September 1971 25p

studio sound

TETRAHEDRAL AMBIOPHONY

DOLBY 320B REVIEW

INSIDE MAJESTIC STUDIOS

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

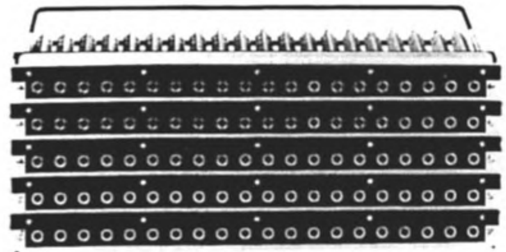
HAMPSTEAD HIGH FIDELITY

91 Heath Street, Hampstead, London N.W.3 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 + 45db ref V/dyne/cm²
Weight 11 oz. (300 g.)



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.
38 Hereford Road, London W2 5AJ
01-229 8054 or 01-229 9111

SONIFEX SOUND EQUIPMENT

★ Introducing a range of versatile, high quality sound equipment, suitable for a wide variety of studio applications.

★ Illustrated; Type B1000, six channel, single group, portable studio mixer, with comprehensive facilities and excellent technical specification.

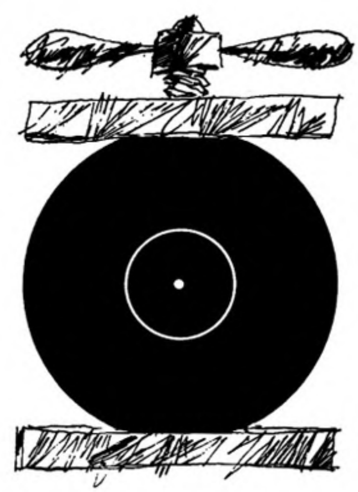
★ A further range of amplifier assemblies are available, providing microphone to line amplification, equalisation, virtual earth mixing and high level output functions.

★ Specialised sound equipment can be manufactured to individual requirements and specifications.

For further information:—

SONIFEX SOUND EQUIPMENT
93 STANWELL WAY, WELLINGBOROUGH
NORTHAMPTONSHIRE

Telephone: Redwells 2142.



for all Professional, Custom, & Trade Pressings

C. H. Rumble Ltd., Benedict Wharf, Benedict Road, Mitcham, Surrey. Telephone. 01-648 5106

TPA SERIES-D

integrated circuit power amplifiers

Over the past few years we have become one of the foremost manufacturers of professional power amplifiers.
We are now taking THE LEAD IN EUROPE as the first company to use the most advanced power stage and driver stage integrated circuits.

TPA 50-D Spec.

Power Output	**100 watts rms into 4 ohms** **65 watts rms into 15 ohms**
Freq Response	**±0·1dB 20Hz to 20KHz into 15 ohms. -1 dB at 150 KHz**
Total harmonic distortion	**Less than 0·04% at all levels up to 50 watts rms into 15 ohms**
Input sensitivity	**0 dBm to 100 mV**
Noise	**-100 dB**
Rise time	**2 µseconds**

For full technical information contact

HH ELECTRONIC

CAMBRIDGE ROAD
MILTON CAMBS
CAMBRIDGE 63070

it's new, it's light
it's **KOSS K-711**

costs only £10

The Koss K-711 is a new concept in design, providing a standard of sound inviting comparision with headphones costing twice the price

KOSS *hearing is believing*

KOSS T.M.D. Ltd.
11 Redvers Road
London N. 22
Tel. 01-888 0152

Please send me free of charge full details on this and other Koss models

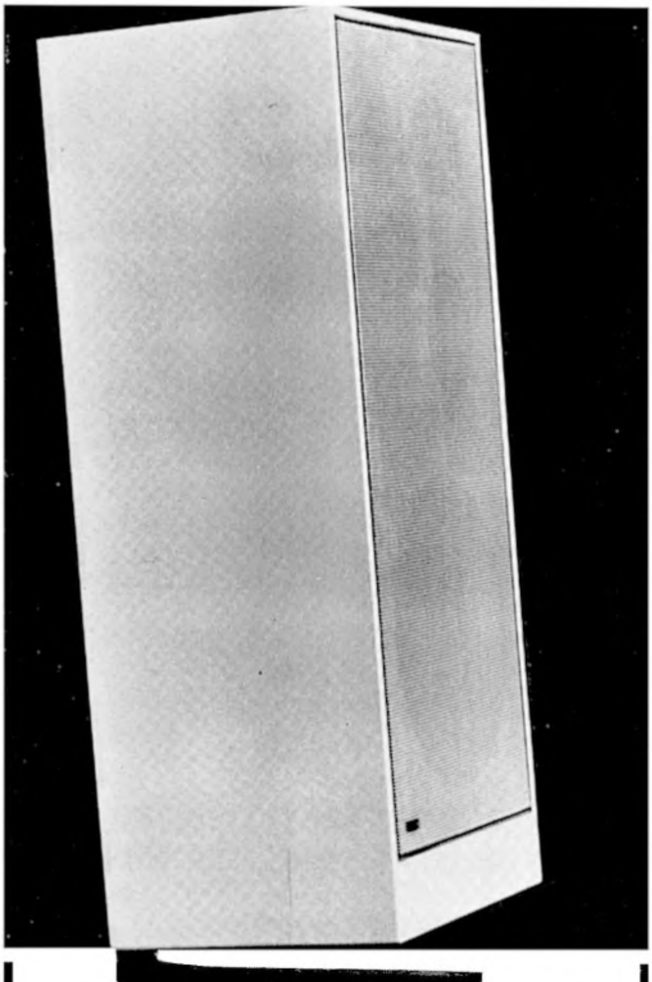
Name...

Address...

Heco P.6000. the professional one.

SPECIFICATION
Frequency Response: 20-25,000 Hz.
Power Handling: 60 watts RMS.
Impedance: 8 ohms.
Cross-over Frequency: 250/800/3,000 Hz.
Speaker Assembly: One 12" woofer. One 5" mid-range speaker. One upper mid-range hemispheric dome radiator. One ultra-high hemispheric dome radiator.
Recommended Retail Price:
£110·00 in Teak. £115·00 in white.
Stand extra.

FIVE YEAR 5 GUARANTEE



Please send me full colour literature and test reports on Heco Speakers.

heco

NAME ....

ADDRESS ....

....

Send to: **Dept. SS, Acoustico Enterprises Ltd, 6-8 Union Street, Kingston-upon-Thames, Surrey** Tel: 01-549 3471/3 (3 lines)

It's back again!

Beautiful Shamrock

FERRO-SHEEN
POLYESTER BASE
recording tape

Once again this top quality recording tape is coming in from the USA and is being made available at a price all can afford. Do not confuse SHAMROCK Ferro-Sheen with cheap tape, it is a quality product made by AMPEX, America's largest producer of high quality tapes for industrial, entertainment and domestic use.

Shamrock *recording tape*

TOP QUALITY AT THE LOWEST PRICE

SHAMROCK Ferro-Sheen has always been difficult to get, over here, but with a special arrangement with AMPEX G.B., our continuity of supplies is assured. SHAMROCK Ferro-Sheen is a superior product.

THE GREATEST VALUE IN RECORDING TAPE

You get more good clean sound for your money with SHAMROCK Ferro-Sheen than with any other tape anywhere near the price... SHAMROCK Ferro-Sheen is extensively used by Educational Authorities, Universities, Language Laboratories and Tape Recording Clubs.

SHAMROCK Ferro-Sheen recording tape is available only on 7" reels. 1800ft L.P. 75p per reel, 3 for £2.50, 6 for £4.45, 12 for £7.75. 2400ft D.P. £1.15 per reel, 3 for £3.40, 6 for £6.85, 12 for £13.75. P & P is 5p PER REEL on all orders under £5.

POST THIS COUPON TO DAY

Music Tapes Mail Order,
36 High Street,
Salisbury, Wilts.

Please mail to me at the address below, the following reels of Shamrock Ferro-Sheen recording tape.

7" L.P. .... @ £..

7" D.P. .... @ £..

I enclose 5p per reel for P & P if my order totals less than £5.

Name ....

Address ....

....

(Offer available in U.K. and Northern Ireland only).

If you're looking for a high professional performance stereo tape deck, then look no further. AKAI's **X-200D Cross-Field Stereo Custom Deck** will fully meet your requirements. This smartly designed deck boasts AKAI's unique Cross-Field Head that gives you true sound reproduction. This exclusive and world-patented head has created a sensation in the tape recorder world by offering one of the widest recording ranges available today. And high fidelity recording can be attained even at very slow speeds.

The X-200D also incorporates 3 motors, automatic continuous reverse with sensing tape, manual reverse, 3 speeds of 1-7/8, 3-3/4 and 7-1/2 ips, 3 heads, automatic stop/shut off, instant stop control, and solid state pre-amplifier with two integrated circuits. Frequency response: 30 to 26,000Hz (±3dB) at 7-1/2 ips. S/N ratio: better than 50dB. Max. recording capacity: 8 hours monaural, 4 hours stereo at 1-7/8 ips.

AKAI's **AA-6300 Solid State AM/FM Multiplex Stereo Tuner Amplifier** and **SW-155 Hi-Fi Stereo Speaker System** are perfectly matched with this X-200D professional stereo tape deck.

Audio & Video

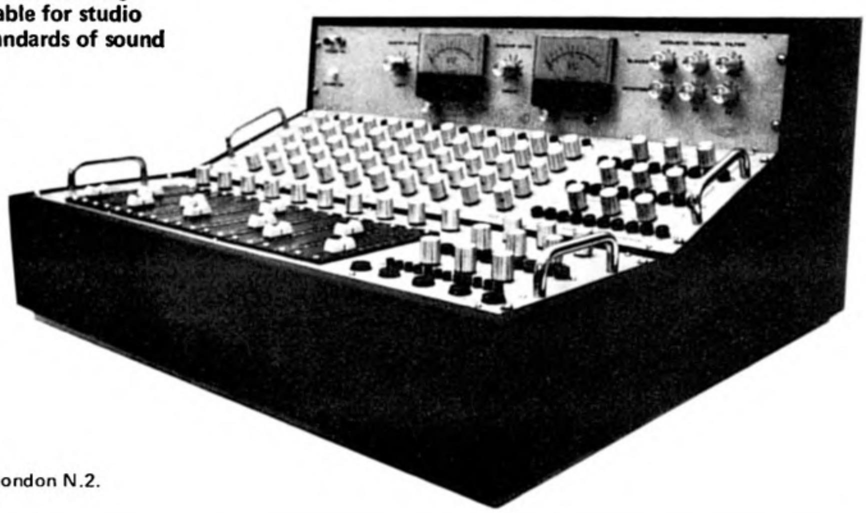
AKAI®

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

Rank Aldis-Audio Products, Rank Audio Visual Ltd.: P.O. Box 70, Great West Road, Brentford, Middlesex Tel: 01 568-9222

PMS 10 by Midas...
Not really a studio console...
but mainly a PA mixer

However, it's just as useful in the studio, and our range of single channel modules are highly suitable for studio builders demanding the most exacting standards of sound quality, without a vast capital outlay.



Ten Channels each with fader and input sensitivity control, panning control per channel; Left and Right Master volume each with Vu Meter and Compressor; three sets of push button operated mid-range filters, acoustic compensation filters; Independent Monitor level per channel, mute buttons, headphone selector buttons and absolute determination to surpass all previous standards of live sound quality, make this the best mixer any group could own.

Midas Professional Amplification
Midas Sound, 128 High Road, East Finchley, London N.2.
Telephone 01-444 7707.

DJ RADIO PROGRAMMES
FOR THE UK & ABROAD

We have a superbly equipped DJ RECORDING STUDIO complete with 3 instant start turntables and 2 Spotmaster jingle machines.

We are currently recording a series of weekly programmes in stereo for the American market and have many other interesting projects in hand.

CAN WE HELP YOU IN ANY WAY?

ROGER SQUIRE STUDIOS

55 Charlbert Street, St. John's Wood, NW8

Telephone 01-722 8111

BAILEYS FOR DOLBY A and B

Dolby A units and Revox A77 for hire. Kellar Dolby B unit **£49·50,** on demonstration. Wharfedale Dolby B D.C.9. **£99.** Bell & Howell Dolby B D.C.S. 1700 **£106,** on demonstration. Cambridge Audio, K.E.F. Quad on demonstration. Revox Recorders slightly marked, otherwise as new—1108 (2-track HS) **£234,** 1102 **£169,** 1102 HS **£215.**

131 THE PARADE, HIGH STREET, WATFORD WD1 1NA
or
166 ST. ALBANS ROAD, WATFORD, HERTS.

Send for Price List

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
38 HEREFORD ROAD, LONDON, W.2
01-229 8054

What makes AKAI's **GX-280D Stereo Tape Deck** so outstanding is that it gives you wonderful GX sound. By "GX sound" we mean sound reproduced with the AKAI-developed **glass and x'tal (single crystal) ferrite head.** We call this head the GX Head, which is the first of its kind in the world. In conventional heads, tape dust and wear greatly reduce sound quality. But our GX Head is "dust free" and "wear free" and guaranteed for over 150,000 hours of service life! **Breakdowns of this head before 150,000 hours of use will be replaced free of charge.**

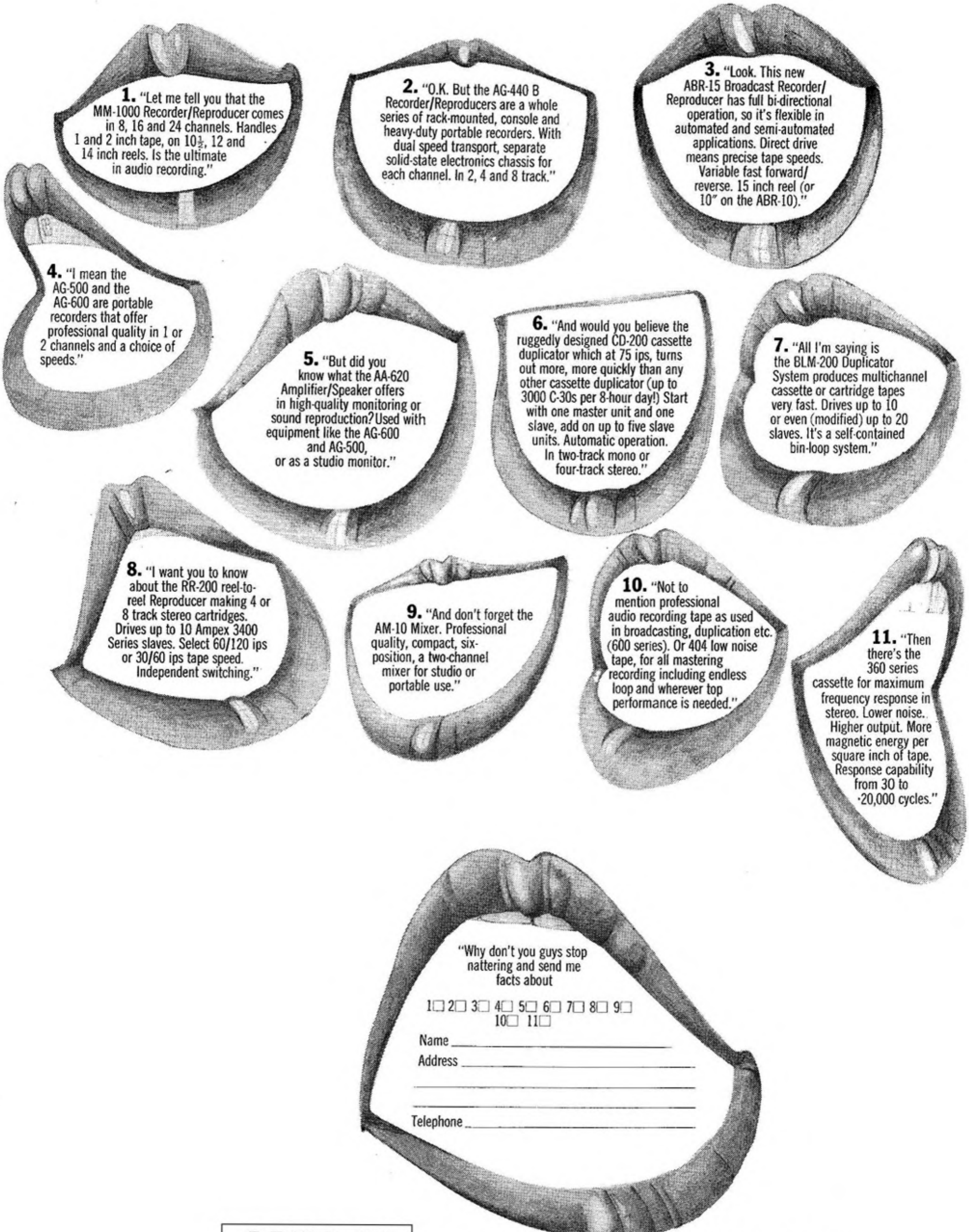
This GX Head also produces a "focused field" which makes possible the recording and playback of high frequency signals without distortion.

This high performance GX-280D also features such professional specs as 3 heads, servo-control motor for direct capstan drive, automatic reverse, automatic stop/shut off and pause button with lock. The two 7-inch reels can be completely covered with an optional plastic dust cover.

The GX-280D is perfectly matched with AKAI's **AA-6600 Solid State AM/FM Multiplex Stereo Tuner Amplifier** and **SW-155 Hi-Fi Stereo Speaker System.**

Audio & Video
AKAI®
AKAI ELECTRIC CO., LTD.
Ohta-ku, Tokyo, Japan

Rank Aldis-Audio Products, Rank Audio Visual Ltd.: P.O. Box 70, Great West Road, Brentford, Middlesex Tel: 01 568-9222


1. "Let me tell you that the MM-1000 Recorder/Reproducer comes in 8, 16 and 24 channels. Handles 1 and 2 inch tape, on 10½, 12 and 14 inch reels. Is the ultimate in audio recording."
2. "O.K. But the AG-440 B Recorder/Reproducers are a whole series of rack-mounted, console and heavy-duty portable recorders. With dual speed transport, separate solid-state electronics chassis for each channel. In 2, 4 and 8 track."
3. "Look. This new ABR-15 Broadcast Recorder/Reproducer has full bi-directional operation, so it's flexible in automated and semi-automated applications. Direct drive means precise tape speeds. Variable fast forward/reverse. 15 inch reel (or 10" on the ABR-10)."
4. "I mean the AG-500 and the AG-600 are portable recorders that offer professional quality in 1 or 2 channels and a choice of speeds."
5. "But did you know what the AA-620 Amplifier/Speaker offers in high-quality monitoring or sound reproduction? Used with equipment like the AG-600 and AG-500, or as a studio monitor."
6. "And would you believe the ruggedly designed CD-200 cassette duplicator which at 75 ips, turns out more, more quickly than any other cassette duplicator (up to 3000 C-30s per 8-hour day!) Start with one master unit and one slave, add on up to five slave units. Automatic operation. In two-track mono or four-track stereo."
7. "All I'm saying is the BLM-200 Duplicator System produces multichannel cassette or cartridge tapes very fast. Drives up to 10 or even (modified) up to 20 slaves. It's a self-contained bin-loop system."
8. "I want you to know about the RR-200 reel-to-reel Reproducer making 4 or 8 track stereo cartridges. Drives up to 10 Ampex 3400 Series slaves. Select 60/120 ips or 30/60 ips tape speed. Independent switching."
9. "And don't forget the AM-10 Mixer. Professional quality, compact, six-position, a two-channel mixer for studio or portable use."
10. "Not to mention professional audio recording tape as used in broadcasting, duplication etc. (600 series). Or 404 low noise tape, for all mastering recording including endless loop and wherever top performance is needed."
11. "Then there's the 360 series cassette for maximum frequency response in stereo. Lower noise. Higher output. More magnetic energy per square inch of tape. Response capability from 30 to 20,000 cycles."
"Why don't you guys stop nattering and send me facts about
1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐ 11☐
Name
Address
Telephone

FERROGRAPH-DOLBY

We are proud to announce that R.E.W. Audio Visual Co. have been appointed sole U.K. distrubutors.

FIRST AGAIN

R.E.W. are pleased to announce that the first reel to reel tape recorder with built-in Dolby noise reduction system is now available to the public.

The Ferrograph-Dolby is the first machine to offer true high fidelity on 4 track recordings at 3¾ i.p.s. Also for the professional user, the Ferrograph-Dolby gives studio quality at a reasonable cost.

The range of Ferrograph-Dolby Tape Recorders, which carry the incomparable Ferrograph 3 year guarantee, can be seen at either R.E.W. Showrooms.

FERROGRAPH SERIES 7

This famous range brings professional quality to the Hi-Fi enthusiast. Series 7 machines are always in stock at R.E.W.

FERROGRAPH SERIES Y

These models are specially made for use in Science, Industry and Professional Sound Recording, and are supplied to these users free of Purchase Tax.

Dolby 713 Mono 2 track Tape Recorder £226·27
Dolby 713H Mono 2 track high speed Tape Recorder £235·95
Dolby 702/4 Stereo 2 or 4 track Tape unit £272·25
Dolby 702H Stereo 2 track high speed Tape Unit £281·93
Dolby 722/4 Stereo 2 or 4 track Tape Recorder £308·55
Dolby 722H Stereo 2 track high speed Tape Recorder £318·23

DOLBY SYSTEM

R.E.W. AUDIO VISUAL CO. West End Showrooms:
146 Charing Cross Road, WC2. Tel: 01-836 3365
Headquarters, Showrooms and Mail Order:
266-8 Upper Tooting Road, London SW17.
Tel: 01-672 4471/2 and 9175.

To Dept. SS, R.E.W. Audio Visual Co.,
146 Charing Cross Road, London WC2.
Please send me full details of Ferrograph-Dolby
Tape Recorders ☐ Ferrograph Series 7 ☐ Ferrograph Series Y ☐
NAME ....
ADDRESS ....
....

studio sound
INCORPORATING TAPE RECORDER

SEPTEMBER 1971 VOLUME 13 NUMBER 9

EDITOR DAVID KIRK **CONSULTING EDITOR** JOHN CRABBE

ADVERTISEMENT MANAGER ROBIN WELLS

ASSISTANT ADVERTISEMENT MANAGER TONY NEWMAN

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

PERMIT A NEW editor formally to greet his readers and to outline his plans for the future of STUDIO SOUND. The name is Kirk incidentally and, with the late editor John Crabbe, I have nursed this journal since autumn 1963.

The transformation from *Tape Recorder* to STUDIO SOUND was a gradual process, beginning long before the change of title and still continuing. It involved a heart-searching purge of *Tape Recorder* contributors, an unpleasantly destructive task. More difficult, however, was the task of finding new writers actively involved in the audio professions. Maintaining a high standard of outside contributions is the main headache in producing what has become predominantly a trade journal. An unhappy solution adopted by many such publications is to minimise feature articles, or omit them altogether, making room for page after hack page of (often old) 'New Products'. Cheap to produce but of doubtful long-term benefit to the host trade.

I have not been happy with the standard of technical accuracy in this magazine and confess my responsibility for some very peculiar equalisation characteristics that have appeared in the past; responsibility in the sense that an editorial staff is expected to know more than any author about the declared field of interest.

A perfect sound recorder is one which reproduces signals exactly as received. A good journal, on the other hand, must produce an output of substantially higher quality than its input. Our editorial staff has been expanded in a serious endeavour to reduce incoming distortion without adding any distortion of our own.

STUDIO SOUND has concerned itself excessively, in my opinion, with life as it exists between microphone and loudspeaker. I hope we shall be able to take this chain rather more for granted, devoting increasing attention to what goes into the microphone. We are kidding ourselves if we accept that the recording industry's sole interest is in the quality of its equipment. **D.K.K.**

FEATURE ARTICLES

REGULAR COLUMNS

EQUIPMENT REVIEWS

COVER PICTURE
Close-up of a Tonus ARP *electronic audio synthesiser.*

SUBSCRIPTION RATES
Annual UK subscription rate' or STUDIO SOUND *is £3 (overseas £3·30, $7·92 or equivalent). Our associate publication* Hi-Fi News *costs £2·82 (overseas £3·36, $8 or equivalent). Six month home subscriptions are £1·50* (STUDIO SOUND) *and £1·41* (Hi-Fi News).
STUDIO SOUND *is published on the 14th of the preceding month unless that date falls on a Sunday, when it appears on the Saturday.*

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

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.

TURNTABLE

A column of readers' problems and correspondence

SONG FODDER

From: R. Greenberg, 61 Brands Hill Avenue, High Wycombe, Bucks.

Dear Sir, Peter Bastin is so right about the dismal song fodder trotted out in the Eurovision Song Contest ('Talkback,' June issue). However, surely he misses the point as regards the jury for this depressing spectacle. 'People should be judged by their equals, by people who have gone through the same sort of thing, or by people with professional experience in that particular field.' That is all very well for an Eisteddfod, a Ballroom Championship, or an International Competition for serious musicians. There, clearly-defined standards of technique, performance and artistry serve as guidelines. But who are really the ultimate judges of a popular song? Precisely those 'empty-headed "celebrities" and greengrocers' who will buy a pop disc by the thousand if they happen to like it, without caring a damn for the recording artist's 'blood, sweat and tears' . . . still less for the composer, arranger, and recording technicians.

In the fickle world of popular music the only thing that has ever mattered—from Irving Berlin to Bob Dylan—is whether a song captures the public imagination. Very often it does so through an indefinable magic no panel of 'experts' would have perceived on first hearing. Songs which have proved their greatness were eliminated by many a Broadway producer during the tryout of a new show, in the belief (*their* belief) that the public would vote them a miss. 'The Man I Love' and 'From This Moment On' are but two examples. And let's not mention the recording organisation that turned down the Beatles' first hits.

Nevertheless Mr Bastin has a point, although he doesn't seem to have quite thought it through. It might perhaps be worthwhile leavening the non-professional jurors with a sprinkling of disc-jockeys and A & R men, whose votes could either be considered separately or combined with the rest. This would provide the element of professional experience at present lacking. But I've a suspicion they would prove just as susceptible as their non-professional colleagues to 'the girl singer's dress, her hairstyle,' and so on. For this reason I have always felt that, short of transferring the whole charade to radio, the jurors should not be allowed to *see* the performers—only listen to the songs. The viewing millions would still get their full measure of gyrations and flashing teeth, while the judges would be obliged to concentrate on the merits of the material being put over. And as for the foreign-lyrics problem, why doesn't someone provide the jurors with line-by-line translations of every song not in their own language?

If it proves anything at all, the Eurovision Contest shows that, Common Market or no, there still exist subtle but fundamental differences in pop-music tastes between the various European nationalities. That is a built-in bias that can never be eradicated. So a song that is truly *for Europe* is a very rare bird indeed. From the British point of view, 'Puppet on a String' happened to be one of that species, and it took flight just at the right moment. Whatever the constitution of the jury, it would almost certainly have come out on top.

To complicate matters still further, there will always be strong commercial pressures involved, both in the run-up to the Contest and afterwards. This year, the gnomes of Denmark Street and Radios One With Two, bending over backwards to keep their fingers on the erratic pulse of popular demand, apparently decided very quickly that the winning song simply wasn't a commercial proposition for the mass record market. So the whole farcical business grinds to its logical conclusion: while the winner has presumably sold like hot cakes in its country of origin, and in those with allied tastes, has anyone over here actually been allowed to *hear* it recently? *Yours faithfully*

THE AR-3A REVIEW

From: Denis Wratten, Acoustic Research International n.v. Radiumweg 7 Amersfoort, Holland.

Dear Sir, Before commenting on his assessment of the *AR-3a* speaker, we must point out that Mr Shuttleworth starts his review by misrepresenting AR's claims. Having quoted AR's criteria for a perfect loudspeaker, he leaves readers with a clear impression that AR claim that the *AR-3a* meets them, because he fails to point out that we ourselves state that they cannot be met. He goes on to say that AR claim that the rising top in recordings justifies a drop in the response of the speaker. This is not so. What AR state is that the rising top in recordings does exist and that it must be rolled off somewhere if natural balance is to be obtained. We have said that, if it is done in the speaker, a more accurate total result is obtainable than if it is done elsewhere. He says that AR have used only a string quartet, a classical guitar and nickelodeon in their live-versus-recorded tests. This is not correct. These are the only live sources we have used in *public* live-versus-recorded concerts. In the simulated tests, we regularly use all kind of music, choral, voice, and white noise, for development work. Having misrepresented AR in these ways, Mr Shuttleworth goes on to write a review that is of questionable validity in several respects:

1. The use of a 'test tape' for reviews of this kind does not allow a meaningful evaluation of the accuracy of a speaker on the part of the reader: who is to say that Mr Shuttleworth's tape is itself accurate? It is differences in the accuracy and balance of the recordings, we imagine, which have caused the inconsistency in the reviewer's reactions to different types of signal.

Against Mr Shuttleworth's opinion of the *AR-3a*, we can quote those of a great many other people who are indisputable authorities on the sound of live music, and this is well known. But the value of such controversy is limited. Reviewer's comments of this kind tend necessarily to be a description of his sensations rather than of the speaker system, and his sensations are naturally coloured by his own prejudices, as well as by the accuracy of the recordings. This is why AR hold that measurements and controlled listening tests are more meaningful tools for speaker evaluation where accuracy is the criterion for performance.

2. It is indeed a pity that lack of facilities or experience in how to use them should have prevented Mr Shuttleworth's attempts at controlled testing from being meaningful. It was as a controlled listening test, or a qualitative method of validating quantitative data, that the simulated live-versus-recorded comparison, unsuccessfully attempted by Mr Shuttleworth, was devised by AR. To carry out this test, it is essential that the conditions are carefully controlled. Little data is given in the review as to how these tests were made.

3. The validity of any test of this kind depends on the recording of the reference source being made correctly. For example, the microphone position must be chosen so that the direct radiation from the source matches its energy output. It is quite possible that either there is no microphone position for speaker x at which this condition is met, or that Mr Shuttleworth failed to find it.

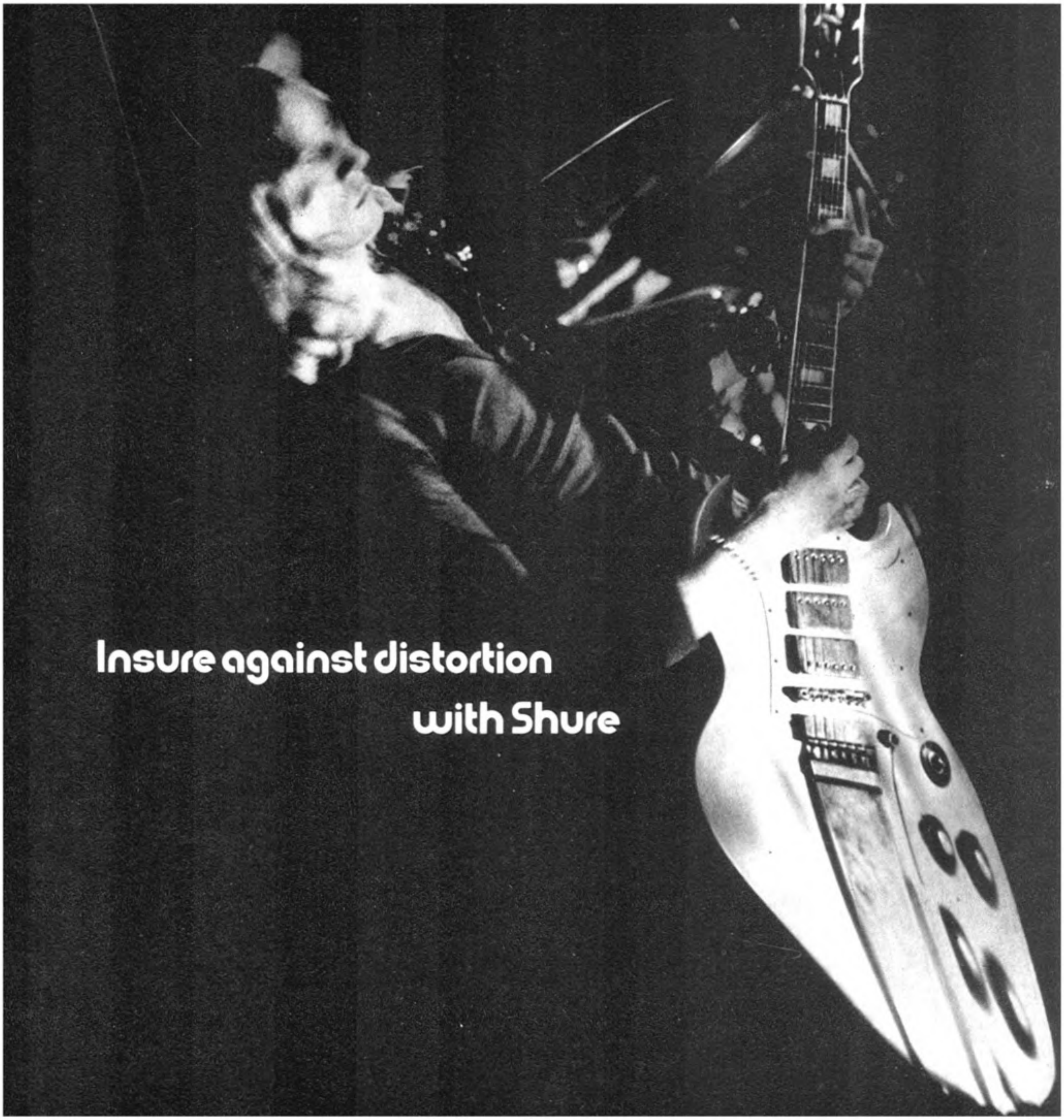
4. No information is given about the compensation for ground reflections which would be necessary to make the test valid.

5. *The frequency response curve published was evidently measured incorrectly.* [*Our italics* —**Ed.**] No indication is given of the method used. Be that as it may, AR guarantee their published performance data and every speaker we produce is tested and rejected unless it comes within tight tolerances of standard. It is in fact quite a simple matter to analyse the main features of the published curve, which from its appearance was most probably made in an anechoic environment with a microphone I meter on tweeter axis. If this was the case:

6. The roll-off below 60 Hz could be due to measurement being made in a 4π environment.

7. The notch 1-2 kHz would be a local interference effect due to the cabinet edge moulding.

(*continued on page 438*)


Insure against distortion
with Shure

8. The roughness 5-15 kHz would be due to local interference effects between midrange and tweeter and to various cabinet reflections which result from the exceptional dispersion of the drive units.

9. Note that these effects are not the result of inaccuracies in the energy output of the system, and only appear when it is measured in this way. The test techniques used and published by AR are designed to avoid just these pitfalls. When Mr Shuttleworth's curve is modified to compensate for these effects, it ends up looking very close indeed to our own published data.

10. A further point which casts doubt on the validity of his review is that Mr Shuttleworth fails even to mention two performance characteristics, distortion and dispersion, which play an important part in determining the overall accuracy of any speaker.

11. Lastly, we would draw attention to the fact that readers may have gained the impression from this review that the *AR-3a* is particularly suitable for monitoring 'pop' music. Although it has been used for this application, we would point out that the *AR-3a* is designed for accuracy, not high power ability. Although it has higher power capability than the speaker 'X' which Mr Shuttleworth uses for comparison, the *AR-3a* is not designed to sustain the 'discotheque' sound levels frequently used for monitoring 'pop' music. In these applications, fusing is essential to protect the speaker from high average power levels. We would not wish to argue with Mr Shuttleworth's subjective impressions and judgements of the *AR-3a*. We feel however that such comments are not very helpful in allowing a reader to evaluate the accuracy of a speaker system for monitoring purposes, particularly when he supports them by measurements and tests which contain several important errors in scientific method.

Yours faithfully

John Shuttleworth comments:

I am sorry if I gave some readers the impression that AR claim to have met their design criteria quoted at the beginning of my review. I do not in fact state this, and those readers I have been able to ask did not think that I had. I wrote the preamble after reading the AR literature and before testing the speakers, and felt then, as I still do, that AR's design criteria are relevant and correct, except of course where they depart from it over HF response. The quotation about correction for rising response in recording was taken direct from AR literature, and according to Mr Wratten AR still state that the rising top should be rolled off somewhere and that the best place to do it is in the speaker, I can't see how this differs materially from the quotation in my review, and I still can't agree with the statement. I believe that the best place to make corrections to tonal balance is in the amplifier, where the user has more control. If Mr Wratten reads my review again he will note that I say 'AR state in their literature that they use a string quartet . . . etc for live-versus-recorded tests', and do not use the word 'only'. Mr Wratten however still does not claim that they use any other live sources except in the simulated *tests and this is a vastly different matter.*

In my preamble to the Spendor review (September 1970) I briefly explained my reasons for using a test tape. I agree that by itself this could be misleading, and on any section of the tape where a speaker shows up badly I check with live-versus-recorded comparisons. Any differences noted would naturally be mentioned in the review, and in the case of the 3a the check on 'live' items confirmed the results obtained from the tape. In all cases where an opinion *as to quality of sound from the 3a was given it was the opinion of a listening panel, not just my own. I had hoped that the quotation from a member of this panel would remind readers that this was how the tests were made.*

I fully agree with Mr Wratten's comment on the simulated live-versus-recorded tests which I still feel are highly suspect, and perhaps it is too great a reliance on these that have led AR to fall so far short of some of their design criteria. I only included this test in the review as an experiment: it was suggested by AR in their literature. However I would like to know what compensation for ground reflections Mr Wratten suggests I should have used for a speaker and microphone suspended 10m up in the air. Despite all the pitfalls of this method, which AR now seem ready to admit, my attempt could not have been so unmeaningful as Mr Wratten suggests. It did at least confirm the results found by other methods. The statement that the frequency response curve I gave was measured incorrectly *seems to imply that there is a* correct *method of doing it. If AR or anyone else can tell me what this is I will be delighted to learn.*

Different response curves can be obtained from the same speaker in the same environment merely by measuring at different distances and on different unit axes, and the best that can be hoped for is an idea of the general balance and an occasional indication of 'funnies' in the system. Surely the important thing is to state how the given curve was obtained. Since the 3a reviewed was lacking in HF response, the curve taken on tweeter axis was the kindest one to publish, and this is the one given, as stated clearly in the review. AR do not appear to publish a curve of the system as a whole, but as I understand it measure the response of the bass unit out of its cabinet and buried in the ground, and the response of the treble units in the cabinets with the speaker grill removed, integrating the results obtained. Whether this is more or less valid than measuring the response of the system as a whole on different unit axes in an anechoic environment I am not prepared to argue. However it seems that when AR have made their correction to my curve, which they seem happy to do without any direct knowledge of the factors involved (important errors in scientific method?), it ends up close to their published data.

I apologise for not mentioning that the 3a has very low distortion and better than average dispersion but, as stated at the beginning of my review, it was being judged by monitor and not domestic standards, and the coloration had in my view already proved it unsuitable for the purpose. If AR can get the general balance as good as its other parameters the 3a would indeed be a speaker to get excited about.

I think it a pity that Mr Wratten should assume, without any detailed knowledge of how my tests were carried out, that they contain 'important errors in scientific method' and that 'lack of facilities or experience in how to use them should prevent my attempts at controlled testing from being meaningful'. Presumably this statement is based only on the fact that he doesn't agree with the results obtained.

It might help Mr Wratten to make a more measured judgement if I detail how I do the most important of the tests—the live-versus-recorded comparison. While I haven't the space to give all the detailed checks needed to the ancillary equipment before I start, I can give some idea of a few of the other precautions taken.

The high quality calibrated equipment mentioned in my Spendor review is installed in a listening room adjacent to the studio in which musicians and other performers are gathered.

In this case the 3as and a pair of Spendor BC1s were taken and individual items were first balanced on the 3as until the nearest approach to the original sound could be obtained when walking from studio to the control rooms. The Spendors were then switched instead of the 3as, and their sound compared to the original in the studio.

The experiment was then repeated, this time balancing first on the Spendors and then switching to the 3as.

Lastly another run was taken balancing on headphones and then switching in the 3as and Spendors in turn and comparing them with the original sound. This whole procedure was then repeated using the Quad ELS instead of the Spendor, and it was on the results of this that I stated: 'It was only compared with the Quad ELS and an outstanding monitor that it was obvious the 3a had a fair bit of coloration'. In all cases the Spendors or Quads were preferred to the 3as.

The balancing engineer has to know which speaker is in use, but the listening panel should not, they should merely be asked which sound is nearest the original. The sound source must be of high quality. No one can make a meaningful judgement between two things that are bad. (One of the serious drawbacks to the 'simulated' method.) The listeners must be experienced engineers and only be asked to make judgement for very short periods. Great care must be taken to get sound levels right—and so on.

McKENZIE ON CHROME

From: Andrew G. Petite, Advent Corporation, 377 Putnam Avenue, Cambridge, Massachusetts, USA.

Dear Sir, I've just finished reading Angus McKenzie's article on chromium dioxide tape in the March issue and want to both thank and commend him for having written the first intelligent article on the tape. One rarely comes across a writer who so thoroughly investigates a subject and so quickly grasps the significance of it.

I don't know if you are familiar with Advent since we are virtually unknown outside of the States (and also still little known within them), but we are the company who first marketed Crolyn cassette tape, marketed the first cassette recorder with the Dolby B system, and manufactured the first separate add-on Dolby B.

What was particularly uncanny about the article was Mr McKenzie's proposal of a new playback equalisation to take advantage of Crolyn tape. Our new cassette deck incorporates a Crolyn playback equalisation of 70 and 3180 μS!

Yours faithfully

STUDIO DIARY

BY KEITH WICKS

ROGER SQUIRES micro-studio in NW8 makes the number one news spot this month. Three people have been successful in obtaining radio work as a result of demonstration tapes made at the studio, and all in the last month. The first was DJ Stewart Marx (real name Stewart White), who, with no radio experience at all, managed to land a job with Radio One. Roger tells me that the BBC audition test is a very difficult one to pass, as about 40 demo tapes are submitted each week, and only one person is accepted each month. This makes it a notable achievement, especially as most people accepted have usually had previous radio experience behind them. The only other successful audition tape submitted by DJs to Radio One in the last two months featured Peter Powell and was also made at this studio. By sending in a complete demonstration programme to the Corporation, Roger Squire has managed to get John Vine, who has been on the Squire mobile staff for 1½ years, a job with the local station, Radio Medway. John is to do a half-hour programme called *Be My Guest*, and it is to be recorded at the Squire studio, as the BBC liked the quality of the demo programme and granted him the option of doing the show live or prerecorded. As an understandably happy Roger Squire declared, 'This is what my studio is all about —trying to help disc jockey's careers'.

Mike Batt, of Belfry Productions, has been at **Wessex Studios** recording the first of several albums of tributes to well known artists. It consists of instrumental versions of the Rolling Stones' biggest hits, and it was engineered by Robin Thompson. Robert Young recorded another single for CBS with Keith Mansfield producing and Mike Thompson engineering. Mike also worked with producer Deke Arlon at the Talk of the Town, recording Lovelace Watkins. The equipment for this mobile session was hired from Pye Studios—Wessex, with little demand for mobiles, do not have suitable equipment of their own. A 24 channel, eight track Neve desk was used, together with a pair of eight track Ampex recorders. American artist Rick Powell has been using the studio for a number of sessions, all arranged by Jack Mandell, one of the most prominent fixers in the country. Rick was making albums of gospel music for sale in the States and in Switzerland. John Worth, who wrote Adam Faith's hit *What Do You Want*, and Eden Kane's *Get Lost*, is now working for Chapter One Records with Les Reed. He recently finished producing a Julie Sullivan album of various artists' past hits, with a big orchestral backing. Centipede, a group of over 50 musicians including no less than three drummers, has been in with producer Bob Fripp. RCA paid for the sessions, which went on from 1 p.m. to midnight on seven consecutive days. The result will be a double album of what studio manager Adrian Ibbetson described as 'sort of jazz material, quite way out, sometimes weird, but clever'. Julie Driscoll and Chips Chipperfield were also featured on these sessions.

At **Nova,** Mike Weighell engineered for Frankie Vaughan and Richard Dodd did likewise for UFO. Victor Sylvester, more quick than slow, recorded an LP in a day, and a new group, Lockjaw, laid down tracks for release on Pleasurama, with ex-Animal bass man McCulloch producing, and Mike Weighell engineering. Mike was also at the controls for sessions by Julia Foster, produced by Alan Tew, and for Julie Ege, who was making a single with Jackie Rae. Eric Holand engineered for Maurice Gibb, who was producing more Lulu numbers to be released on an Atlantic album.

Gerald Chevin recently left Nova's permanent staff, and is once again working on a freelance basis. Gerald has just got married, and I'm sure engineers everywhere will join me in wishing him 'excellent reproduction'.

Kohichi Oki has been playing the organ at the **Jackson Recording Company's** studio in Rickmansworth. The material is to be released by CBS in Japan, and by Adrhythm in this country. The company is doing an increasing amount of work using electronic instruments, and have recently been using an ARP synthesiser, a *VCS3*, and, of course, a Moog. Guy Fletcher and Doug Flett have been in to make a number of demos of their songs. At the moment they are enjoying a fair measure of success: they have material on a Presley LP which is currently number one in Japan. In addition to this Guy was responsible for writing the number five record in Holland's hit parade.

Since I last reported on **IBC Studios,** their Studio B has been reopened with 16 track facilities for voice-overs and reductions. This has allowed the main studio to be used exclusively for recording. A New Seekers album produced by Dave Mackay and engineered mostly by John Pantry has just been completed, and Mike Claydon has engineered several Richard Barnes sessions for Bron Management, to be released on Hit Records. Bryan Stott was the engineer on a Tony Hazzard album, and is now working on one featuring Fields, produced by Graham Fields for Sympathy Music, and destined for release on the CBS label. Susan Maughan has been in with producer Bill Landis on sessions for Spark Records, and Matthew Ellis has been doing an album with Producer Gerry Dane for Goliath Enterprises, engineered by Damon Lyon-Shaw. Mike Claydon engineered a Pedlars album which was produced by Cyril Smith, and Mike is now working with Elton John for Dick James Music. John Pantry was at the desk for orchestral sessions with producer Hamish Christie. Work is under way on a stereo album of Shaw's Pygmalion, and future bookings include more Barry Ryan sessions, and Brass Monkey business for Egg Productions.

Lots of work has been done on and in the studio by the **Marquee** engineers. Studio Manager Phil Dunne reports:

'For monitoring, we have switched to JB Lansings, as these seem to be the only speakers you can balance with and always get it dead right. There is also the question of power handling. No one wants to blow his head off, but what we *do* want is a clean response. We use stereo monitoring here rather than four speakers. In this way everything is in reasonable perspective from the word go. Clients are not led into believing that they have recorded something better than they really have, only to be disappointed later.

'One of our engineers, Phil Thomas, is particularly bright when it comes to logic circuitry. This is something that seems to be creeping into studios now, and Phil has designed for us a digital readout system, operating from the Ampex recorder in the tape room, which is remote from the control room. A digital readout clock is situated on top of the desk and is used by the balance engineer when he is working single-handed. You can go anywhere on the tape and the clock will count up or down on five digits. If you want to go back to any predetermined position, you press a button marked FIND, and the machine takes itself back, finds the position, and plays it out to you, all by logic. It's all running in breadboard form at the moment, and should be permanently installed within a month. Things like this are bound to speed up a session considerably. Roger Pharo worked with Phil Thomas on this project.

'We have just finished the tape library, which also houses the echo plates, and I am now sorting out the tape room. We are going to have a mixer in there so that we can copy from machine to machine, and also monitor the tapes in stereo.

'In the studio, we have now got some big screens which I designed. They are 3m high. With four of them, you can cut right across the studio, putting strings in one half and everyone else in the other half; no problem with separation. The screens have big glass windows in them so that communications between musicians are not impaired. Each artist now has an individual foldback mixer on which he can obtain exactly what he wants to listen to.

Phil Dunne then gave me a run-down of the artists who have been using the studio recently:

'Keef Hartley's big band recorded a live concert from the Marquee club. This was quite an event, with 18 musicians on stage, including some of the best jazz players in the country. I engineered the show, the producer was Neil Slavin, and the result will probably be the band's next LP on the Deram label. Pentangle have been in doing some work with Colin Caldwell engineering, and Danny Williams of

(continued on page 443)

Moon River fame has been in with producer Gil King to do a theme tune for a TV series. Medicine Head are now doing well in the charts with their *Pictures in the Sky*, which I recorded. The group consists of just two people, and is a very difficult one to record. John Fiddler plays bass drum, high hat, guitar, and also sings, and Peter Hope Evans plays Jew's harp and harmonica. The record was produced by Keith Relf, and the end result is quite fantastic. It follows their album, *Heavy on the Drum*, which was released by Warner Brothers on John Peel's Dandelion label, and both album and label are doing well.

'Cyril Tawmey, a great exponent of what they call 'real' folk music, has been doing some work with producer Fred Woods, the sessions being engineered by my assistant, Tony Taverner. I have just finished recording a double album for Chris Barber. The Barber band still conjures up a trad image, but this is in fact very far from the truth. The band is now very progressive. Some of the things they do verge on Blood Sweat & Tears, while other things would only be called classical. Everything they do seems to fit. It's strange that they're such big business in Europe—Spain, Scandinavia, Germany, Italy, the lot—while in England, it's just the 100 Club maybe once a fortnight for the hard core of jazz fans. Barber's LPs still get played on all the good review programmes, and people still buy his records, but as far as TV is concerned he gets jammed in with something like Morecambe and Wise, and ends up having to play *Petit Fleur*, or something terrible like that. It's a shame, as the LP is quite brilliant in some respects. We've just started another one with him, and it's interesting, because other artists are approaching him and asking if they can join in because they like what he is doing. Ashton, Gardner & Dyke are on some of the tracks of his latest album.

'We have had another hair-raising experience with Roger Ruskin Spear. He brought in his giant kinetic wardrobe, and frightened us to death for the second time in three months, this time doing an EP called *Ruskin Spear Comes To Terms With Trousers*. There is no doubt about it, he is very, very clever, and can make music out of the most unlikely things like tailors' dummies, mattresses, trouser presses, and so on.

'I did some things for Byg Records of France with big Greek Vangelif Papathanafiou. He is a cross between Henry Mancini and Paul McCartney, with black hair, beard, and a big crucifix around his neck. Although a muscular type, he is the most gentle person, and a most talented man. In this country, not many people have heard of him, although they know the group he used to belong to—Aphrodite's Child—but on the continent he is a highly-revered figure. He's a keyboard player, and has a Hammond *B3* along with an electric piano, electric clavinet, and a mini synthesiser. He puts them all through a 10 channel mixer he has on the organ, and puts the whole lot out with added echo if required, through a big array of stereo speakers. It's not a raucous sound, just clean, and beautifully powerful. It's got lots of depth, and he plays things, and chants. He's got a microphone which he also puts through the system. Everything takes on this huge sound, and all we have to do is to stick up a microphone, and it's all there. Vangelif did an LP of free jazz with Tony Oxley, and Tony was saying that he'd never heard anything like it before. The producer was Giorgio Gomelsky. The great thing was that, after working from 9 a.m. to 6 a.m. (no kidding) without a break, he would go out to Covent Garden, buy a crate of strawberries, and get a pint of cream from somewhere, and we'd all sit in the studio and devour.'

West of England's main studio

At **Intersound,** Honeybus have been putting voices on an album for Page International. The engineer was Vic Finch, who also worked with another Page artist, John Killigrew, adding brass, strings, and woodwind to his album. Two *Pick of the Pops* budget albums, engineered by Ian Southern, and featuring no one in particular, have just been completed for Pickwick. Ian's other recent work has consisted of Reditune material for Rediffusion International Music, and (even more exciting) a Spontaneous Combustion album produced by Greg Lake of ELP fame. This took a week to make, and is due for release quite soon. A rather unusual job about to be undertaken by this studio, which is owned by London Weekend, is the recording of an educational radio drama, which will be transmitted by the BBC.

Trident engineers Robin Cable and Roy Baker have been working with producer Richard Perry on some Neilson sessions. David Henschell was at the controls alongside producer Tony Brainsby for some work with Derek Armstrong. David also engineered Deep Purple for Purple Productions, and Mike d'Abo for Gem. Roy Baker was the engineer and Roger Bain the producer for Black Sabbath. Elton John's partner, Bernie Taupin, has been in with producer Gus Dudgeon for sessions engineered by Robin Cable, and the same desk team were at work again for Ralph McTell. Ken Scott has been engineering for America, Aubrey Small, the New Seekers, and Diana Gillespie. Ken has been doing quite a lot of work with producer Davie Bowie, and has been involved in production work as well as engineering. Penny Kramer, who deals with Trident bookings, has been enchanted by the singing of Sean Phillips, and forecasts that he is 'worth watching, because he is really going to make it now'. Therefore, more about Sean. He is an American artist, writes poetry as well as all his own ballads, and has just come here after a successful time in the States. Other artists at the studio have included T Rex, John Kongas (who is currently in the charts with *He's Going To Step On You*), the Tremeloes, Swedish actor Vjorn Anderson (of *Death In Venice* fame), Atomic Rooster, Osibisa, Ditch Cassidy (not Butch), and Raymond Froggatt.

Raymond Froggatt has also been to **Mayfair Studios**, where he has been laying down tracks for Bell Records. Director Gary Levy returned from Spain, and heard the studio sounds of Sands. Steven Arlan, who did a lot of recording and TV work in the '50s and '60s, and was singing with the big bands, went to America and made his name there, ending up on Broadway. He is now back in England, and has been recording at Mayfair with producer John Shakespeare. Other recent work has included film tracks by Pete Brown, now completed, more Ken Connor tracks for Avenue, and film music produced by Terry Warr for the film *Suburban Wives*.

For the past eight months, all the sessions at **West of England Sound Studios** in Torquay have been engineered by Tony Waldron. Elizabeth Usher, the other director of the company, is doing a full time course in Law at Exeter University, and is therefore unable to put in time at the studio.

During a hectic month, Robert Knight brought in a new group from Plymouth to put down two original numbers, and Bernard Greenaway has been in with more novelty songs. Feast booked rehearsal time in the recently opened rehearsal room below the studio, as did Elgor, a group made up of individuals from all over the country who work through the Clayman Agency of Birmingham. A new group, Quite a Bit a Lot, features Kim and Glen Turner, brothers of the Wishbone Ash bass player and singer, Martin Turner. The group laid down two new songs of their own. This session was produced by Tony Waldron, who was also responsible for the longest session of the month, featuring Together. Four songs and two instrumental numbers were recorded, the group using a new range of amplifiers and speakers soon to be marketed by the studio for GP Electronics, a local firm specialising in the manufacture of audio products. Adulphus Rebirth did some tracks shortly before a two-week closure which enabled the building of Number Two Studio to begin. This new studio will work both separately and in conjunction with the existing facilities, and should soon be ready.

West of England's mobile unit has been out again, this time for a choir and organ record shortly to be released by RA Records on their Special label.

The president of **Sound Exchange Studios,** New York City, is Orville Greene, and the vice president Bob Morgan, who has been at the studio for just over a year. Engineering vice president is Steve Katz, and the rest of the engineering staff includes Brian Condliffe, a Londoner and one time road manager for the Hollies and the Yardbirds. Brian has been at the studio for about a year, and learnt his job by working with Steve Katz. Tom Caccetta, another staff engineer, played bass with an English group, the Undertakers, four years ago, and has also been a member of the Jackie Lomax Alliance. He has now been engineering for over two years.

(continued on page 447)

AROUND THE STUDIOS

MAJESTIC Recording Studios are at Clapham Common which, while not too far from central London, is still distant enough to escape exorbitant overheads. For this reason, Majestic are able to offer eight track recording facilities for only £14 per hour, four track for £12, and stereo or mono for £10. The studio is quite large, accommodating up to 70 musicians. There are two separation booths adjacent to the studio, and the well-carpeted premises are attractively furnished. There is a licensed bar, buffet and car park and this studio must be congratulated for providing such good facilities at such reasonable rates.

I visited Majestic to sit in on a Rocking Horse session. While number one engineer, Roger (Desperate Dan) Wilkinson, went behind the desk to tone up his muscles with a chest expander, second-in-command, Alan Grandy, told me the interesting story behind the building of the studio.

AG *Mike Morton, whose Congregation is the resident band at Mecca's Orchid Ballroom, Purley, has several other interests in the entertainment field. Among other things, he runs a couple of bingo halls, one of which used to be the Majestic Cinema. The building stood neglected for about eight years, then, two years ago, Mike bought the premises, and reopened them for bingo. Last year, he had the idea of getting a small studio to do a few things of his own, and was looking around for suitable premises. Eventually, the idea ballooned out, and he decided to open a major recording studio. Then he realised that there was a lot of room going to waste at the Majestic building, as only the cinema stalls and stage were being used for bingo. Mike found that it was possible to rebuild the circle and upper circle areas into a sizeable studio suite. About £70,000 was spent on the conversion.*

KW That includes equipment and everything?

AG *Yes, the whole lot, furnishings as well. As you can see, it is very well furnished, with luxury carpet everywhere. A wall was built to block off the front of the balcony, and the separation booths, studio, and control room were built behind it.*

KW When did you open for business?

AG *We did some work last year but we found we had a few teething troubles to sort out. We decided to get a better desk and to change the control room. We eventually reopened last January.*

KW What alterations were made to the control room?

AG *Major structural alterations, and also acoustic changes. The control room used to be double the size it is now. A hallway, and what is now the reception area, were originally part of the control room.*

KW What was wrong with the control room as it was?

AG *That was before I came to Majestic, but I understand it was quite bad. It was so large in there, it was difficult to monitor at the best of times.*

KW But in theory, at least, a large monitoring room is desirable, assuming, of course, that it has the correct acoustic treatment.

AG *Yes. I don't know what was wrong, but it was put right. Eddie Veale of Acoustic Consultants was responsible for the final acoustic treatment. When we had these problems, Mike Morton employed Dave Hadfield of Maximum Sound Studios on an advisory basis to get things put right. Dave suggested certain changes and brought in Eddie. At the time, Dave was the studio's official general manager but he no longer has any connection with it.*

KW So who manages the studio now?

AG *Mike Morton runs the studio from his office at Streatham, which also deals with his other businesses. There are three of us at the studio. Roger Wilkinson is first engineer, I am second engineer, and Penny McLaughlin is our receptionist.*

KW I remember meeting Roger at Maximum Studios last year.

AG *Yes. He has worked at several other studios. He used to be at Advision, then Recorded Sound (now Nova), Maximum Sound and Spot Sound (now Mayfair). Then he came here. My previous stint was at Maximum, where I spent six months before coming here.*

KW What did you do before coming here?

AG *I used to have a band, and have been writing songs for some time. This is still my main interest. The reason I got into this side of the business was to make contacts and to get a better understanding of what goes on from the engineering point of view. I understand the other side of the business, and musically I know what I'm doing, but producing records is a totally different concept from just leading a band. Also, as far as writing is concerned, you're not just writing for an instrument, you're writing for the desk and whatever else is being used to record the material. These days a songwriter, if he's interested in the end product, which is the record, has got to know not only about production, but about engineering as well. At least, I think so.*

KW What sort of band did you have?

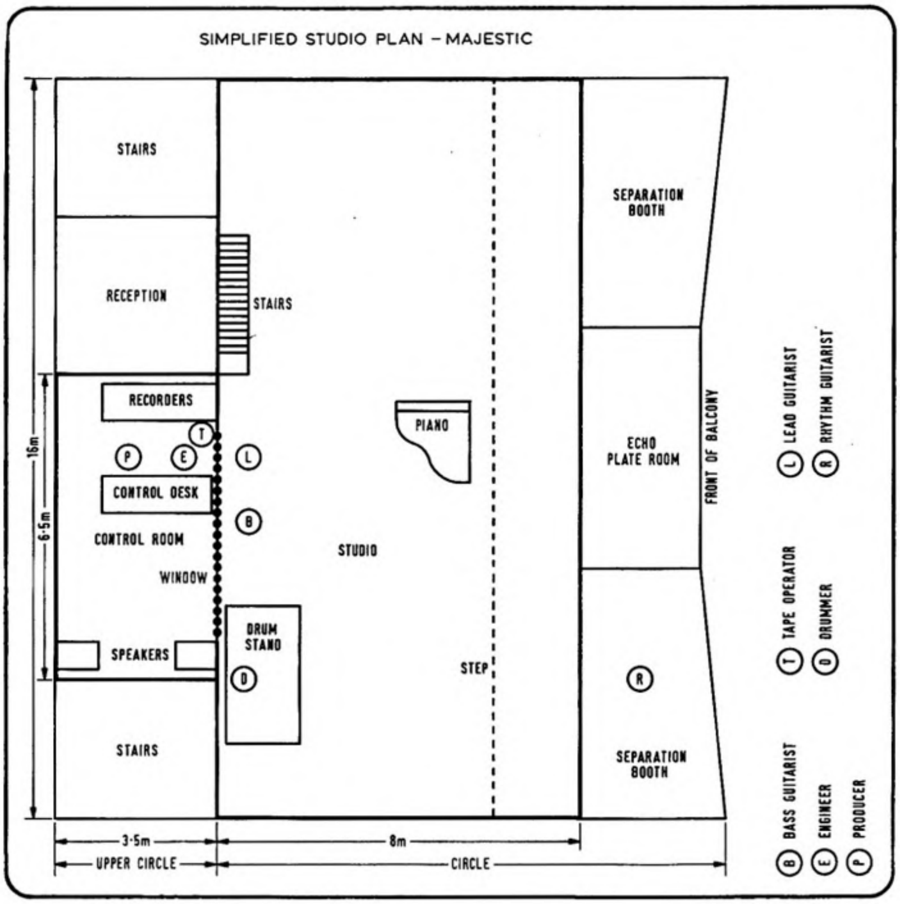
AG *In the old days it used to be a jazz combo, but it was not until I started writing that I considered a full-time musical career, and it took a long time to make the decision. I am, of course, very interested in the production side, so I tend to hear things from this angle. I have produced one or two of my own demo records, nothing very substantial as yet, but I want to do more of this kind of work.*

KW Tell me about the control room desk. Does it have all the facilities you need?

AG *Well, it's an eight track Cadac, about two years old, which we got from Morgan Studios. Its got 16 channels with full equalisation, and there are three built-in Pye compressors. We also have some separate equalisers by Audio & Design, and some limiter/compressors by the same firm. It's one of the first desks by Clive Green, Cadac's chief engineer, so it's a very basic desk, and probably one of the quietest ones*

Majestic

by Keith Wicks



around. Quite honestly, there are lots of facilities it doesn't have that we'd like. The monitoring facilities are rather limited, and we can't put echo on monitor, although it's not really essential to be able to do that.

KW But are you thinking of getting a new desk?

AG *We intend to go 16 track as soon as possible, and when we do, we'll probably get a new Clive Green desk.*

KW And recorders?

AG *We have mono, stereo, four track and eight track machines, all Ampex. When we go 16 track, we'll probably convert the eight track model. It's already fitted with 50 mm guides. We're also thinking of a reduction suite, but that will come after we have a 16 track studio.*

KW The desk you have at the moment would then be used for reduction?

AG *That could well be, but all this is in the future. At the moment, most of our time is spent in getting the studio off the ground, and the money is just starting to come in.*

KW I must say I like this sound here. Not as harsh as at some studios I could mention.

AG *We use Cadac 100W amplifiers feeding a pair of Altec Lansing speakers in Cadac cabinets. They are the same kind of speakers as used at Nova Studios.*

KW What microphones do you use? Neumanns and AKGs, like most other studios.

AG *Neumanns, AKGs and also Beyers. We keep a good range.*

KW How are you miking up the drums for this session?

AG *We've put an AKG D12 on bass drum; the snare drum and high hat are covered by an AKG C12; a Beyer 500 is used for the large tom-tom, and the rest of the kit is covered by a Neumann U87. This is a pretty normal set-up for us.*

Far left: Roger Wilkinson on Cadac.
Centre left: Alan Grandy on *MM-1000*.
Centre right: Alan Grandy on Cadac.
Right: Alan Grandy on percussion.

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

KW I see you have a special stand for the drummer.

AG *It's just some acoustic padding built into a wooden framework mainly to stop the cymbals splashing all around the studio.*

KW Was that Dave Hadfield's idea? The reason I ask is that I know that he used to play drums in a group, and is particularly concerned about getting a good recorded drum sound. At Maximum he uses a partially screened rostrum, which apparently works quite well.

AG *I don't know who designed our drum stand, but it certainly works okay.*

KW As you have two booths, I thought you might have put the drums in one of them.

AG *At the moment, the booths are acoustically much too live for that. The ceilings and walls are much too hard, and I think the drums would probably be unrecognisable in there. We plan to make dramatic changes in the acoustics eventually. Another thing is that, from the musicians' point of view, it is preferable to place them fairly closely together if possible.*

KW So why the rhythm guitar in a booth?

AG *It's an acoustic guitar, and we've done this to get good separation as well as a particular sound. Jimmy Campbell, who is playing the rhythm guitar, is the main writer for the group. Billy Kinsley, the bass player, used to be with the Merseybeats. He also writes some of the numbers. Bob Falloon is on lead guitar, and getting a good effect here using a wa-wa unit. The drummer is Stan Gorman, and the group are just doing the final track of their first LP for Philips with producer Hal Carter. Most of the tracks on the album were written by Jimmy, although Billy did write one or two.*

KW Do you have any instruments available for groups to hire?

AG *We have the usual grand piano in the studio free of charge, and there is a Lowrey organ with a 50W Leslie speaker. For this we charge £5 per session, regardless of duration. There is also an electric piano which can be fed through the Leslie to get a rather nice effect. It takes the sharpness off, and if you're doing things with just a few instruments, it gives a nice roundness. If you've got lots of instruments, I think it's better to keep the edge on it, and just put it through a straight amplifier. We also sometimes put a guitar through the Leslie. I know that Hank Marvin is rather keen on doing that at the moment.*

KW Your facilities are very good, especially considering the low charges. I suppose you can use the hall downstairs for recording live shows.

AG *We haven't done any yet, but our publicity man, Roger St. Pierre, tells us that there is a possibility we may be recording a live show here featuring one of the top British groups. We have seats for about 1,000 people, so the hall could prove quite useful.*

KW Any other plans for the future, besides going 16 track and building a reduction room?

AG *There are numerous ideas under consideration, such as building a roof top cafe, both for clients and outsiders.*

KW Things seem to be going well for you, in spite of the fact that you started in January, when work was relatively difficult to come by. I think that Majestic has a great future.

STUDIO DIARY continued

Equipment at this studio includes a 16 track Ampex *MM 1000*, with custom-built doors to protect it from accidental damage, and a console with KLH *Model 6* monitoring speakers and Ampex remote control facilities. The 32 microphone preamplifiers are fitted with variable attenuators, controls for two cue systems, and echo monitoring facilities. This desk was built by Daniel N Flickinger of Hudson, Ohio.

Steve Katz and Richard Factor have come up with a digital tape timer which reads in minutes and seconds, and has the capability of searching for predesignated locations on the tape. I seem to have heard this somewhere before.

The list of artists at the studio over the last year includes Joe Cocker, Jimi Hendrix, Shirley Scott, Chuck Berry, Ike and Tina Turner, Ten Years After, Ramsey Lewis, Dave Von Ronk, Paul Butterfield, and John Mayall. Can't be bad.

The **Jack Clement Studios** in Nashville, Tennessee, have been busy with work for the Royal, Capitol, Heartwarming, Barnaby, Dot, Autumn, Mega, and Decca Record Companies. George Richey produced Sonny James and also the Stonemans for Capitol, and Ray Stevens has been in again completing his own album, and producing for Payton Hogue. Bob MacKenzie produced both the Singing Rambos and Dot Rambo for Heartwarming Records.

RPM Studios, Johannesburg, are a division of the Record Producers and Manufacturers group of companies, active in record production and retailing, film production, and CCTV. The studios were set up in 1968, and were designed and built by the company's chief engineer, Geoff Tucker. The main studio was equipped with a Neumann mixing console with 20 channels and four outputs. Recording equipment consisted of four track, two track and mono Studers. The radio production studio has a six channel RPM desk feeding a Studer Pilotone machine. Both studios are equipped with CCTV for post sync music or speech dubbing. In 1969, a preview/dubbing theatre was added, equipped with two Cinemechanicca 35 mm projectors, one 16 mm projector, three Magnasync 17.5 mm recorders, and a 10 channel RPM mixing desk.

Sound Exchange Studios (New York) console with KLH *Model 6* speakers and Ampex remote control.

RPM Studios have been responsible for the mastering of recorded material for the RPM Record Company, and the recording of music for the soundtracks of RPM Film producers. Since January 1971, the recording studios have been extremely busy producing material for outside production companies in the jingle, film and record fields. This includes a new series of jingles for Groovy, music tracks for independent film producers, electronic music for Protea Films, and a quadraphonic recording of electronic music for Potchefstroom University.

The studio purchased a *VCS3* Synthesiser in November 1970, and has since put it to good use in the production of an LP of classical music under the supervision of resident composer, Mike Hankinson. This has been accepted for release on the A & M label for the Western Hemisphere, Australia, and the Far East.

In the pop field, the studios have taken on Chris Kritzinger from Brussels, who produced material for the Polydor, Ronnex, and Pallette labels. His South African production of *Rain, Rain, Rain* is 14 in the local charts. At the moment, Chris is busy looking for material for the local Afrikaans scene.

The staff are now busy modifying the main studio desk for 16 track work, and await the arrival of their Studer *A-80-16*.

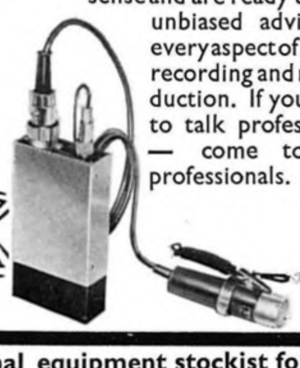
J. J. Francis
THE PROFESSIONAL FOR PROFESSIONALS

NAGRA III's URGENTLY REQUIRED FOR CASH

We are the acknowledged off-the-shelf stockists of NAGRAS and accessories for immediate delivery

Sennheiser, A.K.G. and Audio Radio Mikes

We carry an extensive range of SENNHEISER, A.K.G. and Audio Radio microphones and have knowledgeable sound sense and are ready to give unbiased advice on every aspect of sound recording and reproduction. If you want to talk professional — come to the professionals.



IMMEDIATE DELIVERY *ON ALL PRODUCTS*

The professional equipment stockist for SENNHEISER, A.K.G., BEYER, AUDIO-RADIO MICROPHONES, PERFECTORS, etc.

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

HOLLICK & TAYLOR RECORDING Co. Ltd.

RECORDING PROFESSIONALS OF THE MIDLANDS

8-Track 4-Track 2-Track
Stereo-Mono Recording
Leevers-Rich—Studer—Stereo Nagra
Neumann and AKG Microphones
Comprehensive Mobile Unit
Independent Production
Demos and Pressings
Producers of Grosvenor Records

HOLLICK & TAYLOR
16 Grosvenor Road, Handsworth
BIRMINGHAM 20
021-356 4246

LEVEL CONTROL EQUIPMENT

Superb Performance—moderate cost

F600-M Mk 2

Limiter/ Compressor

A Mk. 2 version of the well established F600 unit. Gain within the system is normally 25dB with output level of 0dBm (+8dBm to order). Compression ratio better than 25:1; variable attack and release controls with auto network. Noise–70dBm. Response: 10Hz–50kHz for –3dB. Distortion: 0.1% for 25dB reduction at 1kHz.

also available
F700 Compressor/Limiter and E800 Equaliser.

Audio & Design (Recording) Ltd.
St. Michael's, Shinfield Road, Shinfield Green,
Reading, Berks. *Telephone:* READING 84487 (STD 0734-84487)

RECORDING STUDIO TECHNIQUES

QUADRAPHONICS *by Angus McKenzie*

I WAS recently asked to record a public concert at St. John's, Smith Square, as an audition tape for the choir. Although all that was required was ordinary stereo, I took the opportunity to tape the event in quadraphonic sound to see how this would cope with the superb acoustics of St. John's.

Two AKG *451E* cardioid capacitor microphones and two Calrec *1050* were used with the capsules mutually 90° in a horizontal plane, the forward facing pair pointing to left and right of the orchestra. The capsules were placed as close together as possible. The four balanced outputs from the mike were taken to a mobile quadraphonic mixer specially designed for the purpose, and the line outputs from the mixer fed into two Dolby *A301* systems, thus Dolbying all four tracks on a Sony *3664*, recording at 19 cm/s on BASF *LH* tape, with the machine's NAB curve of 50/3,180 μS. The peak recording level shown by the PPMs was approximately 510 pW/mm. Although many of the tetrahedral systems being tried out might in theory give a better spherical coverage, the practical difficulties of arranging large speakers correctly for playback rather tend to make such a system impractical. In any case, a study of the polar diagram of even the best loudspeakers shows that there is a danger of high frequency holes in the middle at any wider than 90° angles (as Bob Auger has already pointed out). A microphone configuration has to be chosen which suits the particular conditions. However, experimentation is not always possible, and I am not sure that I agree with his theory that a multi-mike balance can have a coincidental mike added to it instead of adding spot mikes to the output of a coincidental mike. Nevertheless the difference between the two techniques is subtle. On this occasion I was most grateful for the assistance of Basil Lane, Ian Hardcastle and Jim Eyres, as well as that of my own colleague, Ren Hunter.

After listening to the replay of the quadraphonic recording it was generally agreed that the realism and musical satisfaction achieved by this means were considerably greater than with a two-channel 38 cm/s Dolbyed recording. The soloist in Dvorak's *Inflamatus* and in Brahms's *Alto Rhapsody* had just the right perspective against the orchestra, and we did not think that extra pan-potted mikes would have improved reproduction of any of the performers. It was possible to obtain a great depth to the sound, the choir sounding behind the orchestra but perfectly clear and realistic.

Initially some listeners thought that, although the sound was exciting, the quadraphonic effect created did not produce obvious sound sources from behind. As soon as the rear speakers were cut, however, everyone agreed that the performance fell flat. The psychological effect can therefore be described as an increase in realism rather than impact, showing up ordinary stereo as the poor relation only when the quadraphonic element is removed. This brings me to the point that, having heard quite a lot of commercial quadraphonic sound, I have been bitterly disappointed with much of it. Many American engineers in particular seem to want to use it for extra effect rather than realism. I have a quadraphonic recording of a Chopin piano concerto which places the listener's head inside the quadraphonic piano and it sounds quite ridiculous.

Manufacturers have still to produce effective mounting systems for quadraphonic grouping of capsules, although AKG are seriously considering making a quadraphonic version of their *C24*. Each capsule, a back-to-back cardioid, will have independent connections giving four such cardioids with their axes mutually at 90°. Each of the sections will have its own FET amplifier. An external control box will allow the mike to be used conventionally in any two-channel stereo configuration if required. John Mosely of Command Studios experimented with this idea some years ago using a Neumann *SM2* microphone. Apparently this worked quite well although it only proved suitable for locations where natural reverberation could be obtained from the back of the church or concert hall, not for the recording studio where acoustics are somewhat dead.

On mobile recording sessions, the control of natural reverberation pick-up is most important and it is necessary to know one's microphones well. This applies particularly to the variations in polar diagram which can be achieved with such microphones as the AKG *C24*, *C12* and Neumann *SM69*. If a single coincidental mike is used, the distance from performers to microphone controls not only the amount of reverberation but the distant sound pick-up and the width of the sound stage.

Assuming that the microphone is set with the capsules mutually at 90°, the crossed figure-of-eight characteristic will give the greatest stereo width, but produces at the same time a high degree of reverberation pick-up. If, in order to reduce the reverberation pick-up, it is desired to work closer to the artists, performers at the extreme left and right edges may be picked up in the false (i.e. out of phase) quadrant of the coincidental microphone. The result is to produce more of their output in the difference channel than in the sum channel. This not only produces a rather undesirable sound quality but makes it more difficult to cut on to disc, since the overall cutting level may have to be reduced. It is of course possible to correct this by subsequently reducing the difference channel but, as this is equivalent to narrowing the angle between the two capsules, it will be found that the balance will favour the performers in the centre at the expense of those at the side. This can only be corrected by an increase in the angle between the capsules and an appropriate simultaneous change in their polar diagram characteristics. For example, an angle of 120° is approximately suitable for a hypercardioid setting, often referred to as cottage loaf. For these reasons it is true to say that there are relatively few correct positions for a coincidental microphone which will give both a full width image (or whatever width of image is required) and a given required reverberation pick-up.

In churches the organ is usually found either to the side or rear of the building, while the musical performers are situated elsewhere. Unless the engineer is extremely lucky in his location, it is very difficult to obtain an adequate balance between organ and performers. The organ will therefore require independent mikes. A single mike used on the organ and pan-potted to the appropriate position will tend to sound as if it had a point source, and therefore a pair of mikes are to be recommended. An organ will not normally be required to use the full width of the sound stage. Cardioids have an element of cross-talk and will give a good sound when balanced correctly and set at 90°. However the addition of these mikes to the general balance will introduce further reverberation pick-up from the building, and consequently it becomes necessary to reduce the reverberation from the main mikes in compensation.

I had to use separate microphones for an organ in a recording of Bach's motets. I placed the choir at the altar end of the church about 25m from the organ. The main mike was an AKG *C24* stereo capacitor on a boom about 3m above floor level. The organ mikes were two *451E* capacitors at 90° to one another and nearly 10m above floor level. These mikes had to be very carefully positioned. This meant a compromise between balancing the sound from all the organ pipes at their different heights, keeping a fair distance from the organ, and avoiding excessive reverberation. I found that I had to alter the polar diagram of the main stereo mike to compensate for the chosen level for a particular organ piece. This gave approxi-

(continued overleaf)

mately the same reverberation for each piece, with certain exceptions where the producer required more or less reverberation to suit the character of the particular motet.

What was especially noticeable about the technique was the accuracy with which all the performers in the choir were placed, together with a sense of depth in the sound. Multimike enthusiasts might well have close-miked the different sections of the choir and used separate reverberation microphones. However, I feel that such a technique would not have given the accuracy of positioning or the sense of depth that the comparatively simple technique that I used gave, although it may have been initially more difficult to balance. Although it took 30 minutes to balance on the first session, the performers were rehearsing anyway, and nearly 80 minutes of music was recorded in only four three-hour sessions. It was found that in practice almost no level control was necessary for any of the recordings and only on one occasion did the recording level reach a higher level than intended. The reason on this occasion was a 4 dB increase in vocal level between two takes of the same piece of music.

There are several dangers in using coincident stereo microphones in churches, not the least of which is that of heavy reverberation approaching the microphone from the sides and entiring the false quadrant out of phase. A typical example of this would be the use of a stereo microphone placed 3m above floor level between two sets of choir stalls spaced some distance apart. Should the choir stalls run in line with the longest length of the church, a considerably higher proportion of reverberation will hit the side of the mike from the main area of the building and this will sound most peculiar, quite apart from the fact that it will be largely cancelled out if the tape or disc is subsequently reproduced in mono. A further disadvantage is that the singers in the choir stalls on the rear pick-up side of the microphone will have their positions reversed with respect to the front side. Under such circumstances a coincidental microphone would therefore be better placed rather higher up and back from one end of the stalls, looking down on the choir. Such a configuration would present an excellent antiphonal effect in the recording and, with careful control of the reverberation pick-up, the sound produced should not only be very pleasing to listen to but should also prove suitable for the Hafler system, using a rear difference channel.

This brings me to my final point. Coincidental microphone stereo has a far greater potential for the derivation of effective fake quadraphony than multi-mike stereo. To prove this, I recently played a number of early EMI stereo disc recordings, such as those made by Sir Thomas Beecham. I consistently obtained a considerably better quadraphonic effect than could possibly be derived from most modern stereo recordings made with a multimike balance. Over the last few years any number of dreadful fake stereo records have been made from what were good mono recordings. Thus the importance of being able to extract good fake quadraphonjc information from current stereo recordings should not be overlooked.

by Peter Levesley*

designing a studio mixer

PART THREE CIRCUIT CONSIDERATIONS

IN the previous article we saw how, if we could discover a microphone's output voltage under different conditions, a preamplifier could be designed which would operate with acceptable distortion in any tolerable environment (tolerable to musicians that is). It was shown that most high quality 200 ohm dynamic microphones generate the same sort of output voltage level under the same conditions and we decided that the following characteristics were needed:

- Input Impedance of about 600 ohms.
- Maximum input before overloading of about 80 mV rms (–20 dB).
- Self-generated noise equivalent to an input signal of about 0.4 μV (–125 dB).
- Capability of accepting 'balanced' input signal.
- Overall gain of about 1,000 times (60 dB) with gain control at maximum.

We deduced that the optimum arrangement was to divide the gain of the amplifier between two stages connected by a gain control. In this article I intend to clarify some basic ideas and develop designs for practical circuits which operate on these principles.

First stage amplifier

Fig. 1, repeated from Part Two, shows the design I set up as an illustration of what was wrong. The undesirable features could be summarised thus:

- Too much gain.
- Too high an input impedance.
- Too much self-generated noise.

We could tackle each of these problems in turn but in this case what we need is a technique which does everything at once. Fortunately there is such a technique: negative feedback, applied in a manner known as the Virtual Earth Method.

Virtual earth amplifiers

This approach to Virtual Earths is essentially a non-mathematical one and any shortcomings in it can be blamed on myself. For the moment, let us not bother about the difference between resistance and impedance and merely remember that Ohm's law applies to both of them. Also we can make a resistor behave as though it has a value different from that printed on its body. **Fig. 2a** shows a simple example. Here we see a resistor marked 'R' in series with a meter and a battery of B volts. We produce a voltage between P and Q of the same polarity as the battery B but with a voltage one tenth of B less—and the final result is a voltage of about 0.1B volts across the resistor. Normally we would expect that a battery of 10V connected in series with a resistor of 10K produces a current of 1 mA. However, instead of 10V drop across R, we have 1V drop. In other words, we have made a 10K resistor look like a 100K resistor.

Similarly, in **fig. 2b** we can see that, by reversing the polarity of the battery within the box and by making it nine times the voltage of battery B, the resistor R can be made to look like one tenth of the value printed on it.

FIG. I

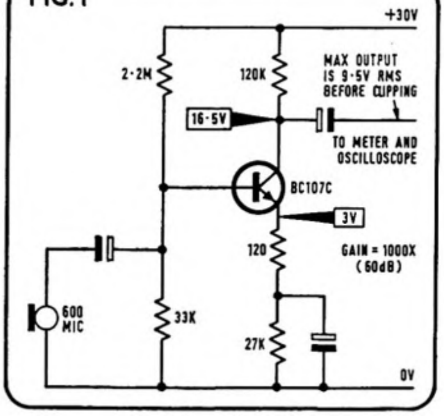
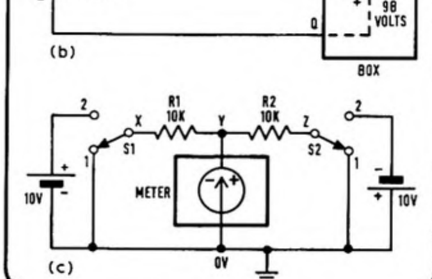


FIG. 2



Theoretical circuit

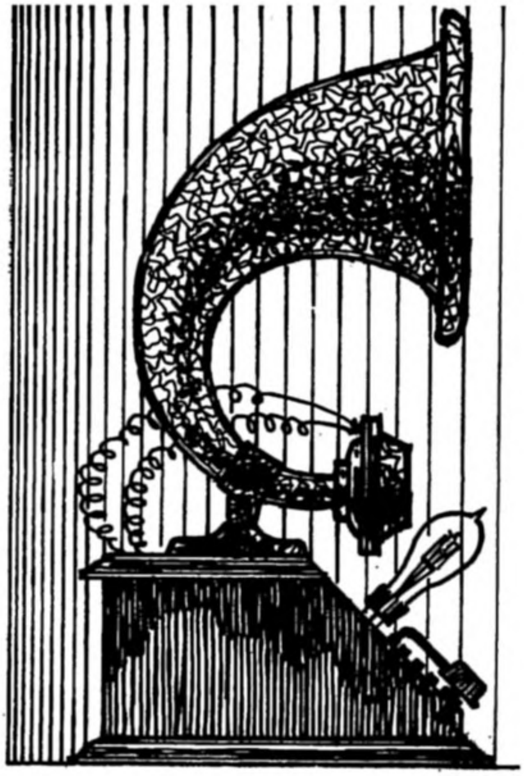
Fig. 2c shows a circuit arrangement that should be of some assistance to the understanding of many of these concepts. Here we see two resistors, R1 and R2. They are each equal to 10K and they are connected in series. To the centre point labelled Y, we have connected a meter. This is a high impedance meter the scale of which is centre zero reading. To the other ends of each resistor, we have connected a single-pole changeover switch. The switch will either connect to the common side of the meter or to a battery terminal. The batteries are of equal voltage (10V), but are connected with opposite polarity. With both switches set to position 1, as shown in the diagram, the meter will read zero. If S1 is changed to position 2, leaving S2 as it is, a current will flow through R1 and R2 in series and generate a voltage at point Y which will be read by the meter. This voltage will be 5V because R1 and R2 act as a potential divider. If we return S1 to position 1 and switch S2 to position 2, the meter will read in the opposite direction, again 5V. What will happen if both switches are set to position 2 simultaneously?

We have already seen that currents due to battery 1 deflect the meter in a positive direction and currents due to battery 2 deflect the meter in a negative direction. With both batteries connected simultaneously, therefore, the currents generated will oppose one another, producing a deflection on the meter of zero. Although we have a total of 20V available in the circuit, the reading on the meter is 0.

Let us imagine that battery 1 is not aware of the existence of battery 2 and its associated switch, but we have arranged things so that when switch 1 changes over, switch 2 changes over as well. We would have the rather surprising result that, applying 10 volts to R1 will produce no deflection on the meter. We would assume from this that point Y is shorted to the common point of the two batteries. We can therefore make the following general statement: if the resistor values are equal and the battery voltages are always equal and opposite then, no matter what these battery voltages are, point Y will always stay at 0V. We can call point Y a node point. Since it makes no difference whether battery 1 is connected positively or negatively, then we could just as easily use alternating voltages provided that they are always in opposite phase at opposite ends of the system. In AC terms, zero volts could be called earth, thus point Y is always virtually at earth point. It is a **virtual earth point.**

(*continued on page 453*)

* Walsall Timing Developments



when you buy

Celestion Studio Series

Loudspeakers for the Perfectionist

you enjoy the sound experience of 47 years

Take a look into a Celestion Ditton 15 and you will appreciate the skill and care which goes into the design and manufacture of Celestion's marvellous Ditton high fidelity loudspeakers.

Meticulous attention to detail, from the superb furniture finish right through to the precision engineering at the heart, ensure the quality for which Celestion are world renowned.

For the sheer enjoyment of your favourite music the Celestion Sound Experience has no equal. Just send your name and address and full details will be mailed at once.

Celestion

ROLA CELESTION LIMITED

DITTON WORKS, FOXHALL ROAD, IPSWICH, SUFFOLK IP3 8JP

Please mail details of all the Dittons. SS 10

Name

Address

Fig. 3 shows the conditions in the circuit in the form of a graph. Resistance is marked along the horizontal axis in thousands of ohms. The vertical axis represents voltages. The simple case is shown where point X is 10V positive, point Z is 10V negative and point Y sits in the middle at zero volts. The opposite polarity case is shown in dotted lines. If R2 were made 20K instead of 10K, then it would be necessary to make battery 2 a 20V battery in order to keep point Y at no displacement. This condition is shown in broken lines at the point Z′.

We can see, therefore, that the voltages at each end of this voltage see-saw pivoted about the point Y are in the same ratio as the resistor values between each end and point Y. There is an electronic circuit which, when a voltage is applied to the network at point X, can be made to detect the degree of displacement at point Y and generate a suitable compensating voltage at point Z which will cause minimum displacement at Y. Such a circuit is known as the virtual earth amplifier and is the basis for most of the amplifiers used in a mixer system. The amplifier needed for this operation would have the following characteristics:

a) A sufficiently high input resistance that it does not load the node point excessively.

b) A sufficiently low output resistance that the network has negligible loading effect on the output voltage.

c) It must invert the input signal.

d) It must have a high gain.

It will be seen straight away that these requirements are non-critical. This implies that the circuit would be virtually independent of amplifier performance and would depend almost entirely on the ratio between two resistor values, which is a rather healthy situation from the point of view of long-term stability.

In our original example with the batteries the circuit behaves exactly as if a 0 ohm resistor were connected between the node point and earth. In the case of our virtual earth amplifier, however, the resistor can appear to have some finite value which depends on the value of R2 and the gain of the amplifier.

Fig. 4 shows a circuit arrangement which illustrates the virtual earth amplifier. The operational amplifier is labelled –A. This indicates that it inverts the input signal. Let us imagine that this amplifier has a gain of 1,000 times. If we feed in a signal of 1V rms at point X, the gain of the amplifier will be such that the inverted voltage at point Z will make the displacement at Y appear minimal in comparison. We know, since the amplifier has a gain of 1,000 times, that the voltage at Y must be $\frac{1}{1{,}000}$ of the voltage at Z. Also the voltage at X and the voltage at Z are very nearly the same, because R1 equals R2. Therefore, the voltage at Y must be about 1 mV. We have lost 999/1,000 of our signal across R1, and it seems as though a resistor of 10 ohms is connected between point Y and earth. There are no resistor values in the entire circuit anything like 10 ohms and so we have produced an imaginary resistor *approximately equal to the value of R2 divided by the amplifier gain.* Since this is the case, we could make this resistor any value we like by altering the amplifier gain and R2. The value of the imaginary resistor is not affected by R1. Negative feedback has reduced the input impedance of the overall system to a value of our own choosing. We can, thus, make it 600 ohms if we like and this can be used as the load for a microphone.

FIG. 3

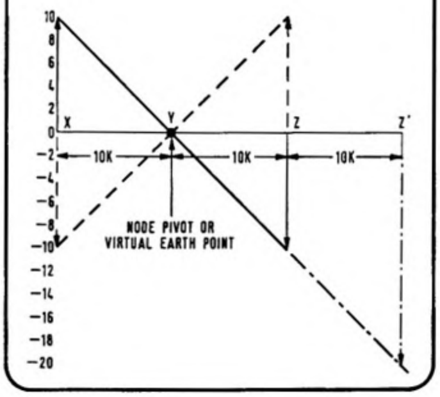
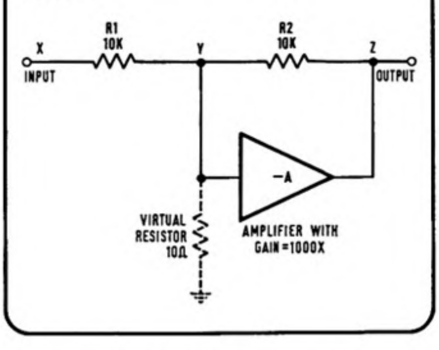


FIG. 4



The system has an added advantage that this imaginary resistor is also seen by the amplifier as its source resistance and 600 ohms is approximately the sort of value that produces the lowest self-generated noise in the amplifier.

Practical designs

In this section, we get down to practical designs for microphone amplifiers. Two possible alternatives are available and they have the following features in common:

1. There are two sections to the amplifier, connected by a gain control. The input section has a gain of approximately 100 times (40 dB) while the output section gain is 10 times (20 dB). Each amplifier section is a variation of the virtual earth principle, the input section being designed for low noise and low input resistance. The output section is designed with the accent on fixed gain and low output resistance.

2. The printed circuit card will fit to a Painton 15-way connector which, together with the chassis mounting socket, form a very robust mounting system. The design of the connector pair is such that no board guides will be needed and polarised guide pins ensure that the board cannot be reversed in the socket by accident. For a permanent wired application the board can be fixed to the panel by small brackets and wire connections made to the row of terminal holes. This method of mounting will be standard throughout the whole range of cards available to go with this series.

3. The two boards are interchangeable, connections having been kept on the same pins where necessary.

4. The output section can be switched to operate from the input section or from a separate high level input. This would give the facility of a microphone/line changeover.

The principal difference between the two designs is that the first type *MPA1* can be used either with or without its input transformer while *MPA2* cannot be used without the transformer. A brief circuit description of each type follows.

Tr1 and 2 form the operational amplifier for the virtual earth circuit, the open loop gain being set by the ratio between R4 and R5. R3 is the feedback resistor corresponding to R2 in fig. 4. R1 is here represented by the impedance of the microphone. The virtual earth resistance, as we said before, will be given by $\frac{R3}{Gain} = \frac{100{,}000}{150} = 666$ ohms. This is in effect in parallel with R1 and the resistance 'seen' by the microphone will be 666 ohms in parallel with 5.6 K, near enough to 600 ohms.

The feed to the selector switch is taken from the emitter of Tr2 via C3. R7 is included to keep C3 charged and in this way clicks which occur when the switch is operated can be

(*continued on page 455*)

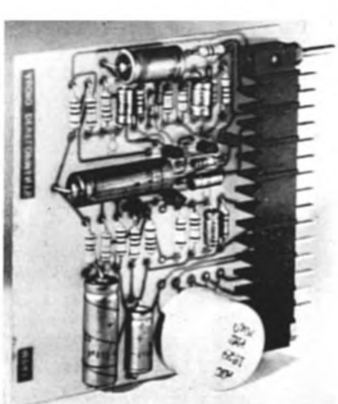


FIG. 5
MPA1

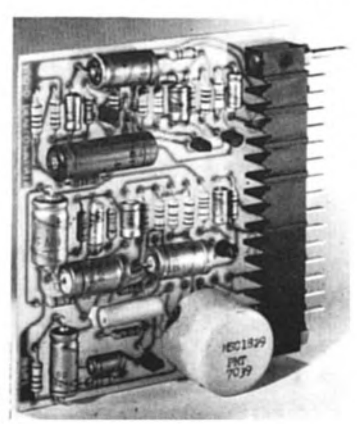
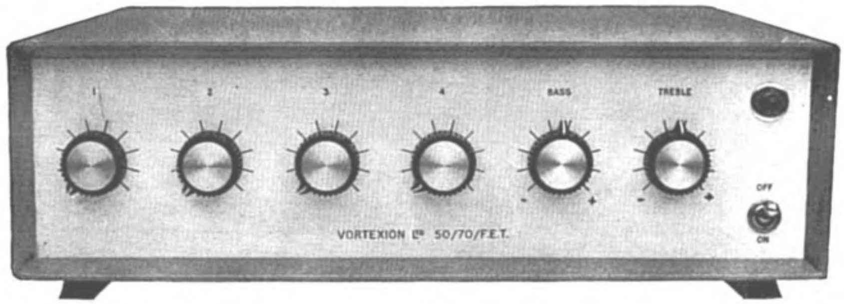


FIG. 6
MPA2

Vortexion

THE VORTEXION 50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4-WAY MIXER USING F.E.T's

This is a high fidelity amplifier (0.3% intermodulation distortion) using the circuit of our 100% reliable—100 Watt Amplifier (no failures to date) with its elaborate protection against short and overload, etc. To this is allied our latest development of F.E.T. Mixer amplifier, again fully protected against overload and completely free from radio breakthrough. The mixer is arranged for 2-30/60Ω 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.



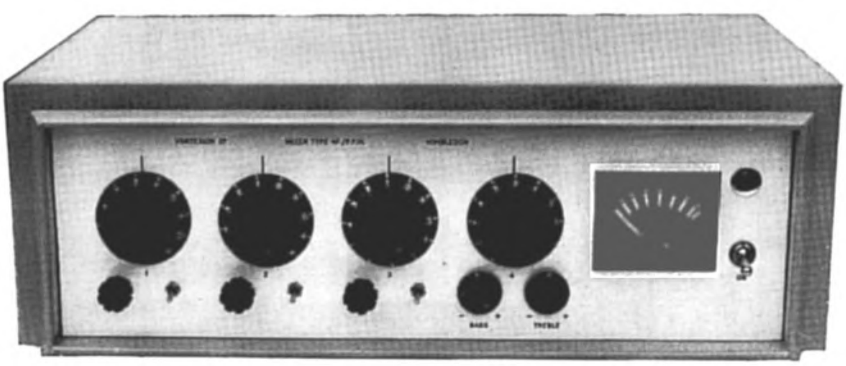
50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 5-WAY MIXER USING F.E.T's
This is similar to the 4 way version but with 5 inputs and bass cut controls on each of the three low impedance balanced line microphone stages, and a high impedance (10 mg) gram stage with bass and treble controls plus the usual line or tape input. All the input stages are protected against overload by back to back low noise, low intermodulation distortion and freedom from radio breakthrough. A voltage stabilised supply is used for the pre-amplifiers 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 100 V balanced line or 8/16Ω output are selected by means of a rear panel switch which has a locking plate indicating the output impedance selected.

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

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

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

F.E.T. MIXERS and PPM's



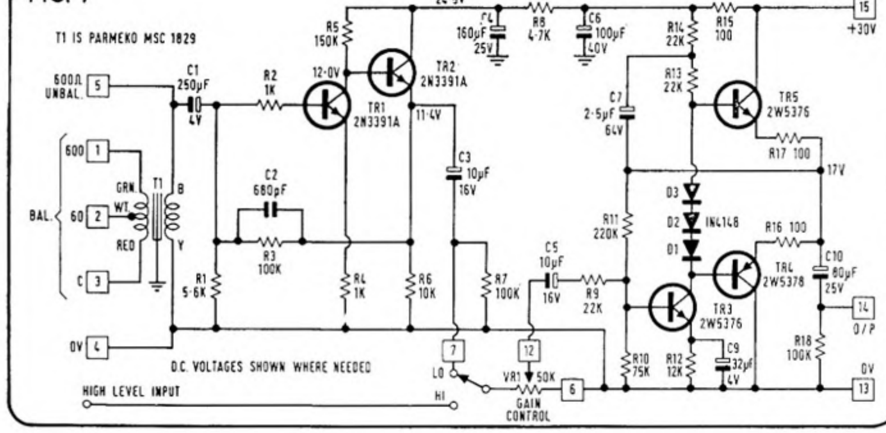
Since we have been supplying professional mixers for 25 years we have delayed the introduction of solid state units until they were at least as good as their valve counterparts. (Which will continue where required.)

The various sections of the FET mixers and BBC type PPM's have been performing successfully for several years in other equipments with complete reliability. The PPM also uses an FET in its time constant circuit so that polyester capacitors can be used. The response from the 600Ω output (25Ω source impedance) is level 20 Hz to over 30 kHz with very low intermodulation distortion to zero level +12 dB. The input signal voltage range is over twice that of the valve unit and the noise at least halved.

VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, S.W.19

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

FIG. 7



avoided. In this case, a 50K potentiometer is used as this would make a suitable load for a high resistance device such as a guitar pickup.

The output section is a power amplifier with an output capability of about 8V rms across 600 ohms. The gain between pins 12 and 14 is 20 dB, established by the ratio between R11 and R9. The output transistors form a complementary pair. This ensures good signal handling capability on the positive and negative half cycles of the output waveform, the standing bias current being about 2 mA.

The noise output of the whole amplifier is worse with the microphone connected than without, due to the fact that the amount of negative feedback from Tr2 emitter to Tr1 base is altered. With the microphone plugged in the total amount of this feedback is reduced because the impedance of the microphone appears in parallel with the virtual earth resistance. These two, together with R3, form a potential divider which controls the negative feedback voltage. This effect is undesirable in the lowest noise amplifiers and the problem has been overcome in the following design.

Improvements have been made to increase the overload point (Richardson) and to alter the gain without affecting the input impedance. Variations of output noise with input loading have been overcome by balancing out the effects of two negative feedback loops. **Fig. 11** may help readers understand how this has been achieved. It is not possible in this case to point to any one resistor and claim that it is equivalent to R2 in **fig. 4** because the operation is complex. There are two main feedback paths as shown in **figs. 11a** and **b.** The fragment of **fig. 9** shown in **fig. 11a** contains only those components which are effective in the feedback path when no microphone is plugged in. We can neglect the effect of C1 and C6 at mid-frequencies and voltage V1 is the fraction of the output voltage fed back. The transformer plays no part at this time because, with no load across the primary, the secondary impedance is very high and no signal currents are passed through it. With no input load or signal, then, the feedback resistor is R5, which controls the gain and therefore the noise level.

When the input is loaded by the impedance of the microphone, as in **fig. 11b,** the resistor shown dotted represents the reflection of this input load across the secondary. As with the *MPA1*, the feedback by the direct path through R5 is reduced which would give an increase in gain and noise level. However, in this second case, a further fraction of the output V2 is developed across R9 and fed back to the base of Tr1 via the now-reduced secondary impedance of T1. This forms a subsidiary feedback path which compensates for the increase in gain, reducing the gain and noise level back to the unloaded condition. In this way, the noise output level is held constant, despite variations in input load.

The gain control is made 10K, in this case to act as the correct bridging impedance for 600 ohm lines and a transformer could be connected to the high level input to provide balanced operation on this function as well. The output section is as before, the gain being slightly higher to compensate for the reduced gain of the input section compared with *MPA1*.

FIG. 8

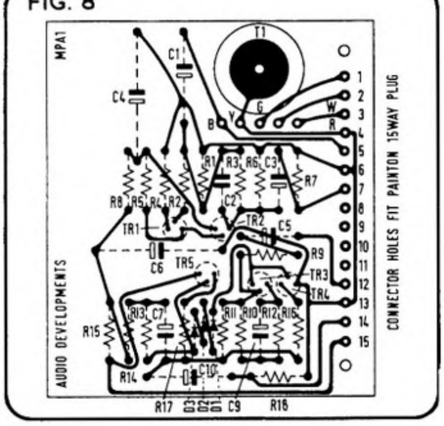


FIG. 10

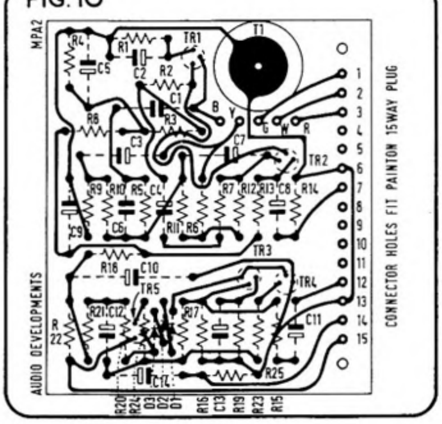


FIG. 11

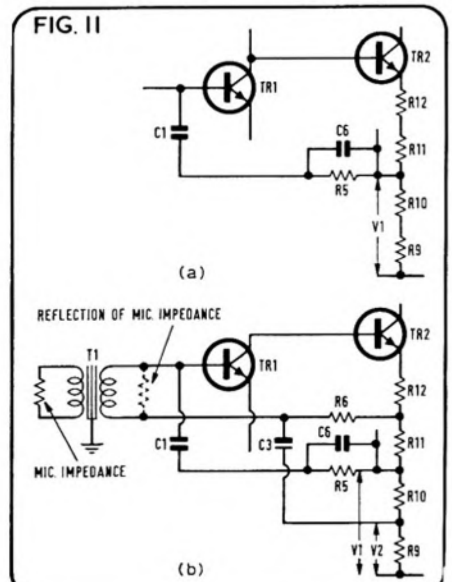
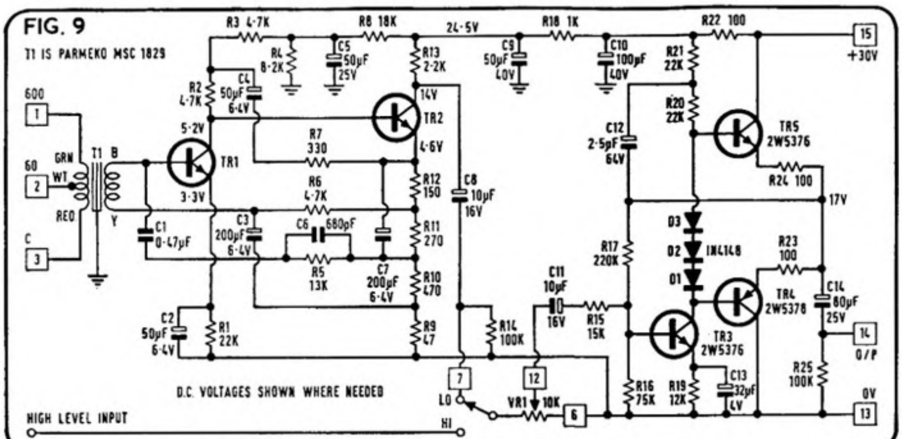
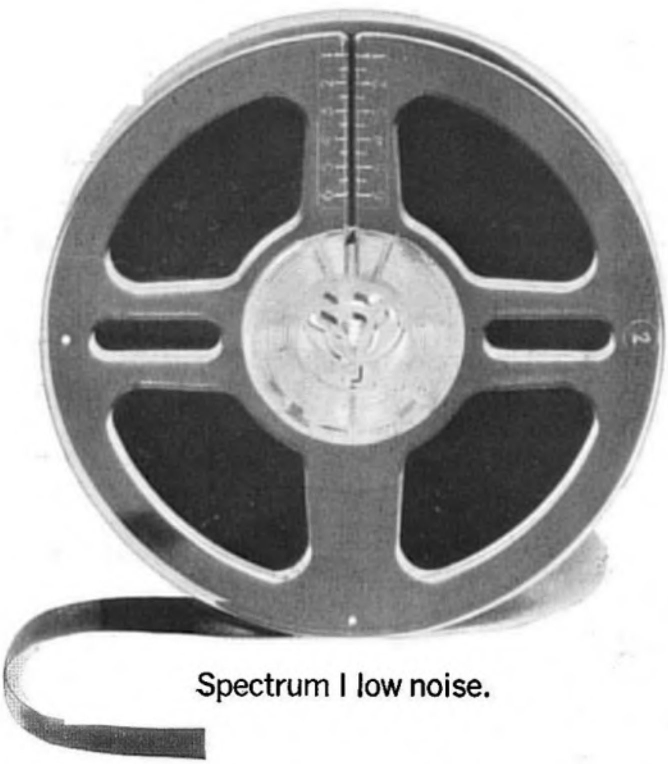


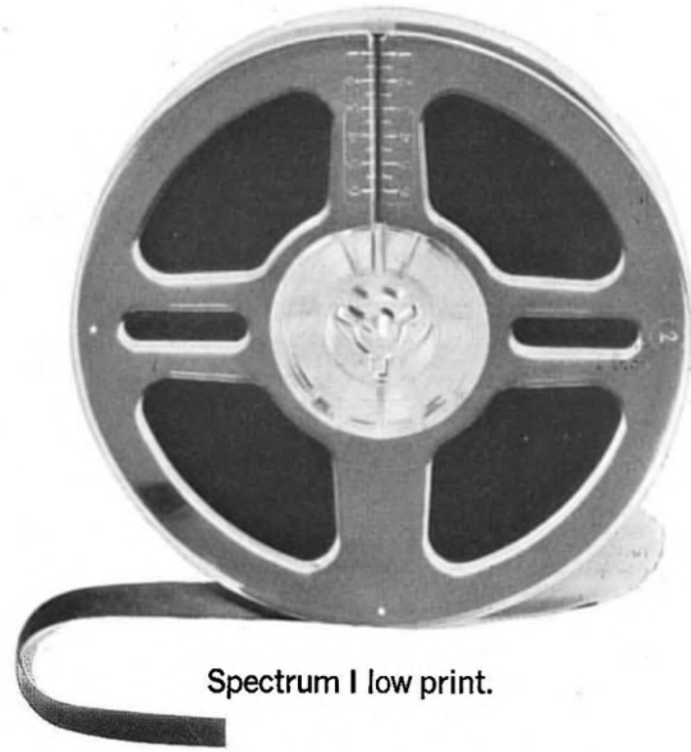
FIG. 9



Pray silence for Spectrum I.



Spectrum I low noise.



Spectrum I low print.

These new low noise and low print tapes show an input/output improvement at 2% distortion of 4dB, or better.

It would take a real effort to overload them. (That should take some of the worry off your mind).

With low noise you'll get a signal to noise ratio as good as you can get.

The low print tape gives remarkably low print through across the whole range of audio frequencies.

In other words, what you put on it, you'll get off it.

You'll notice they're black.

The colour is caused by an oxide process designed to reduce static and

Zonal Film (Magnetic Coatings) Limited. Holmethorpe Avenue, Redhill, Surrey.
A subsidiary of ILFORD LIMITED a CIBA-GEIGY company.

The new 4dB plus tapes from Zonal.

improve conductivity.

Base scratching (which causes debris) and dust attraction are reduced.

And you won't detect any head-clogging or dropouts as a result.

(We learned a few tricks from our experience with computer tapes).

Try breaking it.

Low noise is coated on a tough polyester base, insensitive to temperature and humidity changes.

It also has a special matt backing which stacks better under fast rewind.

And distortions during storage will not develop due to pack settling.

If you're worried about batch to batch consistency, we've only had a .001 rejection out of the last 500 million feet of tape produced.

We can supply in widths up to two inches.

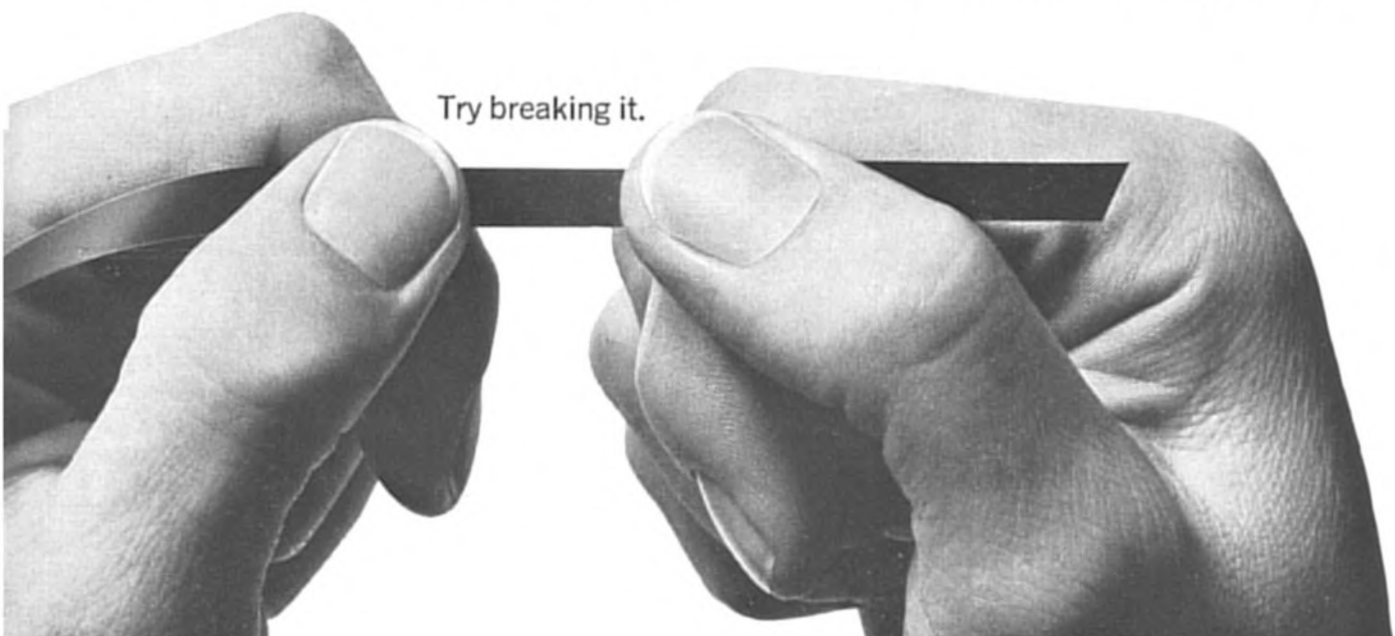
It's black. And it's beautiful.

Ring Tony Pitter for any technical information.

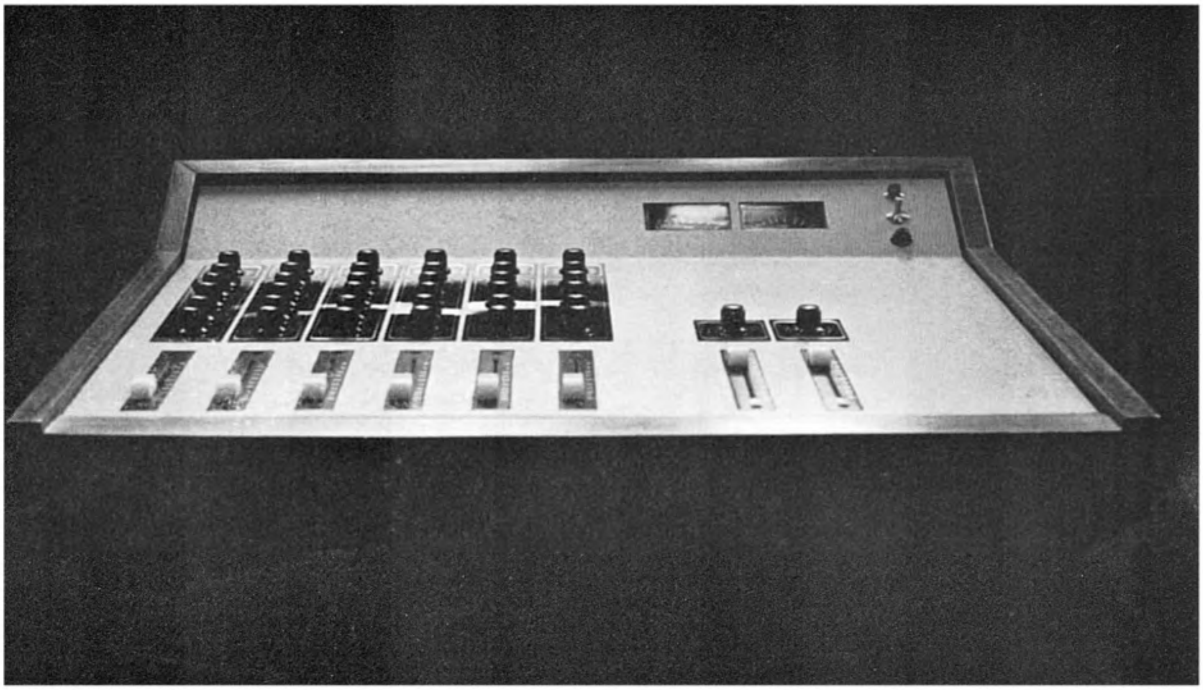
The number is Redhill 64706.

He'll tell you why Spectrum I is years ahead of its time.

ILFORD ZONAL
Spectrum I tapes
(All the better to hear you with).

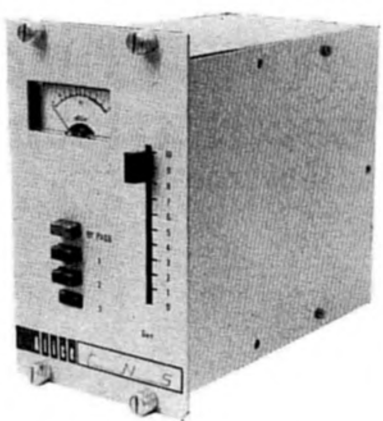


ALICE MAKES MIXERS QUIET



ALICE SM2/CNS

This mixer has a noise level of 147 dB below input* The impossible is achieved by building in a CNS unit. This Crosstalk and Noise Suppressor processes the audio signal by suppressing low level components in a frequency selective manner.



This modular CNS measures 6″ by 3·6″ and has 9 dB, 14 dB and 22 dB suppression capability. The electronics feature integrated circuits and individual voltage stabilisation.

Functions are elimination of studio crosstalk, removal of line or amplifier noise, elimination of print-through and reduction of studio reverb. time.

Price £93 each or £390 for 4 units rack mounted and self powered.

ALICE (Stancoil Ltd) 15 SHEET STREET, WINDSOR
WINDSOR 61308

* 50 Hz-15 kHz bandwidth, input 200 ohms, suppression 20 dB.

Events

PURCHASE TAX CHARGES

LOUDSPEAKERS ARE now subject to alterations in purchase tax. Previously the tax situation was such that one could often find speaker cabinets with tweeters inside them whose sole function would appear to be the reproduction of frequencies in excess of 20 kHz. The position is now as follows: as of August 2 this year, all multi-unit speaker systems sold for domestic use will attract tax except those fitted with 30 cm diameter (or larger) LF units or, if elliptical, having chassis dimensions of 33 cm by 20 cm. Individual units will be taxable as previously, that is:

Cone units: a) circular: 30 cm diameter or greater, non-chargeable.
b) elliptical: 33 cm by 20 or greater, non-chargeable.

Pressure units, Electrostatic units are non-chargeable.

ARP FOR HIRE

THE ARP *2600* synthesiser is now available for hire from F. W. O. Bauch Ltd of 49 Theobald Street, Boreham Wood, Herts, at £25 per day, inclusive of instruction. The *2600* is the smallest of the ARP range of synthesisers but it is capable of all the normal requirements of synthetic composition and experimentation. To paraphrase the information we have received, 'it just needs plugging in'.

NEVE CONSOLE FOR THE BBC

THE CONCERT hall of Broadcasting House is now equipped with a new desk claimed by its manufacturers to be the most comprehensive stereophonic broadcasting sound control console in the world. Built by Rupert Neve in some 19 weeks, the console has frequency correction facilities on all input channels, full stereo grouping and monitoring and stereo width controls. The company is currently building three further consoles for London BBC studios.

PHILIPS' NOISE SUPPRESSION UNIT

A COMPATIBLE TAPE hiss suppression system has been developed by Philips for use with cassette recorders and players. Units incorporating their 'Dynamic Noise Limiter' will be marketed by the end of the year. Designed to operate during replay only, the unit is said to be compatible with existing non-processed cassettes. The circuit comprises a signal splitter which divides the input signal into two parts, one of which passes through an all-pass filter, the other going in turn to a high-pass filter, an amplifier which increases the signal to a suitable processing level, and a continuously variable attenuator followed by a fixed attenuator which re-establishes unity gain.

The variable attenuator diminishes the signal according to its level. Signals above 4 kHz and more than 38 dB below reference level are progressively suppressed, the signals in the two channels cancelling in the adding stage where the two signals are recombined. Low frequency and higher level signals are not present in the output of the attenuator stage and thus are not affected. Philips are applying for patents. Meanwhile the dynamic noise suppression pioneers, Dolby, are making substantial inroads into the Japanese market and it will be interesting to see how things develop. As regards the cassette market itself, Philips seem to be reaping the benefits of their own pioneering. Last year, for the first time, deliveries of cassette recorders to the trade outstripped those of reel-to-reel models: sales of cassette models represented 60 per cent of the market during 1970. The total trade in tape recorders showed an increase of 50 per cent over that of the previous year and Philips claim to have a 25 per cent share of the market.

3M PRODUCE COBALT TAPE

3M HAVE PRODUCED a new series of video and audio tapes which are claimed to give a 4 dB improvement in signal-to-noise ratio and increased HF output without any equipment modification. This is achieved by using cobalt-modified oxide. The company will market the tapes first in helical-scan video format and then for broadcast video and cassette audio. The entire range, designated *High Energy*, should be available early next year.

DOLBY B FERROGRAPH

FERROGRAPH ANNOUNCE new versions of their *Series 7* range, incorporating the Dolby B noise reduction system. These are to be retailed at £320.45 towards the end of August by REW Audio Visual Ltd, understood to be the sole agents. Ferrograph claim that the system improves 4.75 cm/s recordings to a standard comparable with conventional 19 cm/s.

IC AUDIO AMPLIFIER

PLESSEY ARE introducing a new device which has as its main feature short-circuit protection. Capable of delivering 3W rms into an 8 ohm load, the IC has a typical distortion figure of 0.3 per cent, and is driven from 12 to 18V unstabilised supply rails. Ripple rejection is around 30 dB. For further details, the company's address is Cheney Manor, Swindon.

VIDEO DUPLICATOR FROM AMPEX

THE ADR-150, first shown at the NAB convention in Chicago in March, can produce up to five copies of a high band television programme in one-tenth the time required to make a single copy by present one-to-one methods. The machine is now in production and is the television industry's first high-speed broadcast videotape contact duplicator. Ampex also announce a new 25 mm, helical scan recorder (*VPR 7903*), a new high band colour video tape offering low head wear and long tape life (the *171* series), and a new colour television camera, the *BC-230*.

'PROFESSIONAL' SONY

A THREE-MOTOR stereo tape unit with 27 cm spool capacity, solenoid controls and 'automatic programme scanning' is now being offered by Sony at £420 including tax. The *TC850-2* is equipped for $\frac{1}{2}$-track record/playback and $\frac{1}{4}$-track playback.

ALICE MISNOMER

APOLOGIES TO Steve Tracey and F. St. John-Lloyd for an inaccurate caption to a photo on page 389 in our August issue. This in fact depicted Mr St. John-Lloyd receiving an Alice *BD6* on behalf of Mr Tracey.

LATEST OF the tacks-on-hammers variations, but at around £50 a little more expensive, is the PianoMate. According to the makers, Dubreq Studios, the instrument can be used with any piano, even one that is out of pitch—a single control compensates for that. It can even be used without any piano at all, provided you have a dispossessed keyboard with no home to go to. We hope to review it shortly.

BASF REVISITED

Angus McKenzie describes his recent tour of the Ludwigshafen and Willstätt tape factories

IT was with the greatest pleasure that I accepted an invitation to visit BASF's factories in Germany at Ludwigshafen and Willstätt recently. Although the entire visit was accomplished in under two days, I had the opportunity of taking up many points that I had always wanted to raise with the factory, as well as being shown round the plants, test labs and test tape manufacturing rooms. On arrival I was introduced to Herr Elmar Stetter, my guide for the visit, who has an outstanding knowledge of tape technology.

We discussed at length methods of measuring the tape performance. BASF use *M10* and *M5* Telefunkens for this work, as well as a number of smaller machines such as the Revox *77*. For the measurement of professional recording tapes Herr Stetter explained that an 18 μm gap record head was used as this gave the least modulation noise, particularly with thicker oxide tapes. The heads they are using have very accurately-finished trailing edges, giving an excellent high frequency response even at lower tape speeds. BASF found that 12 μm gap heads tend to have a higher modulation noise, whereas 6 μm heads are better again but not sufficiently reliable for testing very thick oxide coated tapes to the maximum possible record levels. They agree emphatically that the bias oscillator should have a symmetry control to minimise its own even-harmonic distortion. They confirm that odd-harmonic distortion does not matter at all, and it is therefore not necessary to measure the total harmonic distortion on bias. It is, however, necessary to establish the symmetry point of the oscillator by adjusting for minimum modulation noise and second-harmonic distortion.

The recording amplifiers used for tape evaluation have been specially made to have a perfect current feed and have therefore a very high output impedance. They also have considerable current feedback to achieve the lowest record head current. Their current-feed amplifiers have no equalisation of any kind so that the exact amount of treble boost required at any particular bias setting can be determined for any tape and any playback curve. The replay amplifiers have extremely low noise and very precise equalisation for the heads, which are mainly ferrite. Very high overload margins are also incorporated for testing tapes at high recording levels.

Although BASF normally use approximately 5 μm gap replay heads for 19 and 38 cm/s, they agree that the only disadvantage of using narrower gap heads is the somewhat lower output level from these heads at middle and lower frequencies, although of course the HF response is improved, particularly for lower tape speeds. They also find a slight variation between the apparent modulation noise reproduced from a narrow gap replay head and that from one with a wide gap.

It was obviously important to have a tape transport system that did not introduce tape bounce, flutter, scrape or azimuth variations, and which did not have any sharp edges which might disturb the oxide coating. Nearly all the machines seen were used in the oxide-out configuration, so that the oxide side of the tape did not touch many parts of the tape transport mechanism. In many cases, these machines are available with heads facing the opposite way for the British and American markets. They emphasised the importance of anti-scrape rollers between the record and replay heads which tend to damp any vibration of the tape passing over these heads. Incidentally, anti-scrape rollers are used on nearly all Telefunken machines and their efficiency has always impressed me. The result is a very clean sound when recording high frequency tones.

I put one hypothetical question. Suppose that a 1 kHz tone is recorded on a tape machine with wide-gap record and playback heads, for playing back on the same machine to a flux level of 320 pW/mm. The tapes might be, for instance, *LR56* with its very thick oxide and *TP18* with a very thin layer of oxide. Suppose they are then played back on an alternative machine with a very narrow gap. I questioned whether there would be any difference in output level between the two tapes played back on a gap considerably finer than the thickness of the *LR56* oxide coating. BASF confirmed my suspicions that the playback levels of the two tapes would still be identical although the thicker tape would have a lower distortion since each oxide crystal would be magnetised to a lower degree, the overall flux being the same.

BASF not only continually test tapes of their own production, including experimental tapes made with unusual oxides, but are constantly

From left to right: Messrs Hine, McKenzie, Andriessen and Stetter.

monitoring other manufacturers' products. They told me that they experimented with cobalt oxide over ten years ago but could not see any particular advantages which were really worthwhile, especially considering the very much higher cost. They agree, however, that chromium dioxide is most promising, particularly for cassettes, and they gave me a sample of 6.25 mm chrome tape with an oxide coating of 10 μm, which is similar to the thickness of average standard play tape oxide. I shall be interested to measure this, although because of the high cost it is not a commercial proposition.

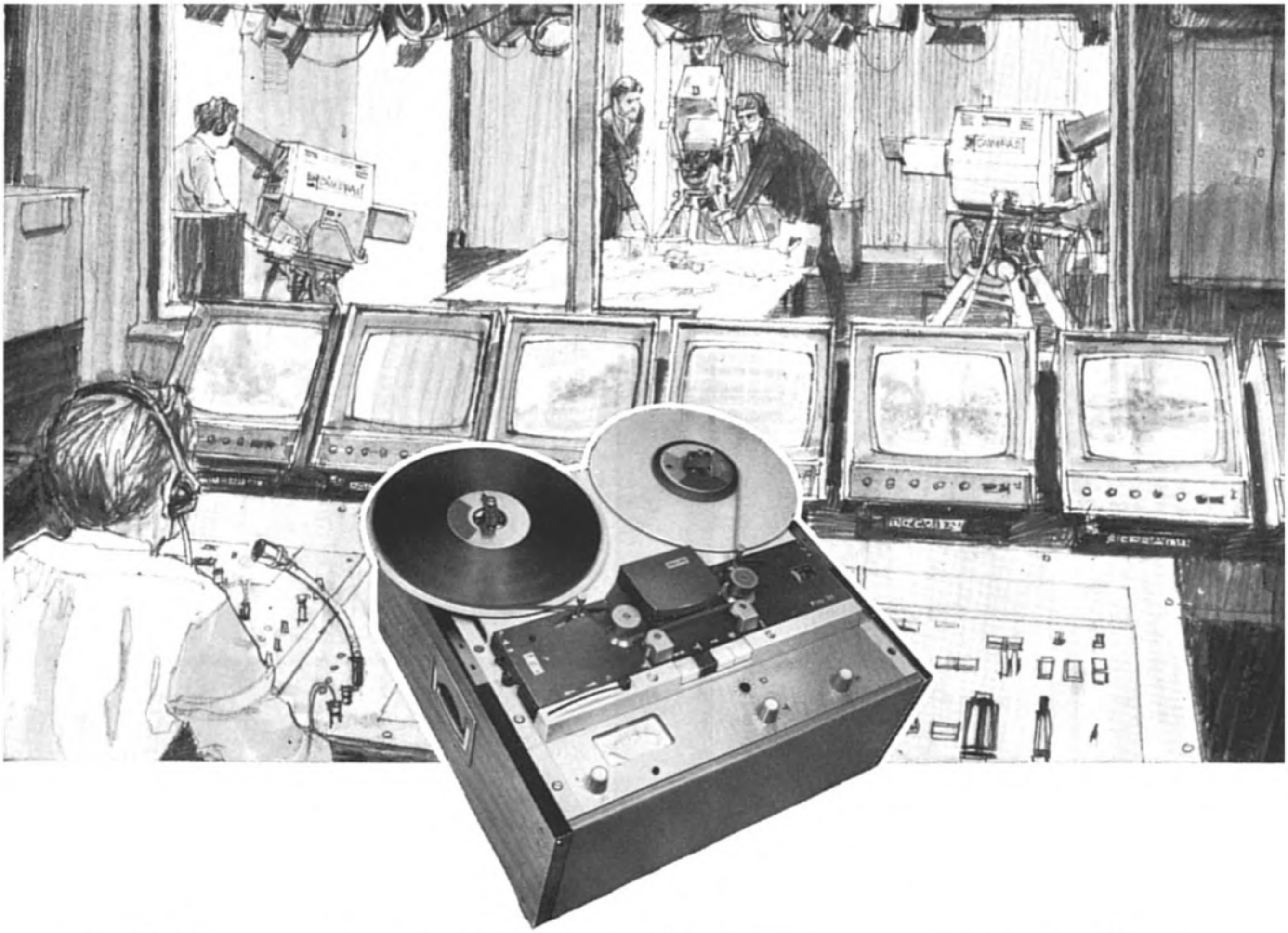
Virgin sections of the DIN standard reference and calibration tapes are kept at the German Standards Laboratory, which is their equivalent of our National Physical Laboratory. They also keep the German standard azimuth reference level and frequency response tapes which are referred to periodically by German tape manufacturers. These original standards were actually made and measured in collaboration with Agfa, and both manufacturers' products are continually checked by both the DIN Board and the aforementioned German Standards Laboratory. The standard reference levels are checked with a magnetometer, which is an extremely difficult instrument to use with the very low magnetic fields resulting from the magnetisation of recording tape. Normally they apply DC through the recording head to produce a particular flux in a playback head, and then an AC current through the same record head giving an RMS value on replay identical to the value of the DC magnetisation of the first recording. The first recording is then measured carefully with a magnetometer to establish this precise flux which by definition is then identical to the flux produced by the AC field and hence the reference of 320 pW/mm.

The reference level on 19, 38 and 76 cm/s test tapes is referred to as DIN level 320 pW/mm and is recorded across the full width of the tape. The DIN standard allows a tolerance of ±0.5 dB from the stated value and BASF claim their tapes are normally to a considerably narrower tolerance than this, although they reserve the right to take up the full tolerance. For 9.5 cm/s test tapes, the reference level is 250 pW/mm, and for cassette tapes the reference level is as low as 160 pW/mm, approximately 2 dB below the now accepted standard Dolby level. Although the tolerances of the higher speed test tapes are very tight, those for the lower speeds are not so tight because of the difficulty of maintaining correct azimuth for long periods at very short wave lengths. At 9.5 cm/s, for instance, in the frequency run from LF to 4 kHz, the tolerance is ±0.5 dB, for frequencies of 6.3 and 8 kHz, it is ±1 dB, and for 10 kHz and above, ±2 dB. I questioned the looseness of the latter tolerance and the lack of repetition bands on the 9.5 cm/s test tapes, and they explained that even a slight variation in back-tension due to different diameters of tape on the supply spool is enough to cause marginal differences of azimuth, which could then lead to overcompensation to obtain a flat playback during the test tape recording process. Despite the accuracy of their tape transports, they found that minute bowing of the tape also gave rise to small changes of azimuth, all of which make it uneconomic to record repetition bands at the very speed where they are, in my opinion, most necessary. The existing 2 dB tolerance at very short wavelengths is necessary because of the difficulties in maintaining perfect head-to-tape contact. They explained that their test tapes have to be correct at any point across the width so that they can be used with any number of playback tracks across the tape with identical results. It is much more difficult to maintain perfect azimuth on a full track tape than on a half track mono one since even the slightest azimuth misalignment could cause a cancellation at the two extreme edges of the tape, thus giving reduced output.

Master speech tapes are first recorded at 38 cm/s on *LGR* tape which also contains special pulses to change the oscillator frequencies and levels on specially-built equipment. A skilled operator continually monitors the test tape while it is being recorded. He corrects any discrepancy in level at the beginning of each frequency tone by making any necessary adjustments, which do not normally take more than a second or so. After copying, each test tape is checked by a second operator who notes down all the levels for reference purposes, in case a customer should ever wish to query a suspected variation from normal.

Stereo test tapes normally supplied for 38

(continued on page 463)



Philips Pro'36 Studio Tape Recorder

For broadcasting studios, theatres and recording studios, sound and film production studios. *In portable, console or unmounted versions*

As one of the newest additions to the Philips' range of professional audio equipment, the Pro' 36 is a natural part of the studio scene. Remember too, it's backed by world-wide Philips-Pye service. And an unrivalled range of microphones. Check these Top Ten Features:

● Second generation Ferroxcube heads ● Plug-in units minimise maintenance time ● All functions push-button operated; semi-conductor switching ● Three speeds, electrically switchable ● Automatic correction filter for each speed ● Servo-controlled capstan speed ● Brakes and pressure roller solenoid operated ● Automatic tape lift ● Build-in filters for CCIR and NAB ● Tape tension control for Cine reels

rely on Pye for professional studio equipment

rely on PYE TVT

Pye TVT Limited, Cambridge, CB1 3JU, England. Telephone: Cambridge (0223) 45115 Telex: 81103 cm/s are made on machines having an intermediate-width guard band between the tracks, with both full-track and stereo recording heads on the equipment. The reference level in this case is 510 pW/mm, 4 dB above normal mono DIN level. The idea is that on a mono full track machine, a half track recording made at this level would be approximately the same playback level as a full track mono test tape. The centre-band modulation is, in fact, recorded full track, and then erased with a stereo head which leaves a fine recorded track down the centre of the tape for replay head alignment.

Cassette test tapes are made on open spools and placed in cassettes in England for the British market. In the open reel format, the azimuth of the cassette tapes can be guaranteed to ±2 minutes of arc, but this cannot be guaranteed in the cassette format because of the inherent tape weave problems. Although I once felt that the price of test tapes was rather high, having seen the care with which they are made I now realise the price is fully justifiable, although I would like to see purchase tax abolished on what is very definitely an industrial test instrument.

BASF and Agfa were recording frequencies of much shorter wavelength on their test tapes many years before British and American manufacturers. I can well remember German 19 cm/s test tapes over ten years ago having frequencies up to 16 kHz when those produced in England had a high frequency limit of 10 kHz at that speed.

Almost all BASF professional recording tape is manufactured at Ludwigshafen in part of a colossal factory complex on the banks of the Rhine. This complex also produces fertilisers, among a large number of other chemical products, yet everything was extremely clean. In addition to one or two specialised industrial tapes, domestic and computer tapes are made at their other factory at Willstätt. This is near the Black Forest in a pollution-free zone, and has a particularly clean water supply. I was taken round the Willstätt factory and saw tape being manufactured. It was here that their domestic low noise, high output tapes were first prepared. The oxide used for this tape has much longer ferric oxide crystals suspended in a different type of solvent and binder. At first BASF encountered difficulties with oxide shedding but within a short space of time this was overcome. Their *LH* tape has some 2.5 dB less tape noise than normal tape and has 1.5 to 2 dB higher overload capability, as well as an improved HF response. In general, low noise tapes inherently have a somewhat worse print-through/signal ratio than normal tapes but if they are used carefully and stored well this should not be of too much consequence. BASF claim that their *LH* tapes give a performance at 9.5 cm/s of the same order as conventional tapes at 19 cm/s provided that the recorder used is of sufficiently high calibre. One interesting fact which emerged is that their 27 cm reels of *LP35LH* tape have a plastic backing slightly thinner than those supplied on smaller spools, although the properties of the tape itself are almost identical. In fact, the tape should really be called *LP30LH* in this format. Thickness is halfway between LP and DP.

At Willstätt, production tapes are continually checked for mechanical and magnetic consistency. The plant produces several different tapes and the test laboratories continuously test samples from the production runs. Computer tape, cassette tape, domestic low noise tape and a professional tape may all be undergoing testing simultaneously in the large laboratory.

Checks for modulation noise and distortion, frequency response, sensitivity, consistency and freedom from oxide-shedding are done mainly on *M28* Telefunkens modified in some cases for cassette tape testing, and also on some machines of BASF's own manufacture. The five per cent distortion levels of C60, C90 and C120 cassette tapes were being measured, and the averages actually seen were +5.5 dB, +4 dB and +2.5 dB respectively with reference to a playback flux of 160 pW/mm. I have previously commented on the high distortion level of cassette tapes, and quite a number of people appear to have misunderstood that the standard level referred to by Continental manufacturers is this 160 pW/mm per mm and not 200 pW/mm which has been used as a standard level elsewhere. It will thus be seen that, even under the finest laboratory conditions, a *C60* cassette with the highest output capability still gives five per cent distortion at well below 320 pW/mm. Many musi-cassettes made in England are recorded to a higher flux than this, somewhat erroneously in my opinion. BASF normally use a 2 μm gap head cassette measurements, the tests being made on an NAB reel basis. Mechanical properties being tested included continuous measurement of oxide thickness and slitting accuracy, measured on photo-electric apparatus the output of which displays the percentage deviation from perfect slitting. Tape bowing, stretching and tightness of wind were also under test.

Much of the art of making a good recording tape is in the correct choice of binder and solvent, as well as the type of ferric oxide used both in respect of precise chemical composition and method of preparation. The same also applies to the manufacture of chromium dioxide tapes, with which they have only recently become involved. I recently tested an early sample of BASF's chromium dioxide tape in cassette format and found it marginally better than any other product. I know BASF claim that chromium dioxide has a very good future with very slow tape speeds and video tape applications.

More consistent

It was agreed that 38 cm/s biasing at 1 kHz was reasonable for comparing tapes of completely different types from different manufacturers. Nevertheless, better and more consistent results could be achieved on all BASF tapes by using a 10 kHz recorded tone approximately 20 dB below DIN level and watching the replay level: the bias should be increased such that the output reaches a maximum and then drops back about 2.5 dB at this frequency, at which point the bias is further increased. This bias is claimed to be the best compromise. The point for minimum modulation noise could be adjusted slightly in manufacture to coincide with the best bias point for good frequency response and low distortion. In the early days of tape recording, both to achieve low modulation noise and low distortion it was usually necessary to use a somewhat higher overdrop at 10 kHz resulting in considerably more HF pre-emphasis being necessary in recording. With today's recording techniques, often involving recording HF at fairly high levels, a good high frequency response becomes essential, this being obtained with the biasing procedure previously explained.

For 9.5 cm/s BASF recommend an overdrop of 3.5 dB at 6.3 kHz since low bias would cause greater low frequency distortion, particularly with the 3,180 μS bass pre-emphasis on recording which has been internationally agreed for this speed. This argument applies even more strongly to the curve of 1,590 μS bass pre-emphasis recommended for 4.75 cm/s, a pre-emphasis of which I strongly disapprove, as do a number of BASF engineers.

I queried the frequency accuracy of the 1 kHz tone recorded at the beginning of all the higher-speed BASF test tapes and was told that this is most important since the precise speed of any tape recorder can be ascertained by playing one of these test tapes on a recorder connected to a frequency counter.

BASF agree that a DIN level on the front of a 19 or 38 cm/s test tape can be used for either of these speeds since the time constants are reciprocal to the speed. A 1 kHz tone recorded at 38 cm/s should replay 500 Hz at 19 cm/s at the same level and vice versa. Incidentally the error playing back at 9.5 cm/s is so small as to be insignificant for normal applications. Playing a 38 cm/s tape at 9.5 cm/s gives a frequency of 250 Hz, rather close to the 3 dB point of the time constant of 90 μS.

BASF mentioned one useful trick for checking any possible saturation that might exist in the record head gap. Although rather difficult to carry out in practice, they place a replay head with its gap very close to the record head gap on a tape recorder and examine the waveform obtained from the replay head. The same method is used for measuring bias applied to record heads in some high speed cassette copying equipment. It is unwise to load the bias supply circuits for measurement purposes since the frequency can be 2 MHz or so in equipment that has a 16 or 32 times speed-up.

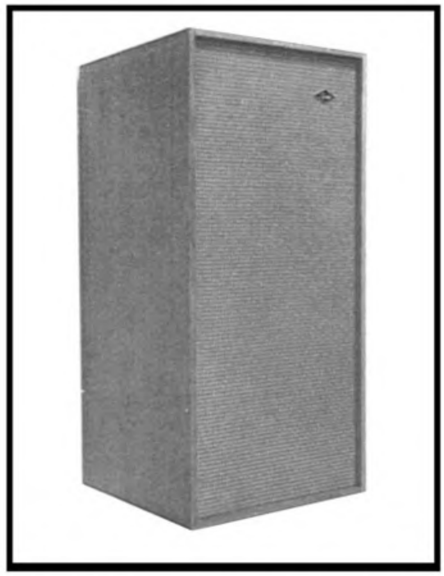
The subject of measured noise levels on professional tapes was discussed. BASF claim that some matt-backed tapes with rather coarse oxides (particularly samples not made by them!) are inclined to give a noise measurement more favourable on some machines than others as compared with other types of tape. This would appear to be due to the effect of rough particles tending to hold the average surface of the tape slightly away from the replay gap and therefore tending to impair the high frequency performance. I would confirm this in that some of these tapes had to have rather more treble boost applied in recording to give an overall flat response. For some while, BASF have been trying to produce a tape with a significantly better HF output performance, while not impairing other characteristics. With the Dolby noise reduction system in mind they recently developed a new tape, type *SP50M*, which in initial tests appears to have an excellent overall performance although it is likely to be very expensive.

I would like to thank Mr Bob Hine, BASF's professional tape section manager in Britain, for accompanying me to Germany and introducing me to so many of his colleagues, who were most courteous and helpful.

Spendor

The Spendor Loudspeaker has been designed for that section of the audio market which requires accurate reproduction quality.

Acknowledgement is given to The British Broadcasting Corporation for their design information which is incorporated in this loudspeaker.

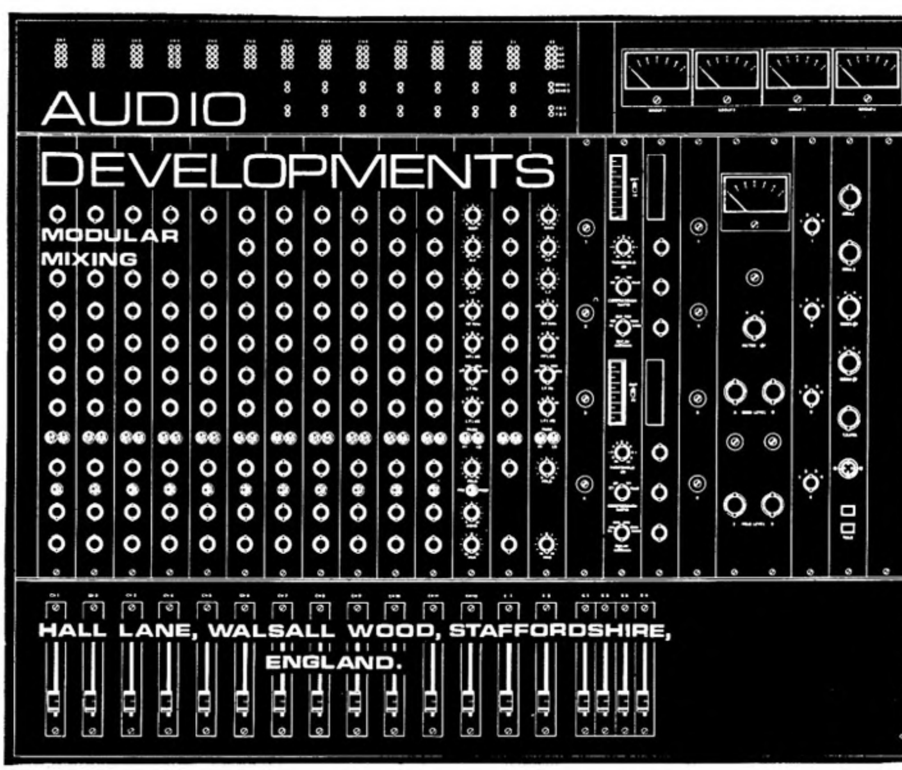


Type BC1. Size: 25″ x 11¾″ x 12″
Units: Spendor 8″ Plastic Cone
Celestion HF 1300
S. T. & C. HF 4001G

Type BC1A. Units as above and fitted with the Spendor M.208 power amplifier. This loudspeaker is now being used extensively by the British Broadcasting Corporation.

Further details may be obtained from

SPENDOR AUDIO SYSTEMS LTD., **3 Station Approach, Redhill, Surrey RH1 1NX**



PATENTS REVIEW

ADRIAN HOPE

ONE of the snags with cassette recorders is that the end of the cassette can sneak up on the user. With reel recorders it is easy to have the machine switch itself off at the end of a tape, but with simple cassette machines there are problems in achieving this. In the fullness of time there will doubtless be dozens of proposals in this direction as well as dozens more for sounding an alarm at the end of a cassette. In the latter field there is already a system whereby a metal foil attached to the tape end is detected by two electrodes and so sounds off an electronically produced signal. The metal foil must be accurately located and, because not all commercially available cassettes have such foil, a user is left with the problem of trying to attach the stuff himself. As anyone who has fiddled with cassettes knows, it's all rather like mending a watch.

Matsushita Electric of Japan have a British Patent (BP 1,231,169) concerned with producing a sound at the end of a tape cassette, the sound being produced by a purely mechanical operation. The invention relies on a rotating body which is tightly fitted on the machine capstan and carries a small stub projection. A tension arm is held under spring bias against the tape running through the machine. While the cassette is playing normally, the tape tension is relatively low so the spring bias is able to drive the tension arm fairly hard on to the tape and so make the latter travel round a fairly loose curve. When the cassette comes to an end, however, the tape tension increases and the biasing force of the spring is overcome by the tape tension. When this happens, the loose curve disappears, the arm is deflected, and a sound producing member which it carries at its other end is brought into contact with the rotating capstan stub. The sound producing member—which in practice is simply something that makes a clonking noise when knocked—rattles away until the machine is stopped. There are various refinements to increase the volume of sound produced but the basic idea is still the same.

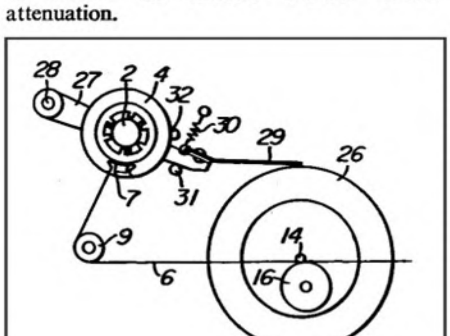
The proposal seems reasonable provided that in practice there does not turn out to be undue wear on the tape from the tension arm and provided that the system does not worsen wow or flutter.

Gone forever are the days when everyone who made a record had been treated to voice training. Pop groups often cover their mikes with foam sleeves but hissing sibilants are still a problem.

Les Industries Musicales et Electriques Pathe Marconi have a British Patent 1,228,795 which deals with an apparatus for automatically cutting down sibilant effects during recording.

Pathe Marconi have statistically analysed the frequency spectra produced by various singers and found that the frequency spectrum extends from approximately 150 Hz to 12 kHz. Pure sibilants, however, are present only in the spectrum between 6 kHz and 12 kHz. Pathe Marconi have used the discovery that a pure sibilant gives rise to a signal with frequency components only above about 6 kHz as a basis for discriminating between the presence of a pure sibilant and the presence of a singing voice with or without a sibilant. This discrimination is made at the input to a recording system and their block schematic diagram shows a microphone feeding a preamp with a hiss-reducing circuit in a path from the preamp to a recorder. The hiss-reducing circuit is built up from a variable transfer circuit (a controllable attenuator with a maximum transfer factor of unity) and a discriminator and control channel. The latter takes a signal from the preamp and provides a control signal which modifies the attenuation of the variable transfer circuit. The circuit is connected in a signal path from the output of the preamp to the input of the recorder.

The discriminator and control channel includes a circuit capable of discriminating between a signal with a frequency spectrum extending from 150 Hz to 12 kHz on the one hand, and a signal having a frequency spectrum of from 6 kHz to 12 kHz on the other hand. This discriminating circuit is followed by a control stage which provides an output signal to control the variable transfer circuit attenuation.



The whole thing is set up so that when only signal frequencies within the 150 Hz to 6 kHz band are present, a zero control signal is produced and the attenuation of the transfer circuit is at a minimum. This is, of course, when there is no real sibilant present. When a pure sibilant crops up, this is discriminated and the control stage sends a signal to the transfer circuit which causes it to produce the maximum amount of attenuation.

Pathe Marconi suggest that the variable transfer circuit can consist of photoconductive elements sensing light produced by microbulbs. When there is no light falling on the photoconductive elements, they remain in a high resistance state and their resistance decreases as more light falls on them. The amount of light emanating from the microbulbs can be governed by the discriminator to get the desired control of attenuation.

Finally, an idea from Herbert Pohler in BP 1,228,097 which should ease some of the problems encountered with recording audio and video frequencies with rotating magnetic heads.

As is fairly well known, one of the main problems with such a system is synchronisation of the tape drive and the magnetic head drive.

Pohler hopes to provide a workable system in which both the rotating magnetic head and the tape drive are handled by a single motor and essentially he achieves this by using a system of hysteresis clutches.

The single motor drives a double-ended shaft, which carries a disc of hysteresis material at each end. Opposite each hysteresis disc—and separated from it by an air gap—there are provided permanent-magnet discs splined to shafts. Thus the shafts are hysteresis coupled to the motor; one shaft indirectly drives the rotating video head and the other shaft indirectly drives the tape transport mechanism. Both the video head drive and the tape transport drive speeds are controlled by an individual eddy current breaking system consisting of an aluminium or copper disc running in the air gap of a brake magnet. Usually the effect of a couple of such eddy current braking systems linked to a single motor would be enough to throw all the synchronisation into confusion. But according to Pohler, because of the hysteresis clutch arrangement, the single motor can cope quite happily. I would guess that if the system works as well as Pohler claims, it could bring the cost of rotating head recording equipment down quite considerably.

Servicing

CLUTCHES

by H. W. HELLYER

ONE of the great virtues of the three-motor tape deck is that it is, *ipso facto*, devoid of clutches.

Well, almost. As I hope to show, even the most simple design can have its bugbears, and some tape recorder makers have managed to add the complication of clutches to otherwise straightforward drive systems. Now that many machines are designed to operate vertically and horizontally with no obvious change, and at least one domestic is built on the tilt (Sony *TC-366*), clutch designs are a matter for study, their servicing demanding at least a rudimentary knowledge of the principles behind their design.

In August and September 1968, we ran a series on the subject, under the title 'What's in a clutch?' It may have been mere coincidence, but the same (August) issue carried David Kirk's field trial of the Revox *A77*—a clutchless performer—and an article with the headline 'How *not* to win a tape recording contest' by John Shuttleworth.

One way to avoid winning is to neglect one's clutches, I suppose. Which wry statement is meant to underline the fact that you cannot hope to make a good recording, however elaborate your electronics, if the mechanics of the matter let you down. You could, at a pinch, dispense with take-up and let your tape spill inelegantly into a wastepaper bin, as do the computer lads. Anything to take the load from the capstan spindle/pressure roller combination. (And even *that* is clutched in some BRC models.)

Funny story: a client brought us a Van der Molen *VR7* tape recorder. Among other things take-up clutch trouble. In fact, this is a belt-driven turntable, using a tyred groove, a flat fabric belt and a weighted, pivoted pulley wheel which adjusts the take-up tension. Chronic disease: overtight take-up, stretched and damaged tape. Cure: get the exact compromise between hard-on pulley position for fast winding and slack-run position for take-up, testing with full and empty 18 cm spools. Adjust with collar and spring combination on push-rods, and, all else failing, by bending the lever arm slightly to shift the centre of gravity of the lead weight.

We did all this, and tested finally with long-play tape, as is our wont. Apparently, our wont wasn't. The peeved client returned, still complaining.

Investigation proved that his real problem was previously recorded tapes sounding flat. We checked, and found that his recordings made with the machine in fault condition were too fast and showed some irregularity. The overtight take-up had, of course, been beating the capstan pressure and pulling the tape past the heads at more than the regulation velocity. Playback was under similar conditions, so, apart from the odd wow, all the music was in the right key.

After repair, correct speed was obtained and the old recordings were slower than they should have been and still wowing. Lesson? Always test after clutch adjustment with new tape and, if possible, a stroboscope or other similar instrument. Incorrect clutch tensioning, although it may not be obvious to the eye—no spillage, no stretch—can cause wow. Excessive back pressure may cause flutter because of scrape between the left-hand guide and the head facing.

Besides the slipping-belt type of clutch action mentioned above, there is the gravity clutch, in a number of different configurations, and combinations of both, further complicated by spring tensioning. Some rules are general for all these clutches and it may be as well to proceed crabwise, laying down generalities before coming to the particular.

Whatever the clutch, the tensions will have been designed so that tape is taut but not snatching when the spool normally used with the machine is at its full and empty limits.

If this seems to imply a compromise—it does! No use our adjusting the clutch tensions with a half-spool of tape, for convenience. I like to begin by ensuring that pinch pressure is correct, so that clutch action is not opposed. A good guide is usually obtained by disconnecting the supply, switching to play, holding the tape at the right of the machine and gently pulling. It should need a positive pull, though not a hefty one, to overcome the inertia and move the tape smoothly through the head gate.

After this, load a full spool of the maximum size the machine takes, thread up and switch on. Set to play and, if there is a pause mechanism, operate it. When this is released, the take-up should be smooth, not jerky, and certainly not with spillage. Watch the tape closely where it comes off the pressure roller, or, if a guide is fitted, the right-hand guide. A tendency to vibrate at right angles to tape travel is a clue to excessive clutch torque.

Gravity clutches, depending as they do upon the weight of the tape and spool on them, will exhibit spillage if felt pads are hardened, allowing the upper section to resist the torque imposed by the driven lower part.

The pull on the tape at the beginning of the spool for takeup should be the same as at the end, give or take a gramme or two. To be accurate, I should say 'a pond or two' but I was jumped on heavily a while ago for using that term in my book *Tape Recorders* published by Fountain Press last autumn. 'Talk plain English,' my correspondent yelled. In fact, the *pond* is the international unit (abbreviation p) corresponding to a weight of 1 gm, distinguishing pressure from mass. It became so 27 years ago, so should need no apology from me for its employment!

To check the pull, a spring balance can be used, and the end of the tape formed into a loop, hooked over the balance hanger, the machine switched to play, and the pull read off. The required amount varies from machine to machine, but an example is 20p for a 13 cm spool. The back tension may be over 100p, to maintain tape/head pressure, and as there is little over a 3:1 ratio between full and empty spool when it unwinds, this tension can vary a lot. Some designs do not take into account the varying angle between full and empty spool—i.e., the tape entry between the flanges, relative to the hub. So the poor old mechanic has hell's own job adjusting clutch torques when a little wear has occurred and the fine balance between full and empty spool tensions is upset.

This can be especially tedious when a common system is used and the fast wind action is simply an extension of clutch action. Even worse, when feed spool back-torque relies on the forward drive system. Tandberg do this, and so, in a rather different way, do some Philips machines. It is essential that all driving and bearing surfaces are clean, and that lubrication is correct.

Note that 'correct'. We had a mechanism on the bench last week that refused to take up when warm. It turned out that some enthusiast had smeared with light grease a fluorene collar, part of a bearing, which really needs lubricating about once in a millennium—the real treatment is merely to keep clean. Lubrication, like courting, should be undertaken with a modicum of circumspection.

Felt pads, such as illustrated in a couple of our benchtop pictures, will often succumb to the patient treatment of hot water, light 'combing' to remove hard dirt particles (and quite often, flakes of aluminium) and drying. If you are in a hurry, a hair dryer can be called into action for the last operation. However you undertake that job, please remember that soap and detergents are *not* welcome, are very difficult to rinse out and can cause some awful problems later. If a felt pad is so bad that it needs degreasing and washing, use a solvent such as CTC and rinse thoroughly afterwards, both in spirit and finally in hot water, before drying and refitting.

In the nature of the thing, some felts will jam up when refitted because they are now fluffier than when first seated. They will work a lot better for being run in. Here we need patience again, and sometimes an endless tape loop to maintain constant tension take-up. A few minutes with splicer and odd end-cuts solves that problem.

Slipping clutches, that is those which are constantly driven regardless of the tape that is on them, will have been adjusted originally for a full spool braking moment. To measure this type of pull, we again need a loop on the end of a tape, but this time the difference between full and empty spools should not apply. We can use any diameter and calculate the pull times the distance between the point of pull (tangential to tape spool) and the hub centre. The *moment* is this distance in centimetres multiplied by the pull in ponds (or grammes, if you insist). A value of around 200 pcm for a 13 cm spool is not unusual. An 18 cm spool will usually give us a reading of around 300. These are by no means exact figures. There is a lot of tolerance and these forces or pulls are only quoted as a guide. The reason they are quoted at all is to urge some users who may not be particularly mechanically minded to take note of what the recorder is trying to do. Do not take it for granted. If you measure a few of these forces when new and keep a note of them, they are a useful check for later maintenance.

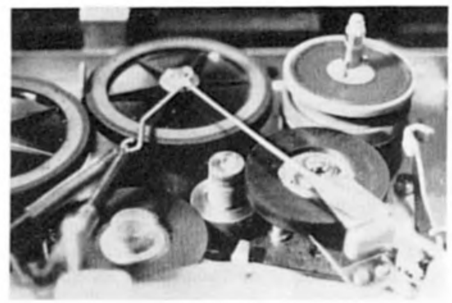
Keeping still to the general, allow me to warn against adjusting one's machine for unusual spool sizes. And by this I mean spool hub as well as outer diameters. On some recorders, also, it is necessary to consider the thickness of the tape which was originally used. There is quite a difference in weight and handling qualities between standard and, shame on us, triple play tape.

The little fellows, cassette mechanisms and pocket notebooks, really deserve separate treatment. I shall content myself with the observation that similar general rules apply. The takeup is by a driven pulley bearing against the tyred rim of a turntable hub. The basic drive must first be ensured and, as this is often belt driven, lack of take-up can be traced to slack or slipping belts. More serious is the seizing belt. The shapes and seatings of belts give the game away. Shaped belts in grooved plastic pulleys are the worst offenders. Often a black smear can be seen, as regular as if it had been painted deliberately in the bottom of the 'V'. Patient cleaning with a drop of spirit is one answer, but belt replacement as well is the only true cure.

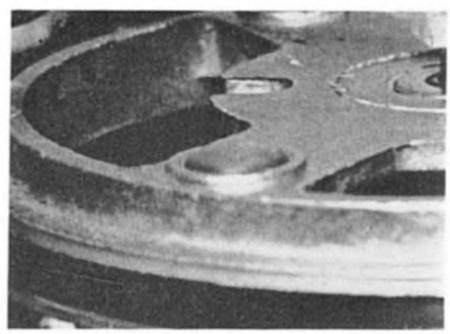
Felts come into play here too, and the small felt pad at the base of the main link pulley can jam at the spindle, where the jamming may not always be suspected. Too frequently, the trouble, can be traced to a reluctant cassette —one that tends to trap the tape. This is another point we shall have to return to.

Promises, promises . . . as my typist says. Before we can keep that one it will be necessary to honour an earlier one to Ferrograph owners. I shall explain all about that next month.

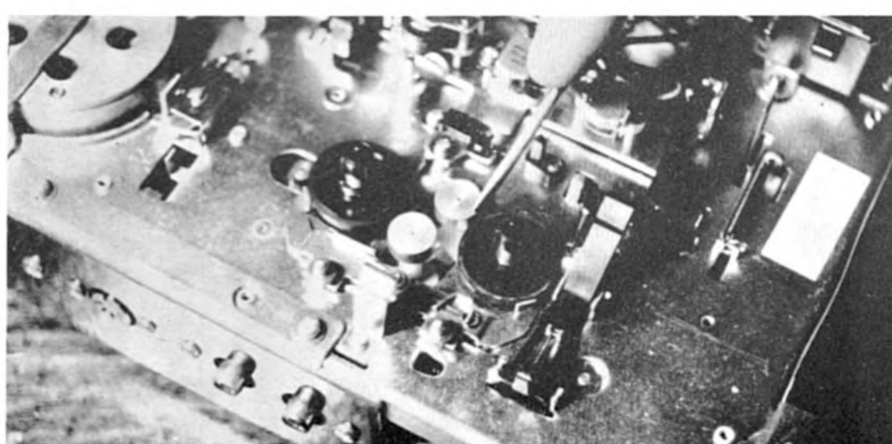
Above: One Sony version, where a combination of belt and pulley drive dictates clutch style. Basically a weight-dependent type but relying on the pulley drive for its efficiency.



Upper right: Sony again but this time the machine is intended for horizontal or vertical operation. Take-up torque is necessarily stronger and setting can be difficult. The pulley rides up its spindle for fast-forward drive and the pulley angle is important.

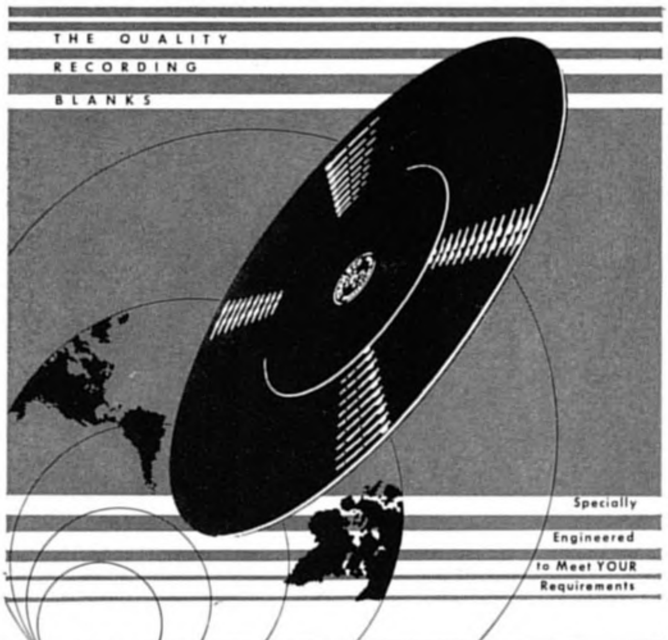


Lower right: Excessive wear. The vulcalan pads that transmit torque from lower to upper sections of this Philips clutch are worn almost flat. They should be domed.



Below: Though smaller, cassette systems present similar problems. This is the Nakamichi multiple-pulley drive.

Be Safe in Sound with TRANSCO



TRANSCO

Manufacture of recording blanks is so full of snags and difficulties that no one in his right mind would claim to produce a perfect blank every time.

TRANSCO is the world's largest manufacturer and depends entirely upon recording blank manufacture for its existence. Therefore the blanks have to be *consistently* good and we believe are the best in the world.

Full range of Masters and Acetates stocked in London.

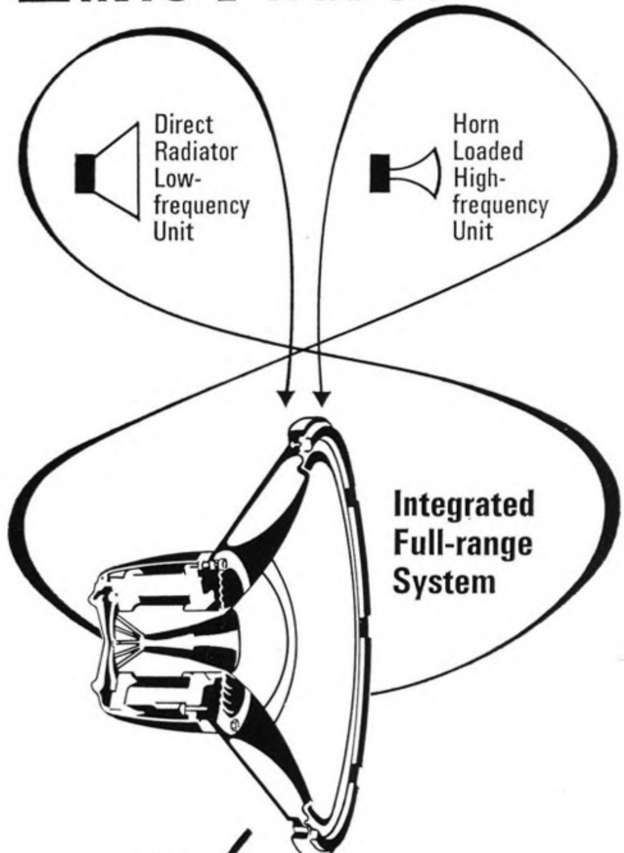
Leonard Wadsworth & Co. Ltd.

(ELECTRONICS)

BROADWAY HOUSE,
BROADWAY,
WIMBLEDON, S.W.19

Telephone 01-542 4258 *Telex 264028*

2 INTO 1 CAN GO!



THE *Monitor* GOLD*

DUAL CONCENTRIC

. . . provides the perfect integrated source needed for stereo. The Monitor Gold is two separate transducers in a single assembly fed by a sophisticated cross-over and treble control network.

TECHNICAL SPECIFICATION

Frequency Response: 30-20,000 Hz.

Power Handling Capacity:
15″ 50 watts, 12″ 30 watts. IIILZ 15 watts.

Impedance: 8Ω nominal, 5Ω minimum.

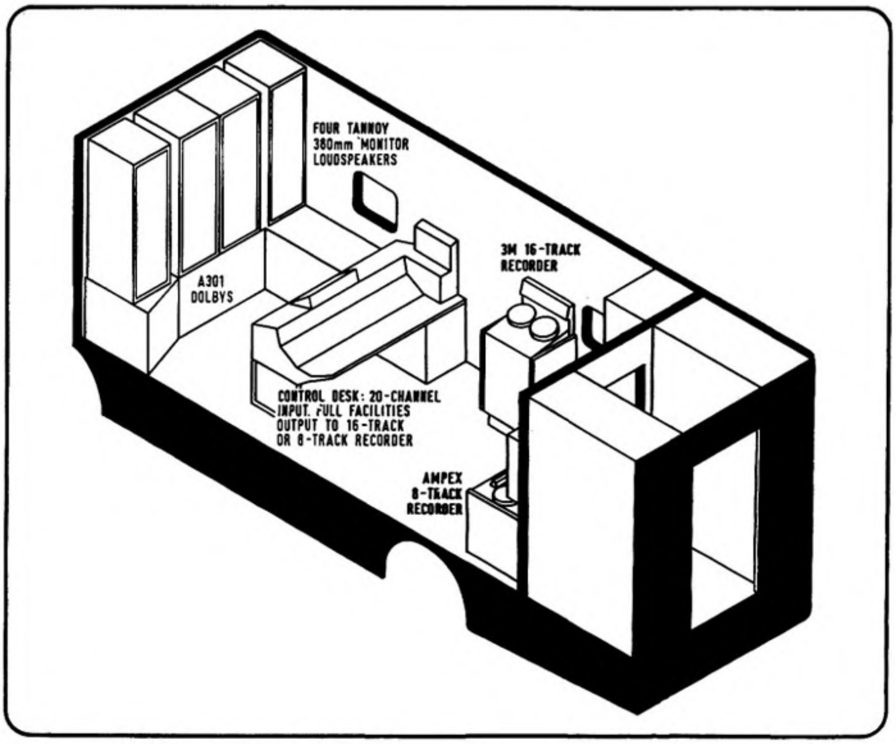
The majority of Recording and T.V. Studios use Tannoy monitors.

TANNOY®

Norwood Road, West Norwood, London, S.E.27. 01-670 1131.

mobile stones

By Adrian Hope



THE high spot for me of the APRS '71 Exhibition was finding the Rolling Stones' mobile recording studio parked outside. For a long time I had been interested in getting a sight of this. I knew that it spent most of its time in the South of France where the Stones are busy sunbathing, recording and getting loudly married. But there it was, a massive Leyland diesel lorry parked outside the Royal Agricultural Hall in Vincent Square, looking very sinister and paramilitary with its tiny windows and grey-green army style camouflage.

What the Rolling Stones pop group originally wanted was permanent access to a good studio, regardless of where they were. The way they answered the problem was to commission a custom-made studio to take round with them. Helios Electronics did the lion's share in putting the studio together.

There was no question of taking an existing lorry and converting it into a studio. Instead a Leyland *Laird* diesel chassis with soft springing (for obvious reasons) was bought and a special body built on to it. Starting with that, Dick Swettenham of Helios designed a recording studio layout with the Stones telling him what they regarded as ideal in the way of facilities. Having mapped out his ideas on paper, Swettenham went to Sandy Brown for acoustic advice. Brown's advice was fairly straightforward. Forget about trying to make the wagon soundproof because, short of armour plating the walls, floor and roof, it just isn't possible. Concentrate instead on getting the inside acoustically as near ideal as possible. This they did, with the result that the relatively small windows are double-glazed solely to keep down condensation. The walls are padded to improve the internal acoustics rather than to keep out the sound of traffic or keep in the sound of the monitors. Even so, people who have worked in the mobile consider that not too much extraneous sound strays in and so far there have been no serious complaints about noise leaking out.

So far the mobile has been used mainly by the Stones for recording at Mick Jagger's country house 'Star Groves' and in France outside Keith Richards's beach-side house near Villefranche. It has followed the group round Europe on one of their more recent tours and has been used for what Rolling Stones Ltd reckon to be the biggest recording job ever done in this country and possibly even the world—namely the 45 microphone set-up used to record the soundtrack of the Frank Zappa film *Two Hundred Motels* at Pinewood. Zappa's group, The Mothers of Invention, were playing with the London Philharmonic Orchestra and the Rolling Stones' mobile was the nerve centre of the recording.

More and more the studio is being used for what is really an excursion into a new outlook on recording. Thus, when Mick Jagger wanted to record in the hall of his home, the mobile was left outside for most of October and November 1970 while the Stones played inside. The result was the LP *Sticky Fingers*. The idea then caught on and other groups started recording in their own homes. Led Zeppelin, for instance, recorded in a tiny room in Sussex. When not in France with its proper owners, the mobile is currently being made available to just about anyone who can afford the £1,500-odd weekly rental.

And what would you get for your money? Basically a three-man team including a maintenance engineer, a driver and a tape jockey. Most groups have their own pet balance engineer and, within reason, anyone they nominate is made welcome in the mobile. The whole package is available pretty well 24 hours a day so that a group can record when and where they like. Looked at that way, the cost is reasonable. It is also reasonable bearing in mind the fact that fitting up the mobile has so far cost Rolling Stones Ltd well over £50,000.

Ian Stewart is currently the man closest to the mobile and he answered some of the questions which came to mind after I had ferreted around the studio. The interior of the truck is surprisingly spacious and comfortable. It is also fully heated and air-conditioned. There are four Lockwood/Tannoy 380 mm monitor speakers in a bank at one end. Housed underneath in neat cupboard space are a full set of Dolby *A301*—nine double units in all, being eight for the 20/16 control desk built by Helios and one for a final stereo reduction machine.

The present plan is gradually to convert Jagger's home into an all-purpose studio while he is away in France. Ian Stewart tells me that the idea is to build a reduction room there and open up some of the dozen or more unused bedrooms so that the house can be used (with

(continued on page 471)

Creating a Musical

Three amateur musical productions recalled by C.H.Bell

I SUPPOSE it all started with the close harmony vocal group we used to have. Two colleagues and I formed the nucleus, increasing to four or more when singers were available.

From time to time members of our recreation club (Hull Corporation Telephone Department) would put on concerts for the staff and we were usually included. One day someone suggested writing a musical. Asked to provide accompaniments, I enlisted the aid of two fellow musicians to form a basic three from which to build up a full background on tape. Over a five year period we produced three shows. Mikes on stage would not contribute much with a moving cast. We therefore recorded the voices together with the desired background, thus boosting the voice without drowning the accompaniment.

We taped the vocalists first with piano only, in stereo. We then copied this tape on a second machine while mixing in a rhythm section on one channel. Clavioline, extra piano, electric guitar and vocal harmony were added on one or the other channels as required, until three copies had been made.

The mikes were low impedance Reslo ribbons and the recorders were a Revox *E36* and a Tandberg *3*. We were pleased with the general effect but the pitch had shifted, which prevented my putting in some second piano parts. When the cast were singing along with the tape, however, the overall effect was satisfactory and the show was well received.

For the second concert, an *F36* and a Tandberg *6* were available. Provided we used the same machine for recording and playing back, there were no pitch problems. In the interests of lower distortion, we made one copy fewer. A drummer was available on this occasion and the results were noticeably better in all respects.

For what was to be the final show at that club, we were assisted by an organist, along with the four-piece rhythm. This enabled us to cut down the number of recordings to two. The organ was fed directly from its headphone socket into one channel, and the rhythm section via the mike into the other. Voices and extra parts—including a miniature vibraphone for a change of tone colour—were put on in stereo and mixed to complete the tape.

On all three occasions, a piano tape was provided at the outset from which the singers learned their parts. Original tapes were held rather grimly in case a later one was spoilt.

During the earlier productions, trying for perfection, we played back each take through good quality reproducers and erased it if unsatisfactory. This was so time-consuming, however, that in the third show we made three takes. The best ones of each group were then spliced together, the splices serving as markers.

During the performances a duplicate tape was kept on a standby machine. As each number was being sung, the reserve tape was run to the next marker. The vocalists were instructed to complete the current number unaccompanied should failure occur. It never did!

Playback was via two integrated mono valved Radfords and two Wharfedale columns.

One setback which stands out in my mind is the occasion when we recorded some solo vocals at my home. The cast had difficulty with one number and we spent all the evening getting it right. Finally we succeeded in putting it on tape but, when it was played back, a hum appeared.

The cast rested while we searched for possible hum loops; the fault eventually proved to be noise from the Tandberg motor picked up by the mikes through the floor.

This cured, we recommenced recording. Then the telephone bell rang. A colleague made a dive for it, stumbling over wires and music stands. Someone's wife was getting anxious . . . The resulting tape was quite funny. I wish I'd kept it.

Talent, we found, comes in unexpected places. One evening, when recording a Latin American number, we needed a maraca player. We tried various bystanders without much success (it's surprising how difficult this apparently simple task appears to most people). A spare wife was standing quietly by, taking it all in, so I asked her if she would like to try. She proceeded to tick over as if she had been doing it all her life.

MOBILE STONES continued

the mobile parked outside) as a round the clock recording set-up where groups can actually live while they record an album.

The Stones were one of the few people to buy a Unitrack recorder before the latter company's demise and the Unitrack will probably find its way into the Jagger home reduction room. I asked Stewart how the Unitrack had performed and the answer seems to be that it was not regarded as particularly reliable until Swettenham had taken it apart and virtually rebuilt it. Fortunately, no one had to rely on the original Unitrack because there was already an eight track Ampex to hand. The Ampex is now housed in the mobile along with a 3M 16 track machine.

There is no power generator in the mobile, the very reasonable thinking being that no pop group will ever be able to perform without a power source. It is always possible to hire a generator. There is mains cable to cover up to 100m and there are separate microphone cables of similar length. In fact two multiway mike cables are used with provision for two foldback mixes for artist's headphones or public address, or for radio or recorder feed (independent of the mobile recording). In addition, every channel has an output on a multicore cable to feed either a PA system or an independent film mixer. The output can also go to special floor mixers for individual performers who can therefore mix for themselves what they wish to hear on their headphones. The cables also handle talkback to artists' headphones and two-way speech to a floor manager. A small Sony CC TV monitor completes the link between mobile and recording area. There is provision for echo from four echo systems in the mobile but connection can be made to any external echo plates if they are available. Echo can incidentally be on the monitors only if the engineer prefers it.

Every control desk channel has full equalisation and stereo panning. There are seven compressor-limiters of various types, selectable into any channel or group, and monitoring is on broadcast-type PPMs.

I was interested to see that the mains input has not only Variac voltage control but is also stabilised to cope with any sudden changes. Stowed away in various cubbyholes round the studio are just about every type of mike you can think of. The Lockwood monitors are fed by a custom-built 70W per channel power amplifier.

When I saw the studio, it had just been serviced by Helios and was due off back to France. They had a busy time cleaning cigarette ends out of the faders and I wondered how the equipment was standing up to being driven around, often at high speed and sometimes over unmade roads. Things have gone, so far, remarkably smoothly, the Leyland springing being soft enough to keep the equipment in one piece, at most with only the odd joint re-make. Remember that the mobile always goes out with a maintenance engineer.

All in all, the mobile looks like something worth considering seriously where, for one reason or another, the mountain must come to Mohammed. My own private fantasy is what will happen when the police tow it away one day and dump it in their car pound.

'Good morning, sir, what can I do for you?'

'I've come for my recording studio.'

PART TWO

experimental tetrahedral recording

by Michael Gerzon

LAST month we described the actual set-up for a recent experimental tetrahedral recording and noted initial listener reactions. Perhaps more important than describing any one particular experiment is to indicate the problems facing anyone trying out similar experiments, and their solutions.

It is first necessary to choose the type of tetrahedral loudspeaker layout that it is intended to use for the playback. Four layouts have been proposed, and these are illustrated in **fig. 1.** The first such system was proposed by Granville Cooper (see ref. 1), and is shown in **fig. 1a.** A second system, using a skew tetrahedral layout, has been proposed by the author (ref. 2) and is shown in **fig. 1b.** A third playback system due to Jerry Bruck (ref. 3) is shown in **fig. 1c,** and a fourth 'sword of Damocles' tetrahedral layout has also been suggested.

A theoretical analysis indicates that the Cooper, Bruck and 'Damocles' layouts suffer from some important disadvantages resulting in an unsatisfactory distribution of stereo images around the listener. The most obvious disadvantage is that if the layouts lie on a regular tetrahedron, all these layouts require some loudspeakers to lie at large angles above or below the horizontal from the viewpoint of the listener (54.7° for the Cooper layout, 70.5° for the Bruck, and 90° for the 'Damocles'). Also, if room height is the smallest room dimension, then all these layouts include a much smaller volume than that of **fig. 1b** (35% for the Cooper layout, 54% for the Bruck, and 69% for the Damocles). These practical considerations make it necessary to 'squash' the tetrahedron vertically to obtain a reasonable listening area. Also, in order to prevent a hole-in-the-middle at the front with these systems, it is necessary to narrow the angle between the front stereo pair of speakers from 109.5° to around 70°. The result of all these distortions of the loudspeaker layout is that sounds coming from directions not close to any loudspeaker (e.g. the sides) will not have an accurate stereo location. In the author's opinion, these practical compromises largely negate the whole reason for tetrahedral sound, i.e. to reproduce sounds from all horizontal and vertical directions from their original direction around the listener.

Perhaps even more serious is that in the Cooper, Bruck and Damocles systems, the loudspeakers contributing the height information lie in the plane of symmetry of the listener's head, whereas the ordinary stereo speakers lie closer to the axis of the ears. As the ears are directional in the treble, this means that the height speakers contribute much less treble than the 'stereo' speakers, which must inevitably degrade the height effect and cause a poor stereo location of non-frontal images. On the other hand, the skew tetrahedral system of **fig. 1b** has all speakers lying at the same angle off the ears' axis, and would therefore stand a better chance of forming good non-frontal stereo images. Its large volume for a given room height makes 'squashing' much less necessary, no speaker lies more than 35.3° from the horizontal, and location of sounds at the sides should not be affected by any squashing. It can also be shown (ref. 4) that it is less liable to hole-in-the-middle, and provides more realistic information to human stereo location mechanisms using small head movements, as compared to other tetrahedral layouts.

It is for these reasons that the skew tetrahedral layout was adopted for experimental investigations, despite its rather odd appearance and its unsuitability for reproducing two-channel stereo. The skew tetrahedral layout of **fig. 1b** may be thought of as a conventional square layout, with the left front (L_F) and rear right (R_R) speakers raised to the ceiling, and the right front (R_F) and left rear (L_R) ones lowered to the floor. The simplest way of visualising the layout is to imagine the speakers as lying on four alternate corners of a cube. Of course, there is no reason why the mirror-image tetrahedral layout should not work just as well but it is thought advisable to standardise on the L_F speaker being high up, to avoid needless incompatibility between recordings. When setting up the loudspeaker layout, care should be taken to ensure that their floor plan is accurately square, although it is a legitimate experimental aim to investigate the effects of distorting the tetrahedron. As explained last month, it is advisable to use four identical speakers of low coloration, and it would be a good idea to point them towards the listener, possibly as in **fig 2.**

The would-be experimenter should be warned against attempting to make A-B comparisons between tetrahedral and conventional four-channel sound by adding another two speakers at the other two floor-level corners of the cube to make a floor-level 'conventional' square layout. Such a comparison would be unfair to the conventional system, which sounds worse when its speakers are very low or very high than when they are at, or just a little above, ear level. A fair A-B comparison requires the four speakers for each system to be placed at the positions optimum for that system.

The one big disadvantage of the skew tetrahedron system is that speaker colorations emerge from directions quite different from those associated with direct sounds, whereas the Cooper, Bruck and Damocles systems have their coloration-producing speakers placed near the likely sources of direct sounds. A fruitful area of investigation is to determine ways of overcoming this coloration problem, and possibilities range from using cubic or octahedral loudspeaker layouts to placing four outwards-firing miniature loudspeakers pointing along the four tetrahedral axes round the head of the listener, so that the stereo image is reconstructed from the diffuse sounds reflected from the walls and ceiling.

Now we must deal with the tricky problem of microphone technique. As explained in ref. 2, it is possible to make tetrahedral recordings with multimike pan-pot techniques, although this requires more elaborate matrix circuitry than is used currently. When only crude directional effects are required, as in much pop music, it is possible to use ordinary two-channel pan-pot techniques to make sounds come from straight above, straight below, from either side, from straight behind or directly in front (ref. 2)

A profound philosophical problem with tetrahedral recording is where to put the microphones. If the tetrahedral system fulfils its aim of reproducing the live sound, then placing microphones several metres up is liable to make the poor listener seem to float high in the air; at least one listener has found Cooper's recording of the *Messiah* disconcerting just because the microphones had had to be placed 10m up. For experimental purposes, placing the microphones at a sensible listening height will allow the realism to be evaluated more effectively. If tetrahedral recording ever becomes commercial, one can be sure that this will be a perpetual source of controversy.

In principle, the coincident microphone arrangement is simple, merely consisting of four cardioid or hypercardioid microphones pointing in the four directions of the cube corners in **fig. 2,** placed as coincidently as possible. The picture of the experimental microphone arrangement used for the Oxford recording last May shows that the reality looks a good deal more confusing (see **fig. 3**).

The subsequent discussion assumes that the microphones used have a cylindrical shape with the capsules mounted at one end, as in the AKG *C451*, Calrec *652* and Calrec *1050* microphones. The simplest way of making such microphones 'coincident' is to make them face into one another, but this would cause a tetrahedral cavity to be formed between them which would cause coloration. To avoid this, it was deemed necessary (perhaps wrongly!) to use the type of 'coincidence' shown in the photo, in which the V-shape formed by one pair of microphones (as in **fig. 4**) interlocks with the V formed by the other pair of microphones. In the view from the front, one of these V's is formed by the two leftward-pointing microphones, and the other by the right-pointing microphones. This choice was made so that any microphone spacing that remains will tend to simulate the left-right spacing of the ears. There are also good arguments for the two alternatives, i.e. using an upward-pointing V and a downward-pointing V, or a forward-pointing V and a backward-pointing V.

Whichever arrangement is chosen, there is some difficulty in setting up. It is possible to obtain adequate flexibility of adjustment by mounting the microphones in a fiendishly complex arrangement of laboratory clamps, but the design of a proper mounting jig is beyond my spatial visualisation. The actual setting up procedure is basically by trial-and-error adjustment, although it helps to mount the left pair of microphones on a separate framework (e.g. of laboratory clamps) from the right microphones, and to arrange that each framework can be adjusted in height, direction and angle to the vertical.

The actual setting up uses the following facts:

(1) The angle between *every* pair of microphones should be 109.5°, which can be checked using 109.5° angle templates as illustrated in fig. 4. The lower template in fig. 4 has its angle vertex cut off to permit use when the other pair of microphones is in place.

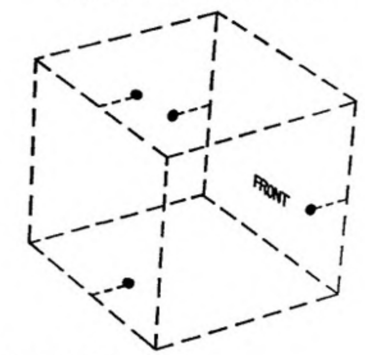
(2) The plane containing the left-pointing microphones is tilted 45° upwards towards the front, whereas the plane containing the right-pointing microphones is tilted 45° downwards towards the front.

(3) When viewed with one eye precisely from the front, precisely from the side, or precisely from underneath, the bodies of the microphones should appear to form an X with arms at 90° to one another. It is very easy to find the position from which the X looks best, and the eye is very good at recognising even small deviations from 90°; this makes this test particularly useful in the final stages of adjustment.

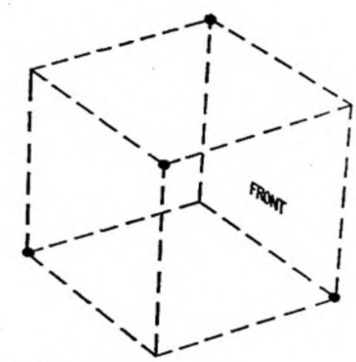
With a bit of time and patience, all angles should be accurate within a degree or two. The procedure is easier for stereo microphones (such as the *C24*) in which one capsule is mounted above the other. One uses two such stereo microphones, and angles the capsules in each 109.5° apart. The bodies of the two stereo microphones are then crossed to form a vertical X with arms at 45° to the horizontal; one stereo microphone is made to point forward and the other backwards.

The choice of what microphones are to be used must be governed by their physical size and their directional characteristics. It is only possible to make the microphones very nearly coincident if they are small. A high degree of coincidence is desirable, as only then is it possible to obtain by a suitable matrixing of the four output signals *any* possible cardioid or hypercardioid output pointing in *any* possible direction. If the microphones are appreciably spaced, such matrixing will no longer have the desired effect, due to wavelength effects. It was by such matrixing that it was possible to convert cardioid microphone outputs to hypercardioid in the experiment

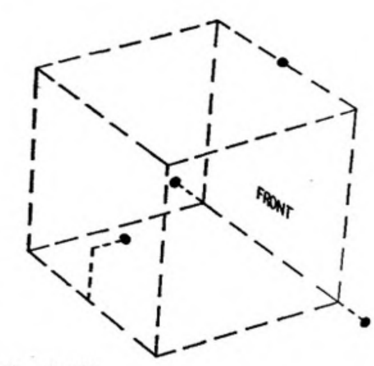
FIG. 1 REGULAR TETRAHEDRAL LOUDSPEAKER LAYOUTS
SHOWN EMBEDDED IN A CUBE WHOSE SIDE LENGTH EQUALS THE HEIGHT OF THE LAYOUT



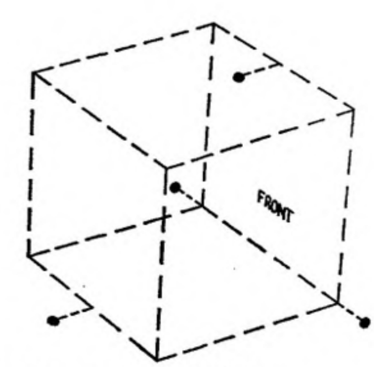
(a) COOPER



(b) SKEW-TETRAHEDRON

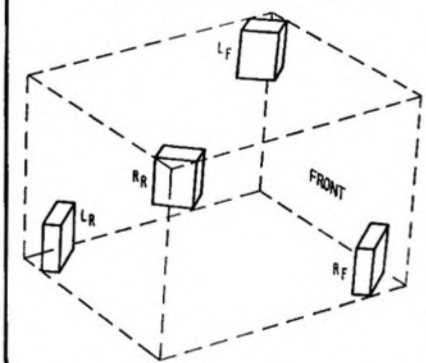


(c) BRUCK



(d) SWORD OF DAMOCLES

FIG. 2 TYPICAL SKEW-TETRAHEDRAL LOUDSPEAKER ARRANGEMENT



described last month. The four capsules should certainly lie within a sphere of 5 cm diameter, and preferably less, in order to ensure that phase effects do not upset the matrixing. As will be described in detail next month, it is possible to rematrix a tetrahedral recording to be suitable for any four-channel playback system, and this flexibility depends on getting the microphones very coincident.

However, it is just as important that all the microphones should be as similar to one another as possible, and if possible, they should be identical. To give a correct reproduced directional effect, the directional characteristics of the microphones must be identical, and should be either accurately cardioid (i.e. 2.5 dB down 60° off axis, 6 dB down 90° off axis, 12 dB down 120° off axis) or accurately hypercardioid. It does not matter if the microphones are not quite hypercardioid enough, as they can always be rendered more hypercardioid by the common mode reduction circuit described in Part 1. A polar response which is irregular or too directional in the treble should be avoided.

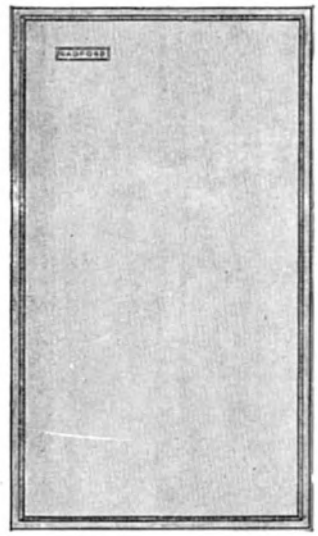
Matrixing the outputs of the microphones can only give good results if they also have a good polar phase response, i.e. do not introduce spurious phase shifts into off-axis sounds. Unfortunately, it is difficult to measure polar phase response and one can only make intelligent guesses as to how good this will be. As a guide, a microphone is likely to have a poor polar phase response if it is a dynamic type, has two units, uses reflection plates, or has an irregular frequency or polar response at high frequencies. The closer frequency and polar response measurements conform to the ideal theory, the more suitable the microphone is likely to be for use with matrixing circuits. On this basis, the AKG *C451* and Calrec *CM652* or *CM1050* cardioids seem particularly suitable.

Because of the stringent requirements on the technical specifications, it is unwise to choose microphones on the basis that they give a good sound when used for ordinary stereo.

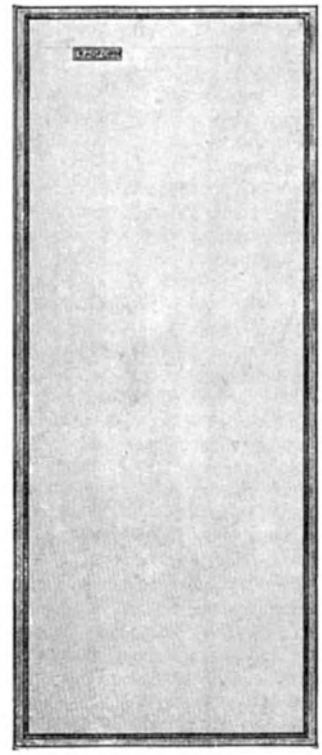
One can make a simultaneous two-channel Blumlein (i.e. 90°-angled crossed figure-of-eight) recording by feeding the L_F and R_R signals into a differential amplifier for the left output, and the R_F and L_R signals into a second differential amplifier for the right output, as in fig. 5. Such differential amplifiers are also invaluable for matching the sensitivities of the

(continued on page 475)

The development of loudspeakers would be very much simplified if a true reference standard of sound reproduction were available. Years ago the axial frequency response characteristic was used as a standard for comparison but this was found to be subjectively unreliable. It has been stated that a good loudspeaker has a sensibly flat frequency response characteristic but a loudspeaker with a flat frequency response is not necessarily a good loudspeaker. This is very true as the static frequency response can be considerably different from the dynamic response i.e. the response to transients. Also axiol frequency measurement is concerned only with the response in a very narrow angle in front of the loudspeaker and gives no indication of the energy response over the horizontal and vertical areas. Transient distortion exists in all loudspeaker systems in varying degrees and it can be demonstrated that the lower the transient distortion the more lifelike the sound. During the last few years Radford have concentrated particularly on eliminating transient distortion from drive units and a realism of reproduction is obtained not previously possible. The two loudspeakers shown here can be considered as reference standards for their size. The TRI-STAR 50 is probably the smallest size wide range high power loudspeaker system available to-day. It uses a closed back type mid range unit as it operates in the same enclosure as the base driver. The MONITOR uses an open back type mid range unit and is therefore contained in a separate enclosure from the bass driver. Both loudspeakers have a frequency response $\pm 3\frac{1}{2}$ dB from 60 Hz to 20 kHz which is just about as flat as can be obtained from present techniques.



TRI-STAR 50 A sealed enclosure for shelf mounting having three units. Mid range driver is a pressure type with enclosed back. Provides high performance with small size. Power handling capacity 50 watts. Matching impedance 8-16 ohms. *Size:* 21 x 12 x 9 in. (53 x 32 x 23 cm.) *Weight:* 35 lb. (16 Kg.) *Price:* **£42·50.**



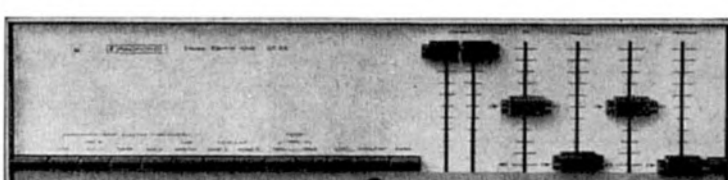
MONITOR For shelf and floor mounting on a suitable stand. Uses three drive units. Sealed enclosure for bass driver. Open back type mid range driver fitted in separate enclosure. Power handling capacity 50 watts. Matching impedance 8-16 ohms. *Size:* 30 x 12 x 10½ in. (76 x 30½ x 26½ cm.) *Weight:* 43 lb. (19½ Kg.) *Price:* **£60·00.**

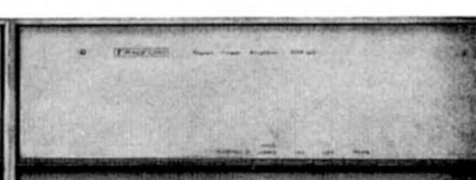
Electronics is a more precise science than acoustics and standards can more readily be established from specific data. The performance standards of the SC.24 pre-amplifier and SPA.50 power amplifier are not equalled by any other amplifier system at the present time. However, many people with sensitive hearing believe that they can hear the difference between good quality amplifiers of different makes having a high specification. The SC.24, SPA.50 combination has been designed to provide a high standard of listening performance as well as a high specification. Among the subtle factors to achieve this are the elimination of cross-over distortion by complementary symmetry output and an extraordinary overload capacity of all the sections comprising the amplifier system, with virtually zero hum and noise output.

Radford aim to make its products a reference standard for others. Write for a leaflet describing the above products or better still visit a franchised Radford dealer for a demonstration and study the quality of workmanship.

PRE-AMPLIFIER CONTROL UNIT TYPE SC.24 A comprehensive stereo unit providing considerable facilities and flexibility. Output sufficient to drive any power amplifier. Mains operated. *Size:* 16½ x 4½ x 9¾in. (41½ x 11½ x 24 cm.) *Weight:* 17 lb. (7·7 Kg.) *Price:* **£80·00.**

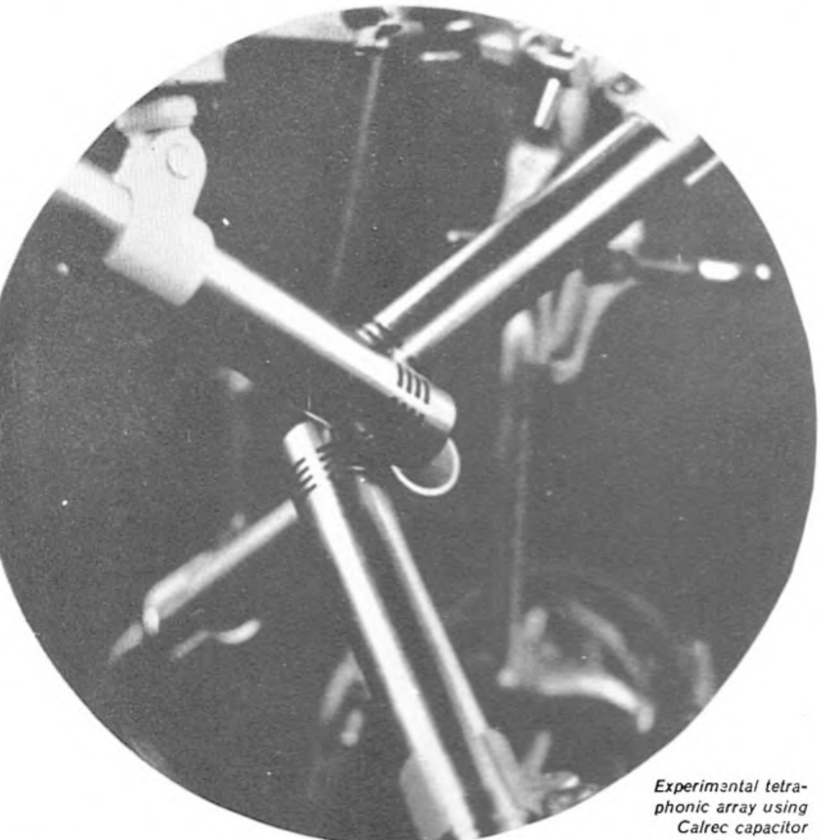
POWER AMPLIFIER TYPE SPA.50 A dual channel power amplifier with power output exceeding 50 watts r.m.s. continuous per channel. *Size:* 10¾ x 4½ x 13in. (27 x 11½ x 33 cm.) *Weight:* 22 lb. (9·9 Kg.) *Price:* **£85·00.**





RADFORD AUDIO LTD., BRISTOL BS3 2HZ

EXPORT EXPOTUS LTD. 10 MUSEUM ST. LONDON, W.C.1



Experimental tetraphonic array using Calrec capacitor microphones.

FIG. 4 V-SHAPE FORMED BETWEEN PAIR OF TETRAHEDRAL MICROPHONES SHOWING ALIGNMENT TEMPLATES

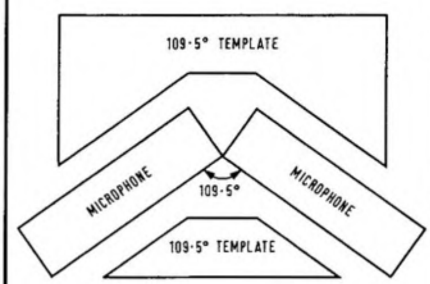
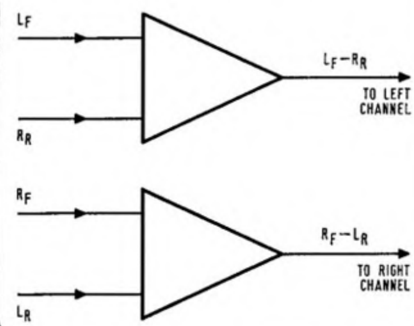


FIG. 5 DERIVATION OF 2-CHANNEL BLUMLEIN OUTPUT USING DIFFERENTIAL AMPLIFIERS



four microphones. If the differential amplifiers are constructed with high tolerance components, then the following 'nulling' method is used: place two of the microphones right next to one another, pointing them in the same direction. Feed them into the line amplifiers with which they will be used during the recording, and take the line amp outputs into a differential amplifier. Monitor the output of the differential amplifier on a speaker, and talk in front of the two microphones. Adjust the gain presets on the line amplifiers until the sound from the speaker is minimised. The two microphones are then matched. This procedure should be repeated retaining one of the microphones as a reference standard and nulling it against the other two microphones in turn, each fed into its own line amplifier. One thereby ensures that the four tetrahedral microphones are accurately matched. If there is some doubt about the accuracy of the differential amplifier used, each nulling should be performed twice, interchanging the two inputs to the differential amplifier between the two nullings. The correct gain preset is halfway between the settings thus obtained.

The four microphones should be fed to the following four tape tracks: L_F (pointing left front upwards) to track 1, L_R (pointing left rear downwards) to track 2, R_F (pointing right front downwards) to track 3, and R_R (pointing right rear upwards) to track 4. This agrees with the usual quadraphonic convention.

It is relatively unimportant whether the microphones are cardioid or hypercardioid as matrixing can manufacture the optimum polar diagram. As yet, the optimum characteristic is not known, although the initial tests reported last month suggest something near 135° null hypercardioids. One problem is that if four cardioids are recorded on tape, and the matrixing to hypercardioids is performed during playback, then there will be a loss of 2 dB in signal-to-noise ratio, because of the loss of common-mode signal energy. In the Oxford experiment, it was considered advisable to record the original cardioids rather than matrixed hypercardioids despite the extra noise, so that the nature of the signal on the tape was known precisely. One would thus be able to calculate exactly what microphone characteristics and technique is produced by any matrixing on playback. Any pre-record matrix used in tetrahedral experiments should be built with high tolerance components, so that the matrix is accurately known.

For the same reasons, all four tape channels were recorded with precisely the same gain. It is helpful to record test tones at the start of all four tracks, so that any difference in channel gains can be corrected during playback. If the microphones are placed at a normal audience distance from the orchestra, then it is likely that the peak energies on all four tracks, front and rear, will be similar, although the rear tracks will sound quieter. If a higher gain is considered necessary on tracks two and four, then test tones are vital. Because of the need to match the four channels accurately, the gain of the rear channels should *never* be varied independently of the front. Remember that the rear channels provide not only ambience, but also stereo information to make the front sound horizontal. The recording engineer for the *Messiah* tetrahedral recording had altered the front-rear balance at several points, and at the playback last November at the University of Surrey it was fascinating to see listeners not knowing this become restless and perturbed at 'something wrong' at those points where the balance had been altered.

The final test for tetrahedral sound is whether it reproduces the overall musical impact of the live sound when technicalities are ignored. For this reason, no compression of dynamics was applied during the Oxford recording. Otherwise, a true comparison with the live sound would have been impossible. Any departure from reality will be far more obvious with tetrahedral sound than with two-channel stereo. The last part of this article next month will deal with methods of matrixing tetrahedral recordings.

1. Granville Cooper, Tetrahedral Ambiophony, *Studio Sound*, June 1970
2. Michael Gerzon, Principles of quadraphonic recording, Part 2, *Studio Sound*, September 1970
3. Jerry Bruck, Interview, *Studio Sound*, December 1970
4. M. A. Gerzon, Recording techniques for multi-channel stereo, *B.K.S. & T. Journal*, June 1971

TELEFUNKEN
M28A £600

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 of the mixer, while in the 'off-tape' mode it is connected to the output of the replay amplifier. Two large VU-meters calibrated to international standard are provided.

CONTACT: BRIAN ENGLISH

A.E.G. Telefunken, A.E.G. House,
Chichester Rents, Chancery Lane,
London WC2
Tel: 01-242-9944

● **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.

CALREC SOUND STUDIOS

Address: Regent Street, Hebden Bridge, Yorkshire.
Telephone: Hebden Bridge 2159.
Directors: C. Beaumont, K. A. Ellis, K. Farrar, P. S. Hopwood, J. Howard Smith.
Studio Manager: J. Howard Smith.
Engineers: K. Farrar, C. Beaumont.
General Information: Calrec is the registered trade mark of Calder Recordings, manufacturers of studio equipment. Their products include desks, monitor speakers, and a range of microphones.
Studio: Area 56 m^2, holding up to 16 musicians.
Control Room: 16-channel desk, with full equalisation, limiters/compressors, and plate, spring and tape echo facilities. Recorders are 'studio quality two-track machines fitted with sel-sync for multi-track ping-pong work'.
Disc Cutting: Mono facilities for lacquers and pressings.
Mobile Recording: Calrec have a mobile unit for location work.
Hourly Rates:

Recording	£5.00
Reduction	£2.50
Editing	£2.50
Copying (including tape, but not spools)	
9.5 cm/s	£6.00
19 cm/s	£9.00
38 cm/s	£12.00

Disc Charges (Lacquers, single sided):

33 RPM 25 cm	£3.25
33 RPM 30 cm	£3.50
45 RPM 18 cm SP	£1.50
45 RPM 18 cm EP	£1.70

Disc Charges (Pressings, each, including cost of master and processing):

33 RPM 30 cm,	50 to 74	£1.70
	75 to 99	£1.50
	100 to 249	£1.40
	250 to 499	£0.60
	500 to 999	£0.50
	1,000 to 2,000	£0.40
45 RPM 18 cm SP,	50 to 74	£0.75
	75 to 99	£0.65
	100 to 249	£0.55
	250 to 499	£0.30
	500 to 999	£0.25
	1,000 tc 2,000	£0.20
45 RPM 18 cm EP,	50 to 74	£0.85
	75 to 99	£0.75
	100 to 249	£0.65
	250 to 499	£0.35
	500 to 999	£0.30
	1,000 to 2,000	£0.25

Tape Charges: 38 cm/s master tapes may be purchased at £4 per reel, excluding spool.

CENTRAL SCOTLAND RECORDING STUDIOS

Address: 6a-12a Canal Street, Falkirk Stirlingshire, Scotland.
Telephone: Falkirk 27055 and 26367.
Proprietor and engineer: James West.
General Information: These studios are part of Central Scotland Audio, a firm which builds studio equipment. James West started doing demos of local bands in 1969, and recently commenced business in these new premises with the objective of providing recording facilities at 'reasonable prices'.
Studio One: 8 m^2, 3.5m high, accommodating up to 15 musicians. Microphones are by Calrec, AKG and Reslo.
Studio Two: 4 m^2, 3.5m high taking up to six musicians.
Control Room (common to both studios): The desk, which was built at the studio, has 14 inputs, with full equalisation, echo, panning facilities, and limiter/compressors. There are two output groups. which feed a pair of Revox *77* recorders. Monitoring is by means of a Leak *TL50* and Tannoy *Gold* speakers.
Music Services: A Hammond organ and Leslie can be hired at a minimum charge of £10 per day.
Sound Effects Service: A library of effects is kept, mainly for use in plays.
Disc Cutting: Can be arranged.
Mobile Recording: Same equipment used for mobile and studio work.
Catering: Drinks available.
Parking: No problem.
Hourly Rates:

Studio One, mono	£3.00
Studio One, two-track	£4.00
Studio Two, mono	£2.00
Studio Two, two-track	£3.00

CENTRAL SOUND STUDIO

Address: 9 Denmark Street, Charing Cross Road, London WC 2.
Telephone: 01-836 6061.
Director: Freddie Packham.
Studio Manager: Andy Curtis.
Engineers: Andy Curtis, Paul Holland, Peter Campbell.
General Information: The studio has been operating for 12 years, recording mainly pop material.
Studio: 9 x 7.5m, and 4.5m high. Microphones used include Neumann and AKG, and there is a separation booth.
Control Room: 12-channel 8-track desk by Sound Techniques, with comprehensive facilities. Recording equipment consists of 8-track, stereo and mono Ampex machines.
Music Services: Grand piano in studio.
Sound Effects Service: Various effects available for copying.
Disc Cutting: Presto cutting lathe, mono only.
Hourly Rates:

Recording, mono	£5.00
Recording, two-track	£6.50
Recording, three-track	£7.50
Recording, four-track	£10.00
Recording, 8-track	£15.00
Reduction, 4-track	£6.50
Reduction, 8-track	£7.50
Editing	£5.00

It should be noted that there are no overtime rates at this studio.
Tape Charges: (per 732m reel):

6.25 mm	£5.00
25 mm	£12.50

Disc Charges (Lacquers):

33 RPM 25 cm single sided	£2.25
33 RPM 25 cm double-sided	£2.90
33 RPM 30 cm single-sided	£2.75
33 RPM 30 cm double-sided	£3.50
45 RPM 18 cm single-sided SP	£1.00
45 RPM 18 cm double-sided SP	£1.50
45 RPM 18 cm single-sided EP	£1.50
45 RPM 18 cm double-sided EP	£2.00

Other Charges: Sound effects are charged at £2 per item, inclusive of all royalties and repeat fees.

GRAHAM CLARK SOUND STUDIOS

Address: PFA House, 182a Station Road, Addlestone, Weybridge, Surrey.
Telephone: Weybridge 43367.
Director: Graham Clark.
General Information: The studio started business in 1968.
Studio: 6 x 4.5m, 2.5m high, holding up to 10 musicians. Microphones are by AKG, Altec-Lansing and Pearl.
Control Room: 4.5 x 3m, 2.5m high. The mixer has 16 channels and auxiliary equipment consists of Audio & Design limiters, AEE graphic equalisers, a Grampian spring reverb unit, and a Binson drum echo unit. Tape machines are by EMI and Revox, and monitoring is through Lockwood cabinets with Tannoy *Gold* speakers.
Music Services: Free use of grand piano and various guitar amplifiers.
Disc Cutting: Epsylon cutter with interchangeable stereo/mono head, and a Connoisseur mono cutter.
Catering: Light refreshments available.
Parking: No Problem.
Hourly Rates:

Recording, stereo or mono	£2.50
Editing	£1.00

Tape Charges (per 366m reel):

6.25 mm	£2.50

Disc Charges (mono lacquers):

33 RPM 18 cm single-sided	£1.10
33 RPM 18 cm double-sided	£1.30
33 RPM 25 cm single-sided	£1.70
33 RPM 25 cm double-sided	£2.00
33 RPM 30 cm single-sided	£2.00
33 RPM 30 cm double-sided	£2.60
45 RPM 18 cm single-sided SP	£0.80
45 RPM 18 cm double-sided SP	£1.00
45 RPM 18 cm single-sided EP	£1.00
45 RPM 18 cm double-sided EP	£1.20

Disc Charges (mono masters):

33 RPM 25 or 30 cm	£6.00
45 or 33 RPM 18 cm	£4.00

Disc Charges (stereo):
Add 50% to mono charges.

DOLBY B320

READERS will be familiar by now with both the Dolby A noise reduction system and the amateur and semi-professional B type system which was announced commercially last year. The original *A505* produced by Dolby Laboratories was a record/playback processor complete with Dolby tone oscillator and meter and could be connected in a manner allowing noise comparison tests to be made with the unit in or out of circuit. In June of last year, Ampex decided to incorporate the B system into all their high-speed cassette duplicating equipment. As a result, Dolby Laboratories were required to produce at short notice a professional version of the *A505*. They decided to use the basic input and output circuits and chassis of the *A301* system, but otherwise to incorporate the simpler B-type circuitry.

The 320 system is identical in size to the *301*; both can be mounted in standard racks. The *320* is specifically designed for use in the preparation of cassette copy masters. It can also be used for normal recording and for playing material which has been recorded using the Dolby B process. As with the *A301*, the record/replay switches are in the centre of the bottom of the back panel. At one end of this panel are two female XLR input sockets below which are 600 ohm output termination switches. Beneath these male XLR output sockets. At the bottom is a mains socket which, incidentally, has an earth terminal. This terminal should not necessarily be connected if other equipment is already earthed. On the front panel are two miniature VU meters with markings for NAB level, referred to as Dolby level, and to the right of them in the centre are an in/out switch for the processor and another for switching in a 19 kHz notch filter. At the bottom is a switch to apply Dolby NAB level tone, which I measured to be 434 Hz and which has a characteristic warble to distinguish it from ordinary lining-up tones. On the right-hand side of the front panel are plug-in amplifier, control and compressor modules for the two channels of the system.

The unit is normally supplied with input and output sensitivities corresponding to +4 dBm NAB level. The input impedance is approximately 10K at most audio frequencies, falling very slightly at the high end. The output impedance is about 500 ohms so that an external 600 ohm load will attenuate the output level by slightly over 5 dB. Alternatively the internal 600 ohm loads can be applied to allow the unit to work at the correct output voltages. If the output loads are left off and the unit is working into a high impedance, a gain of 5 dB above normal working levels will thus be achieved.

I carried out every test with the *320* that I thought relevant to check both performance and design since at the rather high price it is reasonable to expect near-perfection. Such faults as I did find were so minor as to be inconsequential, with one exception. The recording industry is attempting to standardise on NAB level but unfortunately some countries appear to use only DIN level test tapes. Even BASF test tapes recorded to an NAB characteristic have a 32 m Maxwell per mm peak level tone at the beginning. The absence of a DIN level mark on the meters is an oversight which ought to be remedied.

On listening-tests, a ½-track Revox *77* was aligned very carefully at 9.5 cm/s. One half of the processor was connected to the 'record' side of the Revox whereas the other half was connected in the replay chain from the Revox to the external monitoring equipment. With two of my colleagues I listened carefully to AB comparisons between mono signals obtained from stereo A-Dolby masters and to the output from the Revox tape recorder with both processed and unprocessed recordings. In order to be relatively unfair to the system in these tests ordinary BASF *LP35* was used. Although it is relatively low noise, it does not possess the high output qualities of *LH* tape and some manufacturers might be using the lower cost tape for duplicating commercially.

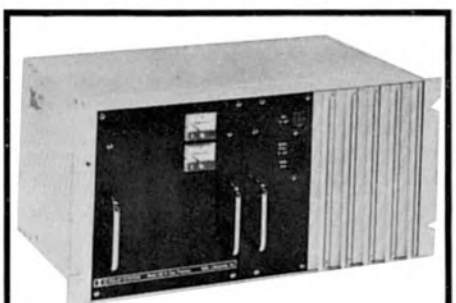
I have had a number of opportunities in the last two months to test the *320* on live sessions as well as by dubbing A-Dolbyed masters to cassette, and in all cases I found that the B system fully meets the manufacturer's claims. In the comparison tests we listened to recordings of a large orchestra playing both very quietly and very loudly, an unaccompanied choir, a piano recording made with a fairly close microphone, and speech both live and recorded. The output from a very high quality stereo tuner was also monitored direct and via the system on a number of types of programme. In most cases no significant deterioration of the programme quality was noted, but since the Dolby B system only operates at high frequencies no noise reduction is applied to hum introduced by the recording system. Thus a hum-to-hiss ratio that was considered acceptable without noise reduction became just unacceptable when listening to very quiet programme material at above normal listening level. This brings home the importance of ensuring that equipment installed with B-type noise reduction has a lower hum level than might normally be thought adequate.

The hum and noise figures were measured with a screened 600 ohm source resistor connected to the input and a B & K *2112* spectrometer connected to the output.

With the processor switched out in both play and record positions, the hum and noise measured −83 dBm. With the processor switched in and on 'record' the figure was −70 dBm, and when on 'playback' it was −79 dBm. With the two processors connected in series, the first on record the second on playback, the noise level was −77.5 dBm with noise reduction in. The main component of the noise was a very slight hiss, well below audibility in spite of very high listening levels and even considerably lower than the measured hiss level of the *A505* prototype B system. The noise levels are referred to 0 dBm out of the unit and an improvement of 4 dB is obtained if they are taken with respect to Dolby level. In practice manufacturers record to peaks at least as high as Dolby level even on cassettes, and often 2 or 3 dB higher on many types of material. For 6.25 mm tape duplication, peak levels 8 dB higher are frequently encountered. The point of clipping distortion appearing on the output was found to be identical to that on the *A301* and was approximately +18.5 dBm at high frequencies and +18.75 dBm at middle and low frequencies. This overload capability was considered more than adequate for all normal purposes.

The harmonic distortion was measured at Dolby level with the processors connected in series and with the first on record and the second on play. The distortion, almost entirely second harmonic, measured just under 0.1 per cent and it can be considered insignificant when compared to tape distortion. I also measured it at levels lower than Dolby level: it has been reported from the States that in one case Dolby equipment had been made available to the

(*continued on page 485*)



MANUFACTURER'S SPECIFICATION
Input: 10K bridging balanced transformer.
Output: Balanced; levels to order.
Overall frequency response: 20 Hz to 20 kHz ±1 dB.
Total harmonic distortion: (+8 dB): 0.1% at 1 kHz. 0.2% from 40 Hz to 20 kHz.
Output clipping point: better than +18 dBm into 600 ohms.
Noise reduction (to B specification): 3 dB at 600 Hz. 6 dB at 1.2 kHz. 10 dB from 5 kHz up.
Overall noise level: 80 dB unweighted ref +8 dBm (600 ohms).
Crosstalk: 60 dB, 20 Hz to 20 kHz.
Dimensions: 225 x 483 x 270 mm (standard rack mounting). 13 kg.
Power requirement: 100 to 125/200 to 250V, 50/60 Hz, single phase, 18 VA.
Price: £390
MANUFACTURER: Dolby Laboratories Inc, 346 Clapham Park Road, London SW9.

WE NEED TO MAKE EVEN MORE MIXERS

MUSICMASTER

8 CHANNEL MONO-
STEREO WITH
SWITCHED INPUT
TWIN Iv OUTPUTS

DISCO II

CROSSFADE—
MIC OVERLAY—
MONITOR
AMPLIFIER—
MAG-CERAMIC
LOW OR HI Z MIC
TO CHOICE.
MONO OR STEREO
AVAILABLE.

WE'VE OPENED ANOTHER FACTORY—5000 SQ. FT. OF IT

AMPLIFIERS — MIXERS — MODULES — MICS — SPEAKERS

At Millbank we've got it—made

Millbank Electronics
BELLBROOK ESTATE, UCKFIELD, SUSSEX
Telephone: Uckfield 4166 (0825 4166)

FRANCIS OF STREATHAM

DECKS WITH PRE-AMPS
(Microphone extra)
Akai 8 Tr. Cartridge CR.800
Akai 4000D Stereo
Brenell MK.6 Stereo
Ferrograph 702/4
Philips N.4505 3 sp. 4 Tr. Stereo
Revox 1102/4 2 sp. Stereo
Revox 1102/4
Sanyo 801 3 sp. 4 Tr. Stereo
Sharp RD 712D 3 sp. 4 Tr. Stereo
Sony 366D 3 sp. 4 Tr. Stereo
Sony 630D 3 sp. 4 Tr. Stereo
Sony 266D 3 sp. 4 Tr. Stereo
Sony 255 Stereo
Tandberg 1800 4 Tr. Stereo
Tandberg 3000X 3 sp. 2/4 Tr. Stereo
Tandberg 6000X 3 sp. 2/4 Tr. Stereo
Telefunken 205 3 sp. 4 Tr. Stereo
Telefunken 203 Studio

MAINS SPOOL RECORDERS
*Akai 1710L 2 sp. 4 Tr. Stereo
*Akai 4000 3 sp. 4 Tr. Stereo
*Brenell Mk. 6
*Ferrograph 713
*Ferrograph 722/4
Grundig 141 4 Tr. Mono
Grundig TK.121 2 Tr. Mono
Grundig 146 4 Tr. Mono Auto.
*Grundig TK248 2 sp. 4 Tr. Stereo
Philips 4303 2 Tr. Mono
Philips 4307 4 Tr. Single Speed Mono
Philips 4308 2 sp. 4 Tr. Mono
Philips Stereo 4404 2 sp. 4 Tr.
Philips Stereo Cassette 2401 Auto.
Philips Stereo Cassette 2400
Philips 4407 3 sp 4 Tr. Stereo
*Philips 4408 Prof. 3 Tr. Stereo
*Revox 1222/4 Stereo
Sharp 708 3 sp. 4 Tr. Stereo
Sharp 711 3 sp. 4 Tr. Stereo
Sony 630 3 sp. 2/4 Tr.
Sony 252 3 sp. 4 Tr. Stereo
*Tandberg 15 2 or 4 Tr./2 sp./Mono
*Tandberg 4000 3 sp. 2/4 Tr. Stereo
*Telefunken M207 2sp. 4 Tr. Stereo
Telefunken 203 Stereo/Mono 2sp. 4 Tr.
Telefunken 201 Mono 4 Tr.
*Uher 714 4 Tr. Mono
*Uher Royal de Luxe 4 Tr. 4 sp. St.
*Uher Varicord 263 Stereo
*Uher 724 4 Tr. 2 sp. Stereo

MAINS CASSETTE MODELS
*Philips RH882 Stereo Tuner/Amp/Cass.
*Sony HST399 Stereo Tuner/Amp/Cass.
Sony TC 330 Stereo Cass/Spool

* Kellar Dolby Stereo
*Rank Wharfedale Dolby Stereo
Philips 2400 Stereo
Philips 2401 Autochange w. ski-slope

*Sony TC 127 Deck and Pre-amp
*Sony TC 122 Deck and Pre-amp
*Philips 250 Deck and Pre-amp

BATTERY MAINS CASSETTE
Philips 2204 — Sony TC.80
Philips 2205 — Sony TC.100
Sony TC.60
Philips TT 392 with AM/FM
Philips RR 290 with AM
Sony CF 100 with AM/FM
Sony CF 200 with AM/FM

BATTERY CASSETTES
Philips EL3302 — Sony TC. 40
Philips N2202 — Sharp 418
Sony TC. 12 — Grundig C.200

BATTERY SPOOL MODELS
*Tandberg Series 11-2
Sharp 514 2Tr 2sp (BM)
Sony TC. 800 B 2Tr 4 sp (BM)
Telefunken 302 4Tr 2sp
*Uher 400L 4sp 2Tr
Uher 4200/4400 4sp Stereo

*Microphones extra

FOR A FAIR AND DEPENDABLE DEAL IN

TAPE and HI-FI

★ Minimum Deposit and 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)
Compact Cassettes C.60—53p; C.90—75p; C.120—£1·05 (pp 3p each).

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
3" reel polyester tape, 600 ft. (P)	25p

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, Sennheiser, Telefunken, etc.

●**HEADPHONES** by AKG, Nikko, Philips, Koss, Eagle, TTC, Beyer.

●**MUSICASSETTES.** All leading makes. Pre-recorded 8-track cassettes and tapes.
Recording tapes and cassettes—All leading makes.

HI-FI DEPT.

● **AMPLIFIERS**
Quad, Rogers, Arena, Philips, Goodman, Nikko, Armstrong, Leak, Tripletone, Tandberg, Teleton.

● **TUNERS**
Quad, Rogers, Leak, Armstrong, Tripletone, Arena, Nikko, Goodman, Huldra.

● **LOUDSPEAKERS**
Quad, Rogers, Kef, Wharfedale, Goodman, Tannoy, Lowther, Leak, Tandberg, Arena, Celestion, Kelestron.

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

Goldring	BSR
Connoisseur	Thorens
Audiotec	Shure
Neat	Sonotone
Acos	SME
Dual	Pickering

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 mins away
OPEN ALL DAY SATURDAY—CLOSED ALL DAY WEDNESDAY

public which had a measured distortion of five per cent at 1 kHz when approximately 20 dB below Dolby level. On the *320*, the distortion at this point and at lower levels was almost immeasurable, being lower than 0.01 per cent. At 10 dB above Dolby (+14 dBm), the processor distortion rises to approximately 0.2 per cent. It was felt that this is the highest level at which the equipment would ever be used, even considering transients. The third harmonic distortion was always very much lower than the second harmonic and it is therefore assumed that such distortion as is present is caused by the choice of the transistor bias point. For operational reasons this seems to have been selected at some other point than that giving minimum distortion. For all these tests, a Radford low-distortion audio oscillator was used with a Marconi wave analyser.

The frequency response of the unit was measured with the processor both in and out, singly and in series in opposing modes, and it was found to be well within specification. The response was measured via the Revox recorder previously referred to, recording at 9.5 cm/s and again at a level of 24 dB below Dolby level —near the point at which the unit is fully noise suppressing. The response was still ±1 dB from 30 Hz to 15 kHz with the exception of a very slight bass woodle present in the Revox itself. It was necessary to introduce a Dolby level mismatch of 3 dB in order for the recorded response at some lower levels to fall outside the limits of ±2 dB over the same audio range. The audible effect of a mismatch of Dolby level was apparently to increase or decrease the brightness of a recording and I found in practice that, under certain circumstances and on some material, such a mismatch can be intentionally introduced to advantage, provided such an introduction of mismatch is not taken to excess. For instance, provided there is no noticeable hiss present, older-type material which has a slightly backward balance can be improved by this means. Furthermore, if hiss is present on some masters it can be partly reduced by operating the Dolby level too low. In this case the replay noise reduction will then reduce the noise to a lower degree than on the original master tape although high harmonics in the music are bound to be attenuated.

For an explanation of the method by which the Dolby noise reduction system works, I refer readers to my article in the November 1970 STUDIO SOUND which gave details of the operational circuits. Basically no real noise reduction is achieved at the higher levels but, as the level is lowered, the point above which noise reduction begins progressively lowers in frequency. By the time the level is reduced to 40 dB below Dolby level, frequencies of 4 kHz and upwards are increased by approximately 10 dB. The point for a 3 dB increase in level is 500 Hz, and the level of boosting becomes insignificant at frequencies lower than this.

Under dynamic conditions the total energy present at high frequencies determines the total upward compression of the complete higher end of the spectrum. In the presence of one high frequency at a fairly high intensity, the human ear will tend not to notice noise which is at other high frequencies but which is lower in intensity, and the system relies on this masking effect for its subjective noise reduction.

With octave filters I confirmed that band noise at higher frequencies was indeed reduced by up to 10 dB when the replay processor was switched on. In practice the subjective effect did not actually sound as much as this, but nevertheless it was most marked. There was also an apparent reduction in the audible distortion products generated by the tape. This allowed, if necessary, a very slightly higher level (about +2 dB) to be recorded for the same apparent distortion as would be heard without the system. The apparent noise level produced using the system with the Revox at 9.5 cm/s was actually slightly better than that produced by professional machines, which use good tape at 38 cm/s, though naturally the hum level became more noticeable by comparison.

The unit is fitted with a 19 kHz notch-filter, allowing it to be used with stereo tuners having insufficient rejection of pilot tone. The provision of this facility is useful even though it is not anticipated that many private users will purchase the professional version. In professional broadcasting applications it is possible that a landline requiring noise reduction could have as its source the output of a stereo tuner which is receiving the broadcast signal for subsequent retransmission. The built-in filter had a rejection of 34 and 30 dB at 19 kHz but its null was found to be slightly higher than 19 kHz, and to have a rejection of 40 dB at 19.084 and 19.135 kHz respectively for the two processors. It is a pity that, at the time the unit was manufactured, the filter slot frequency (which is adjustable) was not preset to give an improved rejection at exactly the pilot-tone frequency. Since pointing out this almost academic filter inaccuracy to the manufacturer, I understand that they are now using a frequency meter for setting up. With the filter switch 'in', a drop of just under 1.5 dB was noted at 15 kHz, showing the filter to be extremely sharp. Significant attenuation (31 dB with respect to the response at 1 kHz) was also noted at double the pilot tone frequency.

Square wave response

The square wave response of the unit when connected back-to-back was not quite as good as that of the *301* system, but was satisfactory nevertheless. The ringing that was noticeable was due to the fact that some elements of the filtering system were in circuit when the filter was not in use. When the filter was in use, the ringing was very much more marked, although never audible under any conditions.

I used the *320* as part of my stereo transmission experiments on the 2m amateur band and it was interesting to note that in each contact the receiving station commented on the improved intelligibility of the signal, particularly under very low reception-signal conditions. In the case of stereo reception, the reduction in hiss level when I replayed a tape of my received transmission via the Dolby in replay mode was remarkable, and demonstrated its eminent suitability for broadcast transmission purposes. It would appear that Dolby B transmissions, if received by equipment fitted with a Dolby replay processor, would have an equivalent coverage area several times that of a normal broadcast, allowing excellent stereo reception of a received signal as low as 25 μV. Experiments are now being conducted in the States with the aim of exploiting this for future commercial use.

When the *320* is used for making copy masters for high-speed duplicating it must be borne in mind that the peak signal level in the system must be compatible with the peak capability of the cassette or cartridge tape, rather than with that of the copy master's tape. For this reason it is possible that some companies may wish to record their copy masters such that Dolby level corresponds to a higher flux level. In cases like this the flux level would be attenuated in the duplicating process by an amount such that the Dolby level then corresponds to a recorded flux of 200 pW/mm per mm. Nevertheless it might avoid some confusion if this flux level were maintained on copy master as well as on duplicate. It should be remembered that for normal cassette duplication a peak level of 2 or 3 dB above Dolby level should not be exceeded, because the final cassette copy may not take levels in excess of this. Any compression used should be applied before the Dolby processing, and copying from the copy master to the duplicated tapes should be carried out on a strictly one-to-one basis with the appropriate equalisation for whichever processing speed is being used.

The unit, with its stabilised power-supply, would appear to be extremely reliable. Many of the measurements obtained were checked after the equipment had been on continual soak test for two months, and all the figures were virtually identical. The unit is very well made, and a recent visit to the factory not only revealed that a large number of tests are carried out on the completed equipment, but that there is a complicated series of tests through which all parts have to pass independently. All the individual modules are shock-tested at accelerations far above any likely to be encountered, and soldered joints are not only inspected under a microscope but are subjected to r.f. cleaning in an oven. It could be said that the price is high, but if it were lowered reliability would suffer and I feel sure that the manufacturers are justified in taking the care they do.

However, I must emphasise that the *320* is not recommended for professional master recording. This is primarily because of the absence of low frequency noise reduction, but it is also because the use of the A system has become standard throughout most of the recording industry. The extreme inconvenience of having B Dolby master tapes and no means of de-processing them elsewhere is a particular reason why the *320* should not be used for original masters. However, it may be used for making both mass-duplication copy masters and copies for clients to play back on their own systems, particularly if the latter are equipped with Dolby B playback modules. These are now being fitted into a number of domestic machines.

Finally, the B Dolby recording is fairly compatible with a non-Dolby one, provided that (in the absence of a playback processor) a treble cut of approximately 6 dB or so is applied to 10 kHz. If this procedure is followed, some hiss reduction will result although it may be accompanied by some loss of top on transients, but this should not prove too serious.

Angus McKenzie

At last, Philips have come up with the final piece of equipment you need to make your hi-fi system complete.

The N2503 Stereo Cassette Deck. You use it in conjunction with your existing amplifier and speakers to record and play back cassettes in stereo and to play pre-recorded Musicassettes of your favourite artists.

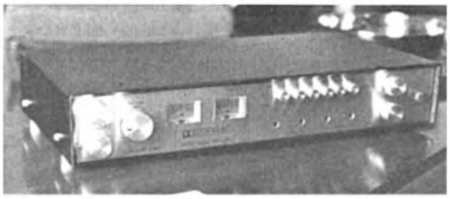
The N2503 is built to the same high standard enthusiasts have come to expect from Philips hi-fi equipment. It has an extremely fast wind/rewind time, a very impressive signal to noise ratio, a sliding recording level control and a recording level indicator. It comes complete with a moving coil stereo microphone, and is also a very handsome piece of equipment, designed to look good in any hi-fi system, with real rosewood sides and brushed silver finish.

The N2503 Stereo Cassette Deck. We think that no hi-fi system is complete without it.

We want you to have the best.

THE MISSING LINK.

PHILIPS



KELLAR KDB1

MANUFACTURER'S SPECIFICATION

Output: *Record:* 580 mV from 50 ohms source. 5K minimum load.
Replay: 580 mV from 5K source. 50K minimum load. Ref Dolby level (185 pW/mm reel; 200 pW/mm cassette)
Overload capacity: ±10 dB (record/replay).
Input: *Record:* 25 mV at 20K for 580 mV out.
Replay: 25 mV at 30K for 580 mV out.
Distortion: 0.1% at 580 mV or less.
Frequency response: 20 Hz to 15 kHz ±1 dB.
Channel separation: 50 dB at 1 kHz.
Signal-to-noise ratio (including hum): 70 dB ref 580 mV, unweighted.
Power supply: Regulated, accepting 200/250V 40 to 60 Hz. Other voltages to order.
Calibration: 400 Hz Dolby level internal sine oscillator.
Connector: Five-pin DIN socket.
Dimensions: 430 x 230 x 85 mm. 3 kg.
Price: £49.50.
Manufacturer: Kellar Electronics Ltd, 'Romagna', Bycullah Avenue, Enfield, Middlesex.

THE Kellar *KDB1* stereo noise reduction unit (Dolby B system) occupies a neat metal cabinet, and is available in black or 'imitation wood' plastic cloth, in both cases with brushed aluminium facia and knobs.

The front panel controls are (from left to right): input level controls for each channel; record gain control; VU meters for channels A and B; record/replay buttons for channels A and B, calibration button; multiplex filter; Dolby on/off button; monitor control button.

Beneath the buttons are four presets: two record level and two replay level. On the right are A and B output level controls and a red mains on/off button.

On the rear panel are two five-pin DIN sockets marked 'recorder' and 'amplifier' respectively.

The unit is designed to process signals from an amplifier, feeding these to a tape recorder. On replay, it deprocesses signals from the tape machine, thence feeding back into the amplifier.

It is assumed that, for domestic purposes, the noise which really matters is largely confined to high frequencies.

A single high frequency band that would cope adequately with noise in the 2 to 3 kHz region would need a fairly wide bandwidth, and the system would produce audible breathing effects as the hiss level rose and fell. The Dolby B uses a variable bandwidth filter in the side chain. Low level HF signal components are amplified in the side chain, and this output is added to the main signal path on record, boosting the low level high frequency signals.

In the playback mode, the side chain output is subtracted from the main signal in a complementary manner returning the programme input to its original level but reducing noise introduced between the record and playback processors. The side chain contains a limiter with a low threshold so that all low level HF signals are passed through for addition (or subtracted on playback) to the main signal, but high level signals are unaltered, the unit is therefore suitable for use with recorders using low tape speeds and large amounts of HF pre-emphasis.

The Kellar unit is in a reasonably sturdy box and the controls worked positively, though not smoothly. The metal-coated push buttons argued with the metal facia and quickly became scratched. The printed board carrying most of the circuitry is firmly bolted down and the components clearly laid out.

After connecting the captive mains lead and plugging in the DIN leads to amplifier and tape recorder, the unit is lined up as follows:

A Dolby line-up tape is played on the recorder with all pushbuttons out, corresponding to the mode labelled below each control. All rotary controls are set at maximum. The recorder's replay level and the Kellar preset replay controls are adjusted until a reading of 0 VU is obtained on the *KDB1* meters. Adjustments should be made so that the gain controls on the recorder and the presets on the *KDB1* are about equally advanced.

The Dolby level tape is then unloaded from the recorder and a virgin tape loaded.

The record/replay and CAL buttons on the Kellar are pressed and this signal is recorded.

The *KDB1* is then switched to playback and the CAL button to off, and the signal just recorded is replayed.

This is repeated adjusting the 'record' preset on the *KDB1* and the record gain on the recorder until they are advanced by about the same amount and the level on replay reads 0 VU on the *KDB1* meters.

The unit is then set up for use. Both record and playback levels must be controlled from the *KDB1* since any alteration of the recorder's controls would necessitate lining up again.

Difficulty was found in lining up using a Sony *TC127* as the output from the Sony was too high and overloaded the input stage of the Kellar.

Dolby Labs were consulted, and offered the loan of a Wollensak recorder which was readily accepted as these machines have a high reputation. The Wollensak has a similar output to the Sony so an attenuator was made up for use with either recorder.

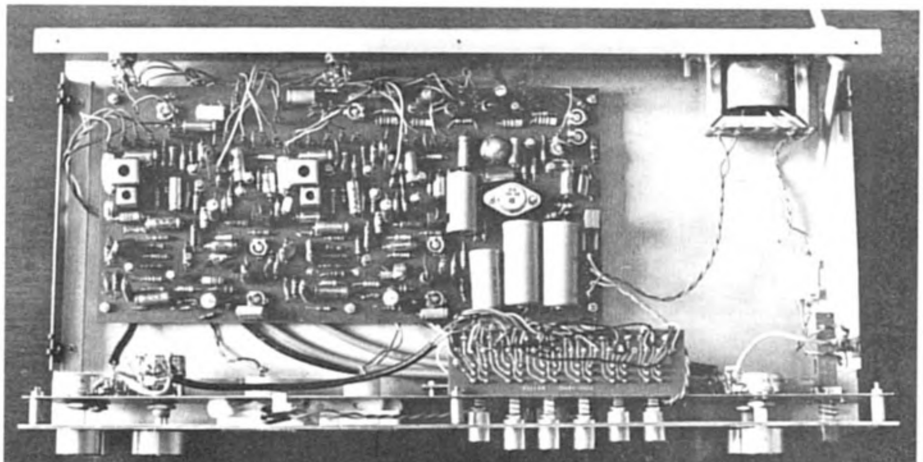
A purchaser is likely to feel very frustrated if he can't use a piece of equipment without seeking advice and buying resistors to make up attenuators, and Kellar Electronics should consider incorporating attenuation to make this unnecessary.

First listening tests were carried out using the *KDB1* with a Philips stereo cassette unit and Sugden Class A amplifier feeding a pair of Goodmans *Maxim* speakers, using Decca Dolby cassettes as the signal source. No problems occurred in setting up this combination and all listeners agreed that the results were outstanding. With tone controls flat, no hiss was audible at what we considered realistic listening levels. The reproduction was not quite as 'bright' as from some discs (most listeners thought this an improvement anyway) and the absence of clicks, plops and surface noise was very welcome. There was certainly no more distortion than from the inner grooves of a

(continued on page 485)

KDB1 Frequency Response. Process on A, Deprocess on B at various levels.

	0 dB	−10	−20	−30	−40
10	0	+½	+1	+1½	+1
20	−½	0	+1	+1	0
30	−½	+½	+1	+1	0
40	−½	0	+1	+½	0
60	0	0	+1	+1	+½
100	0	0	+1	+½	+½
200	0	0	+½	+½	0
400	0	0	+½	+½	0
600	0	0	0	0	0
800	0	0	0	0	0
1K	0	0	0	0	0
2K	0	0	0	−½	+½
3K	0	+1	+1	0	+½
4K	+½	+1	+2	+1	+1
6K	+½	+1	+2½	+1½	+1
8K	+½	+1	+2½	+2	+1½
10K	+½	+1½	+2	+2	+1½
11K	+½	+1	+2½	+2½	+1½
12K	+½	+1	+2	+2	+1½
13K	+½	+½	+2	+2	+1
14K	0	+½	+1½	+1½	+1
15K	0	+½	+1½	+1	+1
16K	−½	+½	+1	+1	+½
18K	−1	−½	+½	0	0
20K	−2	−1½	−1	−2	−1½



BEST DISCOUNTS
SEND 5p FOR BIG HI FI CATALOGUE

BIG DISCOUNTS ON AKAI

AKAI 4000
Superb three head Stereo Tape Recorder with High Fidelity recording and playback. It has a three head system with micron gap. The sturdy mechanism provides excellent durability. Fine oil-finished wooden cabinet. It is a 4-track stereo/mono with 2 speeds, a shield type head for high S/N ratio, a tape lifter in fast forward and rewind operation, a 3-digit index counter and 2 VU meters. List price £124.90. Cash price **£87.50,** P & C £1.75.

AKAI 1720
Surely one of the best tape recorder buys on the market today, combining all the best features of Akai engineering and construction. It is a 4-track stereo recorder with 3 speeds, tone controls, two built-in 5″ x 7″ speakers and an automatic shut off. List price £97·21. Cash price **£76·90.** P & C £1.75.

TAPE RECORDERS P & C £1·75
Revox Tape recorders special prices on application.

Ferrograph 713	£207·35	**£182·60**
Ferrograph 702/704	£228·71	**£199·75**
Ferrograph 722/724	£266·41	**£233·40**
Grundig TK121	£57·35	**£50·45**
Grundig TK141	£63·85	**£56·15**
Grundig TK146	£69·75	**£61·35**
Grundig TK124	£44·90	**£31·00**
Grundig TK144	£49·95	**£33·50**
Grundig TK149	£57·60	**£41·50**
Akai 4000D	£89·95	**£69·95**
Akai 1720L	£97·21	**£76·90**
Akai X-5000L	£177·97	**£145·00**
Akai X-5000W	£177·97	**£155·00**
Akai M-10L	£245·05	**£189·95**
Tandberg 3041X	£109·90	**£94·95**
Tandberg 4041X	£180·00	**£158·35**
Tandberg 1741	£74·00	**£65·10**
Tandberg 1841	£69·75	**£61·35**
Tandberg 1521	£87·00	**£76·55**
Teleton SL40	£38·00	**£33·50**
Philips 4302	£39·00	**£29·95**
Philips N4307	£49·50	**£43·50**
Philips N4308	£60·50	**£53·15**
Philips N4404	£95·00	**£83·45**
Philips N4407	£110·00	**£96·65**
Philips N4408	£126·00	**£110·70**

CASSETTE RECORDERS P & C £1.25

Philips N2202	£27·90	**£21·95**
Philips N2400 including speakers	£90·00	**£79·15**
Philips N2400	£68·00	**£59·80**
Philips N2401 including speakers	£103·00	**£90·60**
Philips N2602 Car Cassette Player	£42·00	**£36·95**
Crown CTR8750	£32·55	**£24·95**
Teleton T7-10	£34·75	**£30·50**
Teleton H8100	£21·50	**£13·95**
Pye 9109	£23·90	**£19·85**

8 TRACK STEREO P & C £1.25

Akai CR80	£115·02	**£101·25**
Akai CR80D	£95·00	**£83·60**
Motorola Car Player	£48·62	**£39·95**
Pioneer TP83 car unit	£39·70	**£34·00**
Pioneer TP85 with FM radio	£84·25	**£72·00**
Teleton STP800 with speakers	£52·25	**£43·75**

Also at:
86 South Street,
Romford, Essex

AMPLIFIERS P & C £1.25

Armstrong 521	£56·00	**£42·50**
ARD2000	£49·00	**£37·95**
Amstrad 8000	£25·95	**£17·25**
Cambridge P50	£88·00	**£72·50**
Leak 30 (Ch)	£56·50	**£44·50**
Leak 70 (Ch)	£69·00	**£53·95**
Lux SQ1220	£124·50	**£84·00**
Lux SQ77T	£66·37	**£54·00**
Metrosound ST20E	£39·50	**£32·50**
Quad 33 + 303	£98·00	**£79·50**
Philips GH925		**£18·50**
Rogers R'bourne (Ch)	£59·50	**£49·25**
Rogers R'brook (Ch)	£47·50	**£39·25**
Rotel RA310	£42·50	**£35·95**
Rotel RA610	£65·00	**£54·95**
Sinclair 2000 Mk 1	£35·00	**£21·50**
Sinclair 2000 Mk 2	£35·00	**£26·25**
Sinclair 3000	£45·00	**£30·95**
Sansui AU222	£62·88	**£51·95**
Sansui AU555A	£86·43	**£71·50**
Ferrograph F307/2	£62·00	**£43·95**
Teleton GA101	£33·75	**£24·50**
Teleton SAQ206	£32·50	**£18·50**

BASF & SCOTCH DYNARANGE LOW NOISE HIGH OUTPUT TAPE

5″ 900′	£1·89	**£1·30**
5¾″ 1200′	£2·17	**£1·50**
7″ 1800′	£3·11	**£2·10**
5″ 1200′	£2·16	**£1·50**
5¾″ 1800′	£3·10	**£2·10**
7″ 2400′	£3·83	**£2·65**
5″ 1800′	£3·09	**£2·15**
5¾″ 2400′	£3·82	**£2·65**
7″ 3600′	£4·75	**£3·30**

BASF, PHILIPS & SCOTCH DYNARANGE CASSETTES

C30 (Philips only)	£0·53	**£0·45**
C60	£0·71	**£0·50**
C90	£0·99	**£0·70**
C120	£1·49	**£1·00**

P & C 10p on all orders.

BEST VALUE ON SONY EQUIPMENT AT CAVES — PRICES ON APPLICATION

CREDIT TERMS
PAYBONDS ACCEPTED
ASK FOR DETAILS

Prices correct at time of going to Press. Subject to alteration without notice. E. & O.E.

F.CAVE hi fi

5 Bridge Street
Richmond Surrey
01 948 1441

27 Eden Street
Kingston Surrey
01 546 7845

Mail Orders to Richmond address

UP TO 50% OFF!

BRITAIN'S ONLY TAPE RECORDER MART

specialising in the SALE, EXCHANGE and PURCHASE of every make of high quality Tape Recorder. Brenell, Ferrograph, Ampex, B & O, etc., we have the lot! Fantastic savings of up to **50 per cent off** original list prices for **Personal Callers only.** Our stocks change daily, **call today** we may have just the bargain you are looking for **—guaranteed—**and you pay **no tax** on secondhand machines.

SUMMER SALE!

EVERYTHING MUST BE SOLD—WE ARE CLEARING OUR ENTIRE SUMMER STOCK OF NEW AND SECOND-HAND TAPE RECORDERS

BARGAINS FOR EVERYONE

TYPICAL EXAMPLES:

NEW MODELS

Philips 4302 Automatic Mono Recorder
List £39 OUR PRICE **£27·50**

Sanyo MR.999 Stereo Recorder
List £101·95 OUR PRICE **£78·75**

Akai X300
Was £364·00 OUR PRICE **£125·00**

Ampex 1163
Was £146·00 OUR PRICE **£105·00**

SECONDHAND MODELS

Akai X355
Was £331·00 OUR PRICE **£149·00**

Akai X4
Was £169·00 OUR PRICE **£60·00**

Uher Royal
Was £188·00 OUR PRICE **£95·00**

Telefunken 301
Was £62·00 OUR PRICE **£25·00**

THE SUMMER SALE TO BEAT ALL SUMMER SALES!
PERSONAL CALLERS ONLY.
No letters, no 'phone calls!

THE TAPE RECORDER MART

242/4 PENTONVILLE ROAD, LONDON, N.1

(200 YDS. KINGS CROSS) Tel: 01-837 8200 (HALF DAY THURSDAY)

normal disc. Many people would, I think, consider purchasing the *KDB1* on this demonstration alone.

The next tests were carried out using the Wollensak recorder and the attenuator provided by Dolby Labs with Quad amplifiers and *ELS* speakers.

Again with the attenuator in the replay circuit no difficulty was experienced in setting up. While the slight 'roughness' of the Decca cassette tapes was more noticeable on this equipment, the sound was still very acceptable, and many listeners still preferred this to disadvantages associated with discs.

This combination was very successful when recording from radio. It was soon evident that faults in a Dolby cassette system are more likely to be due to limitations in the recorder than in the *KDB1*.

The Kellar is not designed for use with studio equipment and no line up tape is provided for 38 cm/s. The unit was next tried with a ½-track Revox at 19 cm/s.

The Revox, having been carefully set up before use, had an excellent s/n ratio to start with and the *KDB1* caused no audible improvement. This was expected as the hiss was too soft to be heard at normal listening levels without the Dolby.

1 ½-track Revox running at 9.5 cm/s was then tried using the *KDB1* in mono (channel A in record, channel B in replay mode) so that the Dolby could be switched in and out for quick comparisons.

A small listening panel of experienced engineers was assembled and recordings of FM broadcasts via Quad equipment were made switching the Dolby in and out at regular intervals. The panel was not told which was 'in' and which was 'out' and in every case were unanimous in preferring the recordings made without the Dolby in circuit though none of them could say why. In an attempt to discover the reason for this, low distortion signals at various frequencies and levels were fed into channel A of the *KDB1* and processed, then fed to channel B and de-processed. Examination of waveforms on an oscilloscope and attempts at measuring with other instruments failed to produce any evidence of increased distortion except that at 1.5 kHz, –15 dB, 0.5 per cent was measured (a fault in measurements or the Dolby B Achilles heel?). Inspection on the oscilloscope showed this to be 2nd harmonic. The noise shown is due to the measuring units and not the *KDB1*, which has a very low noise level indeed.

A frequency response run, processed on channel A, de-processed on B, was next made with the results shown in the table.

This is of course equivalent to processing on one unit and de-processing on another where deviations can add. Considerably better results were obtained if the same channel was used for de-processing as for processing.

Used in the way it was intended, the review unit was slightly below spec. Stanley Kelly tells me that Kellar have introduced test equipment for precise selection of FETs used in the active filter for all production models. It is possible that the slight change in frequency response had an adverse effect on the material used for the listening test at 9.5 cm/s and that this accounted for the preference described above.

Using the *KDB1* with different recordings at different speeds, it soon became obvious that the poorer the s/n ratio of the recording system, the more use the Dolby.

At 4.75 cm/s on cassettes or reel-to-reel, the improvement is remarkable and anyone involved with this speed would do well to consider using the system. At 9.5 cm/s the use of the *KDB1* is desirable in most cases, but properly set up recorders at 19 cm/s should not need a Dolby for normal recording purposes. The *KDB1* produced no audible effect on recordings made at this speed with well lined up Revox *A77* recorders.

It seemed possible that at this speed the Dolby might be of use in making multi-generation copies, though it is difficult to imagine why anyone should choose to do his recordings in this way.

Since it appeared from the tests carried out so far that the main use of the *KDB1* would be with slow tape speeds and narrow track width, all further tests were made in conjunction with the Wollensak. Frequency response, s/n ratio and distortion tests were made on the Wollensak using a BASF C90 cassette recorded at 20 dB below 0 VU on the recorder's meter, played back and the outputs measured on a VU M with the remarkable result of a response within 0.5 dB from 50 Hz to 14 kHz! This was now repeated with the *KDB1* in circuit but at 20 dB below 'Dolby level' and using the same channel to process and de-process, again a response within 0.5 dB from 50 Hz to 14 kHz was obtained.

The wide range s/n ratio of the Wollensak was measured with and without the *KDB1* giving 45 dB without and 50 dB with. Subjectively the effect is much greater than the figure would indicate as the gain is almost entirely tape hiss, which with the *KDB1* in circuit is at a tolerably low level. A 4 kHz tone was recorded at –10 VU on the Wollensak and then replayed with the fundamental filtered out. The residual distortion and noise measured three per cent. When this was repeated with the *KDB1* in circuit, the three per cent figure was still obtained, so presumably, since there had been a reduction in noise, there must have been an increase in distortion, but a little arithmetic shows that this small increase (of the order of 0.3 per cent) is insignificant compared with the total and is amply compensated for the increased s/n ratio.

A 19 kHz tone was fed into the *KDB1* and the output measured the multiplex filter out then in. A drop of over 50 dB was recorded. This proved to be more than adequate for all recorders tried, and those that normally gave beats on stereo broadcasts gave perfectly clean signals with the filter in.

When used with the Revox (recording levels adjusted using the *KDB1* meters), the tape was slightly under recorded according to the Revox meters. When used with the Sony and Wollensak machines, *KDB1* level was higher than that on the recorder's meters.

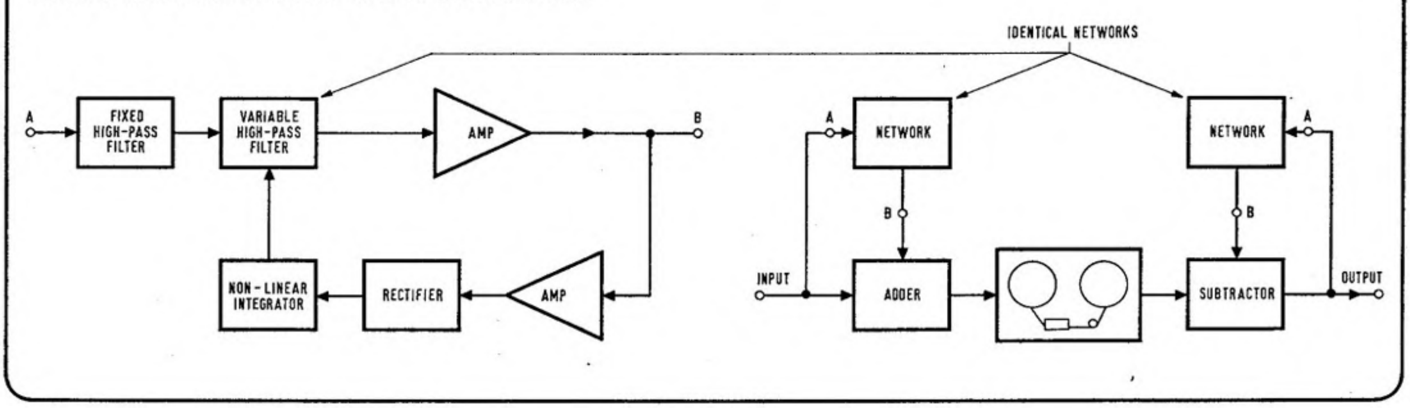
Used with the Revox, tapes made through the *KDB1* would presumably have less distortion than those recorded to 'Revox' level. Used with the other two machines, the tapes would have slightly more distortion, though the s/n ratio would be better.

The VU meters on the *KDB1* are at least as good as those on the other recorders tried and would be considerably better than those supplied on most domestics.

Once lined up, the unit seems to stay that way indefinitely. Provided the instructions are followed and the recorder's gain controls are not touched, the *KDB1* does its job efficiently and easily.

John Shuttleworth

FIG. 1 B-TYPE NOISE REDUCTION SYSTEM-BLOCK DIAGRAM



The big new name to trust. Sharp.

We're one of the biggest names in world electronics.

Our record is one of 50 years of technological achievement; from the first ever radio and television sets manufactured in Japan, right up to today, when Sharp, in conjunction with the North American Rockwell Corporation have commercially developed the microcircuitry that helped put Apollo on the moon.

This technical experience is built into all our products. Sharp audio equipment is some of the finest available today.

Now, British connoisseurs of fine sound can enjoy the excellence of Sharp.

1. Whenever you buy a piece of Sharp equipment you are buying Sharp's high standard of design, performance and technology.

A standard backed by Sharp's special one-year guarantee covering not only parts but all labour costs too.

2. To ensure that our fine equipment gets the best service possible, Sharp's specially equipped service centre is manned by the same efficient team of experts that designed and made it originally.

3. When you buy Sharp audio equipment, you're buying the results of the most up-to-date technology.

Sharp sets new standards—depend on it.

SHARP

For a free Sharp catalogue showing the complete audio range write to:– Sharp Electronics (UK) Ltd., Dept U 48 Derby St., Manchester M8 8HN. Tel: 061 832 6115

Name____________________

Address____________________

Walton & Gordon Ltd., 38a/40 Queen St, Belfast BT1 6EX. Tel: 20656. Peter Dand & Co. Ltd., 111 Clonskeagh Rd, Dublin 6. Tel: 694433.

STA 32L
Solid state stereo tuner/amplifier.
Circuit 42 transistor (including 3 FETs)
1-1c, 28 diode. Type MW/LW/FM
multiplex 3 band superheterodyne stereo
tuner/amplifier. Tuning range 525–1605kHz.
LW 150–370kHz. FM 88–108 Mhz.
Output 80W (40W + 40W) max. music power. £145.00*

RD 712D
Solid state x 3 speed stereo tape deck.
Circuit 11 transistor, 5 diode. Type 7" reel,
4 track, 2 channel, stereo/monaural,
vertical/horizontal operation
DIN jack. Output Line (-6dB 3K ohm). £75.00*

*recommended U.K. retail price

RD 423E
Solid state cassette
tape deck
(standard cassette).
Circuit 18 transistors,
11 diode.
Stereo/monaural
4 track, 2 channel,
DIN jack, output
(-2dB 50K ohm).
£57.50*

LEVELL TG200 CM

MANUFACTURER'S SPECIFICATION

Frequency coverage: 1 Hz to 1 MHz in 12 overlapping ranges.

Frequency accuracy: ±2% ±0.03 Hz.

Frequency stability: Change of frequency for ±10% shift on 33V supply is less than ±0.1% from 30 Hz to 30 kHz. Change of frequency with temperature is less than ±0.0025% per °C.

Output amplitude: 7V rms (20V peak-to-peak) source voltage that can be reduced to less than 200 μV by means of a continuously variable control and a switched attenuator that covers up to 70 dB in 10 dB steps. Power output −74 dBm to +13 dBm (20 mW) into 600 ohm load.

Output accuracy: The meter is calibrated in rms source voltage from 0 to 7V with an accuracy of ±2% fsd.
Additional calibrated scales cover 0 to 2V and −14 dBm to +3 dBm. The additional attenuator error on 2V, 700 mV, 200 mV and 70 mV is ±2%. The additional attenuator error on 20 mV, 7 mV and 2 mV is ±4%.

Output impedance: 600 Ohms ±1% on all settings of the amplitude controls.

Sinewave distortion: Harmonic content is less than 0.1% up to 5V output and less than 0.2% at 7V output from 10 Hz to 100 kHz.
At 1 Hz and 1 MHz the harmonic content is less than 1% up to 5V output and less than 2% at 7V output.

Sinewave amplitude stability: Amplitude variation with frequency is less than ±1% up to 300 kHz and less than ±3% at 1 MHz. Amplitude variation is less than ±0.2% per °C and is less than ±0.2% for ±10% change on the 33V supply.

Squarewave characteristics: Rise time is less than 150 nS at all frequencies. There is no discernible droop at low frequencies. Variation of peak-to-peak amplitude with frequency is less than ±1% up to 300 kHz and ±3% at 1 MHz. The rms amplitude falls about 10% at 1 MHz due to rise time.
Amplitude variation is less than ±0.2% per °C and is less than ±2% for ±10% change on the 33V supply.

Sync output: Sinewave in phase with output, amplitude greater than 1V rms, source resistance 3.3K.

Sync input: The frequency can be locked to an external signal over a range of ±1% per volt rms input up to 10V maximum. The frequency control then varies the phase of the output.

Temperature: The above characteristics are at 25°C but only minor divergencies exist from −10°C to +45°C.

Power supply: Four Ever Ready *PP9* batteries provide 33V ±10% earthed supply. Current consumption is typically 11 mA on sine waves and 15 mA on square waves giving an average battery life of 400 hours on sine waves and 300 hours on square waves. Operation from an AC mains supply is possible when a Levell power unit is fitted in place of the batteries. The output from the power unit is stabilised against mains supply variations.

Size and weight: 180 x 260 x 140 mm, 4.5 kg.

Carrying cases: Cases are available as optional extras. They are stiffened board and felt lined. Shoulder straps are detachable and it is possible to use an instrument whilst in a case.

Manufacturer: Levell Electronics Ltd, Park Road, Barnet, Hertfordshire.

THE Levell *TG200* series of oscillators comprises four models which incorporate identical sinewave oscillators, but can be supplied with or without a meter, or squarewave output. The type chosen for review has a meter as well as a squarewave output but the performance of the less costly models without these facilities should be identical from the point of view of the sinewave output.

The transistorised oscillator covers the frequency range 1 Hz to 1 MHz, and is of novel design in that only a single gang potentiometer is used to sweep the frequency over each of the 12 ranges. Not only does this reduce the cost of the frequency control but it considerably eases the problems of producing an accurately calibrated frequency scale.

Furthermore, it is found that the new Levell circuit has negligible amplitude fluctuation when changing frequency, and even when changing frequency ranges the 'bounce' is only about 25 per cent.

The squarewave output is produced by feeding the sinewave oscillator to a trigger circuit, the output of which is clamped by two 'back-to-back' diodes. The arrangement has the advantage of giving both constant rise time and constant amplitude, irrespective of frequency.

Either sine or squarewaves are selected by a slider switch and fed to a variable attenuator followed by a buffer/power amplifier, which in turn is followed by an rms indicating meter and a step attenuator covering the range 7V to 2 mV (+10 dBm to −60 dBm) ranges. The variable attenuator allows a maximum output of +13 dBm and also allows the output to be reduced to about 200 μV without the attenuator becoming unduly coarse in action. The meter is calibrated in both open circuit rms volts and in dBm when loaded with 600 ohms. In view of the 600 ohm output impedance of the oscillator, this form of calibration can lead to confusion when operating into loads other than 600 ohms or a virtual open circuit, as no internal 600 ohm load is provided.

The output connections are in the form of two banana sockets/terminals on the standard 20 mm spacing, which will accept a BNC adaptor, but an inbuilt coaxial type connector would have been preferred for use with low level signals. A 'sync' input/output is also incorporated and this provides a nominal 1V sinewave output (measured by us at 1.3V rms) for synchronising oscilloscopes etcetera, as well as an input for locking the internal oscillator to an external source. More will be said about this.

The mechanical construction of the instrument is sound, but for those infernal knobs which regularly fall off (Levell tell me that they are looking for a better knob, at the

(continued overleaf)

right price). However, the oscillator uses four *PP9* batteries with a nominal life between 300 and 400 hours with the alternative of a mains power unit. The attenuator switch provides a position for checking the battery voltages by means of the inbuilt meter, and very sensibly checks the battery voltage 'on-load'.

Now to the actual performance of the oscillator. We started by checking the accuracy of frequency calibration, which proved to be within ±1 per cent above 10 Hz (far better than the specification of ±2 per cent) and remained within the specification limits right down to 1 Hz. Loading of the instrument, or switching from sine to square waves had a negligible effect on the frequency. While the frequency stability was not measured with any accuracy, there is no doubt that it is completely adequate for audio work. However, there are occasions when one wants to precisely set to a given frequency, for instance 19 kHz when aligning pilot tone rejection traps, and this operation is very difficult with the direct drive frequency control. A reduction drive would be an improvement here.

The output voltage is a function of the meter error (specified as ±2 per cent) and the attenuator error which varies with attenuator setting. The actual output voltage was carefully checked at 1 kHz to an accuracy of ±0.25 per cent at all attenuator steps, and found to be on the margin of the specified limits and always on the high side of nominal. This was a direct result of the meter reading on the low limit and careful meter calibration would put the instrument very well within its output accuracy specifications. In fact, the attenuator accuracy was in the order of ±0.1 dB, which is really excellent.

Another really excellent feature was the flatness of the output when frequency is varied, we could only measure a fall of 0.1 dB with reference to 1 kHz between 3 Hz and 240 kHz with a final drop of only 0.2 dB at 1 MHz on sinewaves.

The next point of interest for the audio engineer is distortion, which was substantially better than the specification would indicate at audio frequencies, we measured the following total harmonic figures with a Hewlett Packard analyser at 0 dBm output into a 600 ohm load:

Frequency	Total Harmonic	Frequency	Total Harmonic
5Hz	0.056%	10kHz	0.041%
10Hz	0.11%	50kHz	0.051%
100Hz	0.10%	100kHz	0.084%
400Hz	0.046%	500kHz	0.24%
1kHz	0.044%		

The distortion consists mainly of second-harmonic, and the measured total harmonic of 0.048 per cent at 1 kHz with +13 dBm into 600 ohms was found to consist of 0.046 per cent second-harmonic and 0.0C4 per cent third-harmonic. This makes the oscillator very suitable for measuring very low third harmonic distortions if a wave analyser is used. Another useful feature is that oscillator noise is respectably low at about 82 dB below signal.

The sync input/output provides a sinewave output in phase with the attenuator output, or may alternatively be used to lock the oscillator to an external frequency, in which case the Levell frequency control shifts the relative phase between the attenuator output and the sync input.

The pull-in range for a sync input is specified as ±1 per cent per volt rms input up to 10V maximum. We found it possible to obtain a pull-in range of ±3 per cent for 1V input but only just managed the specified ±10 per cent pull-in range with 10V rms input.

Without doubt this Levell *TG200DM* satisfies most requirements for checking frequency response and distortion in all but the most critical applications, but it would be necessary to use an external attenuator for checking the sensitivity of low level microphone inputs in view of the minimum measurable output of 200 μV. Two more 10 dB steps on the output attenuator are really required to provide low level signals for use with the most sensitive microphone and magnetic cartridge inputs of modern amplifiers.

The flatness of the output in the audio range is difficult to surpass, and even the most expensive oscillators seldom achieve such performance. Also the freedom from amplitude 'bounce' is a great asset when doing quick frequency response checks, as the frequency dial can be safely swept across each range without having to wait for the output to stabilise.

Hugh Ford

CLASSIFIED ADVERTISEMENTS

Advertisements for this section must be pre-paid. The rate is **4p** per word (private), minimum **40p**. Box Nos. **15p** extra. Trade rates **6p** per word; minimum **60p**, Box Nos. **20p** extra. Copy and remittance for advertisements in **OCTOBER 1971** issue must reach these offices by **14th AUGUST 1971** 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.

FOR SALE—TRADE

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.

Plug-in Audio Modules of the highest quality, at moderate cost, to build your own mixer. Compressor modules available. Mixers built to your requirements. Write for details to Apollo Electronics, 96 Mill Lane, London N.W.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.

If quality matters consult first our 75-page illustrated Hi-fi catalogue with technical specifications (35p). 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. Please specify requirements. Audio Supply Association, 18 Blenheim Road, London, W.4. Tel. 01-995 1661.

New Tapes. 600" standard play on 5" reels, leadered, poly-wrapped, boxed, 35p each, post paid. Money back guarantee. 500 available. Deroy, Highbank, Carnforth, Lancs.

Building a Mixer. Use our printed circuit modules. Want a mixer built?—ask us for a quote. Expert enquiries welcome. Write: Rugby Automation Consultants, 220 Alwyn Road, Rugby.

VIDEO TAPERECORDERS
50% OFF

BRAND NEW SHIBADEN SV700E

½" Video Taperecorders at Half Price
Only £198 ex-works

Other Video Equipment Available at GREATLY REDUCED PRICES

AUDIO ADVERTISING, (Dept. IVS), 43 Malden Way, New Malden, Surrey
01-942 9635/6

Professional tape only 35p. 1200ft. Agfa on hubs, no joins (p. & p. one box 20p. each additional box 5p). We handle 99% of all s/h professional recording equipment. Send for list. Jackson Studios, Rickmansworth, Herts. Tel. Rickmansworth 72351.

DISK RECORDING MACHINE
AM 32 NEUMANN — mono (full)
78/45/33, Automatic cutterhead moving Unit VA 52, Mounting Cabinet ZT 32, Driving Motor, Microscop Leitz, Amplifier Ortophon, Two cutter head Ortophon. Price £1,600.

STUDIO DAVOUT
73 Boulevard Davout, Paris XXe, France

Hampstead High Fidelity. Sale Starts 26th August. New, Shop Soiled, and Second Hand Equipment. Ferrograph Series 7 Stereo 704 Tape Recorder £169. Tandberg Series 13 Loop Cassette Recorder £59. E.M.I. L.2 Battery Tape Recorder £25. Vortexion Tape Amplifier 7½ & 15 Series 5 Full Track Heads with matched Warite Tape Deck £60. Many other bargains, all subject to being unsold at the time of sale. Hampstead High Fidelity, 91 Heath Street, London, N.W.3. 01-435-0999/6377.

UNIMIXER 4S
Mixing unit for professionals in studio and on location. (1 stereo pair and 2 pan controlled mics.) Any input imp. 25-600 ohms. S/n ratio greater than 55 dB with an input signal of 180 µV at 200 ohms or 70 µV at 30 ohms. Individual test certificate. Price **£45.** Recent reviews from leading hi-fi magazines available on request from:

SOUNDEX LTD
18 Blenheim Road, London, W4. *Tel. 01-995 1661*

STUDIO FACILITIES

Your tapes to disc. 7". 45—£1.50, 10". L.P. £3.50 1". L.P. £4.00. 4-day postal service. Masters and Vinylite pressings. Top professional quality. S.A.E. photo leaflet: Deroy Studios, High Bank, Hawk Street, Carnforth, Lancs.

J & B Recordings. Tape to disc—latest high level disc cutting, all speeds. Mastering pressings, studio, mobile. 14 Willows Avenue, Morden, Surrey. MITcham 9952.

Graham Clark Records. Tape to disc pressings. P. F. A. House, 182A Station Road, Addlestone, Weybridge, Surrey. Tel. Weybridge 43367.

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.

EDEN STUDIOS LTD

QUALITY recording, tape to disc and pressing services, all at very sensible rates. Please write or 'phone for leaflet.

11 EDEN STREET, KINGSTON, SURREY
01-546 5577
Affiliate Assoc of Professional Recording Studios

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.

mjb recording and transcription service

Vinyl pressings and acetate demodiscs. Limiting, compression and equalisation facilities; high undistorted cutting levels with feedback cutter heads. Booklet available.
ST. MICHAEL'S, SHINFIELD ROAD, SHINFIELD GREEN, READING, BERKS.
Reading (0734) 84487 Member A.P.R.S.

MISCELLANEOUS

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

Dictating and Audio Service Ltd., 5 Coptic Street, London, W.C.1 (near the British Museum). Telephone 636-6314/5. Authorised Service Agents. Grundig, Philips and other leading makes of Tape Recording equipment repaired to Manufacturers' standards by skilled staff using modern test equipment—audio generators, oscilloscopes, audio volt-meters, etc.

SITUATIONS VACANT

Alice needs a quiet salesman to introduce professional modular equipment to sound people on commission. Applicants should be technically confident. Ring Ted Fletcher at Alice. (Windsor 61308).

UNIVERSITY OF SURREY
DEPARTMENT OF MUSIC
SENIOR TECHNICIAN
for Recording Studio and Mobile Recordings

A vacancy exists for a Senior Technician to set up and maintain professional recording equipment in the Music Department's sound studio. The successful candidate will take part in studio operations and will be responsible for the maintenance of studio and location equipment. He will be working in collaboration with the Senior Lecturer in Recording Techniques on the Tonmeister Course, and should have recording industry experience in the following:—

installation, testing and maintenance of professional recording equipment;

operational techniques associated with music recording, dubbing and editing.

The salary scale is £1,398-£1,707 per annum.

Excellent holiday arrangements and Superannuation scheme.

Application forms can be obtained from the Staff Officer,

University of Surrey, Guildford, Surrey and should be completed and returned by the 1st September 1971.

Electronics maintenance and development engineer is required to take complete responsibility for technical equipment in studio and dubbing complex. He will also be in charge of specialist audio hire equipment. H.N.C. or degree in an appropriate subject essential. Salary will be in the range £1750-£2000 depending on experience in this field. Apply in writing to Theatre Projects Sound Ltd., 10 Longacre, London WC2.

SITUATIONS WANTED

School leaver, eager to start, any level, in Recording Studio. Please ring Tim Young 800 1902.

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.

TRD. Philips PRO20 or similar. Rix, 81 Coppice Road, Highfields, Near Doncaster.

Highest possible cash prices for Revox, Ferrograph, Brenell, Vortexion, Tandberg. 9.30-5.00. Tel. 01-837 8200.

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 and quality tape recorders and accessories, also hi-fi equipment purchased for cash. R.E.W. Audio Visual Co., 146 Charing Cross Road, W.C.2. Tel. 01-836 3365. 266/8 Upper Tooting Road, S.W.17. 01-672 4472, 01-672 9175.

FOR SALE—PRIVATE

One Telefunken 301 Tape Recorder with accessories—cost new £120, sale £50. D. Baker, 116 Debeauvoir Rd., Hackney, N1 D4J.

AKG C24 stereo capacitor microphone, outstanding sample, with extension leads, etc., three spare valves, in case. Neumann KM56 capacitor microphone with nickel cadmium charger, as new. Beyer M160 double ribbon cardioid, new, £30. Beyer M119 and STC stick microphones, £10 the pair. Box No. 611 (London).

AKG C451 with capsules CK1, CKLS, CK9 (Rifle), B46E (Battery power-unit), Clips and Cannon Cables in fitted plush carrying case. New, unused. Recently overhauled by AKG. Cost well over £160. Accept £110. 01-883 5134.

For sale: Uher 400L, two mics., chargers. Excellent order. 19 Armour Hill, Tilehurst, Reading. Tel. 25926. £90 o.n.o.

Heathkit Distortion Meter, made and modified by Terence Long. Box No. 613 (London).

Gaumont Kalee wow and flutter meter, very good condition. Level transistor volt meter, £30. Mixer components, PPMs, circuit modules, etc. All at half cost price, new and unused in original packing. Details on request. Neumann and AKG microphone stands, both as new with boom arms, £10 each. Box No. 612 (London).

Uher 4000 tape recorder for sale, dynamic mike and other extras. Enquiries to Box No. 610 (Sheffield).

Akai 355D. c/w 10½" arms, 3¾-15ips, remote control etc. £175 ONCO. Tel. 01-759-0834 ext. 48.

Uher 4200, 5 Chan. mixer, charger-mains unit, MIC, slide sync., etc. £225. Might split. Tel. 01-759 0834 ext. 48.

To **Studio Sound, Classifieds, Link House, Dingwall Avenue, Croydon CR9 2TA.**

Please publish the advertisement indicated below for.................. insertion/s under the heading ....

Name ....

Address ....

....

....

Cheque/P.O. enclosed £.......:... Is a Box No. required Yes/No. If no, please include remittance to cover name and address and/or Tel. No. Please write in block capitals.

WE SPECIALISE IN BRAND NEW

TOP QUALITY BRITISH P.V.C. MYLAR & POLYESTER RECORDING TAPES WITH FITTED LEADERS, Etc., EX 3"

Thanks to bulk purchase we can offer tensilised HI-FI tapes, manufactured by a British firm of world repute. All boxed individually (sealed if required) in polythene. Our tapes are not to be confused with imported sub-standard or used tapes. Full money refund if not delighted.

This month:- "DRY SPLICE" (19p) given FREE with every order.

Std.				L.P.				D.P.				Boxed	
Length		ea.	3 for	Length		ea.	3 for	Length		ea.	3 for	empty spls	
3"	150'	10p	29p	3"	220'	12½p	35p	3"	400'	22½p	65p	3"	3p
4"	300'	20p	50p	4"	450'	25p	70p	4"	600'	34p	97½p	4"	8p
5"	600'	30p	87½p	5"	900'	40p	£1·17½	5"	1200'	62½p	£1·85	5"	9p
5¾"	900'	35p	£1·02½	5¾"	1200'	52½p	£1·52½	5¾"	1800'	85p	£2·50	5¾"	9p
7"	1200'	45p	£1·27½	7"	1800'	65p	£1·92½	7"	2400'	£1·05	£3·05	7"	10p

All orders despatched by return. *Postage and Packing 9p per order*

STARMAN TAPES, 421 Staines Road, Bedfont, Middlesex

INDEX TO ADVERTISERS

Published by the Proprietors, Link House Publications Limited, 10-12 South Crescent, Store Street, London, W.C.1., and Printed by Arthurs Press Limited, Woodchester, Stroud, Glos. GL5 5PB.

Surprise yourself

Find yourself having fun at the

DO IT YOURSELF EXHIBITION

It doesn't matter if you're a complete beginner. It doesn't matter if you can't even knock a nail in straight.

Come to the DO IT YOURSELF EXHIBITION and you'll find yourself surrounded by three floors of inspiration.

Bring the family, they'll enjoy it. Come and see films, help carve an elephant, ask questions, win prizes, try things for yourself, see the latest in easier home decoration. There'll be experts on hand demonstrating everything from adhesives to welding.

There are special features for women and fantastic displays of DIY craftwork from home and overseas.

So come along to Olympia, and surprise yourself. Find yourself having fun.

OLYMPIA AUG 27-SEPT 11

EMPIRE HALL 10am-9pm

Admission Adults 25p Children 15p

CLOSED SUNDAYS.

19TH INTERNATIONAL HANDICRAFTS & DO IT YOURSELF EXHIBITION
SPONSORED BY DO IT YOURSELF MAGAZINE

The Revox Clinic
A unique service
for enthusiasts

If you are looking for a high quality tape recorder don't miss this opportunity to compare makes and check specifications. If you own a machine already bring your recorder, **Revox or not**, to the Revox Clinic. Here it will be measured free of charge and a frequency response curve provided. If it is a Revox bring a reel of your own tape and we will check the bias too!

You are invited to the Revox Clinic at

University Audio
1-2 Peas Hill,
Cambridge, August 2, 4

Avon Hi-Fi
13 Wyle Cop,
Shrewsbury, August 5, 7

Aberdeen Radio
11 Back Wynd,
Aberdeen, August 9, 11

The Record Shop
31-35 Hermitage Road,
Hitchin, August 12, 14

Tape Recorder Centre
82 High Holborn
London W.C.1, August 16, 18

Billericay Hi-Fi
107 Perry Street,
Billericay, August 19, 21,

Fairbotham
58-62 Lower Hillgate,
Stockport, August 27, 28

Laskeys Radio
42 Tottenham Court Road,
London W.1, August 31, September 4

The Stereo Centre
9-16 Dryden Chambers,
119 Oxford Street,
Bristol, September 6, 8

Revox delivers what the rest only promise

Sands Hunter
45 Hare Street,
London S.W.18, September 9, 11

Griffin Radio
94 Bristol Street,
Birmingham 5, September 16, 18

Hi-Fi Stereo
206 St. Nicholas Circle,
Leicester, September 23, 25

REVOX

Revox
Lamb House, Church Street
Chiswick, London W4 2PB
Telephone 01-995 4551

Also in U.S.A and Canada
Revox Corporation
155 Michael Drive, Syossett
New York 11791
Tri-tel Associates Limited
Toronto, Canada