attractions for commercial sound broadcasting.

On the Sennheiser side, a new range of microphones including the soloist *MD413* cardioid and an equivalent supercardioid, the *MD415*. Sondor have added to their range of sprocketed magnetic film record and replay machines. Six new models are being produced for customers requiring the basic facilities of a Sondor, minus the frills. The basics include rapid start, ease of interlock and the capability of high speed operation in either direction. People: K. E. Owens and Eric Barrett.

A large, custom-built desk and a smaller, standard model will be among the items to be seen on the **Helios** stand, number 41. The larger desk has 32 inputs and 16 outputs and the smaller one has 16 inputs and eight outputs. Originally the smaller desk was custom built



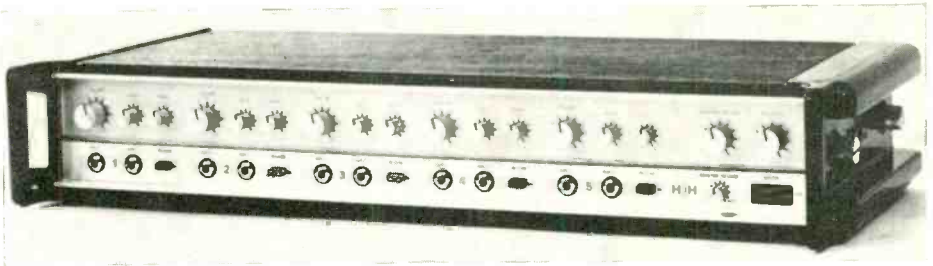
Top: Bias *BE1000* tape machine.

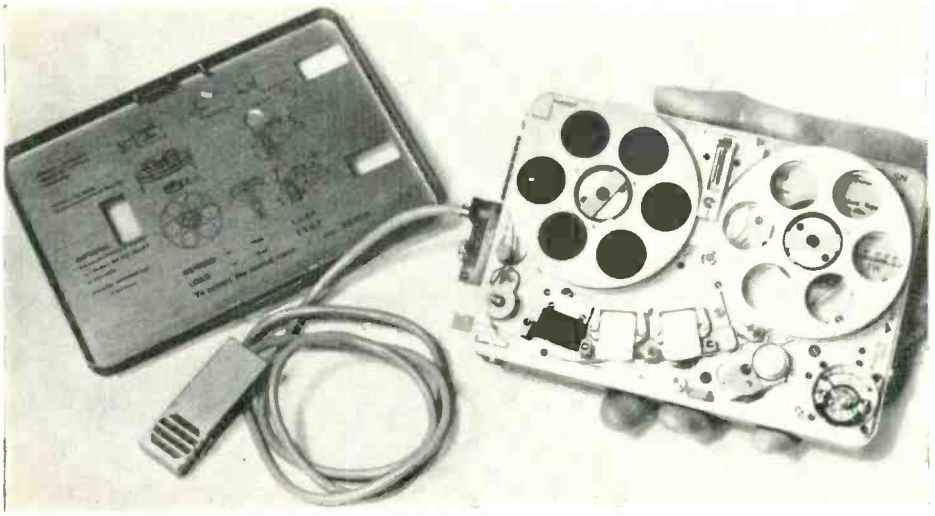
Left: Dolby alignment unit.

High adjacent: H/H Electronic *TPA100D* power amplifier.

Low adjacent: H/H Electronic MA100 mixer/amplifier.

Bottom: Kudelski *Nagra SN* miniature tape machine.



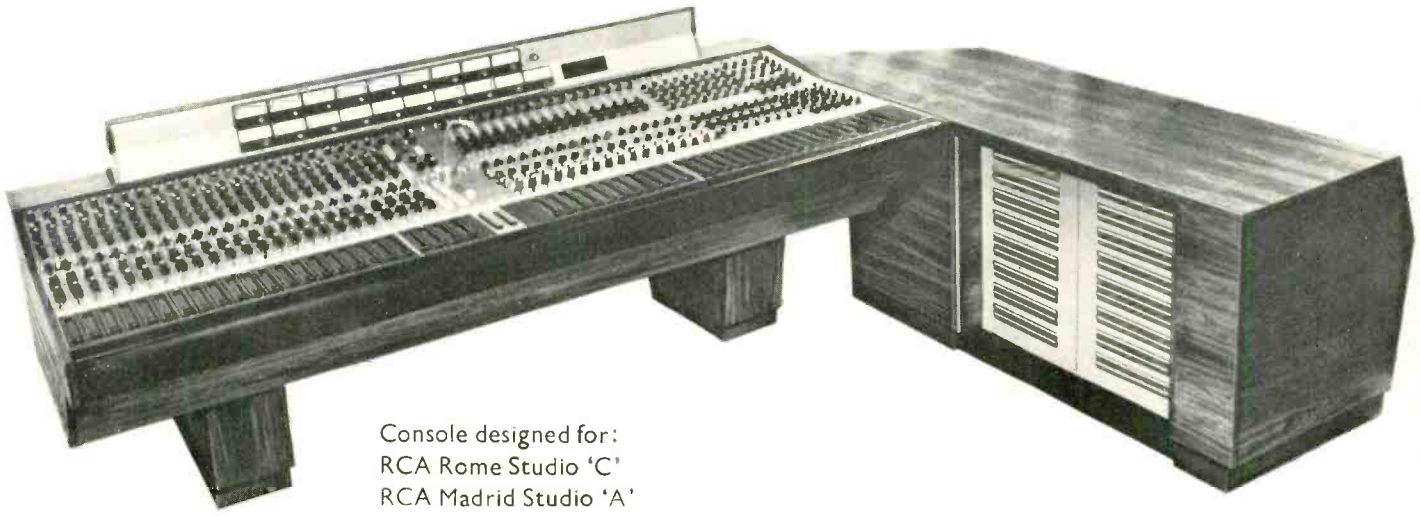


but Helios found they were building so many of them that the desk, which has now been dubbed the *PS* series, has become the first standard model that Helios have produced. Also on the stand will be the Countryman *967* phaser unit, an American unit, and the Powersound spring reverberation unit. Helios will be sharing the stand with Audio & Design.

An exceptional specification at a low price (£79 to studios) is claimed by **H/H Electronic** for their new *TPA100D* amplifier capable of delivering 200W rms. This will appear alongside the *TPA50D* 100W ic and 30/75W *TPA25D* amplifiers. H/H have devoted much of their energy to music amplification, resulting in the *MA100* five channel mixer/amplifier and *IC100* combination amplifier. The *MA100* delivers up to 100W at 0.02 per cent total harmonic distortion. Retail price is £119. Model *IC100* produces 75W into two heavy duty internal

continued 49

CREATIVE SUCCESS COMMENCES HERE



Console designed for:
RCA Rome Studio 'C'
RCA Madrid Studio 'A'

It is acknowledged by Producers, Artists and Musicians that the operational speed and flexibility of the Music Recording Console in any Recording Studio is a most important contributory factor to its success.

The new concept of Cadac Console design is one of no compromise, coupled with advanced thinking. The result is a Console with superb systems engineering and logic, setting a new standard of high performance which leaves you no alternative choice.

Full product and technical information will be available on **STAND 43** at the **APRS EXHIBITION**, or contact —

cadac

Cadac (London) Limited

STANSTED · ESSEX · ENGLAND · Tel: Stansted **3437 & 3132**

continued

speakers, rising to 100W when feeding additional drivers. The amplifier comprises two channels with independent tone controls and reverb. Tremelo and sustain are available on one channel.

Grampian Reproducers will display their range of studio amplifiers on stand 56. These include the *743* low impedance output amplifier, which has a power capability of 100W.

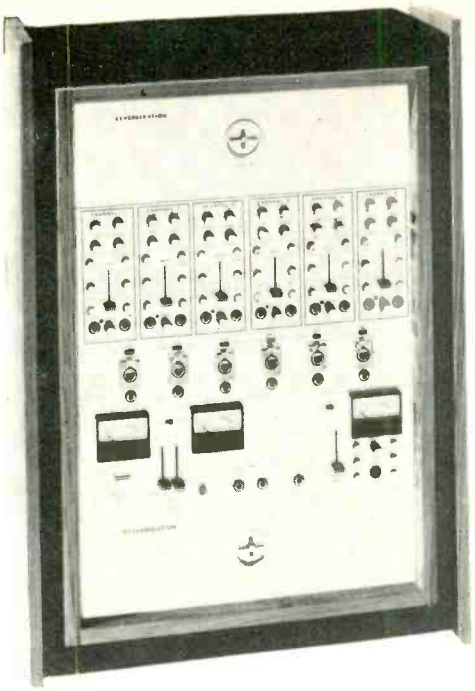
A restyled and improved Woelke wow and flutter meter, the *ME105*, is to be shown by **Lennard Developments**.

Leevers-Rich Equipment will feature a new 16 track recorder, the *J-1600*, based on the existing 25 mm 8 track machine. An exploded working model of the *E200* deck will demonstrate Leevers engineering.

Jacques Levy Professional Recording Services are to feature Audiodisc and Emidisc recording blanks and Audiopak *Model A* broadcast tape cartridges. Capps cutting styli (for Neumann, Westrex and Lyrec cutter heads) will be shown alongside Grampian cutters, *Formula 17 Lubricated* Audiotape, and Pultec amplifiers and equalisers.

Lockwood will present a display of typical monitor units with two new versions of the Lockwood cabinet. The company will also display a new miniature monitor. Representative: Stanley Timms.

3M will feature a 16 track version of the new *M79* designed by their Mincom division. The *Isoloop* drive system is retained but major improvements include a dc servo capstan, 0 to 114 cm/s continuously variable tape speed, three tape reversal rates, remote cue/lift, and a reeling speed above 5 m/s. The control panel is detachable for local or remote operation. NAB and CCIR switchable equalisation, switching transient suppression, and accessible modular electronics.



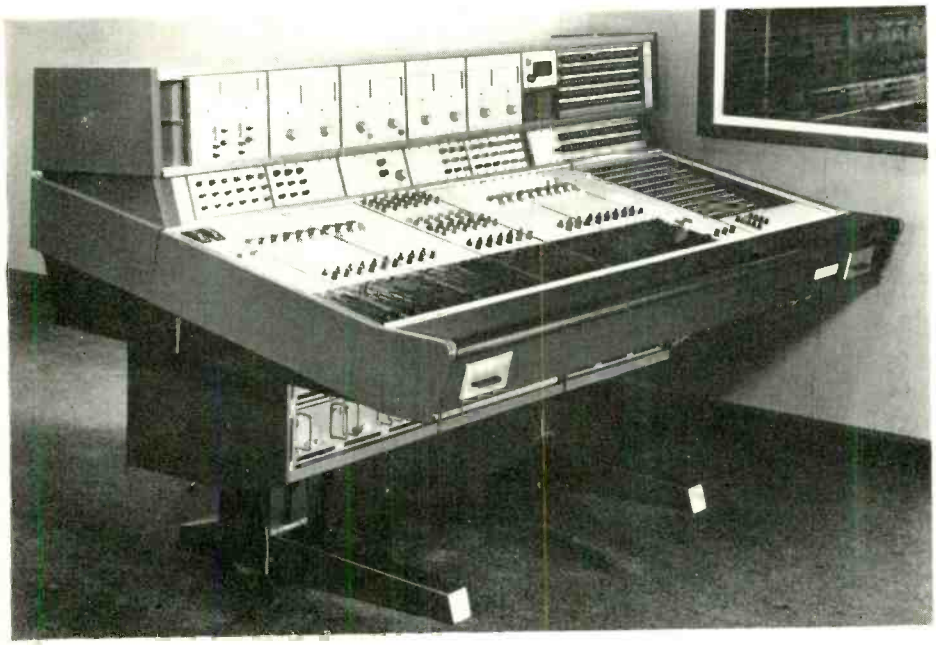
The Crown *D60* disco power amplifier, 60W and 150W loudspeakers can be seen on stands eight and nine. **Macinnes Laboratories** also hope to show stereo tape recorders including the *CX822*.

MSR Electronics will display a prototype disc cutting lathe. The lathe, which will be available in either mono or stereo, has a heavy 41 cm servo controlled turntable. The cutter is variable groove and suitable for masters or acetates. The machine is floor mounted with space for the necessary electronics below the turntable.

A section of a new transportable studio console, a broadcasting console, and some loose modules which offer new facilities will be on the **Neve** stands, numbers 50 and 51.

Orange (who will occupy stand 55, not stand 85 as stated in their June advertisement) will be showing a production model of their 50 mm 24 track tape machine. Orange are part of the Amity Shroeder group and the Amity label will appear on machines of 32 track 50 mm, 16 track 25 mm, eight track 25 mm, and eight track 12.5 mm formats.

Above left: SNS music amplification system and discotheque unit.
Below: Philips audio control desk.

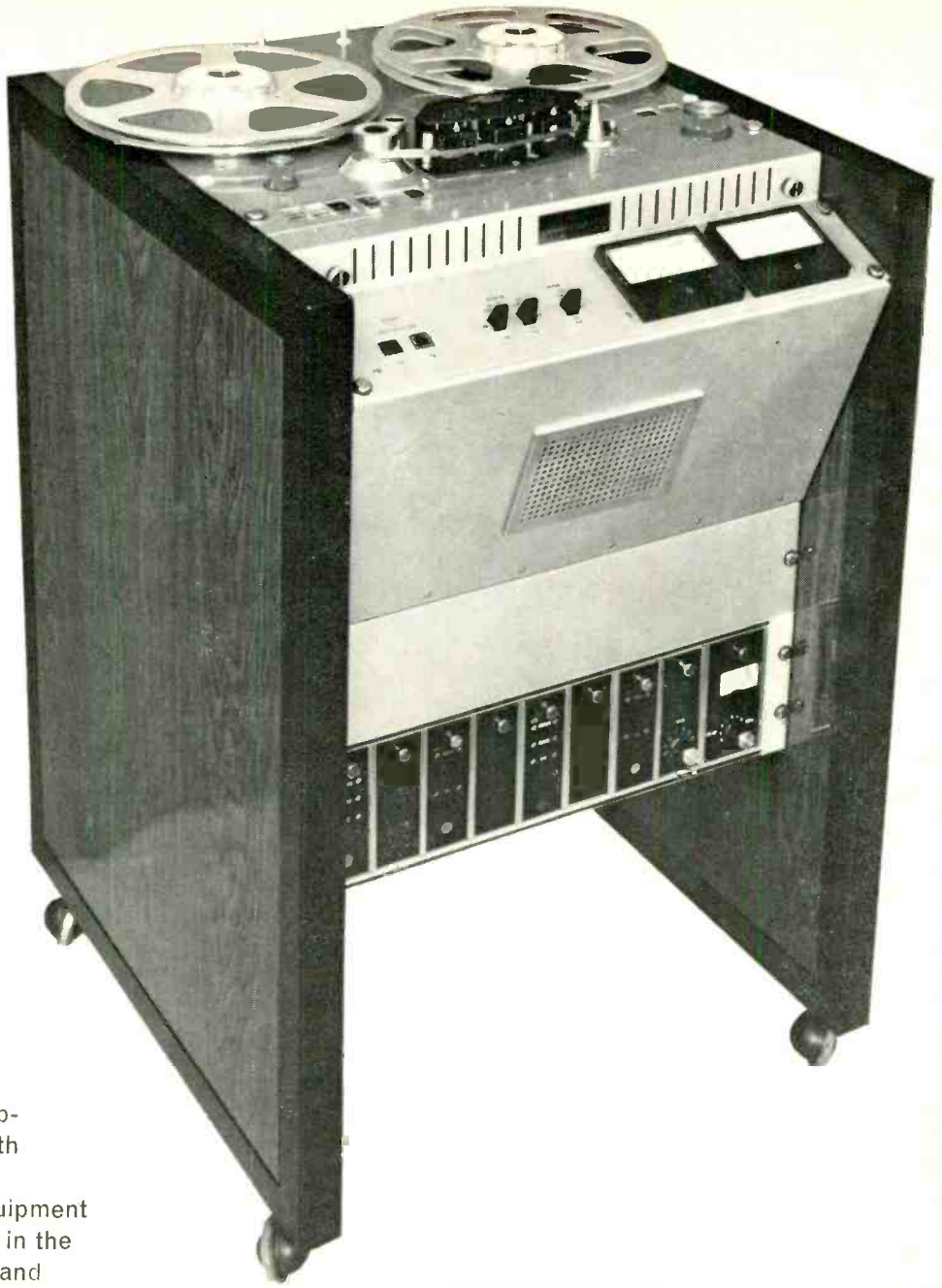


The Philips *Pro 36*, reviewed in this issue, will be shown in its portable stereo form by **Pye TVT**. This machine is also available in console or chassis form with mono, two track or pilot facilities. Main display will be a 12 channel, four group Philips mixing desk constructed around the new *MM11* format module. These are exceptionally small, typically 126 x 95 x 40 mm. The *MM11* module series includes microphone amplifiers, mixing amplifier, electronic switching unit (120 dB damping), matrix amplifier, an inexpensive vu calibrated peakmeter, equaliser, filter, compressor / limiters, oscillator, talkback / slate, correlator and power amplifiers. Among several Pye TVT units on the stand will be the *5740* four channel mixer and 5752 compressor. Representing Pye TVT will be Howell Jones, David Bott and Trevor Foxon. And from Philips Gloeilampenfabrieken: Bram Potappel and Toon Boogers. Magnificent names.

The **Radford** stand (number 27) will be showing three or four types of mixer module as well as an *SC 24* preamplifier, an *SPA 50*

continued 51

Highest attainable technical performance



QUICK AND EASY

No major repair facilities available ?
This professional tape recording equipment needs none and can be used with confidence anywhere in the world.
In the past a fault in sophisticated equipment could mean expensive down time, but in the E200 any fault can be quickly isolated and the part or circuit replaced.
All major mechanical components and sub-assemblies are quickly and easily changed. Many circuits simply plug-in.

LEEVERS-RICH

EQUIPMENT LIMITED

A Member of the MCP Group

Contact **Nick Nichols** at our London office, telephone **01-874 9054** or Telex **935959.** He will be glad to help.

LEEVERS-RICH EQUIPMENT LTD., 319 TRINITY ROAD, WANDSWORTH, LONDON SW18 1YQ

continued

power amplifier and the *FMT4* tuner, which is a phase locked loop design.

Also on show will be a completely new range of speakers, including the *360*; this uses two 25 cm bass driver units with acoustic line termination, four mid-range drivers and four high frequency drivers. It is claimed to handle speech and music from amplifiers having a continuous sine rating of 100W and, if placed one metre from a wall, to give 360° radiation. The speaker radiates at an angle of 270° if placed against a wall.

A range of cards which answers most needs from microphone preamplifiers to ten watt monitor amplifiers will be shown on stand 47 by **J. Richardson Electronics.** The cards are fibreglass and have gold plated edge connectors. The range includes a 42V stabilised power supply card. They also intend to show a modular mixer, each module of which is made up from standard cards that can be arranged in any configuration. Input and output sockets are at the back of each module to make less wiring necessary. Among the facilities which can be supplied are microphone to line switching with 80 dB control range, full equalisation, foldback, echo, pan, and routing into any number of channels. A third item on the stand will be an eight track tape machine which also uses modular electronics.

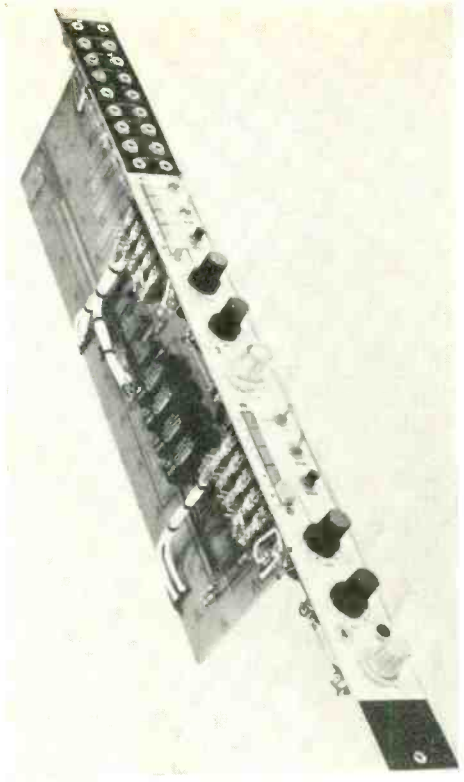
Each group of four tracks has record, replay and selsync amplifiers as well as a buffer amplifier, all of which fits into standard racking.

Shure Electronics will show for the first time their *SM61* omnidirectional dynamic microphone. This is designed to minimise mechanically transmitted noise in hand-held applications, an isolating system being incorporated between the transducer and case. A wind filter is also fitted. Other items on the Shure stand will be the *M67-2E* and *M675* mixers (reviewed in June STUDIO SOUND), also the Audio Level Controller and Audio Control Centre. These units, little more than pocket size, may be used independently or combined to form more elaborate control systems.

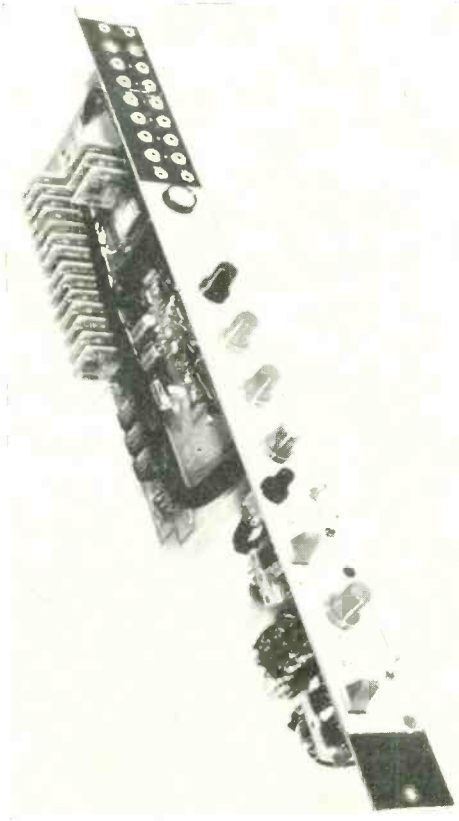
SNS Communications specialise in music amplification equipment and plan to demonstrate several systems, ranging from a basic six channel unit to a 36 input modular mixer including pre/post fade listening and foldback facilities for on-stage monitoring. A new discotheque unit will be shown, incorporating the SNS *Sound Shaper* graphic equaliser. This provides cut and lift in the bass, baddle, middle, preddle, presence and treble regions. Versatidle. APRS 72 will see the first showing of the SNS radio microphone system.

Last year, **Sound Techniques** produced a *System 12* 16 track desk to coincide with the APRS Exhibition. Appropriately, this year sees *System 12 Mk2*, incorporating a fully modular monitor section. An additional unit available for *System 12* is the *Auxiliary 1*, providing a foldback mix independent of the three already provided. *N1* is a digital stop clock with vacuum tube readout of minutes, seconds

continued over



Sound Techniques audio control modules.



APRS 72 Exhibitors

Allen & Heath Ltd, Pembroke House, Campsbourne Road, Hornsey, London N8. 340 3291
Audio Developments Ltd, Hall Lane, Walsall Wood, Staffordshire. Tel. 054 33 4605
AKG Equipment Ltd, 182/4 Campden Hill Road, W.8. 229 3695/6
AV Distributors, 26 Park Road, London, NW1. 935 8161
Audix Ltd, Stansted, Essex. 027-971 3132/3437
Audio & Design Recordings, St Michaels, Shinfield Road, Shinfield Green, Reading, Berkshire. 0628 25204
Allotrope Ltd, Industrial Estate, Thame, Oxon.
BASF (UK) Ltd, PO Box 473, 197 Knightsbridge London SW7. 584 5080
F. W. O. Bauch Ltd, 49 Theobald Street, Boreham-wood, Herts. 953 0091
Bias Electronics Ltd, 162 Randall Avenue, London NW2. 452 6825
British Homophone Co Ltd, Excelsior Works, Rollins Street, London SE15. 639 2080/9
CTH Electronics Ltd, Industrial Estate, Somersham Avenue, St Ives, Huntingdonshire. 0480 64388
Calder Recordings Ltd, Regent Street, Hebden Bridge, Yorkshire. 042 284 2159
Centredisc Ltd, Trident House, St Annes Court, Wardour Street, London W1. 734 9901/4
Cadac Ltd, Stansted, Essex. 027-971 3132/3437
Dolby Laboratories Ltd, 346 Clapham Road, London SW9. 720 1111
EMI Tape Ltd, Blyth Road, Hayes, Middlesex.
Fraser-Peacock Associates Ltd, 94 High Street, Wimbledon Village, London SW19. 947 1743/2233
Feldon Audio Ltd, 126 Great Portland Street, London W1. 580 4314
Freehurst Ltd, Wardour Street, London W1.
Future Film Developments,
90 Wardour Street, London W1. 437 1892/3
Grampian Reproducers Ltd, Hanworth Trading Estate, Feltham, Middlesex.
Gulton Europe Ltd, The Hyde, Brighton BN2 4JU. 0273 66271
Helios Electronics Ltd, 95 Railway Road, Teddington, Middlesex.
HH Electronics, Industrial Site, Cambridge Road, Milton, Cambridge CB4 4AZ. 0223 63070
Hayden Laboratories Ltd, 17 Chesham Road, Amersham, Buckinghamshire. 024 03 5511
Jackson Recording Co Ltd, 13 Denham Way, Rickmansworth. 79 72351
Lockwood & Co (Woodworkers) Ltd, Lowlands Road, Harrow, Middlesex. 422 3704
Lennard Developments Ltd, Lockfield Road, Brimsdown, Enfield, Middlesex. 804 8425
Leevers-Rich Equipment Ltd, 319 Trinity Road, Wandsworth, London SW18.
3M United Kingdom Ltd, 3M House, Wigmore Street, London W1. 486 5522
Midland Sound Recordings, Meeting House Lane, Balsall Common, Coventry. 0676 3-2468
MacInnes Laboratories Ltd, 71 Oakley Road, Chinnor, Oxfordshire.
Rupert Neve & Co Ltd, Cambridge House, Melbourn, Royston, Hertfordshire. 0763 60776
Pye TVT Ltd, Coldhams Lane, Cambridge. 0223 45115
J. Richardson Electronics Ltd, 57 Jamestown Road, London NW1. 267 0723
Radford Electronics Ltd, Ashton Vale Road, Bristol BS3 2HZ. 0727 662301
Rola Celestion Ltd, Ditton Works, Foxhall Road, Ipswich, Suffolk. 0473 73131
SNS Communications Ltd, 851 Lingwood Road, Bournemouth.
Shure Electronics Ltd, 84 Blackfriars Road, London SE1 8HA. 928 3424
Stancoil Ltd, 15 Sheet Street, Windsor, Berkshire.
Sound Techniques Ltd, Industrial Estate, Mildenhall, Suffolk. 352 2354
Tape Music Distributors, 11 Redvers Road, London N22. 888 0152
TRD Ltd, Hall Lane, Walsall Wood, Staffordshire. 054 33 5351-3
Orange Recording Studios Ltd, 3 New Compton Street, London WC2. 836 0374

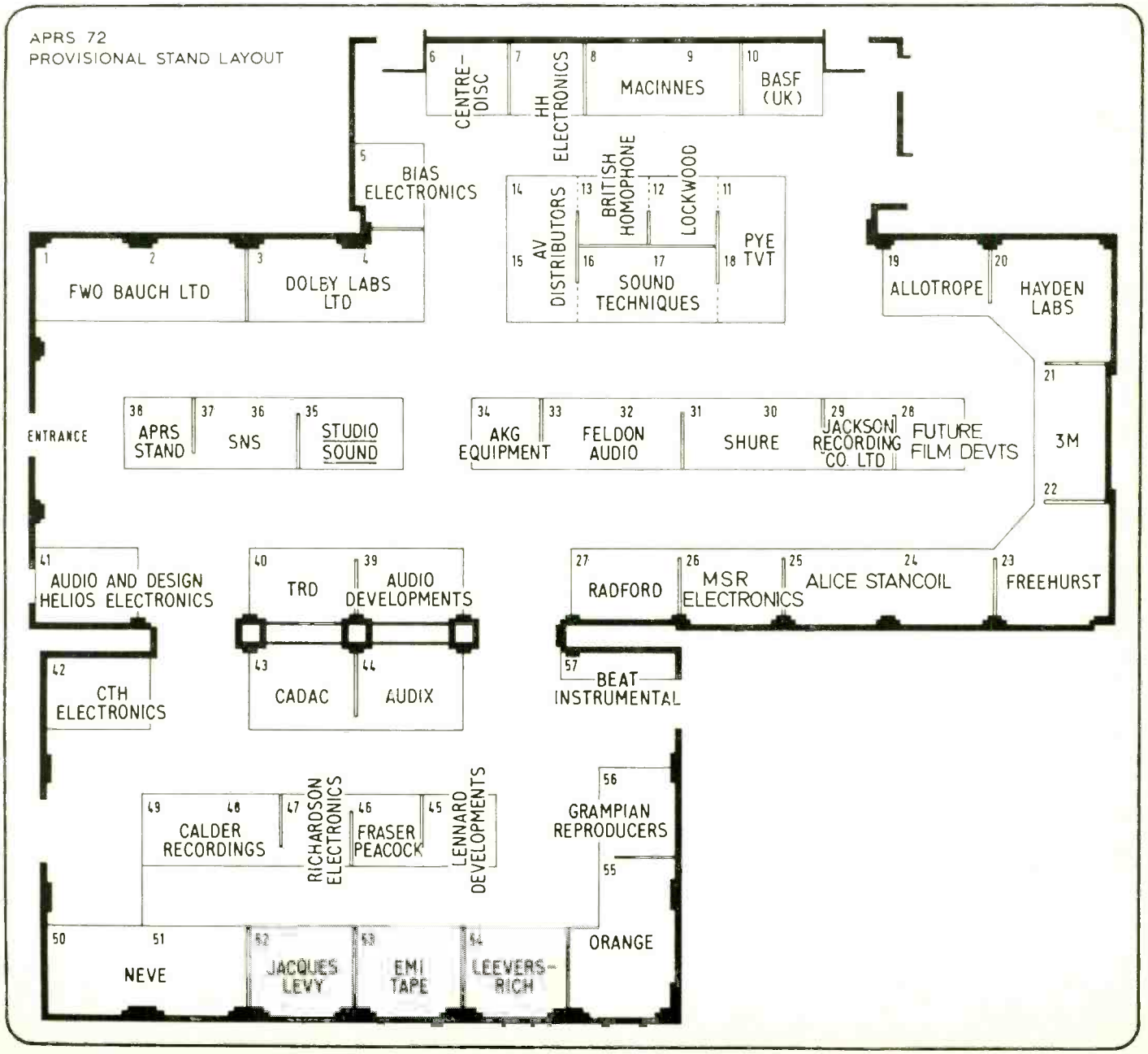
continued

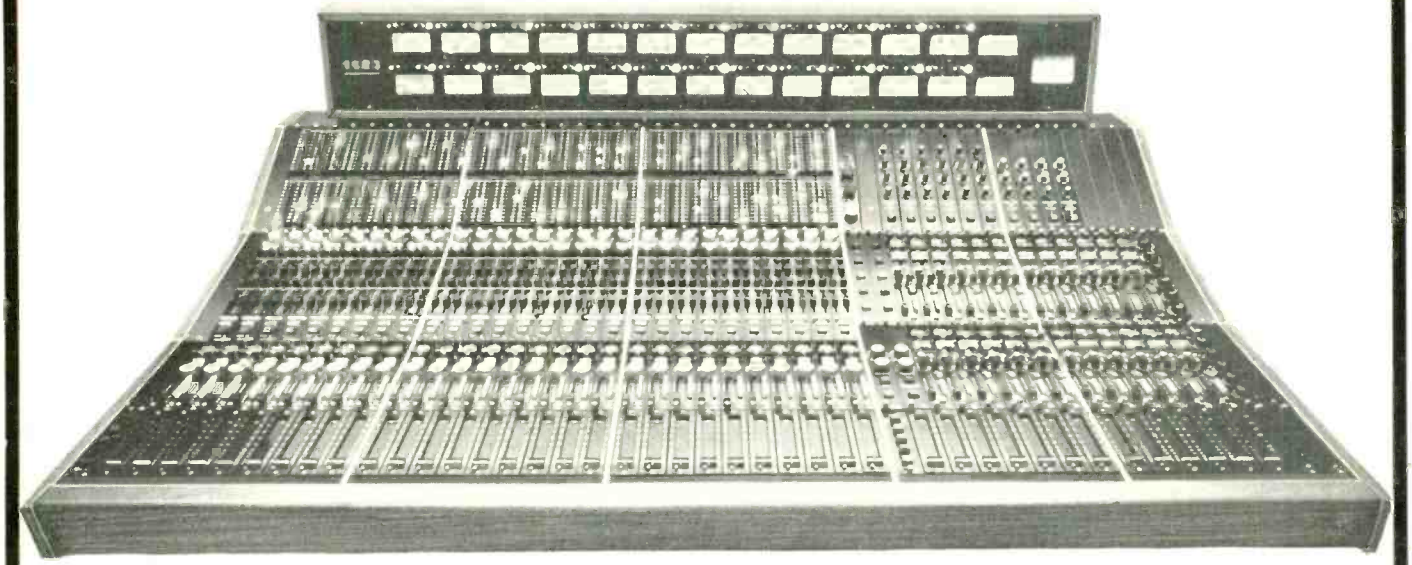
and deciseconds, recycling in 100 minutes. It is designed to meet the need for a reliable, accurate and inexpensive studio clock and is already being widely used. The four controls are start, stop, reset and power on/off. Not the least of its merits, it doesn't tick. Sound Techniques representatives: Geoff Frost, Michael Ford, Ron Pender and Peter Woods.

Tape Music Distributors will be showing two new products with their normal range of Koss headphones. One of these is the *KO747* headphoneset, which retails at £20. The phones are fitted with a volume control, a mono or stereo switch and fluid-filled cushions.

And there's a large bar on the ground floor.

SAIT mixing desk.





The recording equipment created by engineers for engineers

TRIAD

Trident Audio Developments Division
Trident House, 17 St Anne's Court, Wardour St., London, W1
01-734 9901/4

Malcolm Toft and Barry Porter at Stand No 6

TELEFUNKEN
M15

THE LATEST ADDITION TO OUR WELL ESTABLISHED AND COMPREHENSIVE RANGE OF RECORDERS

★ **Electronically controlled capstan motor ensuring maximum freedom from mains frequency variations.**

★ **Tape time counter.**

★ **Relay operated mode selectors.**

For further details contact:

BRIAN ENGLISH

SPECIFICATION:
Dual speed (38—19 cm/s) recorder with electronically commutated DC capstan motor. Available in A or B wind forms with full track, stereo or two-track head format.
Speed deviation: ±0.1%
Wow and flutter: ±0.05% (DIN 45 507 peak weighted)
Slip: 0.2%.
Spooling tension: 100 gm, peaking to 750 gm.
Tape time counter: 0.2% accurate 4s addition after tape end.
Frequency response: 40 Hz to 60 Hz ±1.5 dB, 60 Hz to 15 kHz ±1 dB.
Signal-to-noise ratio: 55 dB (full track).
Distortion: 1%.
Chassis dimensions (hwd): 308 x 645 x 525 mm.
Weight: 53 kg.

A.E.G. TELEFUNKEN

A.E.G. House, 2-4 Clerkenwell Green,
London EC1
Tel. 01-251 0244

Understanding Music Synthesisers

By R. M. Youngson

THE application of voltage controlled oscillators, amplifiers and filters to the synthesis of music has now been elevated to the status of a genre. With the recognition of the need for subtle variability in the control of the many parameters of music, the development was no doubt inevitable but every credit is due to men like Robert A. Moog,[1] J. W. Beauchamp,[2] Hugh Le Caine and H. F. Olson for their imaginative and pioneering work in applied electronic engineering.

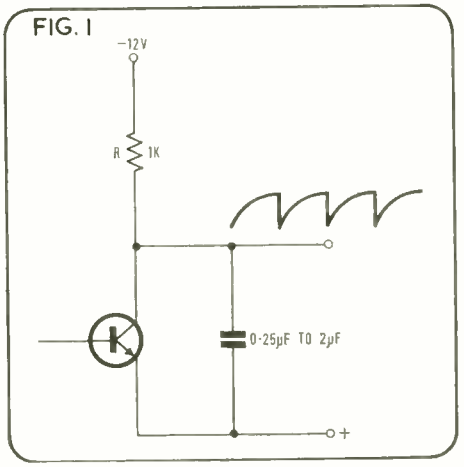
The commercial success of *Switched-On Bach*[3] unquestionably had an important influence on the acceptability of these expensive toys. So the generations of synthesisers succeed one another and we have the Buchla Box, the Tonus ARP series, the Electronic Music Studios' range, and so on. We can safely assume that many others are in the process of gestation.

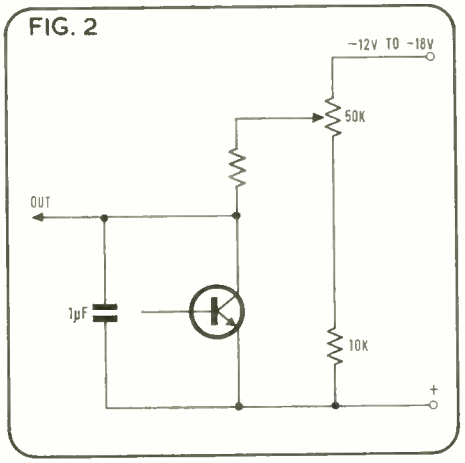
Ironically, these assemblies are already obsolescent; voltage control will inevitably give way to digital systems. That it has not already done so is a consequence of economic rather than technological factors. All the necessary techniques have been developed and digital methods greatly facilitate both the creation and accurate reproduction of highly complex waveform patterns. But the era of the digital sound synthesiser has not yet arrived and a great deal of interest and profit is still to be derived from a study of the design and use of linear voltage controlled circuit modules.

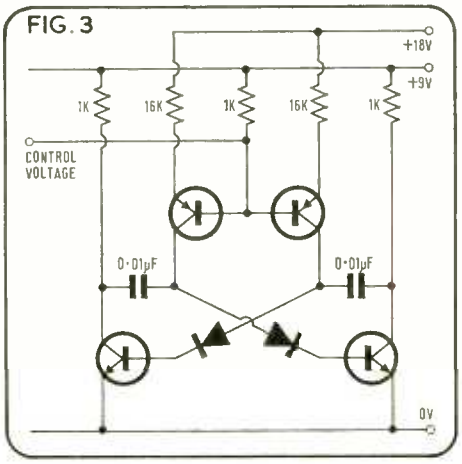
Contemporary synthesisers, however, differ little in principle from those described in the early 60s. Discrete-component modules, which gave way to those incorporating ics[4] are, in turn, being replaced by complete ic vcos and vcas. Patch cords have been replaced by matrix switching systems for routing signals and control voltages. Frequency stability has been greatly improved and the capability/weight ratio increased. Nevertheless, no fundamentally new technique is used and these instruments are still essentially monophonic generators requiring multitrack tape facilities to produce polyphony. Some large synthesisers, however, have two keyboards. The ability to employ synthesisers in real time has increased in recent years and there is a growing tendency to regard them as programmable multipurpose musical instruments. With progress in miniaturisation and simplification of controls, we may expect this role to become dominant.

Oscillators

The trouble about voltage controlled oscillators is that they are, ipso facto, voltage controlled! This apparently ingenuous statement will strike a chord of sympathy in anyone who has ever tried to achieve adequate frequency stability from relaxation oscillators or multivibrators. This is why electronic organ designers have always chosen for their master oscillators circuits using LC tank arrangements in which the frequency of oscillation is determined by the physical (and stable) characteristics of the inductor and capacitor and is largely independent of temperature and voltage variation-induced changes in the gain of the transistor. It is useful to think of the Hartley or Colpitts oscillator as being analogous to a precision clock whose frequency is set by the dimensions of the pendulum. All the active unit has to do is to give the pendulum a little shove from time to time to keep it swinging. If the force of the push should vary a bit this doesn't make much difference to the frequency. Relaxation oscillators, on the other hand, are like watches without balance-wheels: every small change in the tension of the mainspring results in a change in the rate of operation.







Thus we see that a wide range of oscillators are inherently voltage-sensitive and may be used as vcos. The simplest one known to me is shown in **fig. 1.** This oscillator can easily cover the whole audio range and gives a sawtooth output rich in harmonics. You may be unfamiliar with this little-known but extremely useful circuit so a few additional details may not be out of place. This is a negative-resistance oscillator whose function depends on the fact that certain silicon planar npn transistors *operated in a reverse voltage mode* (i.e. with *positive* to the emitter) display a voltage/current relationship which, over part of the curve, is the inverse of Ohm's law. The base of the transistor is left unconnected and it is essential to limit the current by the resistor R or the transistor will be destroyed. Silicon planar transistors must be selected by trial. Most will oscillate easily enough at high frequencies but you may have to try several before you find one that will work right down to the lowest audio frequencies. A practical circuit is shown in **fig. 2.** See that the input impedance of the amplifier is not too low or use an emitter-follower buffer stage. Incidentally, I have been able to demonstrate that these remarkable oscillators can readily be synchronised with each other to form frequency dividers by joining the collector of one to the base of another through a high resistance.[5]

A common design of vco incorporates some form of a stable multi-vibrator and this may be of the cross-coupled or the emitter-coupled or even of the complementary pnp-npn type. A typical example of the cross-coupled variety is shown in **fig. 3.** The current through the two pnp transistors is controlled by their base voltage, which is the input control voltage. This current, in turn, determines the rate of charging of the two timing capacitors and thus the frequency of oscillation.[6] *continued 57*

MSR-2000 disc-cutting lathe stand 26 APRS 72. seeing is believing.

The Series 2000 disc-cutting lathe is designed to cut stereo records with outstanding quality. (An identical Series 1000 lathe is also available for cutting records in Mono)

All MSR Series 2000 lathes are fitted with a 16 inch turntable, with a direct driven DC motor, independent of mains frequency and servo controlled for maximum speed stability

'Varigroove' is provided on all MSR Series 2000 lathes. This is controlled from an advanced head on the tape replay machine

The MSR Series 2000 lathe is equipped with stylus heating and swarf collection systems and is built into a high quality floor standing console

So come and see it on Stand 26

MSR Electronics Limited
MEETING HOUSE LANE . BALSALL COMMON
WARWICKSHIRE . ENGLAND
Telephone (0676) 32468

MSR
Design Engineers to the Recording Industry

helios

Series PS mixing desks

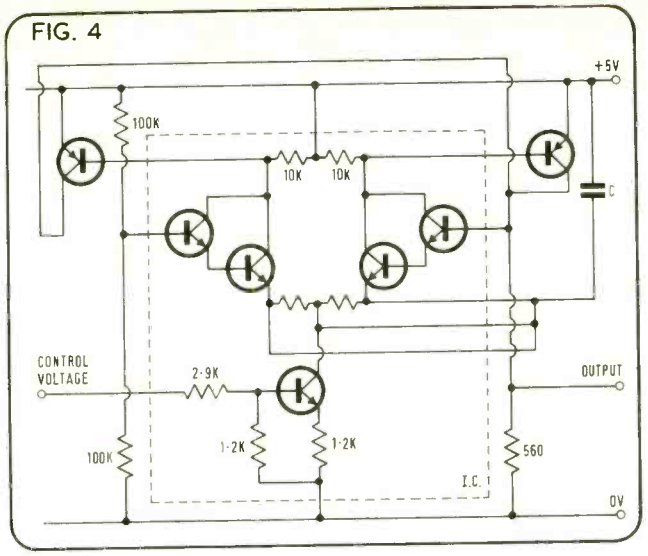
have from 10 to 15 inputs freely selectable to 8 full output groups plus echoes and foldbacks. 8 or 16 track comprehensive monitoring with sync and solo switching. Up to 4 patchable compressors, up to 8 meters, and room for various options to your choice.

If this does not solve your problem, remember Helios custom build consoles and systems up (and down) to any possible size.

Don't ask if we make it — just say what you need

HELIOS ELECTRONICS LTD. 161 HIGH ST., TEDDINGTON
MIDDLESEX, ENGLAND TW11 8HT • • 01-977 7841 & 7877

FIG. 4

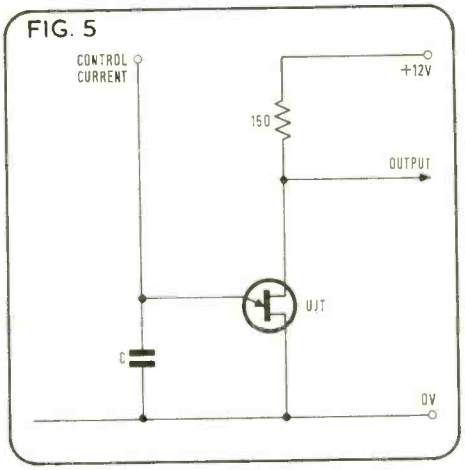


An example of a pnp-npn vco which is of special interest as it makes use of an ic operational amplifier is given in **fig. 4**. The op amp is a Fairchild μC 101 differential amplifier and the circuit is due to A. D. Walker.[7] There is a considerable literature on voltage controlled oscillators and those sufficiently interested can get a start by reading references six to 13.

To return to simple matters, let us take a look at the vco used in the Moog synthesiser. This is the well-known unijunction oscillator of **fig. 5**. Of course, the Moog vco involves a bit more than this very elementary circuit but, before getting involved in the details, let us see how we can make a practical vco out of a unijunction without too much complexity. What we are essentially trying to do is to control the rate of charging of the capacitor C. So we need some resistance between the current source and the capacitor and we need the resistance to be under voltage control. The obvious thing to do is to put a transistor in the supply line and to control its current by varying its base voltage. **Fig. 6** shows how this is done. Subject to the limitations already mentioned, this little circuit makes an excellent vco. The most important limitation is the question of stability of supply voltage. Naturally, quite apart from the effect of varying the control voltage, the output frequency will vary with changes in Vcc.

The real difficulty arises from the extraordinary sensitivity of the human ear to frequency differences. So, let's get this factor into perspective.

FIG. 5



Frequency stability

Pitch discrimination is worst at low frequencies and best at high. This is because the number of Hz for a given musical interval increases with a rise in pitch. For instance, at the bottom of the piano keyboard the frequency of A is 55 Hz and of A♯ is 58 Hz, a difference of only 3 Hz, where as five octaves higher the frequencies are 1760 Hz and 1864 Hz respectively, a difference of 104 Hz. Sensitivity to mistuning, of course, varies from person to person and with varying circumstances, but few people would fail to be aware of the difference between two pitches 10 Hz apart. Musically sensitive people can distinguish a difference of as little as 2 Hz.[14 15] Thus, the long-term frequency stability of an oscillator used for musical purposes should be at the very least ±1 part per 1,000, i.e. 0.1 per cent, which is no mean achievement.

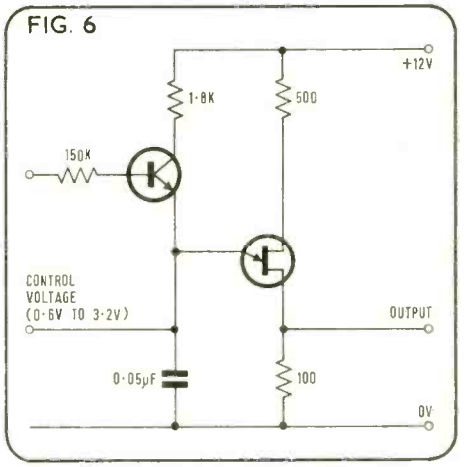
Clearly the stability of the power supply voltages is going to be very important, as will be the percentage change in oscillator frequency with change in supply voltage. If the Vcc of the oscillator in **fig. 6** is set initially at 10V, and the control voltage adjusted for a frequency of oscillation of 440 Hz, variation in the supply voltage gives the following changes in output frequency. (The experiment was repeated an octave higher):

Vcc (volts)	F out (Hz)	F out (Hz)
10	440	880
11	390	780
12	370	740
13	340	680
14	310	620

Inspection of these results will show that the percentage change in frequency is exactly the same as the percentage change in supply voltage. In other words, our power supply will have to be stabilised so as to maintain a voltage of within ±0.1 per cent of the nominal figure. In addition, our control voltage variations will also have to achieve an accuracy of the same standard. So it is no good thinking that you can make a voltage divider network with ordinary 10 per cent or 5 per cent tolerance resistors.

Voltage regulation has been very thoroughly dealt with in the electronic literature in recent years. See Towers,[16 17] Cole,[18] Dutton,[19] Royston[20] or any standard text, such as Texas Instruments' *Transistor Circuit Design*. The current trend is to use integrated microcircuits to do the regulating: only a few external components are then required. An excellent account of this application is to be found in a series on linear microcircuits by T. D. Towers.[21]

FIG. 6



Logarithmic Generators

Musical scales are not linear: the repeated addition of a constant number of cycles to a given frequency will not produce a musical scale. Musical intervals are, in fact, *ratios* of frequencies. Thus, the octave involves a doubling of frequency, the fifth a frequency ratio of two to three, the major third a ratio of four to five, and so on.[22] For musical purposes, therefore, vcos should respond to linear changes in input voltage with a logarithmic change in output frequency. For instance, it might be convenient to arrange that for each 1V rise of control voltage, the vco output frequency rose by one octave. This would mean that the audio spectrum would be covered by a control voltage range of 7V or 8V.

In his early vco design, Moog solved this problem by making use of the exponential volt/amp properties of junction diodes. By means of a balanced differential amplifier and two strings each of four diodes he achieved a current output which was logarithmically related to the voltage input. The circuit is shown in **fig. 7**. The output from this amplifier is fed as a control current to the unijunction circuit of **fig. 8** and the resulting sawtooth is taken via an emitter-follower buffer stage to three wave-shaping circuits producing, respectively, a sawtooth, a triangular and a pulse output.

An important feature of the vco is that it is direct-coupled throughout, thus enabling it not only to produce the whole range of audio frequencies, but also to work at very low

continued 59

MCI For the first time in Britain

JH-16 PRICE **£7,480**

JH-24 PRICE **£10,770**

M.C.I. are proud to announce their JH-16 and JH-24, two machines, that pricewise are far ahead of anybody else. They are already in extensive use all over the U.S. and in several major studios on the continent.

SPECIFICATIONS :

DECK

Tape Width and Head Configuration	One Inch: 8 Tr Two Inch: 16 Tr, 24 Tr
Tape Tension	Constant Two Inch: 6.0oz. ±2% ±2 % for line variations from 105 to 140 vac.
Tape Speeds	15 Ips. 30 Ips.
Long Term Speed Stability (beginning to end of tape)	Less than 10 Hz of 15-Khz. Recorded tone
Flutter and Wow (15 and 30 Ips.)	Less than ·05% Peak (DIN)

ELECTRONICS

Frequency Response (15 and 30 Ips.)	Reproduce: 30 Hz to 16-Khz ± 2 Db Sync: 30 Hz to 16-Khz ± 3 Db
Signal to Noise (Unweighted at 18.5 mM/mm)	Reproduce: 64 Db below ± 4 Dbm Sync: 60 Db below ± 4 Dbm
Input	Record and Erase: Less than 3 Db (Increase over bulk erased tape) Level: 20 Dbm (Minimum) Impedance: 20K (Nominal) Balanced
Output	Level: 0 VU = +4 Dbm Impedance: 600 Ohm Balanced Line Amp Clipping: +24 Dbm
Equalization	NAB
IM Distortion	At Standard Rec Level: 3%

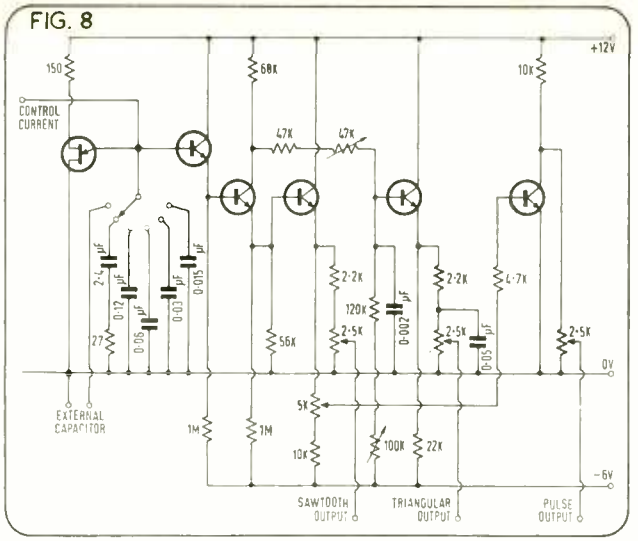
SYSTEM

Size	Console: 33" Wide, 30" Deep, 45" High Remote: 11¼" Wide, 5" Deep, 8" High
Weight	405 Lb. (Shipping)
Power	117 vac, 8 Amp, 60 Hz. (50 Hz. Opt.)
Temperature Range	5 to 45° C

MCI **1140 NORTH FLAGLER DRIVE, FT. LAUDERDALE, FLORIDA 33304**

CONTACT FELDON AUDIO 126 GT. PORTLAND ST., LONDON, W.1. 01-580 4314

continued



frequencies so as to produce waveforms whose rate of change is appropriate for use as controlling inputs to other modules.

The versatility of Moog's vco is greatly increased by virtue of an operational amplifier at its input, as shown in **fig. 9**. The voltage output from this stage is an accurate algebraic sum of the input voltages. In accordance with normal operational amplifier practice, the feedback resistor Rf is adjusted, in relation to the value of the series input resistors to fix the gain of the amplifier. Moog adjusted Rf so that a 1V increase in the sum of the control voltages produced a *doubling* of the output current from the exponential generator. Additional control inputs could be added, if desired. Nowadays it would hardly be worth the trouble to make up this module from discrete components; both differential amplifiers involved would now be ics. The subject of operational amplifiers is very clearly and helpfully covered by G. B. Clayton[23 24] and by the indefatigable T. D. Towers[25] whose series includes, among many other good things, an excellent practical survey of ic voltage regulators. A useful paper on the use of ics in vcos is that of Civit and Bracho.[26]

The method of log function generation used by Dr Moog is not, of course, the only way to do this. Function generators for a wide range of relationships have been important components of analogue computers for years. A method of linear to log conversion commonly used in the past has been the biased diode function generator[27] but such methods are being superseded by the use of modules employing ic operational amplifiers. Precision log generators are now readily assembled from ics or may be purchased ready-made as discrete component, hybrid or monolithic modules.[28]

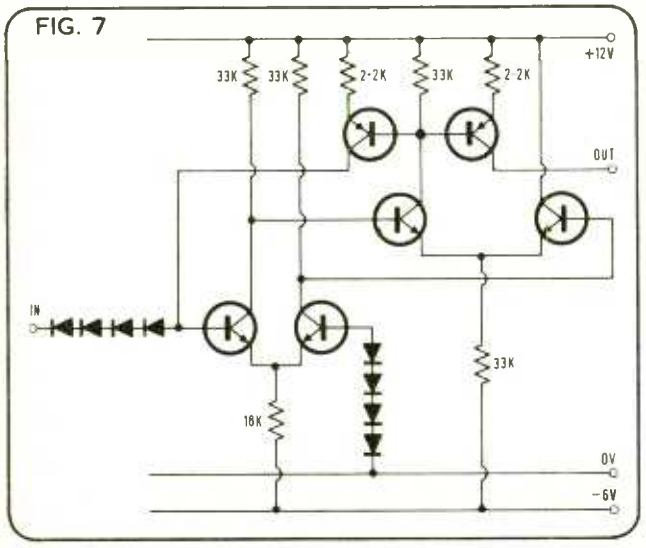
Do not be misled by the fact that the Moog vco is a discrete component module into thinking that it is lacking in elegance or capabilities. Far from it. The arrangement of linear adder, exponential generator and current controlled oscillator summarised in **fig. 10** has the effect that the oscillator frequency is proportional to the exponential (inverse of log function) of the sum of the control input voltages. Several useful properties follow from this. For example, if a suitable fixed voltage is applied across a series chain of 12 equal value resistors, tappings taken to one of the vco inputs from between these resistors will furnish an output of the 12 semitones of the equal-tempered scale (**fig. 11**). Again, if a sinewave voltage of frequency around 7 Hz is applied to one of the control inputs while normal tone-determining voltages are applied to another input, the output will be frequency modulated so as to produce a true vibrato (as distinct from the usual amplitude modulated, so-called vibrato which is really a tremolo). Both the amplitude and frequency of this vibrato can readily be arranged to be under direct manual control, thus contributing an important element of variety and reducing the tendency to the mechanical quality unfortunately so often a characteristic of electronic music. Note that the swing of the vibrato frequency change does not vary when the pitch of the note is changed.

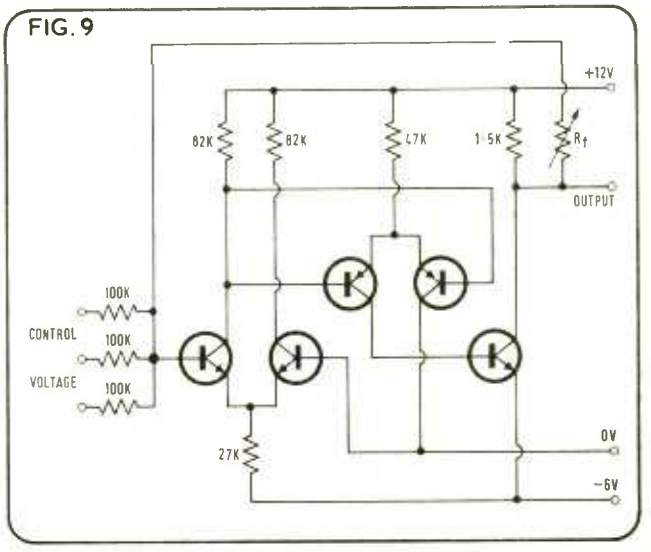
Frequency modulation of the basic pitches need not, however, be confined to modulation at vibrato rates. Moog has described how his modules can produce 'clangorous sounds' stimulating a strong subjective sense of pitch change although having no well-defined pitch of their own. This is done by connecting two vcos together as shown in **fig. 12** and varying a single control voltage. The method ensures that when the frequencies of the sidebands created by the fm are changed, they nevertheless retain a constant frequency ratio to each other, thereby partially satisfying a physiological requirement of perception. Some quite novel effects can be produced in this way.

The vco remains a laboratory tool up to the time that it is connected to a keyboard. At that point it becomes an instrument of music, capable of interfacing with a wholly non-technical musician. Indeed, the acceptability of electronic music synthesisers dates from the time they acquired keyboards. However outlandish the effects of manipulating it may be, a keyboard is something a musician understands and accepts.

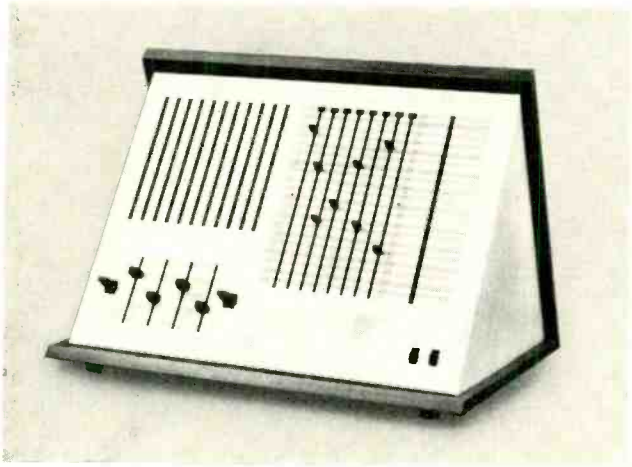
In view of the possibilities of producing control transducers of more advanced and ergonomically superior design to the conventional keyboard (e.g. touch plates using body conduction or proximity switches)[29] Moog must certainly have been tempted: that he settled for a standard keyboard as a primary transducer was clearly a wise decision. His

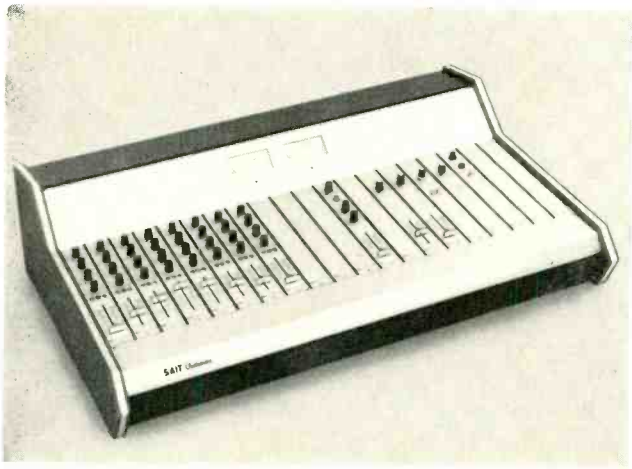
continued 61





Triadex Inc.
MUSE music synthesiser.





SAIT Electronics
S9 range of portable mixers.

Sole agent for
Pearl microphones.

Allotrope Ltd.

5B Thame Industrial Estate,
Thame, Oxon.
Sales Office: 01-437 1892.

MACINNES AT APRS 72

On stands 8 and 9 will be the latest equipment from

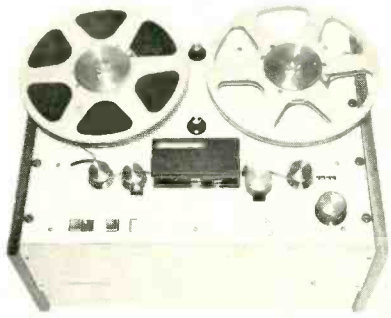
CROWN INTERNATIONAL

including the new D-60 power amplifier, and the Crown speaker Systems.

The latest MACLAB Bass speakers will also be shown including the 200 watt 18″ model M18A.

Sole agents:

MACINNES LABORATORIES LTD
Stonham, Stowmarket IP14 5LB
Telephone Stonham (044 971) 486



BIAS ELECTRONICS

B.E.1000 PROFESSIONAL RECORDER

★Wow and Flutter RMS Total 38 Cm/Sec 0·06%
★Frequency Response Overall 38 Cm/Sec 40 Hz to 18 kHz ±2 dB.
★Noise Overall unweighted below 32 mM/mm Full Track —60dB
★Separate Sensitivity EQ and Bias Adjustment for each speed
★Plug in Electronics ★Plug in Head Block.
★Precision Cast Tape Deck ★Electronic Tape Tension.

Illustrated: STEREO TRANSPORTABLE **£508·00**

BIAS ELECTRONICS LTD
Unit 8, Coombe Trading Est.,
112-120 Coombe Lane,
London SW20 01-947 3121

Distributor to Studios of KEITH MONKS AUDIO Microphone Stands, Etc.

continued

arrangements are, in principle, very simple. Each key operates a two-pole gold-clad wire switch, one pole being connected to the appropriate tapping on a voltage divider running the whole length of the keyboard. As already mentioned, the vco is arranged to give an output change of one octave for a control voltage change of 1V, so a standard organ keyboard will need a very well-regulated 5V. The purpose of the other switch pole under each key is to trigger a sawtooth generator whose output controls the gain of a voltage controlled amplifier, thereby 'turning on' each note. Since this is required every time a key is pressed all these contacts are joined together.

Keyboards are, of course, essentially digital devices (!) and are incapable of producing a true glissando. To overcome this limitation the Moog Company produced, as a supplement to the keyboard, a control transducer consisting of a gold-plated contact strip stretched over a high-resistance ribbon but so arranged that pressure of the finger on the strip allowed contact to be made at any point along the ribbon. A voltage across the resistance ribbon allows the device to be used as a potential divider source of variable control voltage.

So far, I have dealt only with the vco and there is, of course, a great deal more to a synthesiser than that. The Moog *Synthesiser 1*, for instance, contains, in addition to two voltage controlled oscillators, two voltage controlled amplifiers, an envelope generator, a voltage-controlled filter, a reverberation unit, a white noise generator, a set of passive filters, and a regulated power supply. The larger Moog models incorporate the same units in larger numbers and a four or five channel mixer. It is hardly necessary to go into details of reverb units and white noise generators. References to these are ubiquitous in the popular electronic press [30] [31] and elsewhere.[32] Passive filters are dealt with in parts four and five of my series on musical tone synthesis[29] and in most reasonably detailed books on electronic organs. A useful reference text is that of Richard Dorf.[33]

The voltage controlled amplifier is the second basic component of the music synthesiser and is a most versatile tool. The attack and decay characteristics of a musical sound are second in importance only to pitch and certainly rate equally with timbre (content of harmonic and inharmonic partials). It is the function of the vca to determine the 'envelope' of the waveform. A great deal of work has been done in recent years on the detailed structure of musical tones, much of it published in the *Journal of the Acoustical Society of America*.[34] [35] [36] This work has emphasised the importance of the envelope shape in determining the subjective quality of musical tones. The subject is more complex than was originally thought and it now appears that a complete specification of a tone may require data on different envelopes for each of the separate partials.[37] Be this as it may, flexible and dynamic control of the envelope of a tone enables one to produce an extensive repertoire not only of conventional effects but also of entirely new and non-imitative phenomena.

Voltage controlled amplifiers

The oldest and best-known vca is the now historical, variable-μ valve formerly used for automatic gain control in millions of radio receivers. Of course, any single transistor amplifier whose base bias can be varied by a standing control voltage will operate as a vca but for serious musical purposes what we want is a direct-coupled, balanced and stable amplifier capable of working down to dc and preferably with a virtual earth voltage summing input. Such an amplifier is used in the Moog synthesiser. A look at **fig. 13** will show that

continued 63

FIG. 10

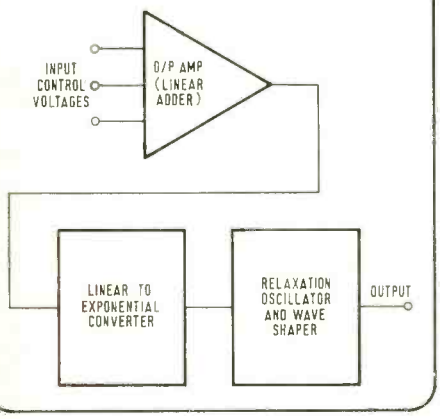


FIG. 11

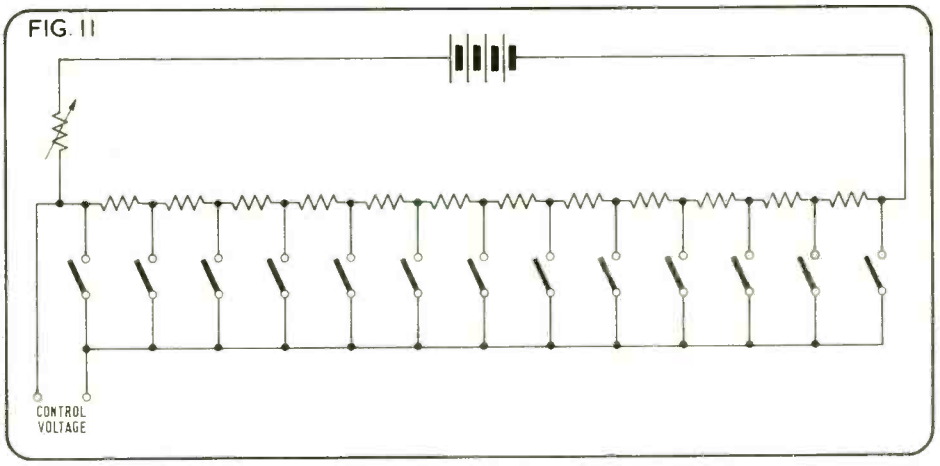


FIG. 12

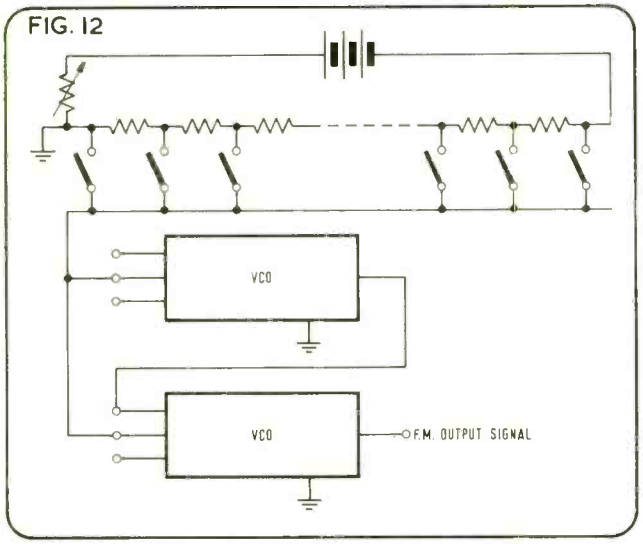
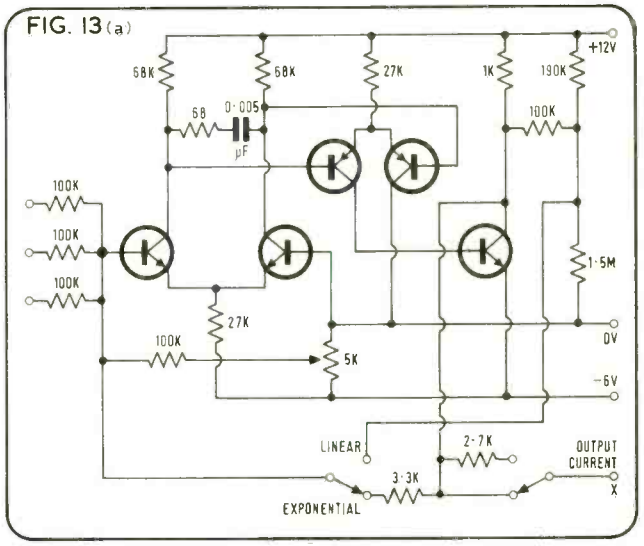
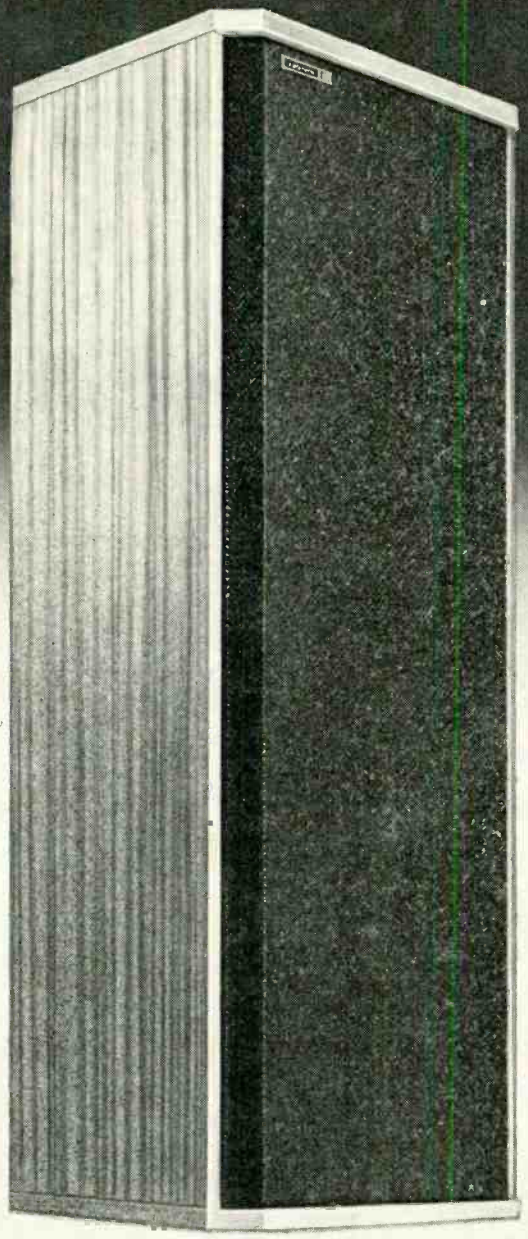


FIG. 13(a)

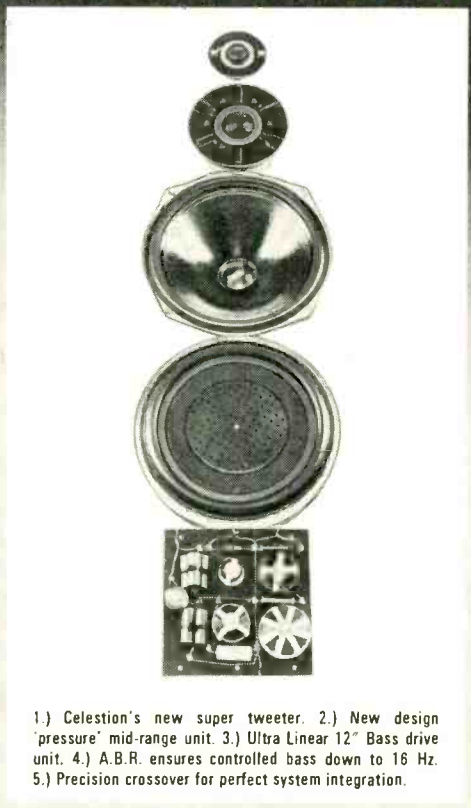


Celestion Loudspeaker Engineering advances the state of the art to a new plateau.

Ditton 66 Studio Monitor



Illustrated above is the Ditton 66 showing the beautiful appearance of the acoustic enclosure.



1.) Celestion's new super tweeter. 2.) New design 'pressure' mid-range unit. 3.) Ultra Linear 12" Bass drive unit. 4.) A.B.R. ensures controlled bass down to 16 Hz. 5.) Precision crossover for perfect system integration.

Section of the new Celestion mid-range unit giving superb power handling and detail.

Celestion Ditton Series

Loudspeakers for the Perfectionist

ROLA CELESTION LIMITED DITTON WORKS, FOXHALL ROAD, IPSWICH, SUFFOLK

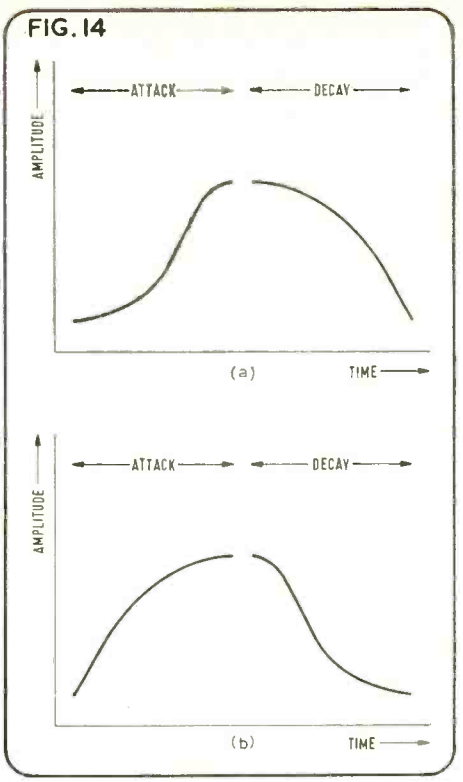
continued

the first section of the vca is very similar to that of the vco, being, in fact, a simple op amp adder. Note that the output can be taken either direct from the collector of the output transistor (exponential mode) or via a resistor (linear mode). The output current from the adder stage is applied to the emitter of the 'long-tail' transistor of the middle stage of a three-stage, direct coupled, balanced amplifier. The base of this transistor is held at a constant potential by a voltage divider and the current flowing through the whole stage is determined by the current through this transistor and thus, ultimately, by the output from the adder stage. The current through this stage is divided between the two transistors in proportion to the difference in the signal voltages at their bases. The absolute current difference at the output of the middle stage is proportional to the total current flowing through the stage, but because the stage is carefully balanced this current is rejected. So the control current, although determining the gain of the stage, does not appear in the output. The third, the output stage, provides a 600Ω output impedance.

The base-emitter junction of the tail transistor in the middle stage has an exponential volt-amp characteristic. The result is that the current in this stage is approximately proportional to the exponential of the sum of the control voltages applied to the adder stage. But when the adder output is applied through a relatively large resistance (linear mode), the current in the control transistor becomes more linearly related to the adder output voltage. The general subject of balanced dc transistor amplifiers is excellently treated by T. D. Towers.[38] Needless to say, ics are specified in all contemporary design.

Vcas may use, as control voltages, any imaginable waveform. A square wave (step function), for instance, will produce an extremely rapid attack and decay and a most unmusical effect. A slow sinewave, on the other hand, will give an amplitude modulated effect known as tremolo. This, if the frequency of amplitude change is right, may be of considerable musical interest. Compare this with the true vibrato, frequency modulation, obtained by using the same input to a vco.

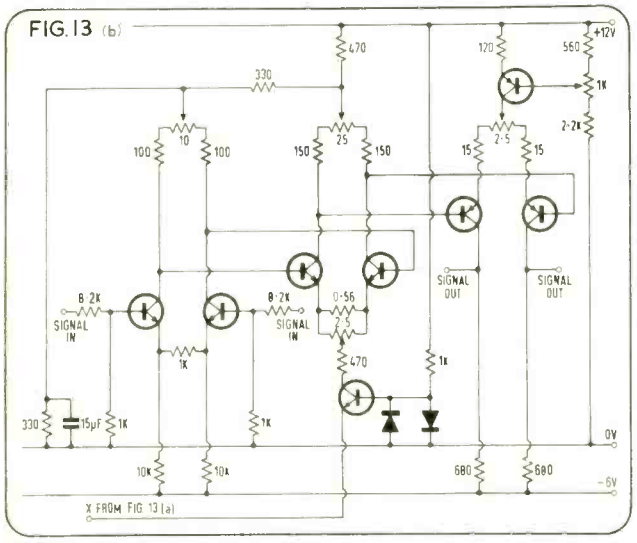
One of the most important uses of the vca is to control the attack and decay of each note played. Natural musical instruments have positive exponential attack and decay characteristics as in **fig. 14**(a). A voltage curve obtained by charging a capacitor through a resistor has, however, negative exponential characteristics as in **(b)**. A comparison of the effects of these two waveforms applied to a vca will immediately demonstrate the superiority of the first. **Fig. 15** shows a circuit for producing a positive exponential attack and decay wave-form of the kind shown in **fig. 14(a)**. Positive feedback is used to produce the desired characteristic.

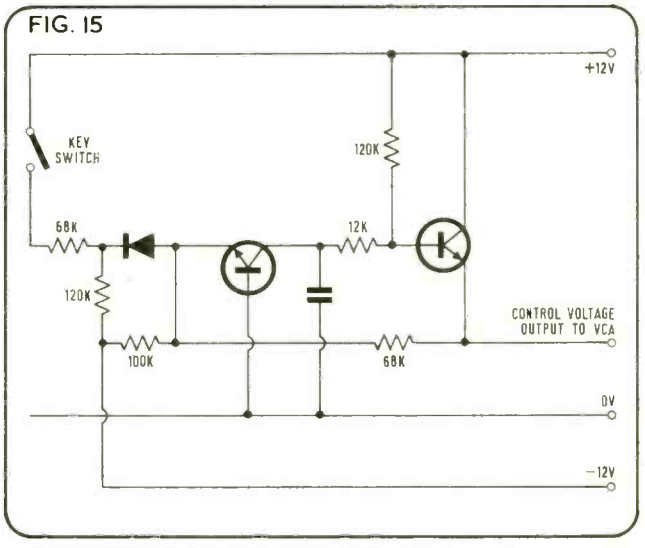


References

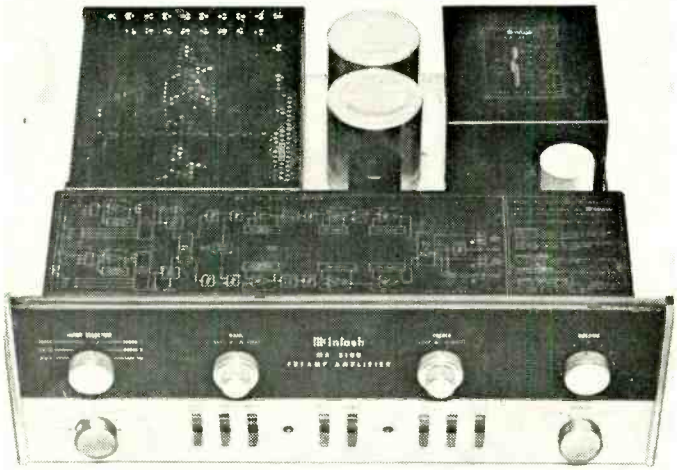
1. Moog, R. A. Voltage Controlled Electronic Music Modules. *J. of the AES* 13 No. 3:200 (July 1965).
2. Beauchamp, J. W. The Harmonic Tone Generator, a Voltage Controlled Device for Additive Synthesis of Audio Harmonic Spectra. *AES Preprint* No. 323 (October 1964).
3. Switched-On Bach. Stereo record by Walter Carlos played on the Moog Synthesiser. CBS *S 63501*.
4. Kindleman, P. J., and Fuge, P. H. Sound Synthesis: A Flexible Modular Approach with Integrated Circuits. *IEEE Transactions on Audio and Electroacoustics* Vol. AU-16 No. 4 (December 1968).
5. Youngson, R. M. Negative Resistance Frequency Divider. *Wireless World* 77:234 (1971).
6. Matthews, K. J. A Voltage to Frequency Converter. *Practical Electronics* 6:229 (March 1970).
7. Walker, A. D. A Voltage Controlled Oscillator using a Standard Integrated Circuit. *Electronic Engineering*. (January 1966:21).
8. Biddlecomb, R. W. Linear Voltage-to-Frequency Converter. *Electronics* 36 No. 17 (April 26, 1963).
9. Brace, L. H. Voltage Controlled Oscillator, Sawtooth Generator. *Wireless World* 68:102 (March 1962).
10. Cakulev and Borislav. High-Performance Voltage to Frequency Converter. *Electronic Engineering* (March 1969).
11. Pease, R. Ultralinear Voltage to Frequency Converter. *Electronic Engineering* (March 1971).
12. Tesic, S. Stable Voltage to Frequency Converter. *Wireless World* 78:78 (February 1972).
13. Signetics Corp. Voltage Controlled IC Oscillator of exceptional stability and linearity. Type No *SE/NE 566* Function Generator. Signetics Corp., 811 East Arques Avenue, Sunnyvale, CA 94086. See *Popular Electronics* July 1971:91.
14. Seashore, C. *Psychology of Music*. McGraw Hill Pub. Co. Pp 408 (1959).
15. Wood, A. *The Physics of Music*. University Paperbacks. Methuen, London. Pp 256. 6th Edition (1964).
16. Towers, T. D. Constant-Voltage dc Supplies. *Wireless World* 74:310 (September 1968).

continued 67





McINTOSH IS HERE!



McIntosh MA5100 integrated amplifier.

With nearly all products, there is one make that stands head and shoulders above others, revered and coveted by everyone. In hi-fi, the name is McIntosh from America. In these days of production rush and economy, the McIntosh policy of "assured performance" makes it significantly different from the rest. Every McIntosh unit – *every one* – is tested to be equal to or better than the superb published specification. At McIntosh, more time means more care and protection for you. You will hear music as never before! McIntosh innovations in solid state electronics allow you to hear new beauty and subtle passages that until now have been clouded by lower reproduction standards. McIntosh is very expensive – outstanding performance cannot be bought at a standard price. Listen to McIntosh at your nearest franchise dealer, or write for details and specifications.

WILMEX LTD

Import Division, 24/26 Ensign Street, London E1 8JD
Telephone: 01-949 2545

THE MELLOTRON®

IS A MELLOTRON . . . IS A MELLOTRON . . . IS A MELLOTRON . . .

HEARD BUT NOT ALWAYS SEEN

MELLOTRONICS LTD., 35 PORTLAND PLACE, LONDON W1N 3AG 01-637 0692

Sound in the Theatre

By Keith Wicks

I DECIDED to investigate theatre sound systems and techniques after receiving a letter from Donald Aldous. He had been to the Prince of Wales Theatre in London to see and hear the 69 Theatre Company's production of *Catch My Soul*, Jack Good's 'Rock Othello'. He told me that, as well as finding the show exciting, he had been greatly impressed with the sound system—so much so, that he thought STUDIO SOUND readers might find the technicalities interesting.

I went to see the show myself and found it enjoyable musically though a long way behind *Hair*. Technically, however, the sound system used for *Catch My Soul* was the best I had heard in any theatre. Ian Gibson was responsible for designing and setting up the sound equipment, and John Becket operated it. After the show, we talked at great length about theatre sound and first they explained how they had become involved in this work.

IG I was a lecturer in mathematics. I have had a life-long interest in music, and once did a course on musique concrete for sixth formers, but that is just by the way.

JB I feel that is very important. Teaching musique concrete is not beside the point because a sound designer should have an understanding of music. You can't be just a cold-blooded technician because it doesn't work. In *Glass Menagerie* Ian was responsible for the music. He selected it; it could have taken someone else years to find. It's absolutely beautiful, the blending of words and music used to have me in tears at the end.

IG I was approached by our full-time drama tutor to do the sound for college plays as I was interested in sound and theatre. After that I did four college plays using multitrack techniques. That was back in 1961. Even then I was producing stereo effects. This work eventually led to doing nine shows for the 69 Theatre Company at the same time as lecturing. The 69 Theatre Company is the resident professional company playing in the University of Manchester theatre.

I saw the first two productions by the 69 Theatre Company at the Edinburgh Festival. Compared with all the other productions I'd ever seen, everything was so perfect to me as an ordinary theatregoer. Everything, that is, except the sound. I approached the administrator, was introduced to the directors and invited to do two shows. That was in Christmas 1968. Having done two shows, the directors invited me to design the sound for all their future productions. Eventually I found that there was a conflict between my educational interests and the theatre. Something had to give and lecturing gave. In June 1970 I resigned as a lecturer and went into the theatre full-time. Now I'm a freelance but with a permanent engagement with the 69 Theatre Company. Practically every show I've done has had some review of the sound design in the press, and I think it is more or less the first time that that has ever happened.

JB Needless to say, not all the things we did were total successes, but every production was a step forward.

IG Getting into this business was a great stroke of luck for me. I was around just at the right time. The first thing I worked on was *Have You Seen Manchester?*, a historical review and survey. This was followed by *Daniel Deronda* with Vanessa Redgrave, in which we had the sound of arrows (fired from bows on the stage) floating through the air and hitting a target on the rear wall of the auditorium. This effect was not always successful for the simple reason that the operator just couldn't cope.

JB That was before my time.

IG That's right, it wasn't John. That was followed by *She Stoops to Conquer* with Tom Courtney. This play transferred to the Garrick Theatre in London. Even now people talk about the horses galloping around the auditorium. That was followed by a new version of *Saint Joan*, in which Saint Joan was burned on the stage at the end. As the brands went into the pyre, there was an increase in sound and a change in the sound quality as the pyre got more alight. It finished up with the auditorium becoming one raging inferno.

KW These bows and arrows and galloping horses—what techniques did you use?

IG They are not a trade secret at all. Theatre critics know absolutely nothing at all about the technical aspects of the theatre. All the critics referred to 'stereophonic horses' hooves' but those horses were not stereo. I was let down badly on that show by someone who was supposed to be putting new equipment in the theatre. We finished up virtually an hour before the technical rehearsal and he was still building a switch panel. The horses were simply switched across the four corners of the auditorium. That was not the way it was planned at all. It was planned as a stereo tape to be faded across the four speakers. Yet the press talked about stereo effects, having no notion of what stereo effects are. The sound started off on one speaker, and then the next was switched in. As the third was switched on, the first was switched out, and so on. I really wanted to pan the sound across the speakers, but I don't think that quadraphonic pan pots were around at that time. Even so, the sound could have been panned around the theatre by successive panning from one speaker to another. Obviously we would now use a quadraphonic pan pot. The majority of my theatre work is in true stereo—even birds and sea. I've very strong feelings about the necessity of stereo in the theatre.

JB The quadraphonic pan pot is the next weapon in the line. Ian had to import a

continued 67

John Becket at the *Catch My Soul* sound system.

NEW ADDITIONS TO OUR EXTENSIVE RANGE OF MICROPHONE STANDS AND ACCESSORIES

BS1/B BS2/B MSPA/B

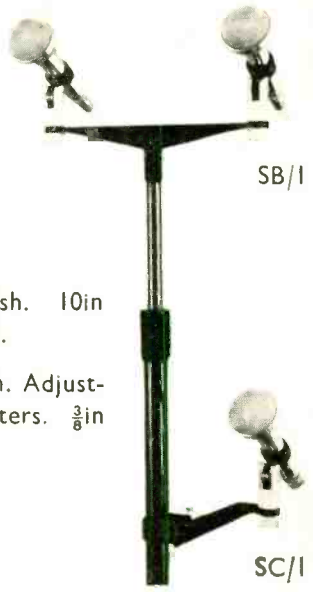
BS1/B Banqueting Stand. 4½ lb base. Matt black finish. 22in max height.

BS2/B Banqueting Stand. 7 lb base. Matt black finish. 29in max height.

MSPA/B Angle Floor Stand. Matt black finish. 80in max height.

SB/1 Stereo Bar. Matt black finish. 10in long. ⅜in locking screws provided.

SC/1 Side Clamp. Matt black finish. Adjustable for different tube diameters. ⅜in locking screw provided.



SB/1

SC/1

For further details write to

KEITH MONKS (AUDIO) LIMITED

26-30 READING ROAD SOUTH, FLEET, HAMPSHIRE

Tel. Fleet (02514) 7316 & 3566

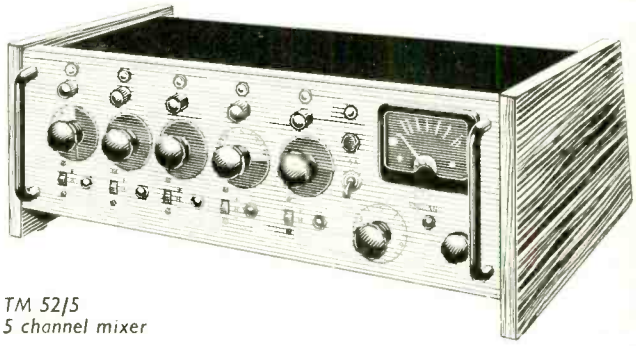
CTH TM 50 MK2 SERIES AUDIO MIXERS

Single or multi-output mixers with up to 40 input channels made to professional standards and incorporating the following features:

- ☐ 'XLR' input connectors
- ☐ Prefade listening
- ☐ 180° self-evident dials
- ☐ Back contacts
- ☐ 'Channel on' lamps
- ☐ Peak programme meter
- ☐ +12 dBm floating output
- ☐ 0-30-60 dB input attenuators
- ☐ 0-30 dB preset channel gain
- ☐ 30Hz-20kHz ±2 dB

OPTIONAL FEATURES INCLUDE:

- ☐ Tone Controls
- ☐ Extra P.P.M's
- ☐ V.U. meters
- ☐ Disc and tape inputs
- ☐ Limiter/compressors
- ☐ Battery operation
- ☐ Portable field units
- ☐ Rack mounting units



TM 52/5
5 channel mixer

CTH also manufacture a range of modular mixing units, consoles, distribution amplifiers, studio disc player units, speaker amplifiers, cable drums and many other items of studio equipment.

CTH ELECTRONICS

SEE US ON STAND 42
A.P.R.S. EXHIBITION

Industrial Estate, Somersham Road, St. Ives, Huntingdonshire, PE17 4LS Telephone: St. Ives 64388 (0480 64388)

SOUND IN THE THEATRE

continued

quadraphonic pan pot from the United States because he couldn't find a British one to do the job he required. If quadraphony doesn't hit them in the ear, nothing is going to.

IG On *Journey's End*, which opened in Manchester last September, I used quadraphonic techniques. That was probably the first time they had ever been used in the theatre. This play recently opened at the Mermaid Theatre in London. My greatest difficulty now is not doing a job but actually being allowed to do a job. In the theatre, everyone says that it's the devil you know rather than the one you don't know. No matter how good your sound is, they prefer to go back to the chap who has done it for the last ten years. Yet in the next breath they'll still complain about it and say how terrible it is.

KW How did you meet up with John?

IG I met John at the 69 Theatre Company. The first show he did with me was *The Tempest*, and every show I did in the Theatre up to *Catch My Soul* was with John. Because he was working with me, I have been able to design sound freely because I know the operator. I design equipment to do specifically what I want it to do and I know that John can operate it.

JB It is exceedingly difficult to find operators to do the kind of work we are doing. Most sound operators have had little or no training and don't have the slightest idea of what can actually be achieved.

KW John, how did you get involved with the theatre?

JB I became interested in the theatre at the age of three. It was a puppet theatre. When I was about 12, I built up a small company of puppets and operators. My puppet theatre was about the size of a small living room. I started in lighting by blowing one of the house mains out during a show. I used a tape recorder to supply music but I was never really involved with sound. At grammar school we had a teacher who was interested in theatre and used to direct the school plays. I started working in those. They were technically really good shows. While I was there, I modified the lighting equipment and persuaded them to buy a lot more.

We used to get full houses, and very good reviews in the local papers. On leaving school I went to Kings Road College and did a theatre course. Again it was on an all-amateur basis but there was money available and the enthusiasm of the tutors was behind us. It was then that I first started thinking about sound in terms of using it with film sync, lighting, and that sort of thing.

I then went to the Central School of Speech and Drama on a technical course. Half way through that two-year course I worked for the 69 Company at Edinburgh. While at Central, I ran the sound studio there and maintained the equipment. During my second year at the school I went to Berlin with the British Drama League as lighting designer and to Zürich with a production from the Central School. I then went to 69, and have since been working with Ian on sound, as well as designing lighting for touring productions. In between times I have also been lighting designer for the Century Theatre in Lancaster.

UNDERSTANDING MUSIC SYNTHESISERS

continued

17. Towers, T. D. Switched-Mode dc Regulators. *Wireless World* 74:370 (October 1968).
18. Cole, H. A. Voltage Reference Source. *Wireless World* 77:446 (September 1971).
19. Dutton, R. H. Design and Construction of Regulated Power Supplies. *Electronics World* 83 No. 2:30 (February 1970).
20. Royston, A. Current-limited Power Supply. *Wireless World* 78:67 (February 1972).
21. Towers, T. D. Elements of Linear Microcircuits. Part 9 Voltage Regulators. *Wireless World* 77:343 (July 1971).
22. Helmholtz, H. *On the Sensations of Tone.* Dover Publications Inc., New York. Pp 576.
23. Clayton, G. B. Operational Amplifiers. *Wireless World* 75:54, 130, 156, 213, 270, 384, 429, 482, 586 (February to December 1969).
24. Clayton, G. B. *Operational Amplifiers.* The Butterworth Group, 88 Kingsway, London WC2B 6AB. Pp 244, Illustrated (1971).
25. Towers, T. D. Elements of Linear Microcircuits. *Wireless World* 76:472, 545, 600; 77-76, 114, 191, 253, 342, 395, 433, 503 (October 1970 to October 1971).
26. Civit, A., and Bracho, S. ICs Simplify v-f and v-t Conversions. *Electronic Engineering* December 1971:36.
27. Crump, A. E. Diode Function Generators *Wireless World* 73:594 (December 1967).
28. Gledhill, B. Can you afford to ignore analogue modules? *Electronic Engineering* March 1970:63 and 70.
29. Youngson, R. M. The Synthesis of Musical Instrument Tone. *Tape Recorder* 11:406, 462, 494, 12:29. *Studio Sound* 12:72, 119, 151 (October 1969 to April 1970).
30. Bassett, A. J. Spring Line Reverberation Unit. *Practical Electronics* 3:880 (December 1957).
31. Judd, F. C. Sound Effects Synthesiser. *Practical Wireless* 46 No. 11 and 12 and 47 No. 1 (March to May 1970).
32. Olson, H. F. *Music, Physics and Engineering.* Dover Publications Inc., New York. Pp xi+460. Figs 376. Tables 36 (1967).
33. Dorf, R. *Electronic Musical Instruments.* Radiofile, 43 West 61st Street, New York NY 10023 Pp 393 (1968).
34. Fletcher, Blackham and Stratton. Quality of Piano Tones. *J. Acoust. Soc. Amer.* 34:749 (1962)
35. Fletcher, Blackham and Christensen. Quality of Organ Tones. *J. Acoust. Soc. Amer.* 35:314 (1963).
36. Fletcher, Blackham and Geertsen. Quality of Violin, Viola, Cello and Bass-viol Tones. *J. Acoust. Soc. Amer.* 37:851 (1965).
37. Risset, J. C. *J. Acoust. Soc. Amer.* 38:912 (1965).
38. Towers, T. D. Balanced Transistor dc Amplifiers. *Wireless World* 74:269 (August 1968).

DIARY

continued

From **Orange**, Brian Hatt reports that Dolby noise reduction cards will soon be available for their range of recorders. With Dolby circuits built into the machine at an extra cost of around £150 per track, customers will save money and space, and will have the convenience of automatic Dolby switching. It will, of course, be possible to switch the noise reduction system in or out as required. Dolby engineers will supervise the fitting of the noise reduction cards in the Orange machines.

Johnny Walker has been back to the **Roger Squire Studio**, on this occasion to help a young, anonymous protégé. Alan Warner of United Artists has been making more information tapes for the company's representatives. Nicholas Priois, engaged on a freelance basis by Vox Sound, produced a range of commercials for exhibition use.

Studio One at **Command** seats an audience of 40 and was used for a live recording by Stud. Others recently at the studio include Ollie Halsall, Atomic Rooster, Nashville Teens and Clive Westlake.

Apologies to Command for an error in the June *Diary*. It appears that John Mosely, though offered the post of technical consultant, declined to accept. He remains a director.

Paul Ryan has spent a lot of time at **Nova** making an album for Ryan Music with producer Phil Wainman. The Fantastics have been in for Gem Productions, and John Leyton made a single for York Records. Pip Williams produced a Samantha Jones single and Mike Hawker produced a single by Davey Sands.

In Manchester, **Indigo's** engineers, Dave Kent-Watson and Bob M. Auger, have recorded a wide range of material since the studio opened in April. Radio 70s, one of the first companies to use the studio, have had a stream of session musicians, vocalists and announcers going in almost daily to record material for its new advertising contracts. Advertising agencies frequently visit the studio to record commercials and presentation work. London's Millard-Rees brought in footballer George Best to tape promotional material. Mobile work by Bob included a live concert recording of the British Youth Symphony Orchestra at the Free Trade Hall, Manchester. At the request of conductor Trevor Harvey, the gear was shipped to Sheffield the next day for a playback to the 125-strong orchestra and Dave taped the same concert that night in the City Hall. Alan Browning and Pat Phoenix have started a series of poetry recordings, Bob adding synthesised backing. Chris Pye laid down tracks of self-penned material with Dave at the desk. Construction of a larger studio has now started and an eight track recorder is due for installation later this year.

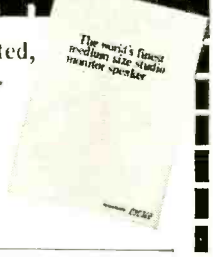
At **Central Scotland Recording Studios**, the Edinburgh rock band, Bodkin, have been recording tracks for an album to be released on the studio's own label. Matt Nicholson recorded demos with Verge, Barry Ryan's backing group, and masters have been recorded for an American language course. Cloth Ears, a local song writing team, have been recording some 'extremely commercial' demos.

The world's finest medium size studio monitor speaker

The Rogers BBC Studio Monitor Speaker offers a standard of performance unequalled by any speaker of similar size. The speaker combines all the qualities sought in a unit designed for monitor use; ultra smooth response, excellent transient response, a most remarkable lack of colouration and very low harmonic and intermodulation distortion. Based on a design of the British Broadcasting Corporation's research department, the speaker is the result of many years research into speaker cone behaviour, the most significant aspect of the design being the main drive unit employing a special plastic cone. The speaker is produced under licence from the BBC and conforms to their specification LS3/6, but, with the important addition of a third drive unit, a modification exclusive to Rogers. Intended primarily for monitoring purposes in the smaller studios, where high power levels are not required, the speaker will give superlative reproduction in domestic high fidelity installations where the associated equipment is of a sufficiently high standard. Each speaker is supplied with an individual response curve graph taken on Bruel & Kjaer automatic curve tracing equipment. Retail distribution of the speaker is restricted to a limited number of carefully selected specialist high fidelity dealers.

Brief Specification: Overall Frequency Response: 40Hz-25kHz. ±3dB 50Hz-14kHz. Power Handling Capacity: 25 watts, speech and music. Impedance: Standard 15 ohms, to order 8 and 25 ohms. Drive Units: Three. Overall Dimensions: Enclosure 12" × 12" × 25". Height including stand 37". Finish: Teak.

ROGERS **BBC**



Rogers Developments (Electronics) Limited,
4-14 Barmeston Road, London SE6 3BN.
01-698 7424/4340.

Please send me a copy of the colour leaflet describing the Rogers B.B.C. Studio Monitor Speaker in detail.

NAME _____

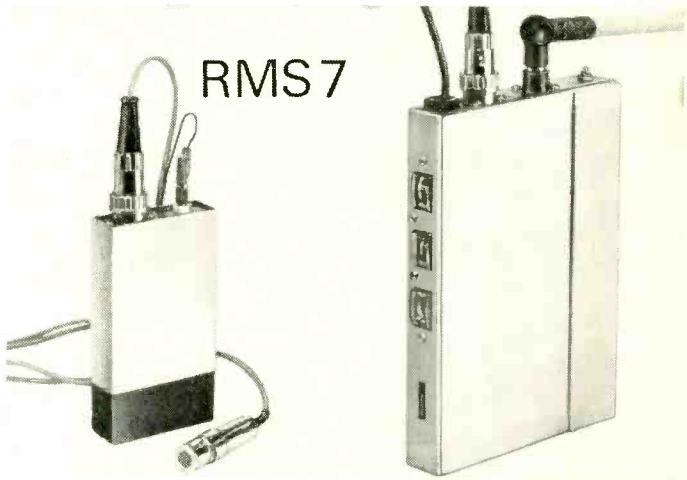
ADDRESS _____

_____

SS/7

Recommended U.K. Retail Prices
(including stand) £83·50 + £12·81 P.T. (less stand) £77·00 + £12·35 P.T.

new radio microphones by audio limited



Developed out of our original Audio Ltd. Radio Microphone System, we now offer for prompt delivery an improved RMS 7 system in which the newest electret capacitor microphone is used. By slightly enlarging the receiver, we have incorporated a block aerial filter to greatly reduce cross modulation interference and facilitate multi-channel operation. The receiver has battery, signal level and tuning meters, also plug-in whip aerial and output plug and lead. The transmitter is easily concealed in the pocket or about the user, and the microphone supplied is smaller than the plug used to connect it. We shall be pleased to forward full technical information on request.

COMPLETE SYSTEMS FROM £184
OTHERS FROM £115

RMS7H
Hand held model

In RMS7H, microphone and transmitter are combined in a single unit. The transmitter is contained within the tubular handle which is as easy to hold and use as any conventional hand held instrument. The microphone can be cardioid or omnidirectional, and is the new electret capacitor type which offers the advantage of a condenser microphone without the problems of power supply for it. On-off switch is incorporated.

★ UHF AND HIGH POWER VERSIONS FOR USE OVERSEAS

Audio Ltd. Radio Microphone Systems as supplied to users in the U.K. conform precisely to Post Office regulations. More powerful systems and U.H.F. systems can be supplied for use overseas in compliance with locally stipulated operating conditions. Transmitters operating up to 500 MHz and with outputs up to 500m Wat 175 MHz can be supplied

AUDIO LIMITED
26 WENDELL ROAD
LONDON W12 9RT
Telephone 01-743 1518

AUDIO

Postscript to the High Quality Mixer

By David Robinson

SINCE the series of articles on a high quality mixer was published from June 1970 to May 1971, I have received many letters from constructors in all parts of the world. I am pleased to say that no troubles have been reported in the majority of cases so the original claim that the circuits represented tested and tried ideas was justified. However, with so much talent at work on the design, it is not surprising that some worthwhile modifications arise. Two such are outlined in this article.

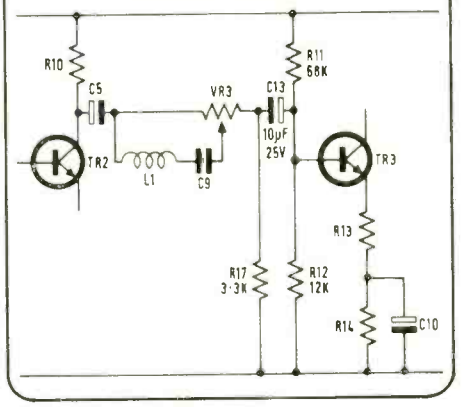
Presence circuit

The tone control stage in the mixer was detailed in fig. 24, page 349, August 1970. While most constructors have found the circuit to be very successful, there have been a significant number of criticisms of noise generated in the presence control. Analysis of these complaints shows that on the whole the circuit was in these instances being worked at too low an audio level (so magnifying any noise), so that inferior potentiometers were being used. However, even if this is said, a circuit should perform reasonably well outside the designed operating level; here the cure is fortunately very simple and can be added to completed or contemplated mixers, both those built on the printed circuits or those using Veroboard or equivalent.

The problem lies in the use of the presence control VR3 as both part of the bias chain to Tr3 and as the variable presence level control itself. Dc is present on the potentiometer and small currents flow as the slider is moved, appearing as crackles at the output. The cure is to isolate the dc and ac parts of the circuit. Fig. 24 showed the original design and **fig. 98** the modified section. Tr3 is now biased by R11 and R12 to the same dc conditions as previously; the presence effect is achieved by VR3 feeding the base of Tr3. Capacitor C13 provides the necessary dc isolation and R17 provides the load impedance on VR3 at the same time keeping the presence network at 0V dc. To understand the operation of the circuit, consider the case with maximum boost when VR3 slider is connected to C13. At frequencies far from resonance, the circuit L1/C9 is a high impedance so that all audio signals passing through VR3 are thus attenuated about 7 dB by the action of the control and R17. At the resonant frequency, L1/C9 becomes virtually a short circuit; the loss of the network is thus nil and the effect is a 7 dB rise at this resonant frequency. At different settings of VR3, the boost frequency is constant but the amount of boost decreases. If frequency changing is also required, then C9 can be switch-selected.

The modification can be added simply to the printed circuit boards using the existing copper tracks, adding links where necessary. With the circuit rearranged in this fashion, it becomes easy to connect for greater boosts than 7 dB by reducing the value of R17. This will entail a loss in overall gain which can be recovered by adjustment of the emitter resistor R13. This can be split into two sections (as is done on the printed circuit card) with one section decoupled, also shown in **fig. 98.** To keep the dc conditions of Tr3 constant, the sum of R13 and R14 should be maintained at 1.2 kΩ approximately; the gain of this last stage is about R15 divided by R13.

FIG. 98 MODIFICATIONS TO TONE CONTROL CIRCUIT



Photostat copies of the complete 'High Quality Mixer' series are available from the editorial office at £3 including postage—**Ed.**

Microphone amplifier

I am indebted to Richard Richardson of Richardson Electronics for this next suggestion. In his testing of the original design, he found that the distortion, while reasonable at normal levels, rose under high level input conditions. Equally important, the distortion rise was

continued 75

FIG. 99 MODIFICATIONS TO MICROPHONE AMPLIFIER

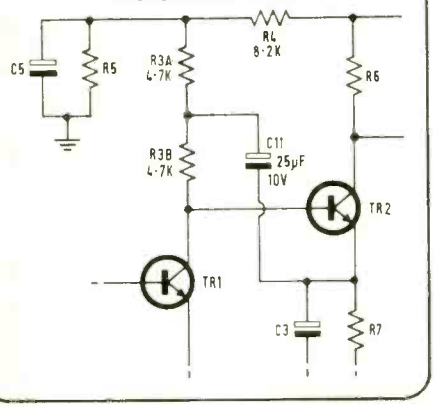
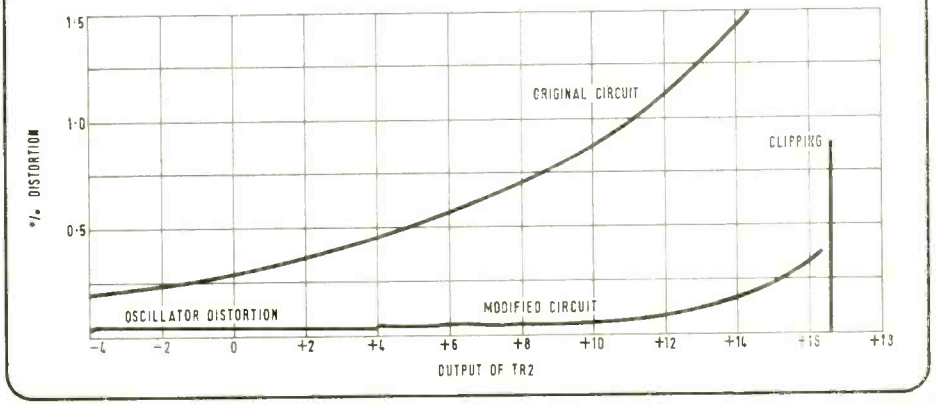
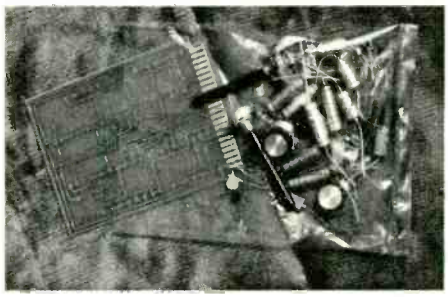


FIG. 100 MIC AMPLIFIER DISTORTION GRAPH



"PACK UP YOUR TROUBLES IN OUR NEW KIT BAG"

CHADACRE ELECTRONICS LIMITED



AUDIO DIVISION 43 CHADACRE AVENUE CLAYHALL ILFORD ESSEX TELEPHONE NUMBER 01 550 7119

Chadacre Electronics Limited are pleased to announce that the following modules may now be purchased in KIT FORM*:

MODULE	*BUILT & TESTED* £	*KIT* £
4300 Phase Simulator	9·00	5·50
4310 Microphone Amp	11·00	7·00
4311 Equaliser	9·00	5·50
4312 Stereo. Output Amp	9·00	5·50
4315 Stereo. VU Driver Amp ...	9·00	5·50
4316 Mixing Amp	7·00	3·75
6301 I.C. Ring Modulator	15·00	7·50
4317 Stereo. Headphone Amp ...	4·25	—
4318 Stereo. Buffer/Bridging Amp ...	4·00	—

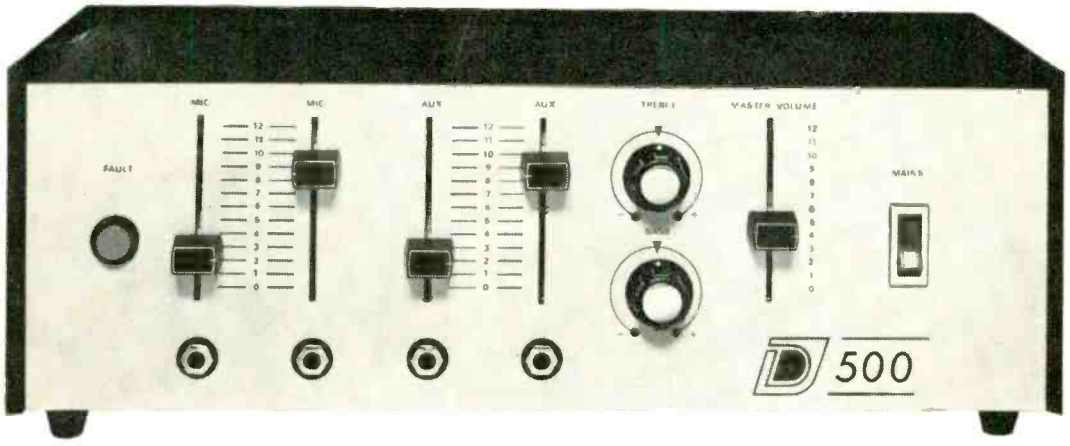
20% Discount on quantities of 10 or more mixed units

P & P: Allow 25 pence/module. Free on all orders of £20 or more

*Kits are complete with all Capacitors, Resistors, Inductors, Transistors, Printed Circuit Board and Illustrated Data Sheet.

If you require further information on any of our Audio products, e.g. Quad, Pan-Pot, Compressor, etc, send only 25p for our fully illustrated catalogue.

NEW D.J. RANGE OF HIGH QUALITY P.A. AMPLIFIERS



D.J. 500
50 watts R.M.S. output

D.J. 700
70 watts R.M.S. output

D.J. 1000
100 watts R.M.S. output

Features

- Exclusive "Fail Safe" Electronic Protection Circuit
- Fault condition warning lamp
- Built-in Bass boost below 30Hz
- 4 channel Mixer with slider controls
- Emitter follower Slave Amp output
- Fibre Glass P.C. Boards

For full details of this range and all D.J. products, please write to the manufacturers:
D. J. ELECTRONICS (HACKNEY) LIMITED, 122 BALLS POND ROAD, LONDON, N.1
Telephone: 01-254 5779 and 4861

Constructing a Limiter

By L. Stickells

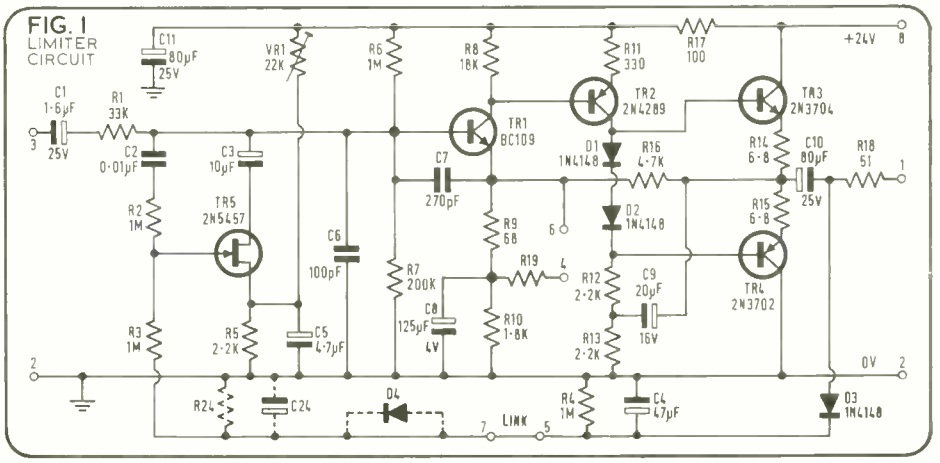
THE circuit about to be described is the basis of a quite effective limiter. While its performance may not be quite up to that of the more expensive and esoteric devices available, it is rather more elegant than most lamp bulb and photo resistor systems.

In this circuit, once the limiting threshold has been reached (at an input level around −35 dB to −25 dB, depending on the chosen output level) the amplifier gain is reduced by virtually as much as the input increases. The output level rises only about 2 dB for a further 30 dB increase in input level. In fact under gross overload conditions it is possible for the amplifier to act as an attenuator, output level being less than the input. The output level at which limiting occurs can be varied from below zero to +12 dB.

The limiter is based on the fact that an fet can be used as a voltage dependent resistor, increasing the gate-source voltage (rather, decreasing the negative bias), decreasing the drain-source resistance. If a suitable fet is used as the lower arm of a potential divider across the input to an amplifier, and the rectified output of that amplifier is used as the control voltage, the reduction of input signal will be dependent on the output level. The output level can be held below a desired maximum almost regardless of input level.

The circuit consists basically of two parts, a voltage amplifier and a voltage controlled attenuator. The amplifier is a fairly straightforward four transistor circuit with a class B output arrangement and bootstrapped collector load on the driver stage to give maximum undistorted voltage swing. Dc conditions are set by R6, R7, R9, R10 and R16 to give half supply voltage at the junction of R14, R15. Input impedance is high (greater than 100 kΩ) to give minimum loading to the previous attenuator stage, and output impedance is low (less than 10 ohms) to give fast attack time to the limiter circuit. The voltage controlled attenuator consists of resistor R1 and fet Tr5. The associated circuitry is for applying the control voltage and reducing distortion caused by non-linearities of the fet. VR1 enables the bias voltage to the source to be adjusted, which in turn varies the 'turn-on' point of the fet, and hence the amplifier output level.

To greater circuit detail. Signal is applied via C1 and R1 to Tr1 base, and to Tr5 drain via C3 which isolates Tr5 from Tr1's bias voltage. C3 can more properly be between R1 and R6, R7. See notes on the printed circuit board. Input signal is also applied to Tr5 gate via C2, R2 and R3. These components reduce the distortion caused by the controlling action of Tr5 from six or seven per cent to something less than 0.7 per cent. So they are a worthwhile, not to say necessary, inclusion in the



circuit. Below limiting levels, distortion should be less than 0.1 per cent. When the input signal rises drastically above normal (+12 dB or so), the distortion does not rise to intolerable levels but begins to fall again almost to that of the prelimiting condition.

Tr1 and Tr2 amplify the signal in the normal way, diodes D1 and D2 supply bias to the output transistors to reduce crossover distortion. Ac gain is set by R16 and R9. R18 is included primarily as a means of raising output impedance for the writer's own purposes and can be shorted out if desired. However, it does also serve to give some protection to the output transistors from short-circuit load conditions and can also improve the distortion figures when feeding a reactive load such as a transformer so there is a case for leaving it in. The control voltage for the fet is taken from the output from C10 and rectified by D3 which can be almost any small signal silicon or germanium diode, though a silicon type is to be preferred where long recovery times are desired.

The rectified signal is smoothed by C4. This capacitor, in conjunction with R4, largely controls the recovery time of the limiter, that is the time taken for the amplification of an input signal to be restored to normal after the gain has been reduced by a large transient peak. The values shown for C4 and R4 give a recovery time of about 2s for a reasonable overload but any sudden very high peak (such as a switch click) can cause the gain to be reduced drastically and this can take longer to recover. The value of C4 can be adjusted to suit the user's particular needs, a longer recovery time is given by an increase in values and vice versa. With C4 upwards of 100 μF, the circuit tends to act more as an automatic gain control, the average output tending to remain below the limiting threshold due to the recovery time becoming longer than the time between peaks from normal programme material. Where programme content has a high background noise, a longish recovery time is probably preferable to reduce the 'breathing' effect that a too rapid recovery from limiting induces. If only short sharp peaks are expected, where a limiter is used as a safety device rather than as a lazy man's fader, a short recovery will probably be preferable, especially if there is low background to the signal.

Construction points

The amplifier has a high input impedance so normal care should be taken to keep output circuitry away from input, and input circuitry screened from hum-inducing fields. In some cases, parasitic suppression of around 50 to 100 pF between collector and base of Tr1 may be beneficial. Most components are not critical in value or type unless the reader intends to use the printed circuit layout, when it will be essential to use 125 mW resistors, Mullard *C426* series capacitors for C1, C8, C9, C10 and C11, and Tantalum bead types for the remaining electrolytics. Apart from the fet, which should be a *2N5457*, the transistors are not particularly critical and almost any equivalent types could be used. Those used by the writer happened to be readily available.

R1 can be any value between 33 kΩ and 100 kΩ. The higher value gives slightly 'stiffer' control and increases the input level that can be controlled, though this advantage may be academic as, with R1 at 33 kΩ, an input overload of over 30 dB can be accommodated. The

continued 73

This Philips 'electronic' record deck surpasses the DIN 45 500 Hi-Fi Standard

The Philips GA202 Record Deck not only betters the internationally respected DIN Standard for high-quality audio, but sets completely new high standards for record reproduction.

Its three speeds (33⅓, 45, 78 rpm) can be adjusted precisely, using the stroboscopic disc and fine-speed controls provided, and are accurately maintained by a tacho generator that keeps wow and flutter to less than 0·13%. Switching on and off is done silently through a bi-stable multi-vibrator. And photo-electronic switch-off at the end of a record is silent and vibration-free, exerting no side-thrust on the stylus.

Floating suspension of the turn-table and pick-up arm gives excellent insulation against shocks and vibration, resulting in very low rumble and very accurate cueing.

The tracking error of the virtually frictionless low-resonance pick-up arm is negligible. And side-thrust may be compensated at all playing weights for both conical and elliptical styli.

The Philips slide-in carrier accepts virtually any pick-up cartridge with fixing centres to the ½" international standard. A Philips GP400 Super M magneto-dynamic cartridge is supplied.

Your Philips Audio Specialist will be pleased to demonstrate this superb record deck. For a free 36-page Audio Guide, write to Philips Electrical Limited, Dept. SP, Century House, Shaftesbury Avenue, London WC2H 8AS.

PHILIPS

We want you to have the best. **PHILIPS**

CONSTRUCTING A LIMITER

continued

higher value degrades the noise figure by a dB or so, however, and also degrades the attainable distortion figures very slightly. So you pays your money and takes your choice. C7 is there primarily as an rf filter and may be necessary in areas in close proximity to a high power transmitter. Normally C6 should suffice. R2 and R3 need not be exactly 1 MΩ but they should be equal. R19 is a means of allowing an alteration of amplifier gain external to the pc board, at the same time maintaining a minimal value for R9, with a pot between pins four and six in parallel with R9. This facility is mainly of concern if the amplifier is used without the limiter circuitry, though it does offer possibilities for experimentation in getting the amplifier to work as a compressor rather than as a limiter. The higher the value of R9, the 'softer' the control. The components shown dotted (D4, C24, R24) are components that can be added to the pc board where a control signal from other than the amplifier output is required, and will be explained later.

Setting up

Amplifier voltages should be 'self centring' as they are directly coupled. If the junction of R14 and R15 is not within a volt or so of half the supply volts and this discrepancy is not caused by component faults, the centre voltage can be varied by altering the value of R10 slightly. The supply voltage is by no means critical, a few volts either way will only have the effect of increasing or decreasing the available voltage swing on the output with the limiting stage 'switched off'. It would be prudent to test the amplifier first without the fet in circuit to make sure it is working satisfactorily. With the component values shown, input/output gain should be about 50 times (34 dB) and the maximum 'undistorted' output that can be expected is +20 dB (8V) if the centre voltage is right. Allowing for component tolerances, +18 dB (6V) is probably more likely. At this level, the distortion over the audio band into a 600 ohm load or greater should be about 0.25 per cent depending on the transistor samples chosen. Higher gain samples tend to give lower distortion than their lesser brethren. Current consumption can be expected to be 7 to 10 mA quiescent and about 15 mA at full output. Current should not reach much more than 10 mA in the limiting condition.

Once the reader is satisfied that the amplifier section is working correctly, attention can be turned to setting up the limiter section. Since fets vary between samples, it is not reliable to set up on static voltages, though 2V to 3V across R5 is a fair starting point.

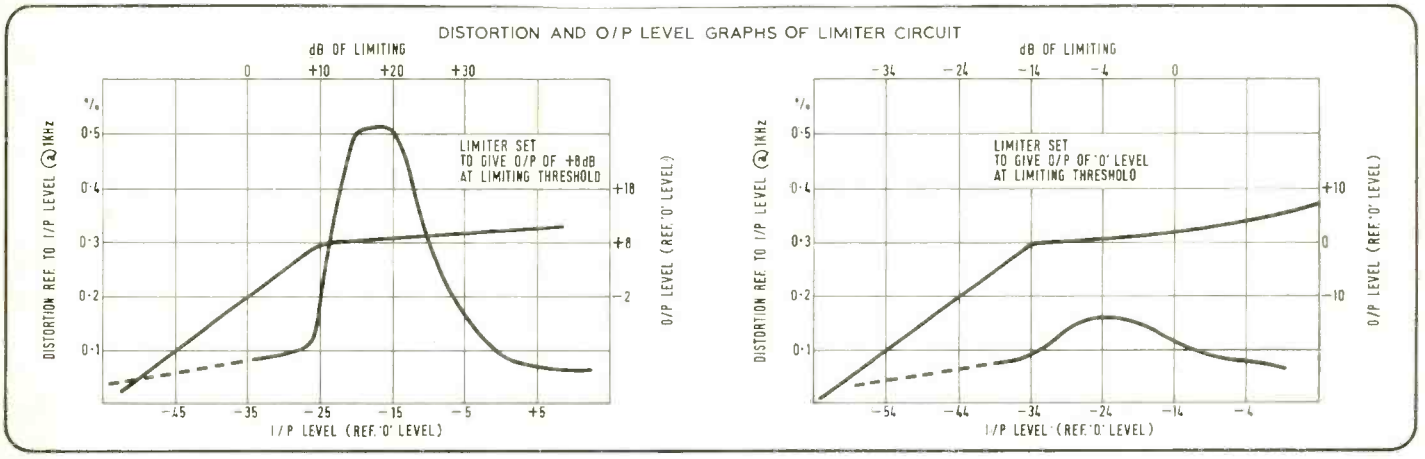
Feed a tone to the amplifier input sufficient to cause limiting (–20 dB, 100 mV) and connect the level meter to the output. VR1 can now be adjusted until the output is that required between about –2 dB (500 mV) and +12 dB (3V), giving time between adjustments for the gain to settle down again. (Where the lower output levels are desired, it may be necessary to reduce the value of R5 by a few hundred ohms with some samples of *2N5457*.) Once the output level has been set satisfactorily, the amplifier will give linear amplification to all signals less than the limiting threshold. To all intents and purposes, peak output will not exceed the predetermined maximum output, almost regardless of input level.

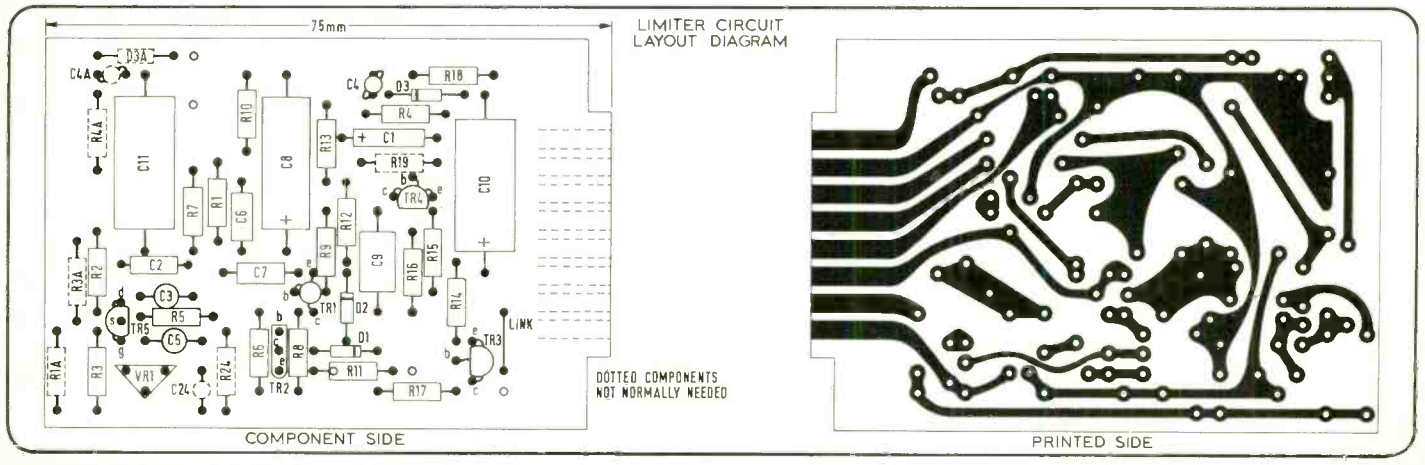
The foregoing comments apply to measurements made by the writer into a 600 ohm load, and it was only later realised that the *limited* output level can differ from that set up if the amplifier is operated into a load significantly different from that it was set up on, so for accurate results the output level required should be set up with the amplifier feeding approximately the load it is intended to operate into. If difficulty is found in getting a low enough output into a load significantly greater than 5 kΩ, a resistor of between about 680 ohms to 1 kΩ could be permanently placed across the amp output terminals.

The pc board

For those contemplating using the printed circuit board, some explanation of its beginnings may be in order. It was originally inten-

continued 75

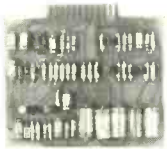




richardson

ANNOUNCE A NEW RANGE OF PRINTED CIRCUIT PLUG-IN MODULES FOR PROFESSIONAL AND INDUSTRIAL APPLICATIONS




This rationalised system allows numerous applications for mixing and amplification—the modules have been developed over the past four years and successfully used in discotheque mixers, studio mixing/recording equipment and custom-built installations. The system now features a universal Mother Board which is designed to accommodate these modules, enabling the manufacture of a wide range of equipment from standardised units.
The modules are constructed on fibre glass printed circuit boards with gold plated edge connectors. These have outstanding performance in respect of extremely low distortion, less than 0.01% at rated output, together with high overload capabilities and overall frequency responses of ± 0.5 dB.

This range of modules includes switchable microphone/line amplifiers—mono and stereo gramophone amplifiers, R.I.A.A. equalised—impedance convertors/buffer amplifiers—tape replay and record amplifiers with electronically switched equalisation—tape oscillator systems—P.P.M. drive amplifiers.
Mixing amplifiers and tone controls are available on either combined or individual modules.
Output amplifiers include line amplifiers up to 10V into 600Ω—monitor and power amplifiers up to 200W into 8Ω.
In addition a range of stabilised power supply modules are available. Mains and line matching transformers, faders, meters, etc, are available ex-stock.

J. RICHARDSON ELECTRONICS LIMITED
57 JAMESTOWN ROAD, LONDON N.W.1
01-267 0723/4874

LOOKS LIKE LOCKWOOD BY THE SOUND OF IT

LOCKWOOD

HARROW · MIDDLESEX
Tel. 01-422 3704 and 01-422 0768

UNBEATABLE – UNREPEATABLE

OFFER

SHIBADEN SV700E 625 and 405 LINE ½" VIDEO TAPERECORDER at under HALF PRICE

SAVE **£200** ON
EX-DISTRIBUTORS
REDUNDANT STOCK
ONLY **£198** EACH

Guaranteed full working order and compatible with latest machines.

ORDER NOW WHILE LIMITED STOCKS LAST

(TRADE ENQUIRIES WELCOME)

AUDIO ADVERTISING (DEPT. IVS)
43 MALDEN WAY, NEW MALDEN, SURREY
01-942 9635/6

A SIMPLE LIMITER

continued

ded as a level-raising amp with a low power output capability which could be plugged into an eight-way 4 mm pitch socket. The limiting circuitry which could be plugged into almost any available space, with some compromises accepted to add versatility (but not too much area) to the original board. Firstly, there are alternative positions for the control rectifier and timing components. If it is intended to work the amplifier as a limiter, only D3, C4, R4, R3 should be put in the 'A' positions. However if the main positions are used, and a path to earth provided from the lower end of R3, the bias voltage applied to the fet by VR1 and R5 holds off any gain reduction until a control voltage is applied from D3. To do this, a connection has to be made from pin five to pin seven, so it is a simple matter to arrange for the amplifier to work 'straight' or as a limiter by a switch between these two pins. A changeover with its traveller connected to pin seven, one fixed contact to pin five, and the other to pin two (earth), is a simple way of achieving the alternative modes. The only drawback to using the circuit as a straight amplifier with the control components left in is a slight increase in noise due to the presence of R1, which, if the circuit is used as a level-raising amp only, should be shorted out or reduced to about 1 kΩ. A link from pin seven to the outside conductor on the pc board is also necessary. This was primarily to allow the control voltage to be supplied from a source other than the amplifier output if desired, by replacing the link with a diode and adding the additional components C24, R24, to the spaces indicated. The gain of this amplifier can then be controlled by the output signal of another source, for example, to reduce background music automatically by a feed from a mic channel.

Astute readers will by now have surmised that amplifier gain can also be controlled by a direct voltage applied to R3, to give the mode of a voltage-controlled and noise-free fader. One snag is the inability to fade the signal out completely but there are possibilities for its use as a remote volume control. If it is contemplated to use the amplifier in this mode, one or two points need attention for optimum performance. For maximum control range, it will be evident that the greater the resistance ratio between R1 and Tr5, the greater the possible attenuation, so R1 should be 100 kΩ and an fet with a lower R_{RS} (on) should be used in place of the *2N5457*, which will only give about 40 dB attenuation. A *2N5459* gives about 50 dB and an fet intended for 'chopper' applications would probably give an even greater range of control. Bias will need to be adjusted so that Tr5 is just turned off with no control volts applied; this is likely to be in the region of 2V to 9V across R5 and the control

voltage variation will be that required to overcome this. Another point to be observed is that the uncontrolled output from the amp should not be too great, or some distortion at the start of a fade could become more than is desirable.

Provision has been made on the board for an alternative input layout which may give better results in some circumstances, as it removes the possibility of the finite impedance of C3 (especially at low frequencies) from becoming significant with respect to the fet impedance in its low state. At the relatively high attenuation that this effect would occur, the resulting change in frequency response can probably be ignored.

For the purist, the layout changes necessitate linking the input signal applied to pin seven to the outside conductor with a non-electrolytic capacitor C1A (a Siemens MKM 0.33 μF [Electrovalue] fits well), replacing R1 by R1A at the other end of this conductor and applying the control signal to the lower end of R3A in place of R3. If the amplifier is being used as a limiter, this can be done automatically by D3A, C4A, R4A. When an external control voltage is to be used, a break should be made in the conductor on the outside of the board where it joins R18, and the control signal applied to D3A anode. Alternatively the D3A anode can be linked round to the now redundant pin three and the control voltage applied there, which would be tidier.

With the input applied to pin seven, the close proximity of C1A to C10 can give rise to some instability with the amplifier input unterminated, and 50 to 100 pF across Tr1 collector/base will probably be called for to prevent this undesirable effect.

Output level variation and total harmonic distortion: the easiest way to describe the performance of this amplifier as a limiter is by means of graphs. **Fig. 2** shows two drawn at two typical output levels. The two curves on each graph represent output level and thd respectively compared to input level. In all cases the general shape of the curves is similar, but distortion at the lower output levels is less than at the higher. Even so, the thd should not exceed one per cent under all reasonable conditions at most frequencies, though it does rise at the bass end somewhat, reaching two per cent to three per cent at 50 Hz. These figures can only be taken as typical as different samples of fet will give slightly varying performance.

Frequency response is within 1 dB from 30 Hz to 16 kHz.

Noise (R1 = 33 kΩ) is 56 dB below 'zero level' output, unweighted. (This will be 8 dB better at the + 8 dBm output level of course.) R1 = 0, $_{RS}$ = 600 ohms gives 60 dB below zero level output.

I have not measured attack time but, with C4 less than 10μF, it should be less than one cycle over most of the audio band. Even with C4 = 100 μF, it should be less than 1 ms.

MIXER POSTSCRIPT

continued

gradual rather than being sudden at the onset of clipping, as is preferable in a well-designed amplifier. The reason for this distortion was the low loop gain of the amplifier and, in searching for an easy way to improve this, Richardson hit on the idea of using a bootstrapping technique for the collector load of the first transistor. This raises the effective value of the load, and hence the loop gain. The original circuit was shown in fig. 22; **fig. 99** shows how the addition of one resistor and one capacitor achieves the bootstrapping. The only other modification is a small change in value to R4. The performance is significantly improved, as can be seen from **fig. 100.** This improvement is particularly noticed when high level input signals are being fed into the microphone amplifier, which may occur when capacitor microphones are being used.

The modification is not quite so easy to carry out on the printed circuit since this module layout is relatively close-packed. The best solution is to replace R3 with the two new resistors R3a and R3b, with their junction 'in the air'. To this 'skyhook' can be added the new capacitor C11; the other end of C11 is connected to the emitter of Tr2 at R7.

Neil Raybould at the controls of his Robinson mixer. This unit will be demonstrated at APRS 72.

The Editor tells me that the series of articles on the mixer was very successful. It is interesting therefore that STUDIO SOUND may be displaying a version of the mixer on their stand at the Association of Professional Recording Studios Exhibition on June 23 and 24. (I hope myself then to be far away on holiday!)

Demand for the printed circuit cards for the mixer is still high and I shall try to be in stock of all cards until the end of 1972. After that time I shall only re-order bulk supplies when the size of an individual order warrants it, or a number of smaller orders have accumulated. Delivery may therefore become extended in 1973. Before then I hope to have described two further circuits for the mixer. One is a peak indicator using a light emitting diode and the other a metering system based on level sensitive lights.

RADFORD

We invite you to see the RADFORD range of high quality audio amplifiers, loudspeakers and distortion measuring equipment on Stand No. 27 at the APRS EXHIBITION at the Connaught Rooms, Great Queen Street, London, W.C.2, on 23rd and 24th June.

Staff will be available to answer your technical questions or discuss any special studio requirements you may have.

EMI 20w Matched loudspeaker set 350
Frequency range: 20 to 20,000Hz.
Our price **£7·00** *plus 50p p. & p.*

EMI 10w Matched loudspeaker set 450.
Our price **£3·35** *plus 25p p. & p.*

13½" x 8¼" elliptical loudspeaker and independent high frequency units with associated crossover network. Frequency range: 55 to 13,000Hz. The cone of the bass unit has a surround designed for high travel giving freedom from distortion when operated at low frequencies.

NOW IN STOCK **EMI 14A/770C Bass Speaker £13·50** *plus 50p p. & p. Technical brochure available* 215 Kit and 315 Kit. Full range of EMI Speaker Cabinets. *Send for leaflet s.a.e.*

PLUGS

Pack 107 5-pin Din	20p
Pack 108 3-pin Din	18p
Pack 135 ¼" Jack	25p
Pack 130 ¼" Jack Stereo	48p
Pack 103 Loudspeaker Plug	15p
Pack 100 Phono Plug	6p
Pack 230 3-pin Socket	23p
Pack 236 5-pin Socket	30p
Pack 234 Loudspeaker Socket	30p
Ready-made leads	
3-pin to 3-pin Din	63p
3-pin to open end	53p
5-pin to 5-pin Din	80p
5-pin to open end	65p
5-pin to 4 phono plugs	93p
Speaker lead Din to spade 12ft.	38p
Extension lead Din plug to socket 12ft.	65p

All leads approx. 6ft. in length. Post free by return.

GARRARD SP25 Mk III

£10·50 *plus 50p carriage.* *Guaranteed new and boxed. Normal Price £15·57*

Plinth and Cover for above £4 plus 50p p. & p

SAVE!! on Audio Magnetics CASSETTES

IN LIBRARY CASES

From the world's largest manufacturer— Audio Magnetics. Lifetime guarantee

Please add 10p p. & p. on 1-5 cassettes 20p on 6-10, 25p on 11-20

ALL ORDERS DESPATCHED BY RETURN OF POST

GARRARD ZERO 100/A Superb quality Teak plinth and cover available at £15 plus 50p p. & p. *Our Price* **£42** *plus 50p p. & p.*

GOLDRING GL69/2 *Our Price* **£19** *plus 50p p. & p.*

DIAMOND STYLI

Replacement styli all at: **75p** plus 13p p. & p.

Double Diamond Add 50p
8TA, 9TA, 9TAHC, GP91, ST4, ST9, EV26, GC8. OTHERS ON REQUEST.
Replacement Diamond Styli **£2·13** plus 13p p. & p.
Orbit MN22 Styli **£2·13**
Goldring G800 Styli **£2·25**

CARTRIDGES

Sonotone 9TAHC (Dia.)	£2·50
Sonotone 8TA4A (Dia.)	£1·50
Ronnette 105 (Dia.)	£1·25
Orbit NM22 Magnetic (Dia.)	£4·00
Goldring G800	£6·50

p. & p. on above items 13p.

We have a comprehensive range of new and used professional microphones, sound, photographic and audio visual equipment. EQUIPMENT TAKEN IN PART EXCHANGE. ORDER by POST. Order with confidence. Orders despatched the same day as received. *Open Mon. to Sat. 9 a.m. to 6 p.m. Thurs. 9 a.m. to 1 p.m.*

J. J. FRANCIS
(WOOD GREEN) LTD
123 ALEXANDRA ROAD, HORNSEY, LONDON, N.8. Tel: 01-888 1662

CASH & CARRY GOODS

Save Nearly £8

SINCLAIR project 60
(*Normally* £23·90) *Our Price* **£16** *plus 50p carr.*

For building into plinths, etc., with two Z30 output stages (20W) and power supply unit. S.a.e. for technical brochure.

Sinclair 605	£21
Sinclair 2000	£22
Sinclair 3000	£30
Metrosound ST20	£24
Teleton 206B	£19·95
Alpha F212	£26

Please add 50p carr. per amplifier.

Other Amplifiers — Tuners — Tape Recorders, etc. Prices on application

SCOOP PURCHASE ZONAL-ILFORD TAPE

Manufacturer's entire stock purchased, 40,000 reels must be sold. First class tape at lowest ever prices.

DON'T MISS THIS FANTASTIC OPPORTUNITY

		Usual Price	*Our Price*
3½" Long Play Polyester	300′	60p	15p
4" Long Play Polyester	450′	72p	25p
4" Double Play Polyester	600′	£1·25	35p
5" Standard Play PVC	600′	£1·05	35p
5" Plain Boxed	600′	£1·00	25p
5¾" Standard Play PVC	900′	£1·40	50p
5¾" Long Play Polyester	1200′	£1·75	75p
7" in plain boxes	1200′	£1·75	50p
7" Long Play Polyester	1800′	£2·50	£1·50
8¼" Standard PVC	1800′	£3·00	£1·00
8¼" Long Play Polyester	2400′	£4·25	£1·50
10" NAB HUB (no spool)	2400′	£4·00	75p

SPECIAL OFFER: Cassette Head Cleaner 30p

All tapes are fully guaranteed. Please add **10p** *per reel for post and packing. Orders over £5 post free.*

Equipment Reviews

Philips PRO 36

MANUFACTURER'S SPECIFICATION (38 cm/s, IEC equalisation).
Tape speeds: 38, 19 and 9.5 cm/s ±0.2%. **Tape width:** 6.25 mm. **Format:** full or half track mono, mono+pilot, stereo or two channel (specification relates to two x 2.75 mm stereo). **Slip:** 0.1% (matt back tape). **Tension:** 60 to 125 g for 1 km tape. **Heads:** Up to four (ferrite). **Wow and flutter:** 0.1% peak (0.04% peak weighted to DIN 45507). **Overall distortion:** 1.5% at 51 mM/mm. **Noise:** −62 dB ref 51 mM/mm. **Price:** £1,100 basic. Review model £1,400 basic.
DISTRIBUTOR: Pye TVT Ltd, Coldhams Lane, Cambridge.

THE PHILIPS *Pro 20* has given excellent service to the recording industry for a considerable time but, like all other manufacturers, Philips have now designed a completely transistorised professional machine which could be said to start where the *Pro 20* left off. The machine is primarily intended to be used in fixed installations in control rooms but the manufacturers can provide a number of different housings suitable for mobile or studio use. The model under review was supplied in a large metal console, the recorder itself fitting neatly into the top, seating into a tray.

The machine is designed to work with cine, NAB or European hub spools and has low and high tension positions which not only alter the forward and reverse tension during record or replay but also control the maximum spooling speed that can be utilised. The tensioning and spooling adjustments are preset at the factory using light-dependent resistors, but unfortunately the back tension does not vary with the amount of tape on the payout spool. This would appear to be of relatively little importance, however, since the speed stability was exceptionally good as were the wow and flutter figures under all conditions.

The main capstan motor takes some time to achieve synchronous speed and when this has been reached a light comes on. The playback speed accuracy was checked using a special calibrated test tape which had a known frequency recorded on it. A frequency counter was used to check the playback frequency of this tape at all three speeds in both high and low tension positions and with the calibration frequency measured when it was at both the outer and inner diameter of the pay spool. I was amazed to find that the accuracy under all these circumstances was ±0.1 per cent of nominal and that the ratio between speeds was held to an even greater accuracy.

The wow and flutter figures were measured to the weighted DIN specification, at the beginning, middle and end of both full NAB and cine spools at all three speeds. In all cases the wow and flutter was at its best at the beginning of the spool and was at its worst at the very end of the spool. At 38 cm/s the wow and flutter averaged 0.025 per cent although this deteriorated at the end of an 18 cm spool to 0.035 per cent. Even the latter figure would be completely inaudible in practice on music and is therefore very satisfactory. At 19 cm/s the average figure was 0.035 per cent, an exceptional figure, whilst at 9.5 cm/s the average figure was 0.08 per cent, although the remarkably low figure of 0.045 per cent was noted at the beginning of an NAB spool.

The accuracy of the timing clock was checked and found to be only 3s out in 32 minutes, a length of tape being measured from end to end at 38 cm/s, measuring with the *Pro 36*'s clock and also with the stop watch. At this point perhaps I should mention that our Editor will not be pleased that the tape machine speeds are indicated in ips rather than cm/s—rather surprising since it is made on the Continent. Spooling is brought into operation by pressing the appropriate button which allows a horizontal quadrant type fader lever to become active. During all the prolonged spooling tests the tape handling was very neat and, despite some violent reversals and many other attempts to fault the mechanism, no trouble was experienced. At maximum speed a 720m NAB reel can be spooled in approximately one minute 25 seconds, and an 18cm 540m reel spooled at full speed at low tension took one minute ten seconds.

The machine starts the playback or record function very quickly, and at all speeds wow and flutter appeared to reach normal operational standards in a fraction of a second. It is possible to drop into record from replay and an extra pressbutton acts both as a safety lock and an editing drop-in record function control. With the button up and the machine switched to record, by manually pushing in an idler wheel the tape is brought into contact with the record and erase heads. When the idler wheel is released a spring pulls the tape away from this head, leaving it in contact with the replay head. With the button down this function will still operate, the idler wheel remaining in whatever position it is manually placed. An additional button allows the tape to remain in contact with the replay head during spooling if required, but to avoid head wear the button should normally be left depressed, in which case the tape does not lie in contact with the heads. No editing equipment is provided on the deck and this will have to be added if desired. In operation the machine is rather noisy, and I found this was due almost entirely to the main capstan motor, which runs continually if the machine is left switched on. Spooling is also rather noisy, a loud buzzing being emitted by the spooling motors. I also noticed that the timing counter clicks during spooling.

Playback speed was checked using a variac with voltages from 200V ac to 260V ac and no noticeable change of frequency was apparent under these circumstances. The total power consumption at 240V was checked and was found never to exceed 200W even on fast spooling. The model reviewed was supplied with the vu meter panel which incorporated vu meter switching, to allow the meters to check both the input and output levels of the machine, as well as input and output level controls. With the machine set up precisely as instructed by Philips's these controls were considerably back from flat out. We thought this extremely bad practice since the controls were continuously variable and could only be reset by recalibrating the machine with a test tape; on more than one occasion one of the controls was accidentally knocked during tests making it necessary to standardise. I therefore consider that each of them should be replaced by a 2 dB per step Stud type calibrated in click steps positive and negative of calibration positions.

The internal electronics included record and

continued over

continued

replay preset level adjustments, the former being independently variable for each speed but the latter an overall control. By suitable adjustments to these we found it possible to operate the machine with the playback level controls flat out, though the playback presets had to be taken back considerably. The hiss level under these conditions was only marginally inferior but the vu meter settings on replay were of relatively little use. The manufacturers recommend that on playback the vu meters should be set on their lower sensitivity positions such that a stereo test tape containing a peak level tone of 510 nWb/m should represent 0 vu, or alternatively normal DIN reference level should come out to –4 vu. This recommendation however might well encourage the use of far too high a recording level since on music the vu meters under-read considerably. In any case I did not find it possible to obtain sufficient gain to achieve this level with the presets, needing about 0.5 dB more gain on replay. A switch on the printed circuit board allows the choice of IEC or NAB playback equalisation without the necessity for re-equalising the playback amplifiers. On record in the NAB position, the correct bass boost is switched in to the record equalisers after being readjusted to give the correct overall response.

The replay response was checked at the three speeds and, whereas the high frequency end was found to be very accurately lined up, a rise of up to +1.5 dB was noted at the bass end. From 500 Hz to 16 kHz at 38 cm/s, the response measured ±0.5 dB with reference to 1 kHz and at 19 cm/s ±0.5 dB to 14 kHz; at this speed 18 kHz was 2.5 dB down on both channels. At 9.5 the response measured ±1 dB from 40 Hz to 14 kHz, 16 kHz being –2 dB with respect to 1 kHz. Since the bass response at this speed was by far the most accurate we must assume that the irregularity of response at the higher speeds—there were humps at 60 Hz and 250 Hz at 38 cm/s and at 40 Hz and 125 Hz at 19 cm/s—must be due to wavelength irregularities between the tape and the replay head. I feel that the manufacturers should try to improve on this, either by an additional preset for the bass end at higher speeds, or by redesigning the tape path over the ferrite replay head. Under all circumstances incidentally we noticed excellent tape contact at short wavelengths and, when testing the machine's performance overall, tape drop outs were virtually unnoticeable, even at 9.5 cm/s. The replay amplifier overload capability was measured by playing a tape recorded to a level of 10 dB above DIN reference level and the playback distortion of which was an accurately measured three per cent. At all settings of the preset and main output level controls the playback distortion gave the same figure provided that an output level of +20.5 dBm was not exceeded, this being the clipping point of the lineout amp into 10 kΩ. The lineout amplifier had approximately 8 dB of gain in hand assuming an output of +8 dBm is required from a record flux of 320 nWb/m. The lineout amplifier had a fairly low source impedance of 100 ohms and was fully capable of operating at high levels into 600 ohms.

The playback noise level was checked at all three speeds and was good with the capstan motor idling but could only be said to be fairly good when the tape was running since hum from the spooling motors measured a little higher than it might have done. The dBA weighted noise figures of the replay amplifier under play conditions, but without tape actually passing the head, measured well since the latter curve has a very considerable attenuation of bass frequencies in which hum would normally represent the major portion of the noise figure. The figures, ref DIN level of 320 nWb/m, were –76 dB at 38 cm/s, –74 dB at 19 cm/s and –71 dB at 9.5 cm/s. The measurements were repeated with a flat measurement bandwidth from 20 Hz to 20 kHz with very steep high and low pass filters at these two frequencies. Under these circumstances there was a very considerable difference in the measurements taken when the machine was idling and with the spooling motors energised. An example of the difference is quoted for the 38 cm/s speed referred to DIN level which was –67.5 dB, deteriorating to –58.5 dB when the spooling motors were energised under play tension. At the lower speeds the difference between spool motors on and off was not so marked as the high frequency noise contribution of the playback amplifier becomes more marked. The hum was third octave analysed and under play conditions the 50 Hz component measured only 61 dB below DIN level with also an odd component at exactly 120 Hz and a level of –65 dB; its frequency checked with a frequency counter. It must be assumed that this 120 Hz at 38 cm/s came from the capstan motor, but that the 50 Hz component almost certainly came from the spooling motors since it virtually vanished when they were disconnected. In operation the replay hum levels will be found to be quite satisfactory but if the machine is to be used for accurate tape testing an improvement is definitely necessary. In any case it is suggested that the manufacturers should do better.

The recording amplifier has independent record level, bias and equalisation for each speed on both tracks, in addition to adjustable record volume controls on the vu meter panel, thus allowing the machine to be set up for different types of tape at the different speeds. The new EMI matt backed tape, type *816*, at 38 cm/s gave an overall response from 500 Hz to 16 kHz of ±0.5 dB with 18 kHz 1 dB down and 22 kHz 3 dB down with reference to 1 kHz. In the bass, however, the bass woodles due to the playback head bumps were +1.5 dB at 80 Hz and –1 dB at 32 Hz, with the usual variations in between. At 19 cm/s the matt backed tape had a plateau of +1 dB from 5 to 11 kHz being –1 dB at 13 kHz and –3 at 16 kHz. At the bass end, the response was ±1 dB from 30 Hz upwards, varying to –3 dB at 16 Hz. If the bias had been lowered slightly and the record equalisation also dropped the response at the top end could have been made slightly better, but under these circumstances the tape would have been slightly under biased.

BASF *LP 35 LH* tape was then checked at 19 cm/s and the high frequency response was very much improved: ±1 dB from 30 Hz to 15 kHz and 3 dB down at 18 kHz. At 9.5 cm/s again using BASF *LP 35 LH* tape the response was +1.5 dB to –0.5 dB from 30 Hz to 15 kHz with reference to 1 kHz. The similarity of response between the two tracks was good at all speeds.

The capability of the record amplifier to drive extremely high levels on to the tape was then checked and it was found that the record head driver had more than ample margin to cater for very high recording levels. No significant second harmonic distortion was noted. The record amplifier's input impedance was 25 kΩ.

The bias adjustment is not quite sufficient in the downward direction to ascertain the peak output of the tape at high frequencies under some conditions and a further available reduction of 3 dB or so of bias at each speed would be welcome. However, more than enough bias was available at all speeds for all type of ferric oxide based tapes known to the reviewer. The distortion of the erase and bias supply was measured and was found to be 0.2 per cent on the terminals of the head, the erase head having approximately 74V across it at 94.5 kHz.

The bias breakthrough was checked on the playback output during recording and was well in excess of 50 dB below DIN level at both 38 and 19 cm/s on both tracks. At 9.5 cm/s, however, the breakthrough was approximately 40 dB below DIN level. This was considered perfectly adequate for all normal users, being at least 15 dB below the level of any equalisation and bias setting up tone levels.

The positions of the input and output XLR sockets follow Continental rather than British convention. They are situated underneath the vu meter panel and in the portable version are rather awkward to get at. This will be particularly annoying in mobile applications as it is necessary to lift the front of the machine up to push the connector into the back of the front panel. It is necessary to withdraw the complete vu meter panel assembly forward to reach the majority of the presets, and this might be inconvenient if tape types have to be changed often. Two excellent spool clamps are provided with a safe and very firm NAB spring lock. These clamps can be removed and small spindles inserted for use with plastic spools. My overall impression of the machine is that it has obviously been designed very carefully and performs well mechanically and electronically. I feel that in future versions the manufacturers should attend to the criticisms raised. The existing model can be safely recommended for use in control rooms but the ergonomics should be carefully considered if the machine is to be used frequently for mobile recording.

The main snag is the very high price asked. When the recorder was first shown about a year ago its appearance was acclaimed by all and I had been looking forward to reviewing it ever since. At Christmas however the price was increased by almost a third, which must surely have affected its sales potential. If Philips had been able to leave the price as originally announced I feel they could have had a real winner throughout Europe. As matters stand it now has many other competitors, each with their merits and some more attractively priced. **Angus McKenzie**

Manufacturer's Comment

We would like to comment on some of the foregoing findings as follows:

The lumping of low frequency response is a

well known effect and work is under way to provide an economical solution to this. The overriding consideration is that the deviations are within the published specifications.

Motor effects are known to the manufacturers. It is our opinion, however, that the motor noise is minimal and would not detract from the machine's use in any but the most stringent conditions of recording in the same room as the microphones are sited. A new motor is being investigated and will be available later this year. Amplifier hum due to motors is normally lower than 72 dB weighted and well within specification. We agree that on this machine it was measured to be in the order of −64 dB unweighted below 510 nWb/m (51 mM/mm). The unweighted noise figures quoted in the specification are as follows:

38 cm/s	62 dB	62 dB (ref 51 mM/mm)
19 cm/s	58 dB	60 dB (ref 51 mM/mm)
9.5 cm/s	52 dB	52 dB (ref 25 mM/mm)

The bias range is being increased for the UK market.

In view of the high quality and exceptional facilities offered compared with other machines, we feel that the *PRO 36* offers excellent value for money and is a first class buy.

It is obvious that the review is the result of an unbiased and painstaking assessment of the recorder by Mr McKenzie and his assistant, Ren Hunter, and we would like to thank them for their efforts.

Replay Amp board has a switch which alters replay equalisation at 19 and 38 cm/s from DIN to NAB response correcting both treble and bass ends. The same switch also operated a relay on the record board bringing in bass correction as necessary, whereas the relay equalisation was found to be correct without altering presets; record presets had to be altered from their DIN position to get an overall NAB response.

Rogers BBC Monitor

MANUFACTURERS' SPECIFICATION

Three-unit moving-coil loudspeaker in teak finish.

Frequency response: 40 Hz to 25 kHz ±3 dB.

Power handling capacity: 25W, speech and music.

Impedance: 15 ohms standard; eight and 25 ohms to order.

Dimensions: 635 x 305 x 305 mm.

Height including stand: 940 mm.

Weight: 16 kg.

Price: £96·31 retail

MANUFACTURER: Rogers Developments (Electronics) Ltd, 4-14 Barmeston Road, London SE6 3BN.

ONE essential for high quality recording or broadcasting is the provision of really high quality monitor speakers for the sound mixer. When the BBC Engineering Division first developed their *LS5/5* for use in control rooms it was so superior to other monitor speakers currently available that it became obvious a corresponding improvement needed to be made in the monitor used in mobile control rooms. The knowledge gained in designing the *LS5/5* was used to this end and resulted in the production of a smaller speaker handling less power but with generally similar characteristics, known as the *LS3/4*.

The original *LS3/4* was designed for suspending from the roof of the mcr. A floor-standing version in a rectangular cabinet was later developed for small studios and it is this version that Rogers now make under licence.

The BBC Research Department must be one of the few organisations fully equipped to design monitor speakers as they not only possess the measuring facilities but can also use the studios for live versus reproduced comparisons over a wider range of programme and for longer periods than would be commercially possible.

The bass unit of the *LS3/4* is a plastic cone unit of the type designed for use as a mid range unit for the *LS5/5* but with modifications to improve the bass response. The original BBC design has one hf unit with a crossover at 3 kHz arranged to equalise the overall axial frequency response at the same time. As the sensitivities of individual hf and lf units vary slightly from sample to sample, an auto transformer is used with 1 dB tappings so that relative power levels fed to the units can be adjusted.

Conditions for producing these speakers under licence are that no changes of any sort shall be made in the design without prior permission being obtained from the BBC. Each speaker produced must satisfy a rigid specification. Rogers have sensibly taken great care over the production of the BBC monitors and have even had a special anechoic chamber built so that each unit can be tested on completion.

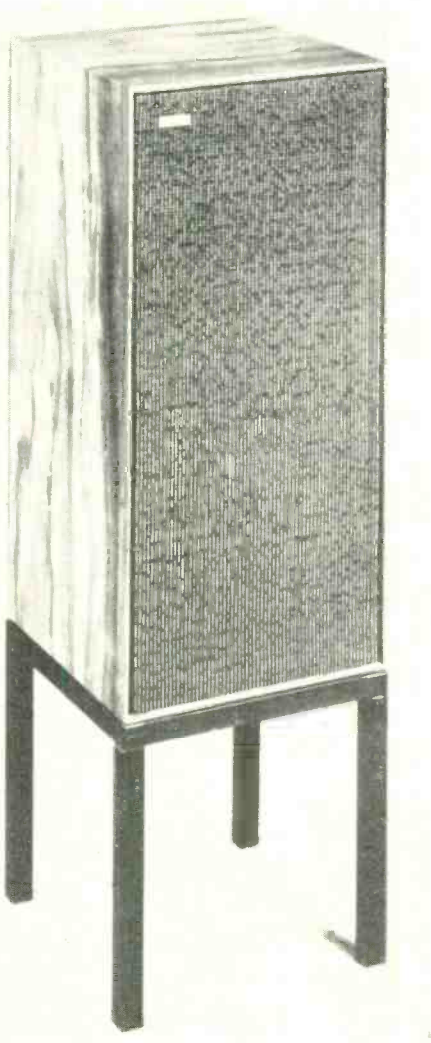
They felt, however, that the response at the upper end, though perfectly adequate for BBC use where nothing much above 15 kHz is broadcast, might be too restricted for some studios. They suggested a design modification to the BBC to add a further HF unit with appropriate crossover network to extend the response. The Research Department have accepted this and the current BBC Monitor as produced by Rogers has the 3rd unit extending its response to 25 kHz.

The early units produced by Rogers seemed to have slight mid-range coloration when compared with the other monitor speakers of comparable quality, and investigations by the Rogers design team showed that this was not due to the bass unit, as supposed at first, but to the cabinet damping. The cabinet is of the 'controlled resonance' type and a range of foams permissible for use were specified by the BBC. Rogers have now selected from this range the one that is most effective in removing this mid-range coloration and, though both the early units and the production versions meet the BBC tolerances, the latter give improved performance on listening tests.

The Rogers BBC Monitor is extremely well made from high quality material, and care has been taken to see that it is pleasing to the eye as well as to the ear. The cabinet work is of a very high standard, and the unit would fit happily into domestic surroundings as well as into studios, thus making it suitable for Hi Fi enthusiasts who want and can afford the best. The speakers are supplied complete with metal stands, the stands being in matt black and of just the right height for correct listening when seated.

Comparisons with the Spendor *BC1* using the speaker test tape showed the two systems to have remarkably similar sound quality, the differences being so slight that on entering the control room where both sets were installed it was impossible to tell which pair was working. Direct switching from one pair to another did show up slight differences, the Rogers seeming to give a very slightly warmer sound than the Spendors, but this effect was so marginal that a change in programme material could alter it.

continued 81



HEARING IS BELIEVING...

THE INCREDIBLE AK154 AND AK155 15 INCH LOUDSPEAKER

A HIGH QUALITY BASED LOUDSPEAKER IDEAL FOR STUDIO USE

For further details contact Roger Dyer at:

VITAVOX
Limited
Westmoreland Road, London NW9 9RJ
Telephone: 01-204 4234

KLARK TEKNIK

Custom built professional electronic recording equipment

Klark - Teknik Limited
M.O.S. Industrial Site Kidderminster
Worcestershire England
Telephone Kidderminster 64027

EST. 12 YEARS

BRAND NEW—SUITABLE FOR ALL MACHINES

RECORDING TAPES & CASSETTES

ALL TOP QUALITY 100% TESTED
BY SUPERIOR AMERICAN AND BRITISH MANUFACTURERS
GENEROUS QUANTITY DISCOUNTS

BASE—**TENSILISED POLYESTER and PVC**
EXTRAS—NO CHARGE—**FITTED LEADERS** EX 3″

FREE ROLL OF LEADER WITH ALL TAPE ORDERS
24 HOUR DESPATCH SERVICE

	St'rd Play		Long Play		Double Play		Empty Spools
3″	150′	**10p**	210′	**11p**	320′	**20p**	**4p**
4″	300′	**20p**	420′	**24p**	550′	**30p**	**9p**
5″	600′	**30p**	900′	**40p**	1200′	**56p**	**10p**
5¾″	900′	**37p**	1200′	**49p**	1800′	**78p**	**11p**
7″	1200′	**44p**	1800′	**64p**	2400′	**95p**	**12p**

3″ and 4″ APPROX LENGTHS

CASSETTES MANUFACTURED by EMI MASTERTAPE
ALL IN PLASTIC LIBRARY CASES

C60 EMI PLAYRITE	**34p**	3 for **£1**	10p P/P on all orders
C90 MASTERTAPE	**50p**	3 for **£1·45**	
C120 MASTERTAPE	**65p**	3 for **£1·90**	

If any goods are found at fault in any way money refunded in full.

SPECIAL OFFER—EMI AFONIC LOW NOISE REEL TAPES and PRE-RECORDED CASSETTES AT LESS THAN HALF PRICE

CALLERS WELCOME

WALKERS

16 WOODTHORPE ROAD, ASHFORD, MIDDLESEX
ASHFORD 52136

continued

My usual test tape of organ and percussion was played at as high a level as possible before cracking, and it was difficult to say whether the amplifier or the speakers ran into overload first. The sound level produced before cracking occurred was very high, showing the Rogers to be excellent speakers in this respect and considerably better than most larger and more expensive systems given the same rather vicious test.

Comments on other sections of the usual test tape were as follows:

Choir: Very natural sound with excellent tonal balance.

Musical Box: Excellent transient response—very smooth and pleasant.

Organ: The bright stops had the correct bite and the bass end a full pleasant tone.

Folk singer (with guitar): A more natural sound on this section than any speakers tested so far.

Dance Band: Very natural with excellent percussion.

Piano Concerto: Silky tone to strings—the piano sung as it did in performance.

Wind Quintet: Very natural.

FIG. 1 ROGERS BBC MONITOR, FREQUENCY RESPONSE
SPEAKER 1 —— SPEAKER 2 ·····

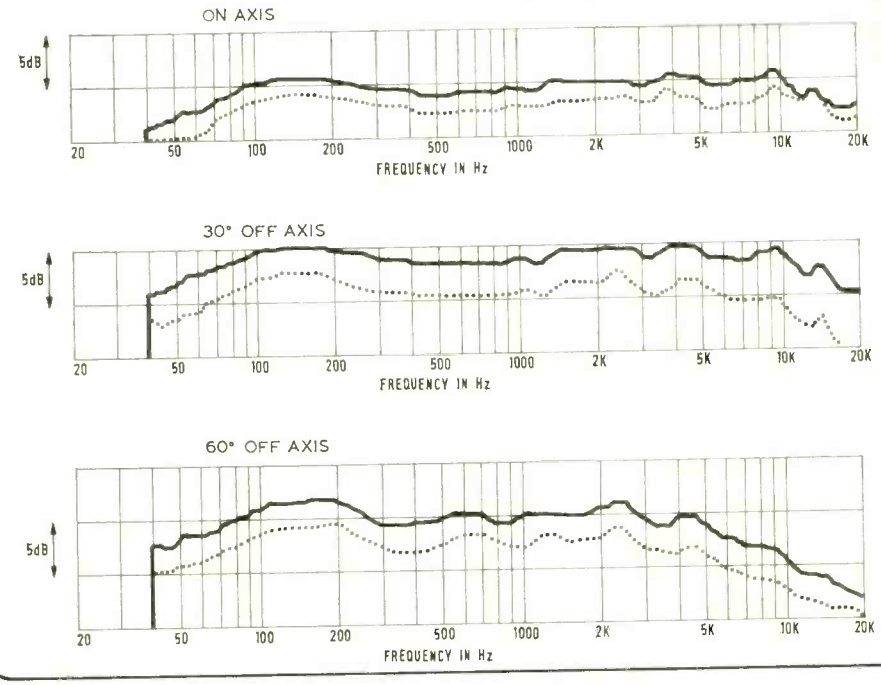
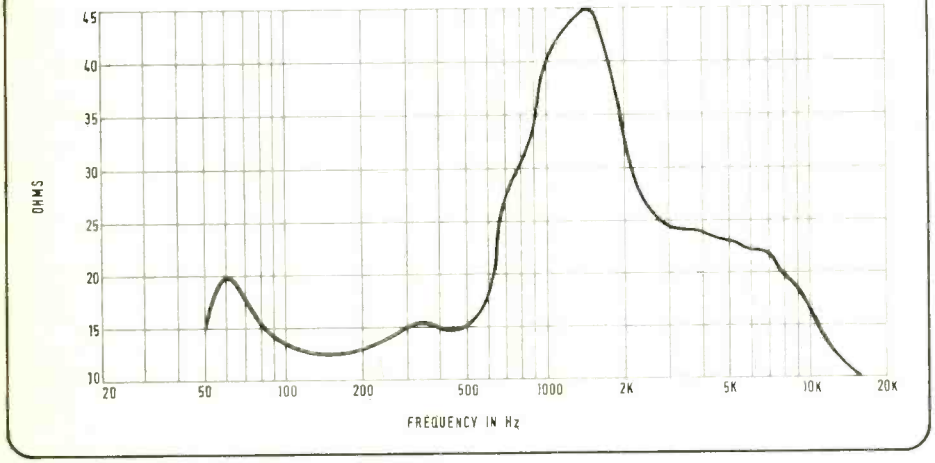


FIG. 2 ROGERS BBC MONITOR, IMPEDANCE / FREQUENCY



Speech: Very natural with no excessive sibilants or chestiness.

Full Orchestra: Excellent stereo picture with a good sound and climaxes handled well.

Organ and Percussion: The percussion instruments were pinpointed accurately and the whole section handled very well.

The units were so good on all the tests using the tape that it was no surprise to find that they performed equally well on the live v recorded tests. The most important of these, and fortunately the easiest to do, is the one on male speech and on this test the speaker was one of the best tested so far.

This is not surprising as the engineers at the BBC Research Dept are very conscious of the necessity for a speaker to sound right on live v reproduced male speech, and so it is to be expected that any speaker designed by them should excel in this respect.

Comparison with other sources including various types of music showed how well the designers had used their facilities in the studios, and how closely Rogers had kept to the standard laid down.

The speaker, although able to handle quite high levels of power, will not give the large sound output favoured by many engineers, and therefore is not suitable for monitoring loud pop in a large control room. For moderate levels it takes its place among the very few excellent monitor speakers that can be relied upon to give an accurate sound and as such it is highly recommended for use where normal listening levels are adequate and quality matters most.

Frequency response curves were taken in an anechoic room one metre on axis, and are given for both review models. The remarkably close similarity between both sets of curves shows how closely the two speakers match—a tribute to the Rogers production team. The impedance curve shows that the speaker will not cause trouble with any decent amplifier, and the response curves are excellent by any standards though, after listening to the test tape and using the speakers on live v recorded tests, they come as no surprise.

The Rogers is more expensive than the Spendor *BC1* or the Quad *ELS*, two of its close rivals, but the price does include the stands and, considering the quality of design, components and workmanship and the thorough test procedure carried out on each speaker, Rogers deserve credit for keeping the price as low as they have.

I am often asked if the Rogers are better than the Spendor *BC1* and if they are worth the extra money. On sound quality the difference is so marginal that an answer would be difficult.

The Rogers cabinet has mitred edges and a decorative moulding. Metal stands are supplied with the speakers (Spendor trolleys cost £17) so if you prefer the look of the Rogers to the Spendor they would certainly be worth considering.

Rogers are to be congratulated on having the courage to undertake the production of this speaker, the integrity to take such care over it, and the skill to do it so successfully.

An industrial version of the BBC Monitor is now available from Rogers. Price to the trade is £45, excluding stand. This version more closely follows the BBC design by omitting the super-tweeter and including an autotransformer for 100V line—**Ed.**

FRANCIS OF STREATHAM

DECKS WITH PRE-AMPS
(Microphone extra)
Akai 8 Tr. Cartridge CR.800
Akai 4000D
Brenell Mk.6
Ferrograph 702/4
National RS803 US 8 Tr. Cart.
Pioneer HR82 8 Tr. Cart.
Philips N.4500 3 sp. 4 Tr.
Revox 1102/4 2 sp.
Sharp RD 712D 3 sp. 4 Tr.
Sony 366D 3 sp. 4 Tr.
Sony 266D 3 sp. 4 Tr.
Tandberg 1800 4 Tr.
Tandberg 3000X 3 sp. 2/4 Tr.
Tandberg 6000X 3 sp. 2/4 Tr.
Telefunken 205 3 sp. 4 Tr.
Telefunken 203 Studio

MAINS SPOOL RECORDERS
*Akai 4000 3 sp. 4 Tr.
*Brenell Mk. 6
*Ferrograph 713
*Ferrograph 722/4
Grundig 141 4 Tr. Mono
Grundig TK. 121 2 Tr. Mono
*Grundig TK.248 2 sp. 4 Tr.
Grundig 146 4 Tr. Mono Auto
Philips 4303 2 Tr. Mono
Philips 4307 4 Tr. Mono
Philips 4308 3 sp. 4 Tr. Mono
Philips 4404 2 sp. 4 Tr.
Philips Cassette 2401 Auto.
Philips Cassette 2400
Philips 4407 3 sp. 4 Tr.
*Philips 4408 Prof. 3 sp. 3 Tr.
*Revox 1222/4
Sharp 706 3 sp. 4 Tr. Mono
Sharp 708 3 sp. 4 Tr.
Sharp 711 3 sp. 4 Tr.
Sony 630 3 sp. 2/4 Tr.
Sony 540 3 sp. 4 Tr.
Sony 252 3 sp. 4 Tr.
*Tandberg 15 2 or 4 Tr./3 sp./Mono
*Tandberg 4000X 3 sp. 2/4 Tr.
*Telefunken M207 2 sp. 4 Tr.
Telefunken 203 2 sp. 4 Tr.
Telefunken 201 Mono 4 Tr.
*Uher 714 4 Tr. Mono
*Uher 724 4 Tr. 2 sp.
*Uher Royal de luxe 4 Tr. 4 sp.
*Uher Varicord 263

MAINS CASSETTE MODELS
*Philips RH882 Tun./AM/Cass.
*Sony HST399 Tun./AM/Cass.
*Sony TC330 Cass./Spool
*Sony TC160
*Sony TC165 (+auto rev.)
*National RS256US

*Keller Dolby
*Rank Wharfedale Dolby
Philips 2400
Philips 2401 Auto with ski-slope

*Sony TC127 Deck and Pre-amp.
*Sony TC122 Deck/PA
*Grundig CN222 Deck/PA
*Alpha CD500 Deck/PA
*Sony TC146 Deck/PA
*Philips 2503 Deck/Pre-amp.

BATTERY MAINS CASSETTE
Philips 2204
Philips 2205
Sony TC60
Sony TC80
Sony TC100
Sony TC100A
Sony TC95
Sony TC146 mono
ITT R.G.D. TC400
Grundig
*Uher 124
Sony CF300+AM/FM
Philips RR290 with AM
Sony CF100 with AM/FM
Sony CF200 with AM/FM

BATTERY CASSETTES
Philips N2000 Mono Player
Philips EL3302 Mono
Philips N2202 Mono
Sony TC12 Mono
Sharp 418 Mono

● All stereo, except where stated ⊕ * Microphones extra

FOR A FAIR AND DEPENDABLE DEAL IN

TAPE and HI-FI

★ NO INTEREST OR SERVICE CHARGES ON H.P. UP TO 18 MONTHS
★ Free Service during Guarantee period
★ Fair Part Exchange Allowance on your old Recorder
★ Reconditioned Recorders available to personal shoppers only

AMPEX TAPE OFFERS

(P—Polyester; M—Mylar; A—Acetate)

7" D.P. 2400 ft (P)	£1·50
7" L.P. 1800 ft (P)	£1·05
5¾" L.P. 1150 ft (M)	88p
5¾" L.P. 1150 ft (A)	75p
5¾" Standard 850 ft (A)	63p
5" D.P. 1200 ft (P)	88p
5" L.P. 900 ft (P)	63p
5" Standard 600 ft (P)	50p

Postage on orders under £3 add 10p, orders over £3 sent post paid U.K.

Splicers, Defluxers, Bulk Erasers, Accessories of all kinds.

● MIXERS by
Uher, Eagle, Sony, Grundig, etc.

● MICROPHONES by
AKG, Grampian, Reslo, Acos, Beyer, Sennhuiser, Telefunken, etc.

● HEADPHONES by AKG, Nikko, Philips, Koss, Eagle, TTC, Beyer, Akai

● MUSICASSETTES. All leading makes. Pre-recorded 8 track cartridges and tapes. RECORDING tapes and cassettes—All leading makes.

HI-FI DEPT.

● AMPLIFIERS
Quad, Rogers, Philips, Goodman, Nikko, Armstrong, Leak, Tandberg, Teleton, Alpha, Wharfedale, Discosound.

● TUNERS
Quad, Rogers, Leak, Armstrong, Nikko, Goodman, Huldra, Alpha.

● LOUDSPEAKERS
Quad, Ditton 15, Sonab, Kef, Wharfedale, Goodman, Tannoy, Lowther, Leak, Tandberg, Celestion, Keletron.

● MOTORS, PICK-UPS
GARRARD inc. S.P.25 Mk. III

Goldring	Macdonald
Sonab	J.P.
Connoisseur	Thorens
Audiotec	Shure
Neat	Sonotone
Acos	SME
Dual	Pickering
Grado	

Diamond styli, Microlifts, Pressure Gauges, Cleaning Accessories, Cabinets, etc.

169-173 STREATHAM HIGH ROAD, LONDON, S.W.16
Between St. Leonard's Church and Streatham Station
01-769 0466 : 01-769 0192

Please note this is our only address. Free parking Prentis Road, 2 min. away
OPEN ALL DAY SATURDAY—CLOSED ALL DAY WEDNESDAY

Agfa

SAVE POUNDS!

FANTASTIC OFFER! Superb quality recording tape at deeply cut prices. Every reel factory fresh and fully guaranteed. SEND TODAY!

Compact Cassettes

	List	Our Price
C.60	£0·75	£0·35
C.90	£1·01	£0·49
C.120	£1·51	£0·60

CHROMIUM DI-OXIDE CASSETTES

	List	Our Price
C.60	£1·35	£0·86
C.90	£1·75	£1·10

LOW NOISE TAPE in plastic library boxes

LONG PLAY—TYPE PE 36

	List	Our Price
5" 900'	£1·63	£0·99
5¾" 1200'	£2·03	£1·24
7" 1800'	£2·94	£1·79

DOUBLE PLAY—TYPE PE 46

	List	Our Price
5" 1200'	£2·01	£1·24
5¾" 1800'	£2·93	£1·79
7" 2400'	£3·69	£2·25

SPECIAL OFFER! Agfa 10½" 4200' PE 36 LOW NOISE. List price: £6.21
OUR PRICE: £3.80 (specify cine centre or N.A.B. when ordering)
LARGER DISCOUNTS FOR QUANTITIES—REQUEST LIST.

mastertape

Low Noise Cassettes

	List	One	Three	Six	Ten	100
C.60	£0·63	£0·31	£0·88	£1·73	£2·75	£25·00
C.90	£0·87	£0·44	£1·26	£2·49	£3·75	£35·00
C.120	£1·17	£0·57	£1·66	£3·29	£4·75	£45·00

Post and Packing: Cassettes 3p each—6 or more post free
Tapes 10p each—3 or more post free
(Overseas orders 20p extra on all prices)

E.P.S.

MAIL ORDER ONLY
(DEPT. SS), 75 HOLLOWAY ROAD, LONDON N.7

SYNTHESISER?

Build your own using Dewtron Professional Modules: Voltage-control system, man-size patching facility, Discount offers on quantity.

VOLTAGE-CONTROLLED OSCILLATOR. New VC0-2 gives SINE, SQUARE and TRIANGULAR symmetrical outputs simultaneously supplied singly or MATCHED and TRACKED! 1v/Octave. All modules obtainable separately, including VC filters, VC amps, Keyboards, contacts, envelope shapers, sample/hold/envelope circuit, VC phaser, white noise etc.

OTHER MANUFACTURERS USE Dewtron Professional Modules in their equipment . . . that's sound reasoning!

Full catalogue 15p from:

D.E.W. LTD.

254 RINGWOOD ROAD, FERNDOWN
DORSET

Quad Electrostatic Loudspeaker

MANUFACTURERS' SPECIFICATION

Full range electrostatic loudspeaker with five units.
Frequency range: 45 Hz to 18 kHz.
Attenuation outside band: Asymptotic to 18 dB per octave.
Total integrated radiation at maximum output: Equivalent to 95 phons in rooms of up to 170m with average reverberation.
Dispersion: 70° horizontal, 15° vertical.
Impedance: 30 to 15 ohms, 40 Hz to 8 kHz, falling above 8 kHz.
Recommended amplifier: Quad 303.
Power supply: 200 to 250 to 100 to 120V, 50 to 60 Hz.
Weight: 16 kg.
Dimensions: 880 x 788 x 280 mm.
Price: £54 (trade), £72 (retail).
Manufacturer: Acoustical Manufacturing Company Ltd, Huntingdon.

IT was suggested in the survey of 'monitor' loudspeakers (May 1971) that the term was virtually meaningless and covered speakers ranging from the good but quiet to the bad but loud. Obviously the choice of a speaker for monitoring purposes will depend on many factors. For anyone wishing to hear what is actually being recorded, the choice is limited to what could be called the good but quiet few. As the Quad *ELS* has been used for many years in monitoring and quality-control rooms, it might be in this class.

The purpose of this review is to compare the Quad *ELS* with other high quality speakers now available, and with original sound sources. The *ELS* is basically a large capacitor with outer perforated plates and a central charged diaphragm. The signal is applied in push-pull to the outer plates which deflect the diaphragm.

The electrostatic system has several advantages over moving coil in that the diaphragm is driven over its complete surface, making its movement predictable. An electrostatic diaphragm can also be made light enough to follow the signal even at very high frequencies.

The designer of such a speaker has three main problems to overcome. First, a basic capacitor transducer is non linear as the force on the diaphragm is not proportional to the applied signal voltage. Second, the load presented to an amplifier is essentially capacitive and therefore difficult to match. Thirdly, the manufacture of a practical full range unit at a realistic price is not easy. In the Quad *ELS* the first problem is overcome by a simple but effective device. Instead of applying a constant voltage to the diaphragm, once it is charged the polarising potential is disconnected. The diaphragm now carries a constant charge and experiences a force proportional to the applied signal voltage. In this way it in turn applies a force which acts directly on the air and is a linear function of the applied signal voltage. The second and third problems are solved together by constructing the speaker of strip units progressively increasing in plate spacing and area from the centre line, together with suitable crossover networks. In conventional jargon, the centre strip is the super tweeter, the two on either side of this the tweeters, and the two outside strips the woofers. Since the centre strip is vertical and narrow, its horizontal dispersion is excellent. Unless some measure were taken to improve it, however, the vertical dispersion would be poor. In the Quad *ELS*, the plates are curved to assist the vertical dispersion.

As constructed, the *ELS* is a doublet source—i.e. the diaphragm radiates on both faces (at least at low frequencies). Having no upward or sideways radiation, it cannot directly excite room modes in two out of three room dimensions. In addition, its polar diagram is such that the mean spherical radiation is reduced by a factor of three at all frequencies, further reducing colour due to the listening room by the same factor.

For optimum results this construction requires that the speaker be free standing and placed well into the room. Two *ELS* were used in this way for the listening tests. They were also tried close to a wall and found to give excellent results provided they were not placed parallel to it. My usual test tape was played and the opinions of the listening panel are given below.

Choir: Clear natural sound, very pleasing.

Bell and percussion: Excellent transients, very clean and bright.

Organ: Full pleasant and natural tone. Having heard the popular fiction that the *ELS* is lacking in bass, we were surprised by the amount of bass produced.

Folk singer: Voice and guitar both very natural.

Dance band: Natural pleasant sound. The leader claimed that the sound was exactly what he heard when conducting.

Piano concerto: The strings had the right sort of 'sheen' and the piano a pleasant singing tone.

Wind quartet: Excellent balance with natural sound from all instruments.

Speech: Opinion was divided here. Some listeners thought male speech a little nasal, others that it was the most natural they had heard. Faults in the recordings were clearly heard.

Full orchestra: Climaxes handled well. A good sound generally with firm bass.

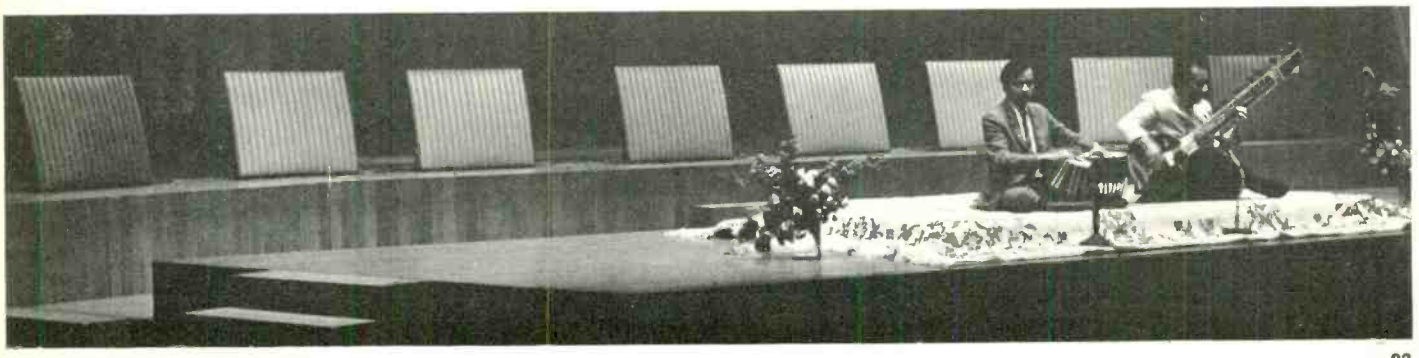
Military band: Listeners claimed that the sound was exactly what they heard when listening to bands in the park. The sound certainly had an 'open air' quality though the recordings were made in a concert hall.

Comparison with other monitor speakers generally showed up the coloration in the other speakers. It was only when compared with the Spendor *BC1* that the 'nasal' quality on speech became apparent.

In all these speakers reviews, any apparent fault in reproduction is checked by a live versus recorded comparison so a male voice was recorded first balancing on the Spendor, listening to the playback on the Spendor and then on the Quad. Then balancing on the Quad and again listening to playback on the two systems. In the first case, the Spendor sounded right and the Quad slightly nasal. In the second case, the Quad sounded right and the Spendor slightly bass heavy. Both these effects were marginal and needed careful listening to detect. On these tests alone it would be impossible to state that one of the speakers was right and the other wrong.

Frequency response curves were taken in free air conditions and show the speaker to have a figure-of-eight polar characteristic at low frequencies and a cardioid at high frequencies. The stereo image was good over quite a wide listening area but within a smaller area the image was even better. This effect has probably given rise to the other popular fallacy that the *ELS* permits only one stereo seat. Over the wider listening area, the image was as good as many other speakers tested and considerably better than most. As can be expected from the excellent response curves, the speaker is one of the least coloured ever tested. This, coupled with its property of exciting room resonances less than more conventional speakers, makes it very suitable for use where acoustic treatment of the listening room is not possible. The *ELS* gives a particularly clear and clean sound and even listeners who preferred the 'warmer' sound of the Spendor or Rogers speakers were impressed by this.

continued over



Eight Quad *ELS* being used for sound reinforcement at the Queen Elizabeth Hall, South Bank.

continued

The transient response of the *ELS* is quite exceptional and, as all material tried on the speaker gave such excellent results, we decided to try to stretch it to the limit. A recording was made consisting largely of deep pedal notes on a large organ together with triangle, gong, cymbals, side drum, bass drum, tympani and tubular bells. It thus consisted of frequencies largely below 50 Hz and above 8 kHz with sustained deep bass together with fierce transients, providing a searching test for any set of replay equipment. It was difficult to find a combination of amplifier and speaker that would cope adequately with this tape as it stretched most systems to their limit, and cracked some, but the *ELS* fed by the Quad *303* and *33* functioned well. Listeners to this last recording were struck by the amount of bass the *ELS* would handle and also by the surprisingly high volume of sound they produced. The stereo image was rock steady, all the percussion instruments being accurately pinpointed.

The flat axial frequency response shows one reason for the pleasant uncoloured sound and the excellent polar diagrams account for the very good stereo image. In sound quality, the *ELS* stands up to the very best monitor speakers available today but does not handle enough power for use at the high levels required in some studios. The size of the *ELS*, together with the fact it should stand reasonably clear of walls, make it unsuitable for use in very small control rooms where its power handling might otherwise be adequate. Studios interested in what is actually being recorded might consider having a quality control room fitted with *ELS* where their more discerning customers and engineers could listen. The *ELS* handles sufficient power for monitoring classical music at moderate levels and is well suited to this purpose. Some studios have been using them in this way for quite a time now, often in conjunction with a woofer to satisfy people wanting to hear thumping bass. When doing serious balancing, the response curves show it is clearly advisable to switch the woofers off and balance on the *ELS* alone.

Comparing the performance and measured curves of older *ELS* units with those submitted for review showed a consistency over five to ten years. Only a careful check of serial numbers enabled the units to be accurately distinguished. It seems that every *ELS* is like every other, almost regardless of age. Barring excessive overloading, it seems that the units are outstandingly reliable. Many of them have given trouble free performance over a large number of years.

A device like this which is reliable and consistent from sample to sample is too rarely met. It is still the standard by which others can be judged and is highly recommended to all who want to hear clean, uncoloured and undistorted sound.

John Shuttleworth

FIG. 1 QUAD FREQUENCY RESPONSE

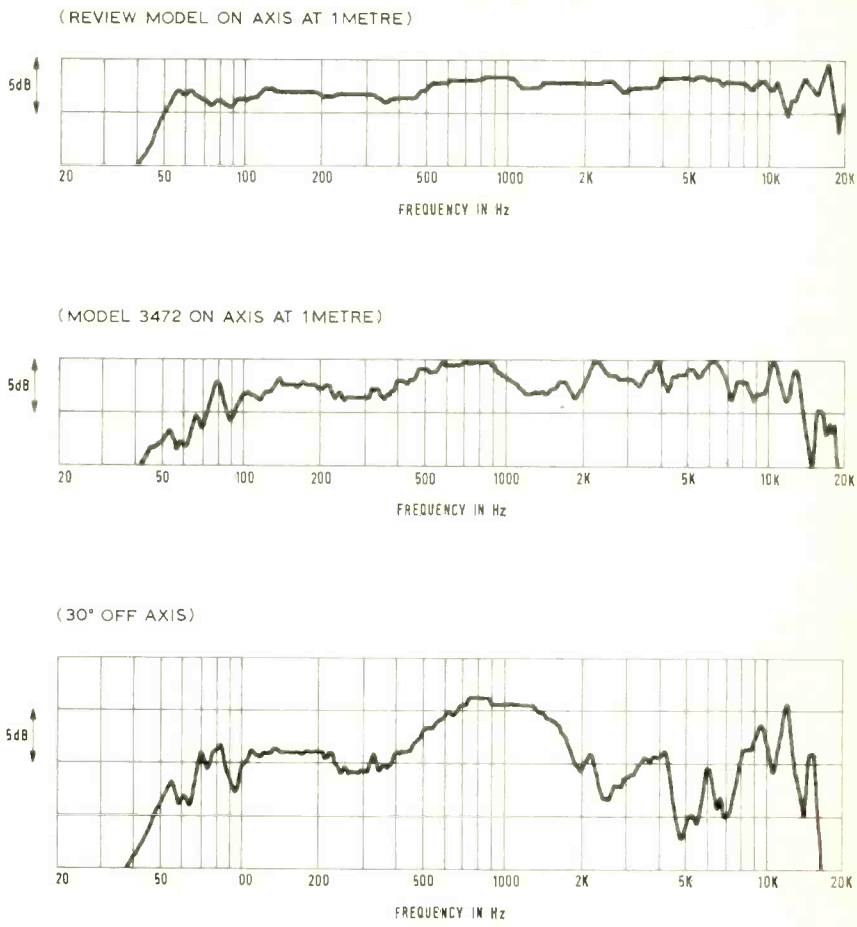


FIG. 2 QUAD IMPEDANCE

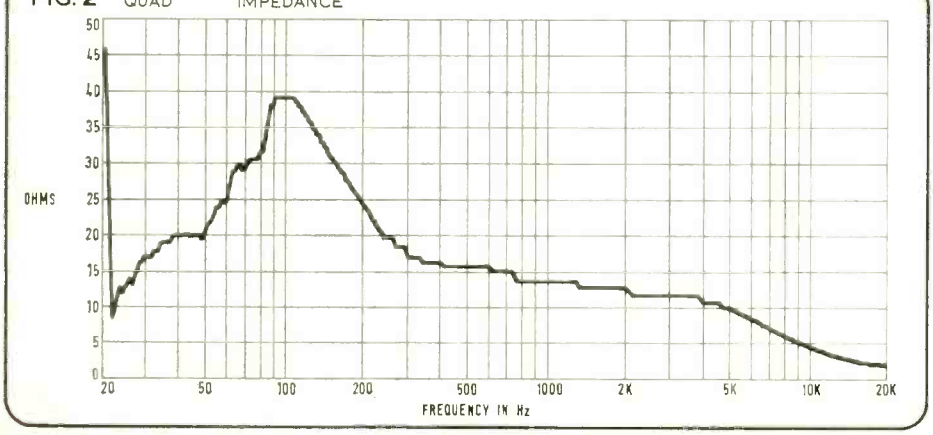
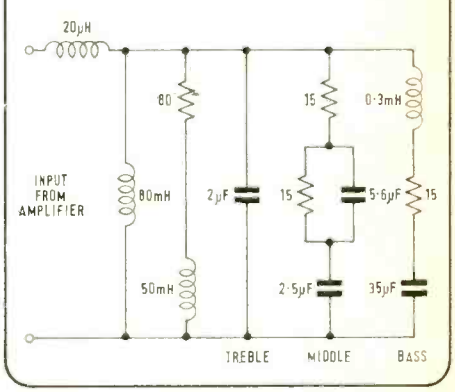


FIG. 3 EQUIVALENT CIRCUIT OF QUAD



Classified Advertisements

Advertisements for this section must be pre-paid. The rate is **6p** per word, minimum **60p**. Box Nos. **20p** extra. Semi-display **£3.00** per inch. Copy and remittance for advertisements in **AUGUST 1972** issue must reach these offices by **16th JUNE 1972** addressed to: The Advertisement Manager, **Studio Sound**, Link House, Dingwall Avenue, Croydon CR9 2TA.

NOTE: Advertisement copy must be clearly printed in block capitals or typewritten.

Replies to Box Nos. should be addressed to the Advertisement Manager, Studio Sound, Link House, Dingwall Avenue, Croydon CR9 2TA, and the Box No. quoted on the outside of the envelope. The district after Box No. indicates its locality.

SITUATIONS VACANT

Young enthusiastic and imaginative sound technician wanted by small creative film company to produce sound tracks. Write full particulars Box 629.

Allen & Heath Ltd require a salesman for their range of professional sound equipment. Good working knowledge of audio electronics is essential. Please write or phone Allen & Heath Ltd., Pembroke House, Campsbourne Road, Hornsey, London, N.8. 01-340 3291, ext. 1.

Excellent opportunity for a mechanically minded young man to work on the manufacture of professional tape recording equipment. Experience in light mechanical/instrument making desirable. Staff position with three weeks holiday and profit sharing scheme. Apply:

BIAS ELECTRONICS
Unit 8, Coombe Trading Estate, 112/120 Coombe Lane, London, SW20 0BA. Tel. 01-947 3121.

SITUATIONS WANTED

Audio engineer (39) seeks position in radio, T.V. or recording studios (preferably London area). Past experience with B.B.C. radio and commercial T.V. in both operational and maintenance capacities. Box 636.

Audio Engineer, 32, ex-B.B.C., seeks position in operational, editing or installation duties (or any combination thereof). Yorkshire area preferred but will travel. Educational T.V. considered. Conversant many aspects of sound with emphasis on recorders and mixers. Offers and/or suggestions please to Box 631.

FOR SALE—TRADE

RAC MIXERS
We build mixers to your exact requirements using our range of printed circuit modules at reasonable prices, e.g. 6 input stereo mixers with tone and pan controls from £100. Please ask for a quote. Or if you wish build it yourself, using our modules—send for details.
RUGBY AUTOMATION CONSULTANTS
220 Alwyn Road, Rugby. 0788-810367

If quality matters consult first our 105-page illustrated Hi-fi catalogue with technical specifications (60p). Members enjoy unbiased advisory service, preferential terms. Membership (40p) p.a. Our associates also manufacture records from your own tapes, or record the Master at our studios (Steinway Grand). Bulk terms for choirs, fund-raising, slim-discs. Please specify requirements. Audio Supply Association, 18 Blenheim Road, London, W.4. Tel. 01-995 1661.

Professional heavy duty slave 100 watt power amplifiers—suitable for all types of public address and discotheque systems—£84.50. Wayne Industries, 23 Ripley Road, Worthing, Sussex.

FOR SALE—TRADE Contd

Swiss 15/7½ Tape Machine. Mint condition, dural deck, with three brand new reels of Scotch 202 10½" spools. Price £215. Please ring 551-2501 (Ilford).

Lancashire. Tandberg, Ferrograph Tape Recorders, etc. Plus over 10,000 high fidelity systems. After-sales service. Holdings, Photo-Audio Centre, 39-41 Mincing Lane, Blackburn BBA 2AF. Tel. 59595/6.

Tame those dB's . . . Plug in professional quality FET compressor module £15.50. For the 'slick operator' . . . 'Voice over' module £15.50. S.A.E. details. Cathedral Sound SS, "Fourways," Morris Lane, Halsall, Lancs. L39 8SX.

Copyright Free Sound Effects Discs. 7" E.P's and 12" L.P's. Catalogue from Rapid Recording Services, 21 Bishops Close, London, E.17.

Complete 805 Outfit including case. Normal price £250. **Special offer £180. Sennheiser MD112 Microphone,** new and boxed. Normal price £44, **special offer £32. AKG D109 Microphone, special offer £9. AKG D19C Microphone, special offer £12. J. J. Francis (Wood Green) Ltd., 123 Alexandra Road, Hornsey, London, N.8. Tel. 01-888 1662.**

Professional tape only 45p. 1200ft. Agfa on hubs, no joins (p. & p. one box 25p, each additional box 10p). We handle 99% of all s/h professional recording equipment. Send for list. Jackson Studios, Rickmansworth, Herts.

SOWTER TRANSFORMERS
for all purposes in
SOUND RECORDING AND REPRODUCING EQUIPMENT
We are suppliers to many well-known companies, studios and broadcasting authorities and were established in 1941. Early deliveries. Competitive prices. Large or small quantities. Let us quote.
E. A. SOWTER LTD.
Transformer Manufacturers and Designers
7 Dedham Place, Fore Street, Ipswich IP4 1JP
Telephone 0473 52794

FOR SALE—PRIVATE

Six channel stereo mixer; two PPMs; Mic or line inputs; Impedance and phase reverse switches; Penny & Giles faders; monitor and talkback outputs, XLRs and Jacks throughout; Illuminated stop/start; etc. Excellent performance. Suit small studio. Offers round £180. Runcorn 66180.

MISCELLANEOUS

Ladders. 24½ft. £9.80, carr. 80p. Leaflet. Callers welcome (Dept. SOS), Home Sales, Baldwin Road, Stourport, Worcs. Phone 02-993 2574 5222. Order c.o.d. Ansafone installed 5222.

Tape and Cassette Recorder Repairs by Specialists. The Tape Recorder Centre, 82 High Holborn, London, W.C.1.

MISCELLANEOUS Contd

Repairs. Our modern service department equipped with the latest test equipment including a wow and flutter meter and multiplex stereo signal generator is able to repair hi-fi and tape recording equipment to manufacturer's standards. Telesconic Ltd., 92 Tottenham Court Road, London, W.1. Tel. 01-636 8177.

STUDIO FACILITIES

YOUR TAPES TO DISC

Records made to order—7in from £1·50, 12in from £4·00. 4-day postal service. Vinyl pressings, photo sleeves, labels. Tax free for schools, choirs, etc. We cut records for many Recording Studios, Record Companies, etc and use the same equipment for you:—

3 NEUMANN DISC CUTTING LATHES including auto stereo system, Philips and Telefunken professional studio tape machines with Ferrite playback heads. DOLBY A301 system. 200W Radford amps into Lockwood monitor speakers. Teletronix and Ortofon Limiters. Revox domestic T/R. Send SAE for photo leaflet.

DEROY STUDIOS
Hawk Street, CARNFORTH, Lancs. Tel. 2273

Coastal Music Studios Ltd. All tape to disc services. Commercial pressings and masters by quotation. Please send for brochure to: 1 Royal Terrace, Lowestoft.

Graham Clark Records. Tape to disc pressings. 124A Station Road, Addlestone, Weybridge, Surrey. Tel. Weybridge 43367.

ROGER SQUIRE DJ STUDIOS
Our specialist studio is available for recording DJ programmes, audition tapes, sound commercials, and jingles. Can we help you?
01-722 8111

Fanfare Records. Tape - disc pressings, demo's, masters, any quantity. Studio/mobile. Neumann disc cutter. S.A.E. brochure. 1 Broomfield Close. Rydes Hill, Guildford. Telephone 0483 61684.

County Recording Service. Demodiscs, mono and stereo pressings. 7" vinyl discs pressed on our own plant. Delivery approx. 14-21 days. S.A.E. for leaflet and price list. Tel. Bracknell 4935. London Road, Binfield, Berks.

RAPID RECORDING SERVICE

LPs FROM YOUR OWN TAPES
48-HOUR SERVICE
MASTER DISCS AND PRESSINGS
RECORDING STUDIO
DEMONSTRATION DISCS
MOBILE RECORDINGS—ANY DISTANCE
Multi-channel facilities for transfer to 8 or 16 mm film tracks. Sound effects library on discs.
Brochure on request from
Rapid Recording Service
21 BISHOPS CLOSE, LONDON, E17

STUDIO FACILITIES Contd

WANTED

Lee Electronics. The Tape Recorder and Hi-Fi Specialists wish to purchase good quality Tape and Hi-Fi equipment for cash. 400 Edgware Road. W.2. Phone PAD 5521.

Highest possible cash prices for Revox, Ferrograph, Brenell, Vortexion, Tandberg. Akai, B. & O., Sanyo, Sony, Uher. 9.30-5.00. Tel. 01-242 7401.

Complete Recording Studios purchased for cash. Also all types of Professional Recorders and associated equipment. J. J. Francis (Wood Green) Ltd., 123 Alexandra Road, Hornsey, London, N.8. Tel. 01-888 1662.

Professional Mixing Desk, minimum 12 inputs, minimum four outputs. P.P.M. or V.U. limiters, etc. Contact Don Blakey, 339 Clifton Drive South, St. Annes-on-Sea, Lancs. Tel. 039 15 21053.

Nagras (all models) and assorted equipment required immediately for cash settlement. Tel. 01-888 1662.

INDEX TO ADVERTISERS

Published by the Proprietors, Link House Publications Limited, 10-12 South Crescent, Store Street, London WC1E 7BG, and Printed by Arthurs Press Limited, Woodchester, Stroud, Glos. GL5 5PB.

SONY & SANSUI SPECIALIST DEALER

SEND FOR SPECIAL PRICE LISTS

LOW DEPOSIT CREDIT · BARCLAYCARD · DINERS CARDS
PAYBONDS · Demonstration Facilities
SEND S.A.E. FOR FULL LATEST LISTS!

SPECTACULAR discounts

KOSS and REVOX

We are specialists for these famous makes. SEND FOR LISTS!

QUAD

For the closest approach to the original sound.
REC. PRICE £106.00
CASH PRICE £89.95
TO PERSONAL CALLERS ONLY

TAX FREE SALES TO OVERSEAS VISITORS! Ask for details of our personal Export plans.

CAMBRIDGE AUDIO
Superb quality Hi-Fi units! SEND FOR LISTS

AKAI BIG VALUE TAPE RECORDERS

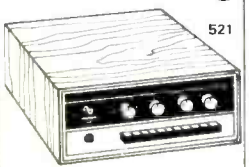
1720L 4 track stereo tape recorder with separate level and volume controls 2 VU meters etc. OUTSTANDING VALUE! Rec £87.36 CASH PRICE £62.95 ! ! ! SEE LISTS BELOW.

Akai 1720L

Hi-Fi, Audio, Tape/Cassette recorders, Radio & TV

UP TO 40% OFF MAKERS REC. PRICES

Armstrong



521

Superb range of Hi-Fi equipment based on the top quality 521 50 watt amplifier shown.
LOOK AT THE VALUE!
SEE LISTS BELOW

Tandberg 6000X

COMPARE OUR PRICES

TAPE & CASSETTE BARGAINS

EMI LOW NOISE HI FI		PHILIPS LOW NOISE		DYNARANGE LOW NOISE		BASF & AGFA LOW NOISE	
5¾" SP	90p	5¾" SP	125p	5¾" SP	84p	5" SP	124p
7" SP	110p	7" SP	145p	7" SP	113p	5" LP	143p
5¾" LP	120p	5¾" LP	110p	5" LP	142p	5¾" LP	204p
7" LP	150p	7" LP	135p	5¾" LP	111p	7" LP	268p
5¾" DP	135p	5" DP	190p	7" LP	140p	8¾" LP	365p
7" DP	190p	5¾" DP	145p	5¾" LP	190p	10" LP	452p
		7" DP	215p	7" LP	273p	10½" LP	142p
CASSETTES			300p	8¾" LP	411p	5" DP	204p
BASF-AGFA SCOTCH EMI		P&C REELS 15p per order CASSETTES 10p per order		10½" LP	63p	5¾" DP	250p
C60	44p			3" DP	96p	7" DP	203p
C90	64p			4" DP	165p	5" TP	250p
C120	94p			5" DP	206p	5¾" TP	310p
				5¾" DP		7" TP	

ROTEL

RX400

Rotel is the big new name in Hi-Fi today. Look at the new RX400 Tuner Amplifier with AM/FM stereo, 20 watts per channel, and one of the most attractive design styles on the market today.
Rec. Price £112.79 CASH
See prices listed below! PRICE £82.50

UHER!

Model 724
APPOINTED STOCKISTS for these top class tape recorders and professional portables.

AMPLIFIERS

c	Alpha F212	£30.20
d	Alpha F200	£25.60
d	Alpha FA300	£31.95
d	Alpha FA400	£37.20
c	Alpha DB5 Dolby	£47.25
d	Amstrad IC2000	£29.95
d	Amstrad 8000 Mk2	£14.95
d	ARD 2000 Wood Case	£32.50
d	ARD 2000 Metal Case	£29.95
d	Armstrong 521	£44.95
	Cambridge on application	
d	Duette SA616	£14.95
d	Duette SA400	£23.95
d	Duette SA500	£29.95
d	F/graph F307 Mk2	£45.95
d	Leak Delta 30	£48.50
d	Leak Delta 70	£58.95
d	Lux SQ77T	£49.50
f	Lux SQ1220	£74.50
d	Metrosound ST20E	£25.95
d	Metrosound ST60	£49.95
d	Pioneer SA500	£37.25
d	Pioneer SA600	£57.75
d	Pioneer SA700	£66.95
d	Pioneer SR202 Rverb.	£34.50
e	Pioneer SA800	£87.35
e	Pioneer SA900	£107.05
e	Pioneer SA1000	£110.15
f	Quad 303/33	£89.95
	Revox on application	
d	Rogers R'brook 2 C	£44.50
d	Rogers R'brook 2	£40.60
e	Rogers R'bourne C	£55.60
e	Rogers R'bourne	£51.60
d	Rota 2200	£24.95
d	Rota 1500	£17.95
d	Rotel RA210A	£24.95
d	Rotel RA310	£33.95
d	Rotel RA610	£53.25
	Sansui on application	
d	Sinclair 2000 Mk2	£23.50
d	Sinclair 3000	£30.95
d	Sinclair Neoteric 60	£44.50
d	Sugden A21	£53.95
b	Teleton 206B	£19.95
d	Teleton 307	£20.50
d	Wharfedale Linton	£42.95

TUNERS

d	Alpha FT150 AM/FM	£38.70
d	Armstrong 523 AM/FM	£40.75
d	Armstrong 524 FM	£31.70
a	Armstrong M8	£7.95
d	Leak Delta FM	£58.50
d	Leak Delta AM/FM	£68.95
d	Pioneer TX500	£53.50
d	Pioneer TX600	£69.95
e	Pioneer TX700	£84.50
d	Quad FM Mk3	£68.88
d	Quad AM3 European	£42.75
d	Quad AM3 Overseas	£42.75
	Revox on application	
e	Rogers R'bourne FM C	£55.50
e	Rogers R'bourne FM	£51.25
e	Rogers R'brook FM C	£41.95
d	Rotel RT320	£43.95
e	Sansui TU555	price on
e	Sansui TU666	application
d	Teleton GT101	£31.95
d	Sinclair 2000	£37.25
d	Sinclair 3000	£35.25
d	Sinclair Project 60	£20.75

TUNER AMPLIFIERS

g	Akai AA8500	£160.95
g	Akai AA6600	£111.50
g	Akai AA6300	£100.75
f	Akai AA6200	£74.50
e	Alpha R200	£58.25
e	Alpha R500	£65.75
e	Alpha R150	£49.90
e	Alpha FA3000	£74.10
e	Alpha FA4000	£82.40
e	Armstrong 525	£69.70
e	Armstrong 526	£79.40
e	Duette SAT 260X	£62.50
e	Duette SAT 460X	£81.50
e	Duette SAT 4370X	£40.95
e	Duette SAT 555T	£51.50
e	Goodmans Module 80	£75.00
e	Goodmans One Ten	£112.50
f	Leak Delta 75	£135.00
f	Pioneer SX440	£76.95
f	Pioneer LX440	£82.50
f	Pioneer SX770	£102.50
g	Pioneer SX990	£129.95
e	Rotel RX150	£54.95
e	Rotel RX200	£64.95
e	Rotel RX400	£82.50
e	Rotel 130	£49.95
f	Rogers R'brook Case	£93.50
f	Rogers R'brook Ch	£85.95
	Sansui on application	
e	Tandberg TR200 MPX	£85.95
e	Tandberg TR200	£76.50
d	Teleton CR10T	£17.25
d	Teleton F2000	£28.75
f	Teleton TFS50	£59.95
f	Wharfedale 100 1	£89.50

PICK UP ARMS

b	Audio Technica AT1005	£15.50
b	Connoisseur SAU2	£11.50
b	Goldring L75	£9.95
b	SME 3009	£24.20
b	SME 3012	£26.15
b	Transcriptor Fluid Arm	£20.95

SPEAKER UNITS

e	EMI 315 SEK	£58.00
e	EMI 350 SEK	£18.20
e	EMI 450 SEK Pair	£20.40
e	EMI 650 SEK Pair	£30.35
e	EMI 850 SEK Pair	£23.70
e	EMI 750 SEK	£32.00
e	Kef Kit 3	£30.50
a	Kef T27 HF Unit	£4.25
a	Kef T15 HF Unit	£5.10
b	Kef B110 Mid Unit	£6.80
b	Kef B200 LF Unit	£7.90
c	Kef B139 LF Unit	£9.90
d	Tannoy 111LZ	£26.35
e	Tannoy 12" Mon Gold	£30.95
e	Tannoy 15" Mon Gold	£36.75
c	Wharfedale Unit 3	£9.95
d	Wharfedale Unit 4	£12.50
e	Wharfedale Unit 5	£18.50

CARRIAGE CHARGES

a..... 12p d..... 50p g....125p
b..... 25p e..... 75p h....175p
c..... 40p f..... 100p x... 250p

SPEAKERS

e	Alpha HT20	£24.55
e	Alpha HT7	£18.75
e	Alpha HT10	£19.95
e	Alpha HT16	£10.50
e	Alpha HT17	£18.75
g	Akai CSS8	£9.87
f	Akai SW155	£48.95
e	AR 4X Teak/Wnt	£38.50
e	AR 4X Pine	£32.85
e	AR 6 Oiled Teak	£57.50
f	AR 2AX Rwd/Pn	£78.95
d	B & W DM1	£31.95
f	B & W DM3	£44.95
f	B & W OM3 Rswd/Wt	£57.50
x	B & W Series 70	£119.95
g	B & W DM2 on application Cambridge on application	
g	Celeste Ditton 44	£41.95
d	Celeste Ditton 120	£23.25
e	Celeste Ditton 25	£50.95
e	Celeste Ditton 15	£30.95
g	Celeste Ditton 66	£83.95
e	Contract 40	£4.47
e	Contract 8	£8.97
e	Goodmans Mezzo 2	£22.50
e	Goodmans Mezzo 3	£25.50
f	Goodmans Magnum	£32.90
e	Goodmans Havant Tk	£21.75
g	Goodmans Minister Tk	£17.95
h	Goodmans Magister	£39.95
g	Goodmans Dimensions8	£51.50
g	JB Lansing 88	£72.00
e	Kef Chorale Tk/Wnt	£22.95
d	Kef Celeste	£22.95
d	Kef Cresta	£20.25
e	Kef Cadenza Tk/Wnt	£34.50
f	Kef Concerto Mk3 Tk	£48.95
f	Kef Concerto Mk3 Wht	£53.50
d	Keith Monks Elf	£14.25
e	Keletron KN800	£11.90
f	Keletron KN1100	£15.25
e	Keletron KN400	£6.45
e	Keletron KN500	£7.95
f	Keletron KN1000	£13.75
e	Leak Mini Sandwich	£18.95
e	Leak 200	£19.95
e	Leak 300	£26.90
f	Leak 600	£39.95
e	Leak 150	£18.75
e	Leak 250	£23.75
f	Quad Electrostatic	£59.50
d	Richmond Mk1 *SAME UNITS & PERFORMANCE AS KEF CRESTA*	£17.50
e	Richmond 350	£16.50
e	Richmond 350S	£19.95
e	Richmond 450	£13.50
e	Richmond 38	£9.45
f	Tannoy 12" Chatsworth	£48.50
e	Tannoy 111LZ Mk2	£33.95
f	Tannoy 15" Lancaster	£56.95
g	Tannoy 15" GRF	£104.00
b	Teleton SA125	£2.95
e	Wharfedale Denton 2	£14.95
e	Wharfedale Linton 2	£18.75
e	Wharfedale Triton 3	£24.50
f	Wharfedale Dovedale	£33.50
e	Wharfedale Melton	£26.95

TAPE RECORDERS

e	Akai 1720L	£62.95
e	Akai 4000D	£65.95
f	Akai X1800SD	£117.85
f	Akai X200D	£112.50
g	Akai M10L	£169.95
f	Akai GX220D	£175.50
f	Akai GX280D	£239.95
g	Akai X2000SD	£229.50
g	Akai X5000W	£315.00
h	F/graph 722	£397.95
h	F/graph 702HS	£176.50
h	F/graph 704	£169.50
f	Grundig TK121	£43.75
f	Grundig TK141	£48.25
f	Grundig TK146	£51.95
f	Grundig TK3200	£106.95
f	Grundig TK147	£78.95
f	Grundig TK246	£106.95
f	Grundig TK124	£31.00
f	Grundig TK149	£41.50
e	Philips 4307	£37.50
e	Philips 4303	£32.95
e	Philips 4308	£47.50
e	Philips 4407	£86.50
e	Philips 4404	£70.95
e	Philips 4408	£104.95
	Revox on application	
e	Tandberg 1521	£61.65
e	Tandberg 1541	£76.75
e	Tandberg 1721	£56.75
e	Tandberg 1741	£60.50
e	Tandberg 4041X	£139.95
e	Tandberg 1841	£56.50
e	Tandberg 3041X	£86.50
e	Tandberg 6041X	£152.95
e	Tandberg 1241	£118.95
e	Tandberg 1641	£79.50
e	Tandberg 64X	£119.50
	Uher on application	

CASSETTE RECORDERS

d	Akai CS50	£103.95
d	Akai CS50D	£86.50
d	Akai GXC40D	£76.50
d	Grundig C200SL	£26.95
d	Grundig CN222/224	£49.50
d	Grundig C410	£35.50
d	Teleton CR1201 with Radio	£25.95
d	Teleton TC110	£18.75
d	Philips 2503	£43.25
d	Philips 3302	£16.50
d	Philips 2202	£18.95
d	Philips 2204	£25.95
d	Philips 2205	£33.50
d	Pye Coronado	£32.95
d	Pye 9109	£17.95

TURNTABLES

d	Connoisseur BD2 Ch	£25.85
e	Connoisseur BD2 A/B	£32.75
d	Connoisseur BD1 Kit	£10.25
d	Dual 1219 /M91MGD	£59.95
d	Dual 1219 Chassis	£50.95
d	Dual 1218 Chassis	£41.75
d	Dual 1215 Chassis	£29.95
d	Dual 1209 Chassis	£31.95
d	Garrard 401 deck	£27.00
d	Garrard Zero 100A	£40.95
d	Garrard Zero 100S	£38.75
d	Garrard SL95B Auto	£36.50
d	Garrard SL72B Auto	£23.95
d	Garrard AP76	£19.50
d	Garrard SL65B Auto	£15.95
d	Garrard 2025TC Auto	£8.50
d	Garrard SP25 Mk3	£9.95
c	Garrard 2000/9TAH/C	£14.50
d	Garrard 3500/KS40A	£13.95
d	Garrard SP25 Mk3 B/C	£15.95
d	Garrard SP25 Mk3 Tk B/C & Sonotone 9TA	£16.95
d	Garrard SP25 Mk3 Tk B/C & Goldring G800	£18.50
d	Garrard AP76 White	£19.90
e	Goldring GL69 Ch. Mk 2	£18.95
e	Goldring GL69 Mk 2B/C	£24.95
e	Goldring GL75 Chassis	£29.95
e	Goldring GL75 B/C	£40.90
e	Goldring GL72 Chassis	£22.95
e	Goldring GL72 B/C LATEST TYPE	£33.50
e	Goldring GL85 Chassis	£46.95
e	Goldring GL85 B/C LATEST TYPE	£58.95
e	Goldring GL101 B/C LATEST TYPE	£22.95
e	Goldring GL705 Comp.	£19.95
d	Leak Delta Base/Cover	£55.95
d	BSR MP60 Chassis	£10.75
d	BSR 610 Chassis	£14.95
d	BSR 310 Chassis	£9.95
e	BSR MP60 TPD1 B/C	£17.75
e	BSR MP60 TPD2 B/C	£15.50
e	BSR MP60 Amstrad B/C	£15.50
e	BSR 610 TPD1 Tk B/C	£20.95
e	BSR 310 TPD1 Tk B/C	£12.95
e	BSR HT70 Tk B/C	£22.95
d	Philips GA202	£53.95
e	Pioneer PL12A A/B/C	£35.95
e	Thorens TD125.Ch	£58.75
f	Thorens TD125AB	£91.95
d	Thorens TD150A	£33.25
e	Thorens TD150AB	£38.95
b	Thorens TX25 cover	£7.50
b	Thorens TX11 cover	£3.95
f	Transcriptor Saturn 2	£54.95
g	Transcriptor Ref	£76.95
g	Transcriptor Ref/SME	£80.50
g	Transcriptor Reference *with 9 or 10 Fluid Arm*	£90.95
d	Wharfedale Linton Comp	£27.95

8 TRACK STEREO

d	Akai CR80	£88.50
d	Akai CR80D	£69.95
d	BSR TD8S	£17.95
d	Metrosound 448	£43.25
d	Metrosound SR30	£65.95
d	Metrosound Mk3 (Car)	£36.95
d	Teleton STP801	£42.95
d	Teleton STP800	£39.95
d	Lear Jet P550	£41.95
d	Lear Jet P560	£52.95
d	Lear Jet LJ277 (Car)	£45.50
d	Lear Jet LJ71 (Car)	£27.75

CARTRIDGES

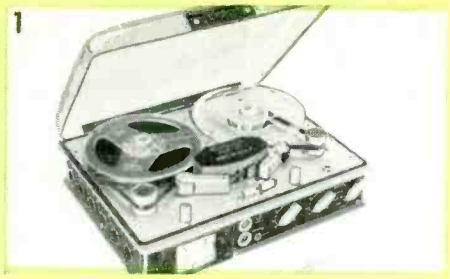
a	Acos GP91	£1.50
a	Acos GP93	£2.00
a	Acos GP96	£2.50
a	Acos GP101	£2.75
a	ADC 10E Mk4	£24.95
a	ADC 10E Mk2	£19.95
a	ADC 26	£48.95
a	ADC220XE	£8.80
a	Audio Technica ATE6 .7 mil	£4.95
a	Audio Technica AT21 .5 mil	£9.50
a	Audio Technica AT55 .7 mil	£3.25
a	Connoisseur SCU1	£4.75
a	Decca Deram	£4.15
a	Empire 1000ZEX	£44.10
a	Empire 999VEX	£31.45
a	Empire 999TEX	£18.35
a	Empire 999SEX	£14.85
a	Empire 999 EX	£11.60
a	Empire 999X	£8.50
a	Empire 909 EX	£8.95
a	Empire 90EEX	£6.95
a	Empire 909X	£6.35
a	Goldring G800 Super E	£16.90
a	Goldring G800E	£9.95
a	Goldring G800	£6.95
a	Goldring G850	£3.95
a	Goldring CS91E	£5.95
a	Orbit NM22/33/44	£2.95
a	Orbit NM44	£2.95
a	Ortofon M15E	£23.25
a	Ortofon MF15E	£19.35
a	Sonotone 9TA H/C Diamond	£2.50
a	Sonotone 9TA H/C Sapphire	£2.50
a	Shure M3D	£4.95
a	Shure M44 .5 or .7	£7.65
a	Shure M44E	£8.85
a	Shure M55E	£9.75
a	Shure M75/6 Type2 MB	£10.95
a	Shure M75E Type 2	£12.45
a	Shure V15 Type2	£27.70

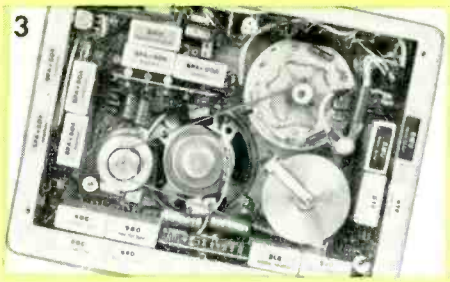
Prices subject to change without notice E.& O.E.

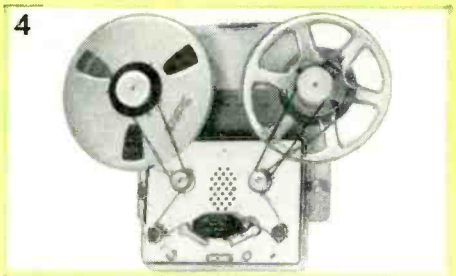
F.CAVE HI-FI TOP DISCOUNTS

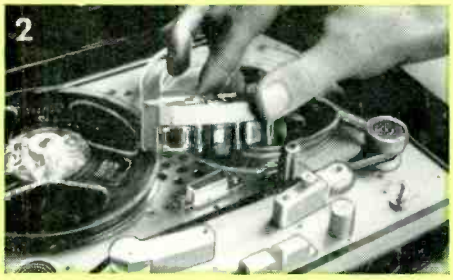
OUR 4 STORES ARE LOCATED FOR YOUR CONVENIENT SHOPPING

WEST END	21 Old Compton St W1	01-437 9369
RICHMOND	5 Bridge St Sy	01-948 1441
KINGSTON	27 Eden St Sy	01-546 7845
ROMFORD	86 South St	ROMFORD 20218

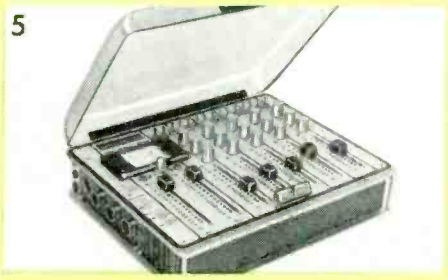








STELLAVOX



Quality and Reliability for the Professional Sound Recordist

The new Stellavox SP7 is one of the most versatile and all-embracing systems for magnetic recording. Weighing less than 8lb the machine is of a revolutionary design supported by a system of unique accessories. This Swiss-made precision tool is used throughout the world by the leading sound recordists and scientists, a record of technical excellence stretching back to 20 years, with service to match.

1. Recorder
Weighing less than 8lb, measuring 3 x 8½ x 10½in, tape speeds 3¾ to 30 ips, or fully variable, 20 Hz to 20 kHz (±) 2 dB at 7½ ips, wow and flutter (±) 0.12% DIN weighted, automatic record mode, starting time 0.1 seconds, rechargeable Ni-Cads or AA size dry cells, built-in condenser mike powering, built-in monitor speaker. Available with optional quartz crystal pilot tone generator and pilot amplifier.

2. Interchangeable heads
The sound head assembly is easily interchangeable. As the heads are changed the machine becomes mono or stereo. Heads can be supplied for any operating mode, e.g.:
Mono—½ or full track. Mono—full track with neo-pilot. Stereo—½ or ¼ track. Stereo—½ track with synchrotone pilot or cue track. Stereo—0.75 mm guard band with flutter filter. Special heads to order.

3. The heart of the Stellavox SP7 is its unique and versatile servo motor, strobe lines on the motor are coupled to photo electric sensing elements which are integrated with the motor. All amplifiers are plug-in, pre-set encapsulations for easy servicing.

4. Reel Attachment
This accessory allows for the use of 10½" NAB or 12" plastic reels; this is particularly useful for studio work at high recording speeds. The attachment can be fitted in a matter of seconds.

5. Mixer
The Stellavox AMI Mixer is the same size as the recorder and weighs 7lb. The AMI has five channels with symmetrical inputs 0.1 mV to 200 mV/200 ohms for condenser or dynamic microphones, line input up to 8V/10K ohms, bass cut, presence lift, bass and treble controls and pan pots. Stereo outputs 1.55V/200 ohms optional 4.4V/600 ohms balance.

A.V. Distributors (London) Ltd
26 Park Rd., Baker Street,
London, NW1 4SH

Tel. 01-935 8161