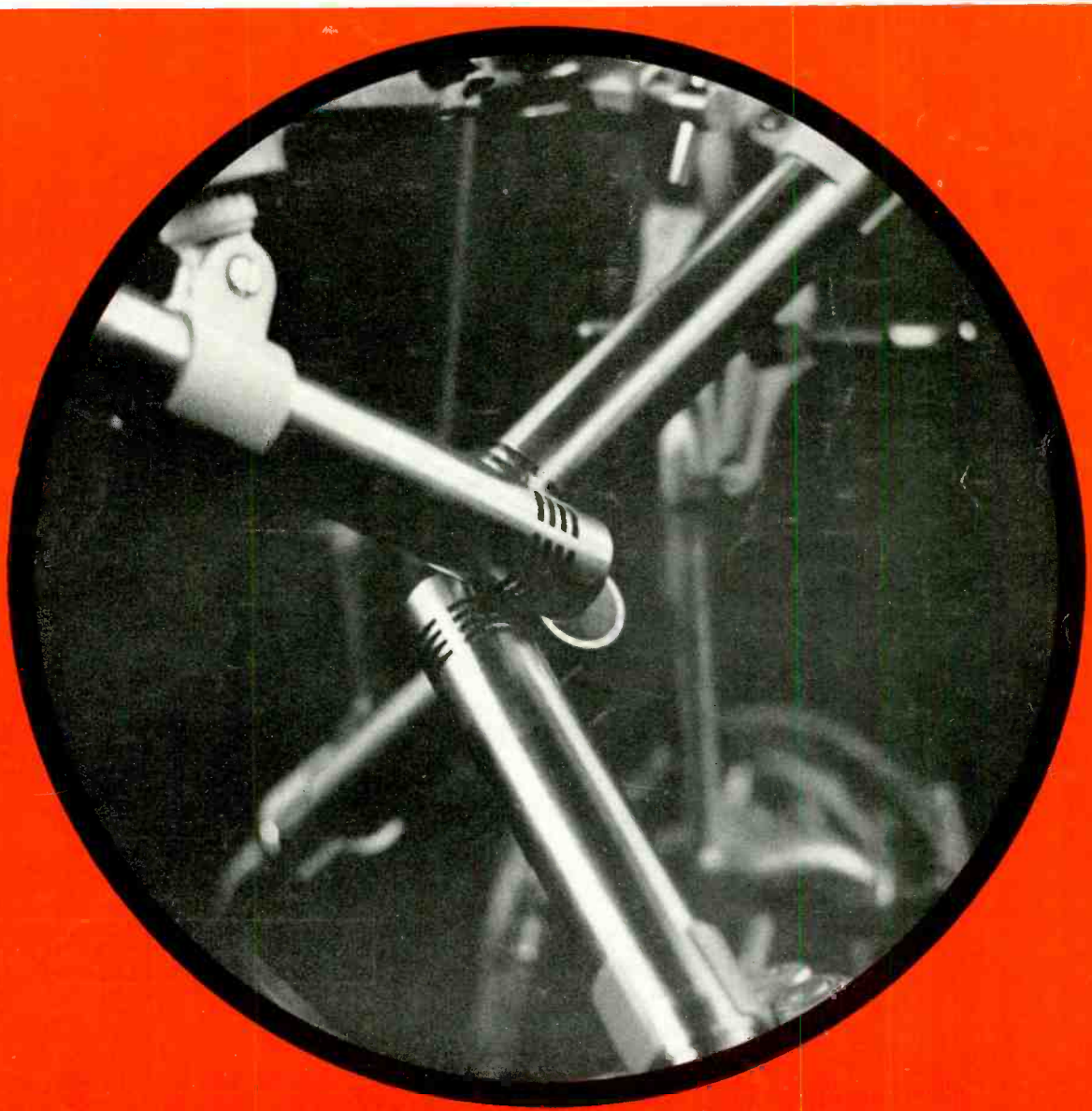
AUGUST 1971

15p

STUDIO SOUND



EXPERIMENTAL TETRAHEDRAL RECORDING
INSIDE INTERSOUND · AKG D202 REVIEW
APRS 71 AND AES 40 EXHIBITION REPORTS
COMMERCIAL RADIO PROSPECTS AND PROBLEMS

Drop in a top studio recorder

London made

C.B.S. Records, Aylesbury, have chosen Leevers-Rich ¼ inch stereo, 1 inch 8-track tape machines and A501 graphic equalisers for the in-plant production of 1 inch masters. These are now tailor-made for use on their Gauss high speed tape duplicator. Both musicassettes and 8-track stereo cartridges are being produced at Aylesbury for world wide distribution on C.B.S labels.

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

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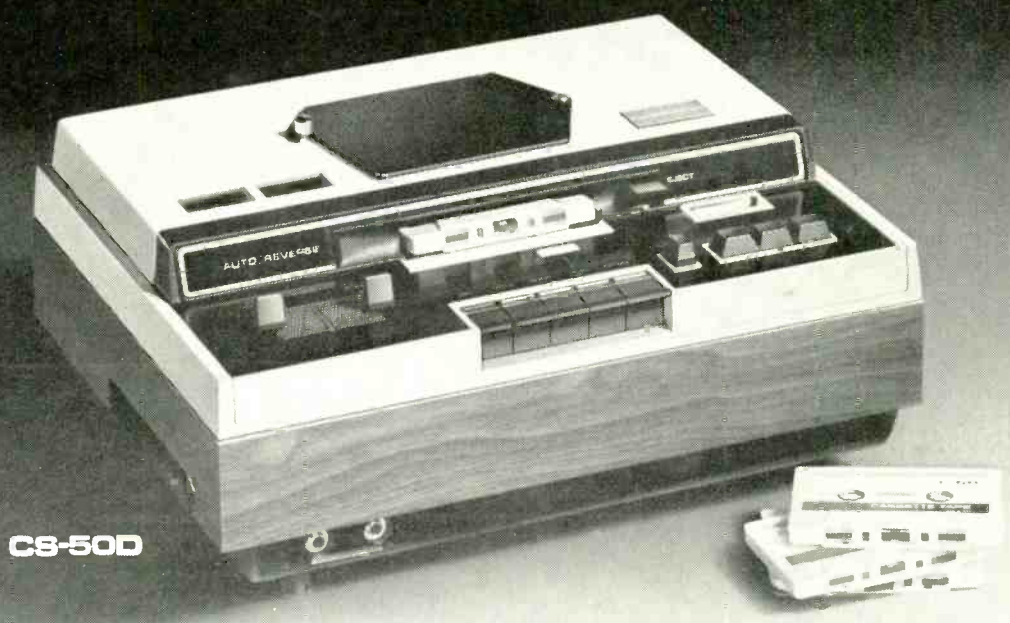
automatic continuous reverse

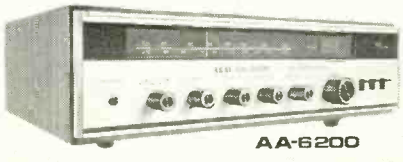
INVERT-O-MATIC



The **CS-50D Cassette Stereo Tape Deck** is another newly developed audio unit from AKAI. It incorporates the world's first "INVERT-O-MATIC" mechanism which makes possible automatic reverse recording. This revolutionary cassette tape deck automatically stops after two full hours of hi-fi stereo recording with AKAI's C-120 cassette tape. The "INVERT-O-MATIC" mechanism also makes possible automatic continuous reverse playpack for as long as you like. Instant manual reverse is also possible.

The perfectly matching speaker system for the CS-50D is AKAI's **SW-30 Jet Stream Speaker System** with a 4″ full range high compliance speaker. The bass sound flows like a "jet stream" from the speaker back load through this bookshelf type unit. The power scale of this low bass sound is equivalent to large-sized speaker systems.

To match the high performance of the CS-50D, the use of AKAI's **AA-6200 Solid State AM/FM Multiplex Stereo Tuner Amplifier** is recommended. It features one field effect transistor in the front end to provide greater sensitivity, two integrated circuits, simplified controls for easier operation, and ceramic filters for better selectivity.



Audio & Video

AKAI®

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

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2 in 1

but actually 3 in 1

The AKAI **X-1800SD Reel-to-Reel, Cartridge Stereo Tape Recorder** is the world's first recorder that offers you the two functions of open-reel and cartridge recording/playback in one unit! It also realized the dream of REEL-to-CARTRIDGE transfer. Thus, this novel tape recorder has all the features in one attractive package that elsewhere would be contained in three conventional recorders.

Reel-to-Reel
4-track stereo/monaural recording and playback with AKAI's unique world-patented Cross-Field Head. Tape speeds: 1-7/8, 3-3/4, 7-1/2 ips (15 ips with adapter). Two-lever system. Track selector. Automatic shut-off. Instant stop control. Four hours stereo recording at 1-7/8 ips.

Cartridges
8-track stereo recording and playback with one-micron gap head. Transfer from reel to cartridge. Tape speed: 3-3/4 ips. Cartridge program selector (can be remote controlled). One hour stereo recording. Program indicator lamp. Automatic stop.

Audio & Video

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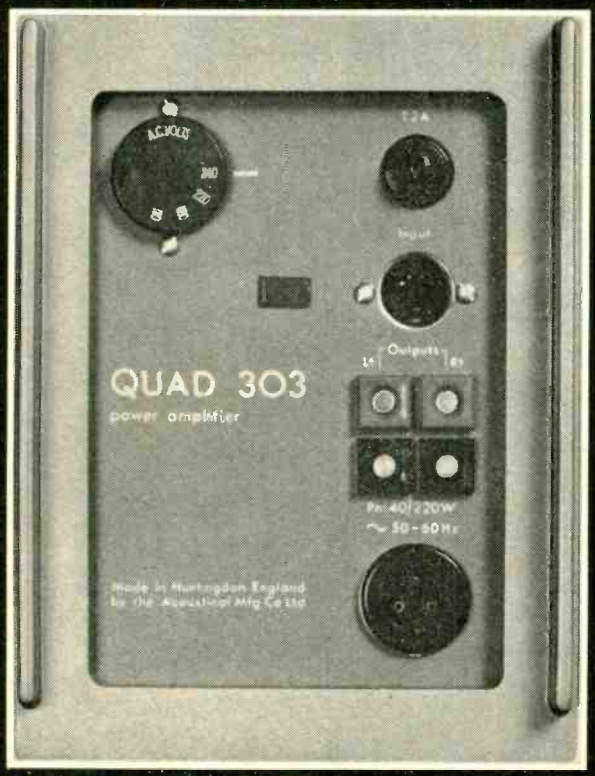
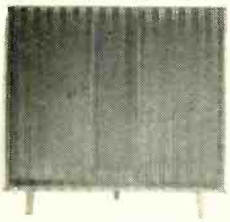
wireless



It has been suggested that a perfect amplifier would be equivalent to a piece of wire with gain.

A piece of wire? First of all it would hum, so we'd have to screen it. This would increase the input capacity so we'd have to make the screening large or the conductor small. Then we would have output resistance and, if of appreciable length, we'd have inductance and termination problems as well. All in all a 303 power amplifier would be much easier.

The funny thing is; even if we had our perfect piece of wire with gain and compared it with a 303, the two would sound *exactly* the same no matter how carefully we listened.



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Studio Sound

AUGUST 1971 VOLUME 13 NUMBER 8

INCORPORATING
TAPE RECORDER

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

COVER PICTURE

Tetraphonic microphone array employed during the experiments described by Michael Gerzon on page 396.

SUBSCRIPTION RATES

Annual UK subscription rate for *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.

LEADER COLUMNS usually pontificate from behind a faceless veil of first-person-plural: a sort of regal public-address for broadcasting the gospel according to *The Daily Excess* or *The Agronomist*. Whether the editor himself or one of his lackeys is responsible for the views offered is not always clear, though assiduous readers can sometimes recognise a particular style peeping through the smokescreen of 'we' and 'our'. For some years in this magazine that anonymous veil has concealed not the editor but his assistant David Kirk. As this issue sees David's elevation to the editorial chair *de jure* as well as *de facto*, it seems appropriate for me to return for one month, writing personally as John Crabbe.

David Kirk joined the staff of *Tape Recorder* in 1963, was appointed News Editor a year later, and became my deputy at the end of 1966. Five-years as a Deputy Editor is long enough for any bright-minded young man, and as David is far from dull(!) I have left the day-to-day management of the magazine increasingly in his hands. The decision to change our name to STUDIO SOUND and pursue an increasingly professional course was taken largely at his instigation and, as this Autumn will see more moves in that direction, the Link House management and I decided to recognise the facts of life by giving David the nominal as well as the practical responsibilities of editorship.

Any magazine worth its salt is bound to have its own distinctive character or ethos, filtering down from an editor whose attitudes and interests may pervade without dominating. Two publications on closely related subjects thus risk a certain sameness if managed by one editor, so it has seemed sensible to allow STUDIO SOUND to drift away from *Hi-Fi News & Record Review*, in outlook as well as contents. This has been achieved most efficiently by encouraging the steady emergence of a new editor, whom I commend to readers most warmly as the man who has in fact been very competently in charge for some time and whose interests are already part and parcel of these pages.

There will of course be further changes in emphasis as we explore the highways and by-ways of professional recording, the multitude of studios used to capture sound and vision for a thousand different commercial and artistic purposes, the constant emergence of new equipment and technologies, etc. We are already very much aware that ours is the only journal in the world concerned so deeply with a wide range of studio affairs, leading to a healthy demand from the USA and a surprising number of requests for information from continental Europe. Indeed, we may even look into the possibility of publishing abstracts of each month's main feature articles in several key languages—especially if Britain goes into the Common Market, as I very much hope we will.

Finally, the Kirk regime will I am sure encourage lively debates in the correspondence columns about microphone techniques, aesthetic/technical aspects of recording, and so on. Some recent letters on these lines prompted one American recording studio to ask for details of coincident-microphone stereo recording, because they had *never heard of it*. J.C.

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

FEATURE ARTICLES

REGULAR COLUMNS

EQUIPMENT REVIEWS

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

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Events

BELDFOIL SHIELD

A MORE EFFICIENT cable screen than wire braid and wire-served shields is employed in cable now being offered by Leonard Wadsworth. Cables using Beldfoil Iso-Shield are manufactured in Chicago by Beldon Corporation and are claimed to possess the shielding properties of a continuous aluminium tube. A thin layer of aluminium is bonded to polyester film, 100 per cent shielding being accomplished by folding back the tape edges to achieve metal-to-metal contact. Lightness, flexibility and small size are among the advantages of the new material.

Further data: Leonard Wadsworth & Co (Electronics) Ltd, Broadway House, Broadway, Wimbledon. London S.W.19.

SEPTEMBER STUDIO SOUND

RESTYLED FRONT covers, thicker paper, more editorial pages and we regret, a higher selling price will occur from our September issue onwards. Offsetting increased production costs and an enlarged editorial team, the price becomes 25p. The result will be a more informative and more reliable STUDIO SOUND.

CASSETTE DUPLICATOR

NEW DEVELOPMENT from Ampex is a high speed cassette-to-cassette copying system operating five times faster than any previous cassette duplicator. Designed for use by small tape copying concerns, the equipment is also suitable for schools, libraries and similar small-scale situations. The left-hand cabinet (see photo) is the automatic-loading recorder, the right-hand unit being the player. The high copying speed (190 cm/s) is achieved by a vacuum chamber tape guide system. Bandwidth of the related electronics is 320 kHz. Total copying time for a 60 minute ½-track mono cassette (30 minutes per track, dubbing two channels simultaneously) is 67 seconds. This comprises 45 seconds dubbing, 17 seconds rewinding (380 cm/s) and five seconds reloading. The equipment cycles automatically until the cassette stack is exhausted. The *CD-200* is marketed in the UK by Ampex Great Britain Ltd, Acre Road, Reading, Berkshire.

DOLBY B IC

THE COST of consumer products incorporating the Dolby B noise reduction system is likely to be reduced early in 1972 by the introduction of a Dolby Signetics integrated circuit. The production rights will be limited for a short period to the Signetics Corporation of Sunnyvale, California, but will later be offered to the entire IC industry. Four IC manufacturers had approached Dolby with this in mind and were said by Dolby to have agreed to the Dolby-Signetics plan.

£25,000 ORDER FOR LEEVERS-RICH

MAGNETIC RECORDING equipment worth £25,000 is being assembled by Leevers-Rich for broadcasting authorities in Nigeria and the Lebanon. Illustrated below is part of the production line concerned with capstan flywheel balancing, working to an accuracy of 0.1 gm/cm.

CBS/SONY ANNOUNCE QUADRAPHONIC DISC

A COMPATIBLE two four channel disc system has been announced by CBS Records in conjunction with Sony. Developed by CBS Laboratories, the system relies on a double helical modulation concept. Four grooves of a quadraphonic CBS disc are illustrated, each modulated as labelled. The front two channels are recorded conventionally while the rear pair are described as producing circular modulations. As the groove advances, a clockwise helix is produced for the left rear channel and a counter-clockwise helix for the right rear.

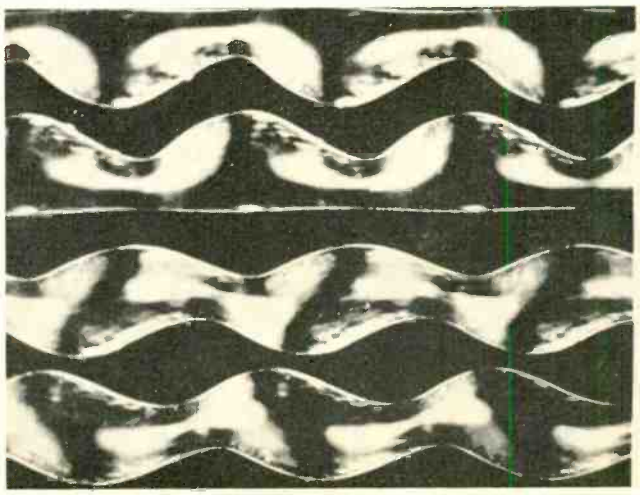
The discs will be marketed in the US for $1 above the price recommended for equivalent two-channel discs to allow for the obvious increase in production costs. Owners of two-channel disc players may reproduce the *SQ* (stereo quadraphonic) records in normal stereo until they obtain a decoder and an additional pair of amplifiers and loudspeakers. The CBS system also lends itself to quadraphonic broadcasting.

DISTORTION DISTORTED

THE advertising department has struck again: The 0.077 per cent distortion (1 kHz at 75W into 8 ohms) specified in the Crown *DC300* advertisement on page 350, July, should read 0.007 per cent. And the 'Niagra' classified should have read 'Nagra'.

W. J. H. BARRETT

AS WE GO to press we learn, with regret, of the death of APRS secretary Bill Barrett.



STUDIO DIARY

BY KEITH WICKS

ROGER Squire has had trouble persuading clients to call his premises **Squire Sound Productions.** DJs making programmes for stations in the United Kingdom sometimes use phrases like 'coming to you from the Roger Squire Studios in London', so Roger has decided that he had better rename his studios to save confusion. From now on, they will be known as **Roger Squire Studios,** and his discotheque business becomes Roger Squire Discotheques.

Emperor Rosko has been in, doing a 'smooth talking show' for American stereo station, WNEW. Tony Mercer, a regular client at the studio, is now recording demo shows for American programme contractor Jim Travers. Tony was approached as he already has a daily network programme on 77WABC, New York, and now does shows for seven other stations.

Feast have been in the **West of England Sound Studio** working on their own new compositions. Bear Harvest laid down some tracks, and two of the group augmented the Faraway Folk on their new single *Faraway*, to be released by Ra Records. Bernard Greenaway, a novelty song writer or, possibly, a writer of novelty songs, travelled from North Devon to record a couple of demos. Many Others from Hertfordshire have been in, and should soon be back to work on an album for the Harvest label.

At **Intersound Studios** (see page 393), Madrigal have been recording their second single for Decca. Producer was Ray Cane, with engineering by Ian Southern. Ian has also been working with Bruce Baxter, who recorded two *Top of the Pops* albums for Pickwick International's *Hallmark* label. Bruce is now recording budget albums for Rediffusion and Simm Soframi of Paris. After a lapse of a year, Honeybus are recording together again and are currently working on a single with producer Pete Dello and engineer Vic Finch. The group are about to sign with Bell Records for worldwide release, and will soon start work on an album. Vic Finch also engineered an album by Nicol Williamson, with musical director David Lindup and producer Nigel Hutchinson. John Killigrew, backed by the Fortunes, also had Vic as an engineer on a number of sessions for the Nepentha label which, I am told, allows artists to perform as they want to perform. Production here was by Pete Dello, who also did the arrangements in close collaboration with John. A new group called Offspring have been in with producer David Paramour to record singles for RCA. Engineer here was Dave Taylor. Other work at the studio has included tracks by Tear Gas for Realisation Seven, and by Northwind for Croham Productions, producer in both cases being Tony Chapman.

Amusing story from an (unofficial) **BBC** spokesman concerns the use of lights rather than bells to indicate incoming telephone calls. Telephone lights have been used in continuity studios for years, as with bells the announcer would have to keep lifting his receiver to eliminate the possibility of a 'phone call ruining his announcements. A useful idea, but now that someone has taken the trouble of applying for a patent for the system, the BBC are going to have to pay royalties if they continue to use it. All rather sad for the Corporation, especially as there is a fair chance they thought of the idea in the first place.

Sound Developments held a reception for music publishers and the press. Main news item was that the price of four track music demo sessions has been reduced from £17.50 to only £12.50. This should attract the small groups, previously unable to afford to work at these studios. All other four track recording will, however, be charged at the higher rate.

Work at the studio this month has included the making of a number of pilot commercials by an advertising firm, already preparing itself for the new radio service.

Tony Visconti produced sessions for T. Rex at **Trident,** engineering being carried out by Roy Baker. Chris Dee, producing for Gem Records, worked on the Fairport Convention album engineered by Ken Scott and on a number of Mike D'abo sessions with engineer David Henschell. Roy Baker was at the controls for Vanity Fair sessions produced by Des Champ. Newcastle group Lindisfarne laid down tracks for B & C Records with engineer Ken Scott and producer Bob Johnson, who also works with Dylan. Robin Cable was at the desk for tracks by Alan Bereeville, who came over from Paris with producer Bernard St. Paul. Ken Scott engineered for the NBC *Laugh In* team, all the way from Burbank, who were recording material for Leon Henry Productions. Audience are doing more work for B & C Records with producer Gus Dudgeon, engineer this time being David Henschell.

At **Mayfair Sound Studios,** Kenneth Connor continued work on his album and John Hudson engineered sessions by Towerhouse, produced by Tony Carr. Macaya, a 'heavy progressive Afro, not quite Osibisa type' group consisting of black Rhodesian, Chris Chewezala, and well known backing musicians, have been recording what Chris termed 'bubbleground music'.

On the technical side, Mayfair have taken delivery of their Rosser Electronics desk, and are now completing installation. The 20 channel desk which has PPMs on the eight tracks, should be operational very soon.

At **Majestic Studios,** Mike Morton has been doing another album in the series *Non-Stop Top Twenty*, which consists of cover versions of current hits. An African girl by the name of Helena Franciose has been in for Proclaim Records recording a song she wrote herself.

The **Jackson Recording Company** took all the Ad-Rhythm distributors, record pressers, label manufacturers and artist on a flight from Gatwick to Biggin Hill, and fed them with food and music. The menu included various items in some way connected with organs, but not the heart-liver-kidney variety. Thus one could have a 'two-foot Tomato', or an 'automatic Hawaiian salad, with 1,000 draw-bar dressing'.

In the studio, Reflection Records have been making a pop-religious Christmas album and a new group, Laughing Kitbag, have also been laying down tracks. The Jackson Company have just finished ten sessions at **Anvil Studios,** featuring groups, organs, strings, and harps, all for the Ad-Rhythm label. Anvil are basically a film company but have a good sound studio with Neve desk and eight track Scully. Malcolm Jackson explained that his own studio was too small for these sessions and he is only equipped for four track working. Next project for Malcolm is to build up a library of electronic music with the aid of a nucleus of composers and a large Moog.

Finally, CBE of 95 rue Championnet, Paris, have recently equipped their studio with a 16 track recorder which uses 25 mm tape. More details soon, if I can persuade them to write to me in English.

THAT WAS APRS 71

Keith Wicks recalls the facts, and John Shuttleworth the impressions, gained at this year's Association of Professional Recording Studios Exhibition 28th-29th May

It is a tradition in STUDIO SOUND *to do the alphabetical round when previewing or reporting exhibitions. For a change, this one is divided, into groups of equipment. Keith Wicks commences the tour, John Shuttleworth providing the concluding summary.*

AMONG the range of microphones and accessories displayed by **AKG** were the *D160* (a new omnidirectional studio microphone) and *C451* FET capacitor microphone, widely used in the film, television, and recording industries. The large number of accessories available for the *C451* includes power units, cables, stands, booms, and a variety of capsules enabling various directional responses to be obtained. The *CK9* 'gun' attachment is useful for film work and in other conditions where the microphone is greater than usual distance from the subject. AKG's handbook on FET studio microphones is extremely well produced, very informative, and well worth consulting if you are in this market.

The *CB1000* amplifying microphone body is an addition to **Calrec's** professional range of microphone equipment. Various capsules can be fitted to obtain the desired directional response.

A range of radio microphone equipment for film and television work was shown by **Audio**, along with their recently developed high quality miniature capacitor microphone, only 9.5 mm in diameter by 51 mm long.

One of the most impressive exhibits was the **Neve** console designed for RCA's Hollywood studios. With 32 channels and 24 tracks, this is the largest Neve desk in existence. By comparison the PSM 8/2, their small portable mixer, looked minute. With eight channels and two outputs this is the smallest in their new series of standard consoles. One of the firm's representatives flew from the Montreux television festival with the unit in a suitcase so that it could be shown in the UK for the first time.

Much smaller still are the **Allen & Heath** six-channel stereo mixers, reported to be selling like hot cakes. Each microphone channel has a linear fader, sensitivity, treble, bass, echo, foldback, and pan controls. Equalisation is provided on both outputs. The size has been kept down to only 220 x 290 x 25 mm, and the price to £100. Another of the firm's products which caught my eye was their new quadraphonic pan-pot. This costs £30.

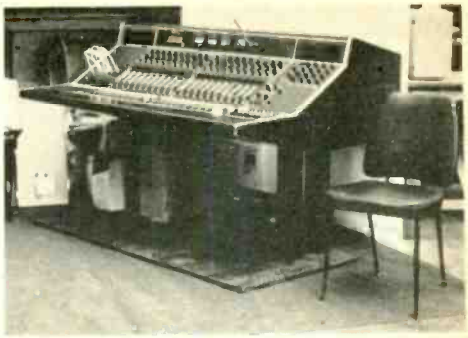
Mixers

Cadac showed their studio control consoles based on their range of modules. They are also producing a loudspeaker system developed with the aid of the aforementioned Mr Eddie Veale. Well worth hearing by anyone in the market for robust monitors; four are now being used at Lansdowne.

Sound Techniques seem to be assured of success with their System 12 desks. This new series is designed to provide multitrack control facilities at budget prices and the first model, *Scheme One*, costs £5 025. For this you get a basic 18 in/out desk, with the usual comprehensive controls. Sixteen track monitors, and four speaker monitors are provided, and echo and foldback can be applied to all inputs and monitors. As these desks are available from stock, Sound Techniques are confident that they can have one installed and working in a customer's studio within 36 hours of receiving the order.

Audio Developments, suppliers of custom-built decks, had an eight-track model on show. One of the modules had been removed to display the excellent workmanship that goes into the building of their equipment.

Helios Electronics showed Island Studio's new 20-channel reduction desk which caters for quadraphonics or two-channel stereo.

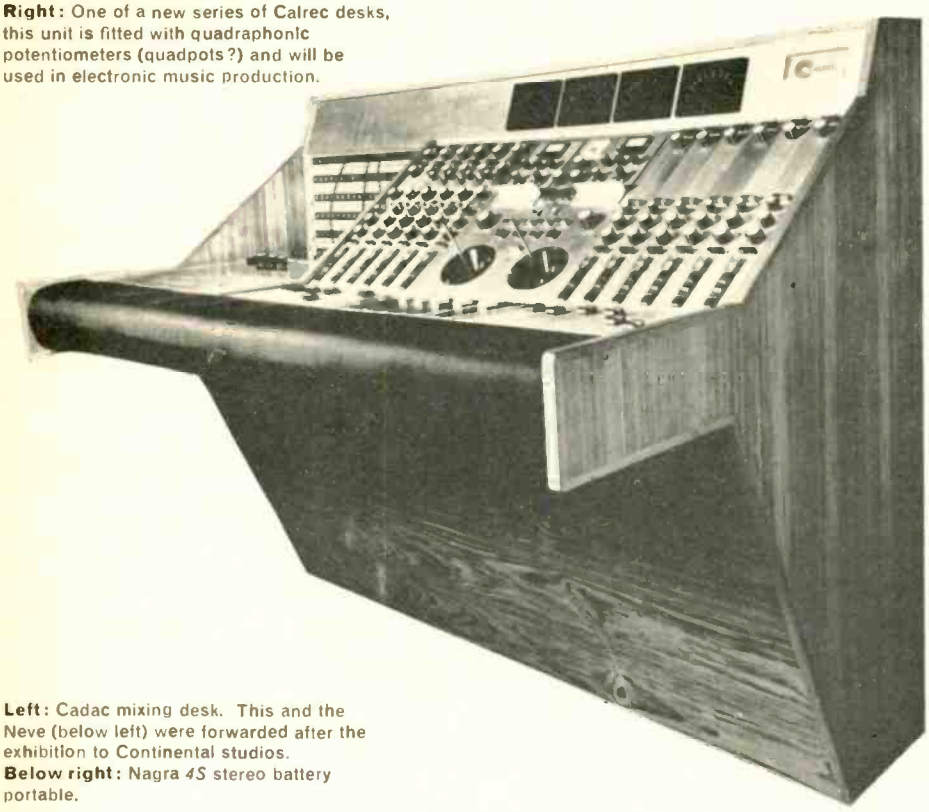


Amplifiers

H/H Electronic, who have supplied power amplifiers to many well known organisations including the BBC and RCA, exhibited their range of direct-coupled power amplifiers. Prices range from £38 for the 25W model, to £79 for the 100 watt *TPA 100D*. The latter can deliver 100W rms into 15 ohms, or 120W rms into 7.5 ohms. Total harmonic distortion is 'less than 0.1 per cent at 100W over most of the frequency range'. From the distortion curve supplied by the firm, the total distortion at this same output level is only 0.3 per cent at 20 kHz. Among the accessories which can be supplied is a 100 Volt matching transformer.

Carston Electronics showed the well tried Crown *DC-300* stereo power amplifier. Each

Left: Twenty channel mixer built for Island by Helios Electronics.
Right: One of a new series of Calrec desks, this unit is fitted with quadraphonic potentiometers (quadpots?) and will be used in electronic music production.



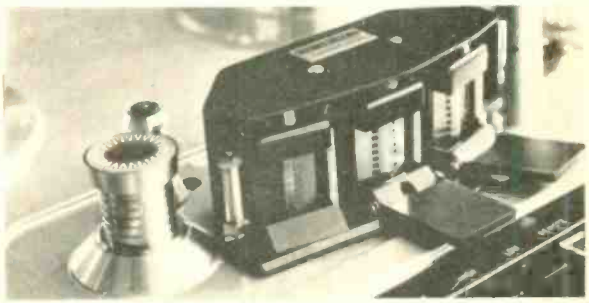
Left: Cadac mixing desk. This and the Neve (below left) were forwarded after the exhibition to Continental studios.
Below right: Nagra *4S* stereo battery portable.

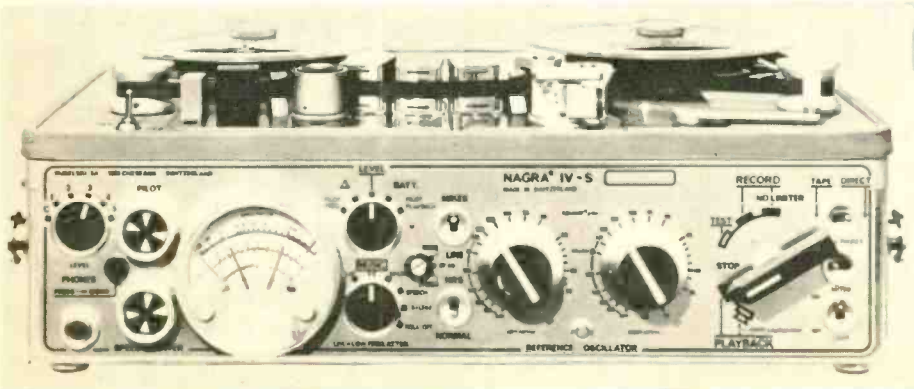
channel can deliver 340W into a 4 ohm load, or 190W into 8 ohms. Total harmonic distortion at 150W is 0.2 per cent at 20 kHz, falling to 0.1 per cent at 4 kHz. At the 75 watt level, harmonic distortion is less than 0.15 per cent at all frequencies below 25 kHz.

The first amplifiers in the *Series 7* range were shown by **Grampian Reproducers**. Type *743* is rated at 50W and type *744* at 100W both being fully protected against short circuit or other incorrect loading. Total harmonic distortion at 1 kHz, and at the rated outputs, is less than 0.2 per cent for the *743*, and less than 0.5% for the *744*. These figures reduce to 0.1 and 0.2 per cent respectively at 10 dB below the rated output levels. These amplifiers are designed for standard rack mounting.

Ling Dynamic Systems, sole UK agents for Altec equipment, showed among other things, the Altec *9844A* speaker system. This wall-mounting studio unit incorporates a new concept in enclosure design. When mounted flush on a wall, the sound is radiated about an axis 10° declined from the horizontal. The *9844A* contains a pair of Altec *414* 305mm bass speakers, and an *806A* HF compression driver with aluminium horn, for the range 800 Hz to 22 kHz. A variable rotary control on the front of the cabinet permits HF shelving from 0 to −10 dB. The continuous power rating is quoted as 30W, although it's anybody's guess whether or not this is on music. The quoted 'response' is 30 to 22 kHz but again suspicious minds are allowed to ponder as the

Left: David Worth (standing) of Scopetronics with new range of multitrack transports in background.
Right: Headblock of a Leevers-Rich.



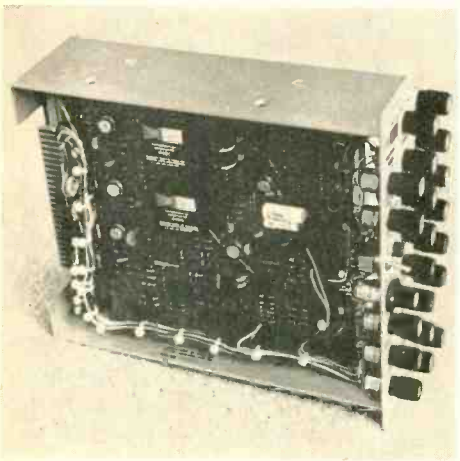


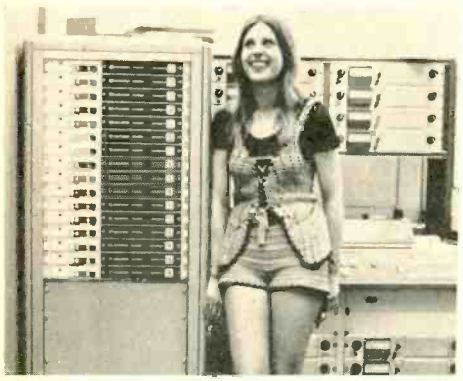
tolerance is omitted. Anyone familiar with Altec products will know that this is a highly reputable firm, so it should be safe to assume that their data sheets, not their products, require attention.

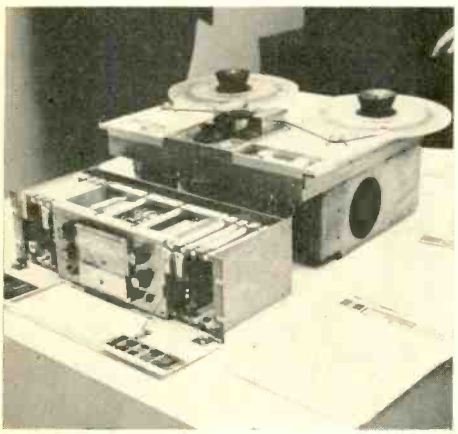
As well as a range of microphones, **Shure** displayed some of their *Vocal Master* public address equipment, which they prefer to call 'vocal arrangement and projection systems'. The *VA302-E* system consists of a pair of speaker columns, and a six input *VA302-C* control console. Volume, treble, bass, and reverberation controls are provided on each channel, the output level, controllable on a master gain pot, being indicated on a VU-meter. Full protection against short- and open-circuits is incorporated in the design.

(continued overleaf)

THAT WAS APRS71







Top left: Module from a Tonus ARP electronic audio synthesiser.
Centre left: 360 Dolby noise reduction units, Mrs Dagmar Dolby and Ampex *MM1000*.
Bottom left: Narrow-tape 3M recorder designed for the cassette industry.

SNS Communications showed their instrument and PA amplification equipment. The prices appear to be secret, as they are not mentioned anywhere on the 'price list' I received.

Tape recorders

Scopetronics showed a range of recorders including their *1151*, which is available in mono or stereo form. The output fader can be used to stop and start the transport mechanism, a feature useful in broadcasting and incorporated in some BBC machines. Operating speeds are 38 and 19 cm/s, within a quoted consistency of better than 2 per cent, thus making an error of 1 minute in a 60 minute programme *within* the specification. Also seen were the *SC/1* and *SC/2* 25 and 51 mm tape transport systems, 'originally conceived by another company who, after considerable expenditure achieved a measure of success, but were frustrated by lack of capital'. These decks incorporate a twin capstan drive before and after the tape head, rather like last year's designs by Unitrack Limited. Scopetronics are to modify the original deck, and 're-engineer parts in certain weak operational areas'. It is expected that this transport system will be available later in the year.

The new *E200* tape machine was featured on the **Leevers-Rich** stand. This is the latest development in their *E* series of 6.25 mm machines, and its fully modularised construction offers extreme ease of access for maintenance purposes. It is available in mono and stereo versions, and can be supplied either unmounted or installed in a rack or console. Prices range from £635 for a mono play-only unmounted model to £1 105 for a stereo record/play model mounted in a 'de luxe' console. Another exhibit was the *Series G* eight-track deck. Total wow and flutter on both *E* and *G* series is quoted as 0.06 per cent RMS at 38 cm/s.

Beaulieu Cinema presented the lightweight Swiss built Stellavox *SP7* battery recorder. Measuring 270 x 215 x 8 mm, it can be supplied in mono or stereo running at any speeds from 5.1 to 76 cm/s. Various heads are available for full, half, and quarter track recording, and for neopilot and synchrotone control tracks.

A new motor with six brushes has been incorporated, and wow and flutter is quoted as less than ±0.12 per cent p-p weighted. The *SP7* can be powered from an internal battery pack or from an external source of 12 to 20V DC, the current drawn being about 0.12A. This low consumption allows solar cell powering in remote (sunny?) locations. The standard machine takes spools up to 13 cm diameter, and an accessory allows 27 cm spools to be used. Prices of the basic recorders range from £502 to £640.

Above: Four-channel 12.5 mm recorder exhibited by Richardson.
Below: Stellavox battery portable, shown here with NAB extenders.

The new 6.3 mm tape transport shown by **J. Richardson Electronics** is intended primarily for studio and broadcast use. Tape speeds are 38 and 19 cm/s or 19 and 9.5 cm/s. Wow and flutter is quoted as being better than 0.05% at the highest speed, and better than 0.1% at the lowest. Function selection is by means of illuminated push buttons, with solid state logic control. The deck can be console mounted or fitted to a standard rack.

Tape Recorder Developments showed a range of recorders for studio, industrial, and

(*continued on page 389*)

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.

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

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DC300

The Finest Power Amplifier in the World!

The CBS Lab Data taken on the DC300 represents in sum the highest performance yet encountered in an amplifier. (*High Fidelity Mar.* '69)

Coming as close to absolute perfection as any amplifier we have ever seen or investigated. (*Audio Oct.* '69)

We tossed up whether to use a Dolly, or a photo of the DC300 or both, but decided to just give you the facts man! When you have read them, and if you know of any amplifier that is as good (not better) we'll buy you one! We're pretty safe!

DC300 power capability is 340 Watts RMS into 4 ohms, 190 Watts RMS into 8 ohms, 100 Watts RMS into 16 ohms each channel.

For power bandwidth we can claim at say 150 Watts into 8 ohms, that it is FLAT from DC to 35,000 Hz! -3 dB point is 45,000 Hz.

Harmonic Distortion at 1,000 Hz at a level of 75 Watts into 8 ohms is a mere 0.007%. At 150 watts this becomes 0.01%. For comparison we can quote at 50 watts RMS at 20,000 Hz THD is 0.1%. At 150 Watts RMS at 20,000 Hz it becomes 0.2%.

Safe so far we feel!

Intermod. Distortion on the DC300 is typically 0.05% at all power levels from 0.01 Watt up to 150 Watts. Difficult to compare as few other amplifiers specify this, but remember it makes the difference between clean and woolly Bass.

Hum and Noise on the DC300 is better than 100 dB below 150 Watts.

Damping Factor is greater than 200.
DC300 is stable under any load condition. Ideal for Electrostatic speakers as it handles capacitive loads so well.

The DC300 is not cheap of course. But it is the best!

U.K. users include The National Physical Laboratory, Road Research Laboratory, Institute of Sound and Vibration, Queen Mary College, Electricity Research Council, University of Manchester, International Entertainers Services Ltd., Island Records, and many others. If you would like more data on the DC300 together with reprints of the reviews mentioned above please let us know.

Remember if you want the Best for your Studio, Disco, or whatever and not the second best, or best in class (whatever that means) the DC300 is now accepted as the one to go for.

CARSTON ELECTRONICS LIMITED
SHIRLEY HOUSE, 27 CAMDEN ROAD, LONDON, NW1 9LN
Telephone: 01-267 2748

THAT WAS APRS 71

Above: Steve Tracey (left) of Tangerine Studios receiving an Alice *BD6* limiter from Ted Fletcher. Mr Tracey's estimated 645 gm came nearest to the limiter's 642.9 gm weight.
Below right: Kepex programme expander module.
Below left: Studer mixing desk on the Bauch stand.

laboratory use at competitive prices.

Pye TVT included the Philips *Pro 36* recorder among the many exhibits on their impressive stand. Basically a mono machine, the *Pro 36* can be easily converted to stereo, and is available as a portable machine, console mounted, or unmounted, for fitting into a desk or standard rack. The long life *Ferroxcube* heads are fixed in position, making azimuth adjustments 'superfluous' says the blurb, or impossible, if you look at it that way. This abolition of head adjustments has been made possible by the fact that Ferroxcube heads can be manufactured with high precision.

Replacement tape heads to fit Scully, 3M, and Ampex recorders were shown on the **Feldon Recording** stand. American made, these heads are cheaper than the machine manufacturers' own heads but are claimed to be technically identical. The new Scully *100 Series* 16 track recorder costs only £8,880, the low price being made possible by omitting non-essentials such as the VU-meter panel. This can be bought as an extra if required.

Bargains were to be had from **Fraser-Peacock Associates.** The Hitachi 19 and 9.5 cm/s reel-to-reel solenoid-operated recorder with three heads and a built-in Dolby *B* system costs only £220. Kellar Electronics have appointed Fraser-Peacock distributors for the *KDB-1* Dolby *B* noise reduction unit, selling at around £50.

Miscellany

Jaques Levy Professional Recording Services are UK distributors for cutting styli by Capps, and a range of products by Audio Devices, a subsidiary of Capitol Industries. Their products include Audiopak tape cartridges and cassettes, Audiotape, Audiofilm for sprocket driven magnetic track recorders, and Audiodiscs mastering blanks and lacquered discs.

BASF introduced their new *SP50M* tape and also provided useful information sheets on various products such as their calibration tapes. The comprehensive range allows tape or film equipment to be aligned at various speeds to DIN or NAB standards.

The **Minnesota Mining and Manufacturing Co.** featured their new Scotch *206* and *207* tape, claimed to have a tougher coating, more resistance to scratching, with a better winding characteristic than the popular *202*. Also shown on their stand was a recorder using 3.2 mm tape. This featured 3M's unique *Isloop* differential capstan drive, claimed to produce 'the lowest wow and flutter in the industry'.

The **British Homophone Company,** formed over 50 years ago and now a subsidiary of **Crystalate (Holdings),** specialise in the custom pressing of gramophone records. Details of this service were provided at the stand. The Crystalate group announced at the exhibition that they have now entered the tape market, having been appointed exclusive agents in the UK and Eire for TDK tape. This will be marketed by British Homophone as well as by Crystalate's sales subsidiary, Peter Bowthorpe & Associates.

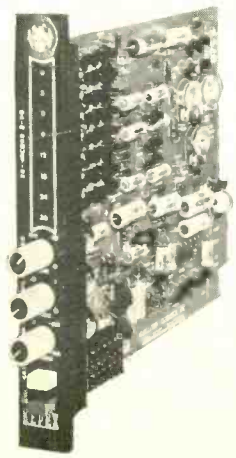
Featured on the **Dolby** stand were the *Series 360* single *A*-type noise reduction units, and the *Model 320* which contains two separate *B*-type processors. The latter are mounted in a standard rack case of the type used for the *A*-type twin processors. Like all Dolby products, the *320* is extremely well made. Originally sold as the '*B* type tape duplication processor', the title has been changed, and the *320* will in future be known as the '*B* type Broadcast encoding processor'. With a stereo signal, the service area of an FM transmitter is greatly reduced compared with the area covered by a mono transmitter because of noise introduced by the stereo coding and decoding circuitry. The *B* type noise reduction system, when applied to stereo FM transmission, allows the station to serve a greater area with the same power output, by virtue of the 10 dB improvement in the signal-to-noise ratio.

Another well constructed model known as Dagmar Dolby was also seen on this stand.

Stancoil (Alice) showed a variety of studio equipment. Among the *BD* range of modules was the *CNS* crosstalk and noise suppression unit, designed to reduce print-through, crosstalk, and other unwanted low level signals. The *CNS* operates by complex expansion dependent on frequency and level, in order to maintain the apparent relative levels of the various component frequencies within the complex input waveform, while at the same time achieving the required suppression characteristic. Size only 91 mm wide by 152 high. Price £93.

Eddie Veale's **Acoustic Consultants** were available for consultation on the various acoustic problems encountered in studios.

For many visitors to APRS 71, the **Bauch** stand was the main attraction because of the wide range of quality products displayed. Indeed most items on a studio's shopping list can be obtained from this company—microphones (Neumann), mixing consoles and recorders (Studer), turntables, compressor/limiters, and reverberation plates (EMT), studio monitoring speakers (Klein and Hummel), and many other items. The most interesting exhibits on the stand were the ARP synthesiser, the first all-electronic audio time-delay system (by Gotham) and the Kepex programme expander made by Allison Research. The latter is designed to 'soak up tape hiss and amplifier noise, and reduce background studio noises'. Apparently it can also remove accidentally recorded echo on a percussion track (so can a bulk eraser), and 'old noisy masters can be scrubbed clean with it'. (*continued overleaf*)



THAT WAS APRS 71

The major item seen on the **Hayden Laboratories** stand was a notice redirecting visitors to the Hilton Hotel, where they would be rewarded with cocktails and a demonstration of the new stereo Nagra. This is based on the mono *4* and accepts 27 cm NAB spools when fitted with motorised extension turntables. Ten years late in coming but none the less welcome for that. Hayden, the Kudelski agent, now also represent Sennheiser whose range of microphones were on display.

Future Film Developments displayed an assortment of plugs, sockets, probes and clips, including the latest microphone connectors by Switchcraft and Amphenol.

Audio and Design exhibited the *F700* Series Compressor/Limiter. This provides a range of compression slopes from 2:1 to 25:1, with switchable attack and release times. Distortion is quoted as 0.1% for 25 dB reduction.

The *Model 901* Graphic Equaliser displayed by **Audix BB** should be of interest to most studios. Vertical sliders give ±12 dB control at 11 logarithmically spaced basic frequencies, and a switch allows these centre frequencies to be changed simultaneously by ±0.3 octave.

The Freeman Synthesiser *Model S. 100*, the first in **Audio Synthesisers'** range of polyphonic instruments, is capable of simulating the sound of several instruments in the same family, playing in harmony. It has a range of five octaves, and pressing one note 'can produce the sound of an entire orchestral string section'. This portable instrument could be useful to groups unable to afford the services of a number of backing musicians.

Test equipment was featured on the **Lennard Development** stand. The *ME 301* wave analyser is designed for narrow band noise and vibration investigation in the range 1 to 330 Hz. Also shown was the *ME 104* wow and flutter meter which can be used on its own, or plugged into the *ME 301*. Fluctuations between ±0.02 and ±3.0 per cent can be read weighted or unweighted to DIN standards. A drift meter is incorporated to show the percentage frequency deviation of the measuring tone from its nominal value. (See last month's reviews.)

Finally, anyone suffering from a shortage of cash may be interested to know that the **Modern Music Centre** of Turnham Green Terrace, and the **Jackson Music Group** of Rickmansworth are both dealing in second hand studio equipment. MMC's representative at the exhibition told me 'Most people here want to buy something, therefore they have something to sell, and that's where we come in'. Both firms operate on a commission basis, and usually have a selection of equipment up to eight track.

Neve BCM 10/2

WHAT are the requirements for a successful exhibition? Good premises for a start. Shuttleworth Great Hall would be easy to reach, both by car and public transport, and would possess adequate parking space. Refreshments would be available in pleasant surroundings and at reasonable prices. Adequate demonstration facilities would be available to those exhibitors who wished to use them.

To my mind the Old Royal Horticultural Hall fell sadly short on many of these requirements, though not necessarily through any fault on the part of the organisers. Visitors arriving by car found no parking facilities other than a surround of occupied parking meters. I was fortunate in finding an empty one.

Refreshments were available in one corner of the hall but were of a pretty basic nature, reminiscent of a roadside cafe. A distinct contrast to the Coronation Suite at the Hilton Hotel where Hayden Labs were showing the long awaited stereo Nagra.

Demonstrations were conspicuous by their absence. Apart from some very clean and well recorded music to be heard through headphones from the stereo portable Stellavox, one might be forgiven for not realising that the exhibition was actually to do with sound. Unfortunately the dates of the APRS Exhibition clashed with other trade shows and a public holiday, so there were fewer exhibitors and visitors than would otherwise have been the case.

By far the largest part of the exhibition was taken by mixers of various sizes, the largest being a mammoth Neve with 32 inputs and 24 outputs, costing £30,000. Coloured lights continue to decorate desks and tape machines. Pleasant to use, I'm sure, and guaranteed to impress the customers.

Tape recorders were scarce, and monitor speakers more so. It was a surprise to find tape machines actually working at all, On one or two other stands visitors could watch the wheels go round but in general the displays were static. Most stands were manned by helpful and courteous assistants.

Microphones came off better than speakers. Eye catching stands were arranged by AKG and Calrec. The Pye TVT stand displayed several microphones bearing a remarkable resemblance to the AKGs on the other side of the hall ! On the same stand, the Philips *Pro 36* was attracting a lot of attention and certainly looks an interesting machine.

Hayden had obviously taken a lot of trouble over their Hilton Hotel displays. The main exhibits were, of course, the stereo Nagra. A range of Sennheiser microphones was displayed and these could be plugged into the Nagra and listened to on Sennheiser headphones.

I certainly saw enough at APRS 71 to make my visit worthwhile. If the Royal Horticultural Hall is not ideal, I would be hard put to find anywhere better.

RECORDING STUDIO TECHNIQUES

RECORDING ON LOCATION *by Angus McKenzie*

I WAS recently asked to record a brass band in a North London hall which, unfortunately, had too short a reverberation time for my taste. Many people consider that brass bands should if possible be recorded in the open air. Unfortunately the elements cannot be relied upon, in this country at least. The band in question included cornets, flugel horns, horns, basses, trombones and a fairly large percussion section, also one of the finest euphoniums I have ever heard. The main sound was obtained from a stereo *C24* capacitor set at approximately 110° with hypercardioid polar diagram. An *M224* cardioid dynamic on a boom stand was used to strengthen the cornets, particularly in the solo passages, and was appropriately panned towards the left. The percussion panned over to the right was miked with an STC *4136* cardioid capacitor.

Because the hall acoustics tended to muddle the LF, the double bass horn, an enormous brass instrument, had an STC *4038* ribbon placed edge on and quite close so that the other brass instruments nearby were picked up in approximately equal proportions. The output from this microphone was panned centrally and gave firm bass to the sound. Bass boost and treble cut were applied to prevent the sound from other instruments from interfering. A small amount of bass cut was introduced into the two panned microphones to avoid any bass phasing problems in the overall balance. I was careful to use comparatively little of the output from the panned mikes in the general balance, in fact only just enough to bring the sound fractionally forward in the general balance. For the euphonium solo, the player was brought forward near the centre and not separately miked. The main *C24* was just over 3m up and tilted about 25° back. It was suspended from the useful *Films & Equipment* boom which is easily portable and not as expensive as one might imagine. In fact the boom is capable of extending to a vertical height of nearly 6m and yet collapses down into two pieces easily fitted into an estate car. The session was also experimentally recorded quadraphonically with four cardioids suspended from the end of the same boom. The temporary control room had rather a live acoustic but fortunately a number of fabric screens were found and placed round the room to reduce reverberation. I used a Heathkit transistor portable talkback system. This has facilities for hearing or talking to the conductor and, although only of approximately 1W peak, was fully effective in stopping the entire band on occasions ! I do not use red and green cue lights as I have found that most artists prefer the less formal talkback cue of 'rolling'.

Some brass bands seat themselves in a formation that produces an unsatisfactory sound stage and such was the case with this particular session. In about 25 minutes we had achieved a balance we liked and only minor changes were made throughout the session to deal with various solos as they occurred. My colleagues and I usually managed to deal with changes of microphone position during a rehearsal of the next number. At the beginning of the session, a lack of brilliance was noticed on the trombones and on investigation it was found that they had moved themselves so as to play to the other half of the band rather than towards the microphone. This brings up the importance of getting musicians used to playing to the mike rather than to an imaginary audience. Having obtained a satisfactory balance I did not have to ride the main gain control at all, thus preserving the dynamics between the different pieces. On the other hand I obviously had occasionally to adjust the gain of the pan potted microphone used for picking up soloists.

A large brass band can produce a marvellous sound and it is interesting that most of them use cornets rather than trumpets. This results in less high frequency harmonics on the left hand channel. When an instrumentalist placed towards the left played directly towards the main *C24*, the timbre nicely balanced the brilliance of the trombones which were placed towards the right.

I recently had the privilege of making the first recording of William Alwyn's *First String Quartet* with the Gabrielli String Quartet led by Kenneth Sillitoe, outstanding leader of the English Chamber Orchestra. Both he and the second violinist played on Stradivarius violins which are particularly noted for their sweet tone. The recording location was Christchurch, Chelsea, which has a superb acoustic with fairly long reverberation. Unfortunately, however, rather a lot of traffic was noticeable, as well as the noise of children in a nearby playground, which caused occasional stops in the session. A mysterious hum in the church was faintly audible. This was never completely traced although every attempt was made, even to turning off every piece of electrical equipment in the church, and we finally assumed it was due to some peculiar air resonance or possibly an electricity sub-station transformer vibrating the ground nearby. Aircraft passing over central London sometimes caused halts in the recording. This raises the importance of visiting a mobile recording location a few days before a recording to check the snags. In this case, nothing could be done.

The quartet was balanced entirely on a single *C24* suspended about 2m above floor level and angled back at 25°. The angle between the capsules was set at 110° and a hypercardioid polar diagram was used. Listening very carefully to the sound, I had to make allowances for the control room having more than the ideal reverberation. When the tapes were played back in my listening room the sound was fortunately as I wanted it, namely a fairly close sound on the quartet (incidentally over 2m from the mike) and with a reasonable amount of church atmosphere behind the performers. Although the recording was made only in two-channel, the possibility of its being suitable for the Hafler system of producing ambience from the back of the room was also considered, thus making possible a reasonably acceptable fake quadraphonic recording for issue at a later date, should the customer company so desire. This method of obtaining fake quadraphony seems to work particularly well when a co-incidental microphone is used. I would have preferred, of course, to have used crossed figure-of-eight polar diagrams which would have given an even better difference channel but this was not possible because it brought too much reverberation into the stereo balance. I found it necessary, incidentally, to bring the first violin slightly forward whereas the cello was moved back. A balance was achieved in about 15 minutes.

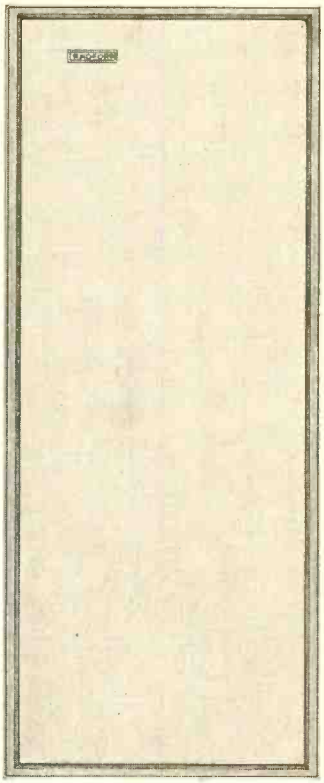
Being very fond of the acoustics in St. John's, Smith Square, Westminster, I was therefore pleased to be asked to record a recent performance of Cherubini's *Requiem* and other works in the now deconsecrated church. The Decca Record Company have a contract, ending in approximately two years time, giving them exclusive rights on commercial recordings made in this location, although the BBC has rights to relay the live concerts frequently given in St. John's.

Since there is no centre gangway in the normal seating arrangements for concerts, it was necessary to suspend all the microphones from pillars in the gallery. Fishermen's nylon cord of some 180 kg breaking strain was used. Both the single *C24* and four capacitor cardioids were slung, the former for stereo and the latter for a quadraphonic recording. The four cardioids were mounted along a stereo cross bar, arranging the capsules as close together as possible. The quadraphonic mikes were suspended a little lower than the *C24* and about 30 cm further back. An additional microphone, an STC *4136* cardioid capacitor was mounted on a floor stand to bring the soloist slightly closer in by pan potting.

Without doubt this location is one of the finest I have ever had the pleasure to work at. I shall describe the quadraphonic set-up used on this occasion in a later article, together with some ideas on microphone technique.

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.**



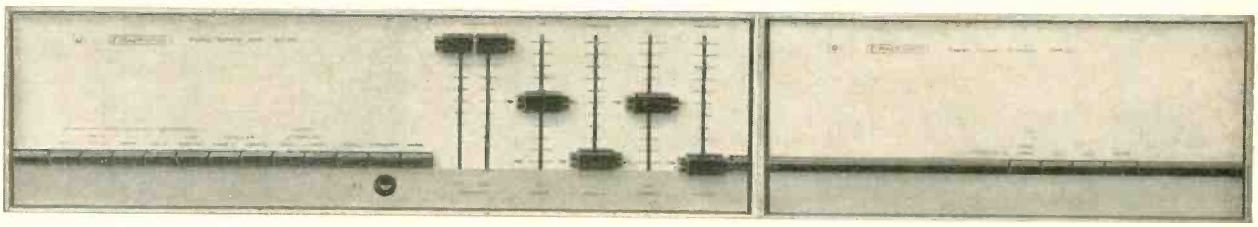
MONITOR For shelf and floor mounting on a suitable stand. Uses three drive units. Sealed enclosure for bass driver. Open back type mid range driver fitted in separate enclosure. Power handling capacity 50 watts. Matching impedance 8-16 ohms. *Size:* 30 x 12 x 10½ in. (76 x 30½ x 26½ cm.) *Weight:* 43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



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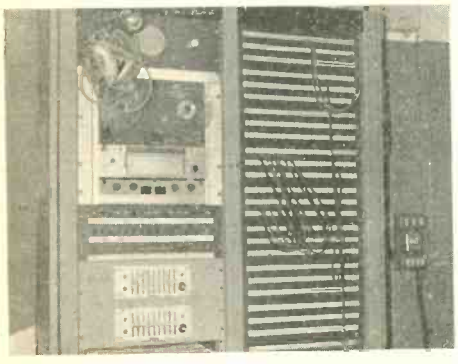
INSIDE INTERSOUND

BY KEITH WICKS

LONDON Weekend took over from Associated Rediffusion at the Wembley television studios in May 1968. Of the five studios in the building, London Weekend used four as normal television studios and the fifth for pre-recording sound for programmes, and for accommodating orchestras when there was not enough room for them in the main TV studio. This worked well and facilities were eventually improved by spending £65,000 on modernisation and re-equipping. Alterations were made to the studio and an eight track Neve desk was installed in a new control room which had served as the vision control room of the original television studio.

By fitting out a separate control room, it was possible to continue using the studio while re-equipping was being carried out. This was essential as the studio was in regular use. When installation was complete, and everything was working satisfactorily, the changeover was effected simply by plugging the studio microphones into another set of sockets, connected to the new control room. In September 1970, this studio became available for general hire and was marketed as Intersound Recording Studios by Intertel Colour Television, a company owned by London Weekend. When Intertel merged with TVR last February, Intersound reverted to London Weekend.



Alan Evans, Head of Sound for London Weekend, is also Intersound's studio manager. He told me of Intersound's progress. As we all know, television sound has a bad name and at first there was some concern that customers might be reluctant to use a recording studio housed in a television building. However, there was no need to worry. Anyone who visits the studio will see that it is well staffed and equipped to produce recordings of the highest quality. The proximity of the bar is a great help to Intersound as unknown recording artists, dropping in for a drink and finding themselves surrounded by well known TV characters, soon get the feeling that they are, at last, part of show business, even if they haven't actually got around to cutting a disc. The atmosphere of television has thus proved to be a factor in retaining customers.

Alan Evans is capably assisted by Vena Nolan, who deals with bookings and information, and by engineers Vic Finch, Ian Southern and Dave Taylor. If this happy band are as friendly to customers as to visiting journalists, then Intersound must prosper, for the success of any studio depends on the attitude of the staff, as well as their ability.

The studio is larger than average, with an area of around 150 m². More than 50 musicians have been accommodated at times and there is room for another eight in the vocal booth. Clients have use of a Bosendorfer Grand piano, and can hire other instruments. Microphones used are by Neumann and AKG, 48V phantom powering being employed for the capacitors. Alan had much praise for the AKG *224E*, which he described as 'probably the best dynamic microphone on the market', because it can be used very close with virtually no ill effects.

The control desk is a 24 channel, eight track Neve model, unusual in that PPMs are fitted as opposed to the usual VU meters used in most recording studios. Why? Because they 'wanted to see what was going on'. I can understand this (but must admit that I, too, was brought up in broadcasting). The four Neve limiters built into the desk have been modified by the studio engineers as they found that, for some purposes, the fastest release time originally obtainable was still too slow. Dolby *361* noise reduction units, of which Intersound have a dozen, are used to ensure comparatively noise-free recordings. There are three Scullys with remote control, one eight track, and two twin tracks. For four track work, a 12.5 mm four track head block is fitted to the eight track machine. A varispeed unit consisting of an LF oscillator and a Quad power amplifier can be used to drive these recorders. Mono recording is carried out on an EMI *TR90* which can also provide tape delay echo. Reverberation is available from six EMT plates all with remotely controlled reverberation time. Originally, four Quad 50W amplifiers, with four Lockwood loudspeakers, were used for monitoring, but peak distortion was a problem. The Quads were replaced by four HH Electronics 100W amplifiers, set to give 50W output, and the peak distortion problem was solved. It was found that the combined bass characteristics of the Lockwoods and the control room produced unacceptable resonances. Because of this Intersound may well end up using J. B. Lansings, two of which are currently on trial. On the subject of loudspeakers, Alan Evans would like to see someone come up with a unit capable of high quality as well as high power. As found in our recent survey of loudspeakers, if you want high power, you have to forget about high quality. Alan considers the BBC *LS5/1* to be the best speaker he has heard but unfortunately it does not handle enough power to make it suitable for his studio.

As the studio is in a television building, it is not surprising to find CCTV is used to link the control room, studio, and vocal booth. Various film, telecine and videotape facilities are available, and clients have access to London Weekend's sound effects library, at a cost of £2 per item search fee.

Anyone requiring further information about this fine studio should contact Vena Nolan on 01-902 9711/2.

TURNTABLE

A column of readers' problems and correspondence

LOUDSPEAKERS

From: Bill Dougans, 26 Netherhill Avenue, Glasgow, S.4.

Dear Sir, In your May Editorial you state that a large gap exists in the loudspeaker market for a high quality high power monitor. While I agree with your concern about the high levels used by some sound balancers, I would be the last to deprive them of their pleasures. Surely they cannot all be deaf! (*Not yet.* **Ed.**)

Recently, I have been privileged to listen to a speaker which could well fill this gap. It is called the Ariston Audio *SR90* and has been developed over the past few months. At the moment it is being assessed in the National Engineering Lab anechoic chamber and early figures indicate an advanced specification.

I am a Quad *ELS* man and therefore rather hard to please. I like the sounds produced by the *SR90*, which is to be heard at Thermac of Glasgow. Needless to say, I have no connection with the company but would like to bring to your attention a possible gap filler.

Yours faithfully

SAVING TIME

From: Peter G. Craven, 100 Abingdon Road, Oxford.

Dear Sir, In arguing for the use of multitrack to reduce setting up time, Bob Auger seems to assume that all other techniques are equally bad in this respect. The following example will show that this is far from the case.

Last December, BBC Radio Oxford recorded the Isis Singers and the producer kindly gave permission for the Oxford University Tape Recording Society to make a simultaneous recording. The BBC used two STC *4038s*, one about a metre in front of and above the sopranos and the other similarly above the altos, mixed on a Nagra to produce a mono recording. Our own set-up was a coincident triplet of Calrec *652s* (cardioid) with matrixing to synthesise a crossed figure-of-eight response. (We are very keen on figure-of-eight and willingly go to this trouble to avoid the constricted sound of crossed cardioids and hypercardioids.) This we placed on the axis of the choir and about four metres away, which was as far as we could get while avoiding reflections from the wall behind.

While the choir was warming up, the BBC engineer flitted to and fro, making numerous and minute adjustments to the height and angling of his microphones. He complained that the men weren't coming through strongly enough, which was hardly their fault as the microphone was pointing downwards towards the women. Eventually, however, he was satisfied, and the choir got down to the serious business of giving a sample of the quietest and loudest passages in order to determine the amount of volume compression needed to keep within the regulation 18 dB dynamic range.

All this gave us ample opportunity to investigate the live sound. It was good from our trial microphone position but we quickly found an even better spot, only 60 cm away, and moved the microphones there—with excellent results.

As soon as the first piece was recorded (it only lasted five minutes) new problems beset the BBC, for the second was a modern work with a high and demanding solo for one of the tenors. His voice was fast giving out and, to conserve it, he did not take part in the run-through. The engineer insisted, however, that a test be made with the tenor singing full voice since he could not otherwise predict how the tenor would be picked up. (No problem for the coincident mikes!) As it turned out he considered the test satisfactory but doing it made the tenor's voice crack during the performance.

I hope this illustrates that it is not the coincident technique, but the 'compromise' techniques, such as coincident pair plus spot mikes, or simply several spaced mikes mixed together, which cause setting up delay. Most music, and this excludes film music and some light music, is balanced for the live listener. To produce an acceptable recorded balance, it is only necessary accurately to record the sound at any reasonable listening position (which is not to say that an optimum position should not be chosen if time permits).

One may wonder how the above session would have been tackled using multitrack. One track for each singer perhaps? Just about possible on a 24 channel machine, and it would give the opportunity of removing at the dubbing stage the contribution of anyone not up to scratch!

With regard to Mr Auger's comments on the time taken for Jerry Bruck's experiments, I repeat that a sensible choice of microphone position will straightaway lead to a satisfactory balance (see Michael Gerzon's March article for excellent advice on this matter). When a coincident enthusiast moves his microphones, it is in order better to capture some subtlety of the acoustic. This the multi-mike technique cannot even attempt.

Yours faithfully

COINCIDENT MICROPHONES

From: F. R. Low, 28 Westham Road, Malvern, Natal, South Africa.

Dear Sir, May I, somewhat belatedly, add my voice to those in favour of a return to the variety of coincident microphones.

In my small way, I have been involved in a handful of stereo LPs recorded for an Indian record company. The music varies from traditional Indian music (tablas and all that) to fairly accomplished beat groups. Incidentally, this is not my personal cup of tea, but we've got to be versatile here! I have found that the best result has been achieved with a crossed pair (BBC ribbon, or capacitors).

I cheat and sometimes use spot microphones panned to correspond with the main image, as the studio is rather small and tends to sound 'muddy', especially with the beat groups' blasting amplifiers.

However, my ears tell me that a good crossed pair of microphones sound far more *natural* than a multi-mike set-up—but a lot depends on the playback equipment. No doubt the small radiogram gang prefer exaggerated multi-mike techniques. *Yours faithfully*

GREATEST OFFENDER

From: Graham Worrall, 102 Church Street, Frodsham, Via Warrington.

Dear Sir, I was very interested to read Desmond Longfield's exposition of BBC recording technique. I feel, however, that he is perhaps a little unfair in his comments. He would appear to be confusing (no doubt together with many others) 'quantities of microphones' with 'multi-mike' technique in its normally accepted sense.

Consider, for example, a performance by a choir, orchestra and soloists to be recorded in two channel stereo. Due to positioning of performers, and bad hall acoustics, it *might* prove desirable to have stereo placings for each, together with a stereo pair for hall reverberation, to achieve an acceptable balance, remembering the problems associated with no visual information. Eight microphones might therefore be used. This could produce a very good spatial image. Multimiking would probably dictate the use of several microphones for each section of performers, producing (as discussed by Michael Gerzon) 'a . . . small number of discrete but poorly defined islands of sound'. I agree the eight microphone technique above is not true Blumlein but, with each pair so placed the final result is similar. Mr Longfield does not give sufficient information for me to support or 'condemn' the BBC in his case but I think I have justified the use of several microphones in certain circumstances.

I am rather puzzled by the beginning of his last paragraph, 'In my experience, the BBC is the greatest offender in achieving totally inaccurate balances. If its producers would try the Blumlein technique occasionally, they might be pleasantly surprised'. While I agree that the BBC sometimes produce rather strange stereo 'noises', I have found that in general the stereo is very good. I have attended several BBC recording sessions, have frequently conversed with engineers in Manchester, and have yet to witness any 'multimiking'. Spot microphones are often needed to reinforce soloists but only within the co-incidentally derived sound stage. The sound produced in the control room, and hence heard by the producer and engineers, is superb. I heard part of a recording of the Hallé orchestra from the control position and had no complaints. The microphones used? Two coincident *C12A*. Perhaps Mr Longfield's tuner requires servicing.

Yours faithfully

IN the September 1970 *Studio Sound*, the author proposed a new system of four-channel recording using the skew tetrahedral loudspeaker layout shown in **fig. 1**, which is essentially a conventional square four-speaker layout with the front left (LF) and rear right (RR) speakers raised to the ceiling, and the front right (RF) and rear left (LR) speakers lowered to the floor. By this means it was hoped to capture the original directional effect of all sounds around the listener, both horizontally and vertically.

Recently, an experimental live relay and recording was arranged using this system. Considerations governing the design of the experiment will be described next month. The following confines itself to a description of the experimental set-up and an account of some impressions obtained by listeners.

The relay and recording was of a rehearsal and public concert given by the Schola Cantorum of Oxford, conducted by Andrew Parrott, of unaccompanied and accompanied choral music, in the chapel of Merton College, Oxford, on May 8. This location has a distinctive 'church acoustic' and the experimental aim was to determine how realistically this could be reproduced.

The following set-up was used for the experiment (see also **fig. 2**). Four coincident Calrec *652* cardioid microphones, pointing along the four axes of the chosen tetrahedron of fig. 1, were placed in the middle of the audience in the chapel at just above ear level so as to provide an accurate comparison between the sound as heard live and as reproduced. These were fed into a four channel equaliser/line amplifier and this fed cable to the Sacristy adjacent to the chapel. In the Sacristy, the signal was split to feed two four-channel tape recorders, a 6.25 mm *Crown* loaned by Carston Electronics and brought by Bob Arthurton, and a 12.5 mm *Scully* loaned by Granada Recordings and brought by David Martin. The four signals were also fed via Quad valve amps into a tetrahedral monitoring set-up consisting of two floor level Quad electrostatic speakers and two Spendor *BC1* monitors placed 2.5m up on the top of stepladders. The floorplan of the speakers was about 3m square. The four channel signals were fed to the monitoring amps via a matrix circuit which allowed the cardioid microphone outputs to be converted into hypercardioids at the turn of a knob.

The four-channel signal was also taken to a pair of differential amplifiers which produced a crossed figure-of-eight Blumlein stereo output for simultaneous two-channel recording.

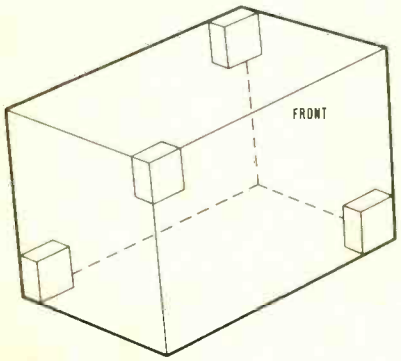
A relatively small speaker layout was used to simulate domestic conditions and to minimise the effect of the acoustics of the rather large Sacristy. As only four people could be seated comfortably within the tetrahedron, only a small number of people were able to take part in the experiment. Among these were Sid O'Connell and Granville Cooper, whose previous experience of other tetrahedral systems proved invaluable in pinpointing strengths and weaknesses of this system. It was possible to compare the reproduced sound with the real thing by passing through the door to the chapel.

The initial setting up of speaker phasing and levels was found to be somewhat difficult and small errors in the channel gains were found to have a considerable effect on the reproduced sounds. When these were correctly adjusted, the basic stereo image was found to be reasonably correct in its directional effect, and sounds arriving at the microphones from above, below, the sides, the front and the back of the microphones were reproduced from these positions also.

When the skew tetrahedron of fig. 1 was first proposed, the author and others were worried that the front stereo image might not appear flat, but would instead tilt downwards from left to right. It was in fact found that a good horizontal stereo image was obtained in all sensible listening positions once levels had been adjusted. The general three dimensional sound picture was judged to be about the most accurate yet heard, and considerably superior to the stereo picture obtained with other systems.

There were two really important flaws heard. The first defect, given the name 'overlap' by Rex Baldock at the time, is the effect obtained when the sound corresponding to one direction emerges to some degree even from speakers in the opposite direction. Overlap is familiar to those who have tried Hafler reproduction with the rear speakers turned up a little too high. Just as a mono sound gains in richness from being reproduced from two speakers, so does a sound gain even more richness if it is reproduced from all four speakers. This extra quality was described as 'openness' by the one listener who liked it but other listeners felt that the richness caused by overlap was rather unnatural and some found that sounds seemed to be coming from both in front and behind at the same time.

FIG. 1 SKEW-TETRAHEDRAL LOUDSPEAKER LAYOUT



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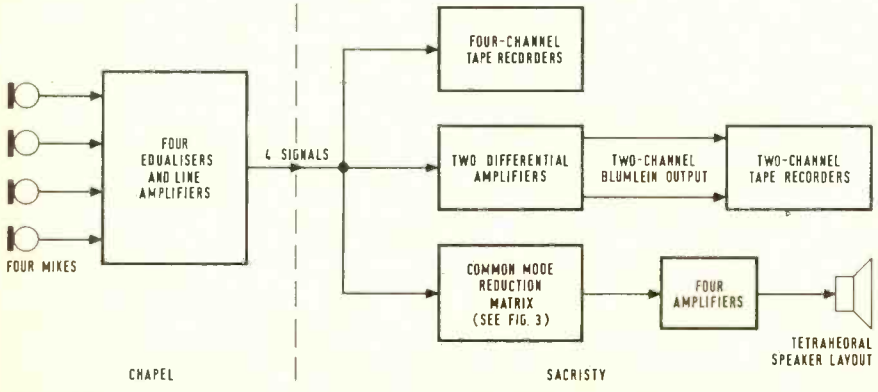
PART ONE by

FIG. 2 BASIC EXPERIMENTAL SET-UP



Calculations show that a sound arriving from the front at the cardioid microphones will be picked up by the rear microphones only 11.4 dB down relative to the front microphones. This degree of overlap can be reduced by using hypercardioid microphones. In the experiment, hypercardioids were simulated by using a common mode reduction circuit to reduce the common mode (i.e. omnidirectional) component of the four cardioid signals. The circuit used is illustrated in **fig. 3**, and a setting of the variable resistor VR at about 0.1R was found to give a considerable reduction of overlap; this setting corresponds to using hypercardioid microphones whose nulls are 135° off-axis, and increases the front-back separation from 11.4 dB to around 20 dB. The pick-up of front sounds by the rear channels can theoretically be eliminated by putting VR=0.183 R, corresponding to 125.3° null hypercardioids, but this is found to cause a lot of out-of-phase overlap for sounds coming from the sides of the orchestra. It was found subjectively that the least overlap corresponded to VR=0.1R very approximately. The result of these preliminary tests was that cardioids give too much overlap, and 135° null hypercardioids, obtained by matrixing, give a much better effect.

The other important flaw in the tetrahedral reproduction is far more difficult to rectify. As readers of this journal are aware, the *ELS* and *BC1* speakers used are among the most uncoloured available. They were chosen for precisely this reason, as fidelity to the live sound was the most important consideration. Unfortunately, it was considered impractical to mount *ELS*s on stepladders, and only two Spendors were available. As an ELS and a Spendor have been found to work well as a stereo pair, being surprisingly similar in sound, it was decided to use two of each as described earlier. However, it was found difficult to match their outputs for the tetrahedral reproduction.

Even when the levels were set optimally, it was found that the coloration from the four speakers caused a very disturbing side-effect. Although the basic stereo image was distributed horizontally, the four loudspeakers were heard as separate and very distracting sources of coloration. The coloration from the Spendors tended to pull L_F and R_R sounds upwards, and the ELS coloration tended to pull the R_F and L_R sounds downwards. These sources of coloration greatly disturbed the overall impression of a homogeneous sound field around the listener, and this is certainly the most serious problem to be solved with this system. Its seriousness is indicated by the observation that the *ELS* is probably the least coloured loudspeaker available and that the *BC1* is generally regarded as approaching it; yet the tetrahedral system made the Spendors seem tremendously prominent as a separate source of coloration and even the Quads were shown up to a lesser extent. If this experiment is anything to go by, tetrahedral reproduction as in fig. 1 is an ideal way for loudspeaker designers to assess so-called 'subtle' colorations — there is clearly an enormous amount of progress yet to be made in loudspeaker design.

The energetic members of Oxford University Tape Recording Society who had done all the hard work of the experiment decided that a mixed Spendor/Quad system was unsatisfactory. The next day they set up a tetrahedral playback system in a domestic room consisting of four *ELS*s, two placed on the floor, and two strapped precariously at ceiling level on stepladders, angled downwards towards the listener to avoid the loss of treble up top (literally!). This set-up gave much better results. The channel levels were found to be less critical, although the bass output of the ceiling *ELS*s had to be reduced to obtain a balance. With this system, the speaker coloration was found to be less disturbing, although its effects were still noticeable. The high degree of overlap given by cardioids was found to be more objectionable than with the earlier system.

The acoustics of the Sacristy had to some extent obscured the subtleties of the Spendor/Quad tetrahedral playback and it was found that, with the all-Quad system in the domestic room, the original acoustics of the chapel were audible with great clarity, even though the sound was being played back from a rather hissy tape. It was possible to analyse the acoustics in the same detail as if one were there live; with careful listening, one could pick out the precise position of a lectern which had obstructed some of the reverberant sound near the microphones. The separate effects of various parts of the ceiling and walls of the chapel were clearly distinguishable, and the whole experience strongly argued against those who claim that four channels need only pick up a generalised reverberant richness and nothing more.

There are many who regard the height effect as an altogether unnecessary luxury and, at first sight, our choice of music with virtually no vertical spread seems to suggest they are right. Yet the listening tests showed quite the opposite—the height effect on the reverberation added very considerably to the realism. Indeed, several listeners standing *outside* the tetrahedron still found the spaciousness of the recording to be superior to that obtained from most conventional four-channel recordings *within* the square of speakers. Another index of the improved realism is that listeners outside the playback room heard a sound that gave a quite uncanny imitation of emerging from a chapel.

Some of the orchestral playing in the concert had been rather scrappy and this was found to be very disturbing musically on two-speaker stereo playback. It was interesting to note that such flaws were far less noticeable on

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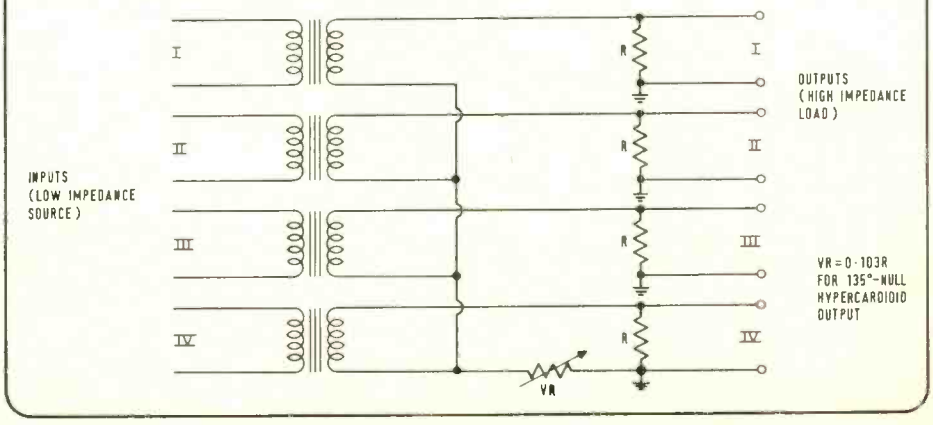
...Recording

MICHAEL GERZON

FIG. 3 FOUR-CHANNEL COMMON MODE REDUCTION CIRCUIT



See dB mag for re-wire studio job

tetrahedral playback which, like the live sound, made it easier to listen through such performance errors to the music. The purely musical value of tetrahedral reproduction should not be underestimated.

This catalogue of enthusiastic initial impressions indicates the tremendous potential of tetrahedral reproduction but it must not disguise the serious problems that remain. When set up carefully, the overall impression is that of a basically realistic sound with a lot of spurious distractions added. Speaker coloration is the most serious and perhaps the tetrahedral system needs to wait until loudspeakers have attained the required standards. Alternatively, coloration might be rendered less disturbing by sharing it out among more loudspeakers, say a cube. The requirement that the amount of overlap must be kept down means that the choice of microphone arrangement is more critical than with other systems, although this problem would not exist with pan-pot multimike recordings.

It seems that the relative balance between the four channels must be accurately maintained right from the live sound to the playback speakers, as a small imbalance can shift a sound farther than with the narrowly angled speakers of two-speaker stereo. It is important to point the microphones accurately, as a 5° or 10° rotation of the image can make the sound seem terribly lopsided. This is especially important since the speakers become more prominent as distinct sources of sound when one's head is not pointing forward.

Another problem is that there is a partial 'hole in the middle' effect at the front, two sides and back (and, one presumes, above and below, although this was not evident in the absence of such direct sounds). The stereo image is certainly there, but it is less rigidly locked in place between the speakers than in the corners. The overall stereo effect does vary with listening position, although the orchestra tilts only near the corners, or if there is a channel imbalance. When one rotates one's head, one has an impression that the sound rotates with it, although the sound tends to lock into a position not far from its original one a little while after the head rotation stops. This rotation was less pronounced for hypercardioids than cardioids, and no rotation occurred when direct sounds surrounded the listener, as with audience applause.

When channel balance was out, it could be quite difficult to determine the precise relative positions of sounds, especially when there was too much overlap. It was also difficult to obtain a good distance effect, and the sound seemed to stop short at the loudspeaker distance, even when the live sound was closer. This disappointing distance effect is puzzling, as I have heard generally inferior systems reproduce all distances, both close and distant, with great fidelity.

These have been some initial reactions to skew-tetrahedral reproduction. It offers a tantalising glimpse into what audio could be like, and one becomes depressingly aware of the overwhelming deficiencies of even the best conventional four-channel stereo. It, or something like it, is clearly the system of the future, but how far in the future is anyone's guess as the practical problems still seem formidable. What is now needed is much more experimental investigation of this and related systems. It is only by patient research, by trial and error, that many of the difficulties can be resolved.

Meanwhile, it seems desirable for commercial recordings to be made containing height information where possible. Tetrahedral recordings made for the skew-tetrahedral layout of fig. 1 are directly suitable for playback over the conventional square loudspeaker layout, although the height effect is then lost. The situation seems to be that tetrahedral recordings can be issued in any genuine four-channel medium, but cannot be played back properly as yet. It should be observed that, if necessary, it will always be possible to rematrix a recording made for one tetrahedral system for playback via another.

A four-channel 12.5 mm tape has been recorded in the above experiment. This tape is available for copying or playback by anyone interested, although deficiencies in the recording set-up have given it rather a dull treble.

Tetrahedral systems can be varied in so many ways that it is essential for experimenters to understand the principles before they start. A naive outlook can render experiments fruitless. For this reason, the second part of this article will deal with the principles, setting-up procedures and uses of tetrahedral recording.

by Peter Levesley*

designing a studio mixer

PART TWO INPUT REQUIREMENTS

IN the first article of this series, we considered the basic features of a sound mixer. The method used was to consider the requirements of the equipment that the mixer is to feed and see how these requirements are met. In this second article, we are going to pay more attention to the mixer input requirements.

A great deal of confusion with regard to decibels and suchlike will be avoided if we talk throughout in terms of millivolts or volts rms for sine-wave signal levels. Amplifiers will be considered in terms of voltage gain but the reader familiar with decibels will find gains in dB and levels in dBm also shown. I do not propose to go into a detailed discussion of microphone types as this material has been adequately covered elsewhere. The same goes for decibels.

Microphone Amplifiers

There is nothing magical or mysterious about a microphone amplifier. Like any other amplifier, it accepts an input signal and delivers an amplified version, more or less distorted at its output terminals. It does, however, need some careful thought with regard to signal handling capability and noise level. We do not want the output to sound like Niagara Falls when we unplug the microphone and neither do we want it to amplify weak signals very well but to distort horribly the moment somebody coughs in the vicinity of the microphone. These may seem to be elementary points, but many designs have overlooked them in the past.

Fig. 1 shows a simple potentiometer stabilised amplifier. The numbers in boxes show DC voltages. We can estimate that the maximum AC output voltage before clipping occurs will be about 9.5V. In practice, it may be somewhat less than this but this figure will do to work on providing that the loading effect of the mater and oscilloscope can be ignored, and we are not being too fussy about frequency response and distortions at this time. The gain of the circuit will be approximately 1,000 times (60 dB) and we can thus show that the maximum input before clipping occurs will be about:

$$\frac{9.5}{1{,}000} = 9.5 \text{ mV}$$

Would this be enough to enable a 600 ohm microphone to be used under all conditions? We shall see later.

As it is shown, the amplifier is looking at a source impedance of 600 ohms, which is low enough to give the amplifier a good noise output figure. It can be shown that a transistor's noise output depends on several factors, one being the impedance of the signal source. A general rule is that the noise output falls as the impedance is reduced until a minimum is reached at about 1 K with a collector current of 100 μA. If we unplug the microphone, we can see that the source impedance will be about 33 K. This would undoubtedly cause the noise output to rise dramatically—probably to the said Niagara Falls level.

Microphone impedance

A more serious objection is the load that the amplifier presents to the microphone. The type of microphone we are concerned with most in sound recording is the dynamic. This used to be known as the moving-coil microphone but we don't hear this name so much now. The ribbon and capacitor microphones can be regarded in much the same way as a dynamic, provided they use a transformer or amplifier, which is usually the case.

FIG. 1

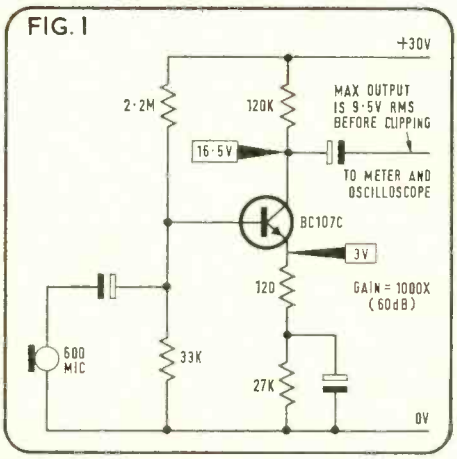
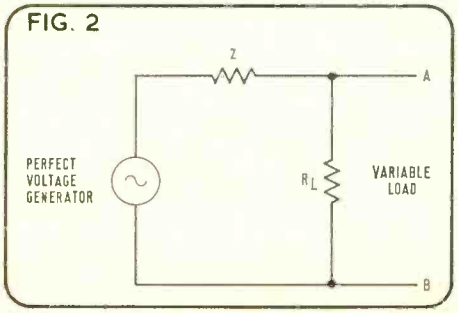


FIG. 2



As far as the amplifier is concerned, we have a signal voltage coming up the cable which originated in a coil of wire at the distant end. This is the justification for considering all three types together. We can represent a microphone as a perfect voltage generator in series with an impedance.

In fig. 2, the impedance Z is known as the characteristic impedance of the microphone and is of great importance to us. Some thought was given to the effect of amplifier output impedance on the connecting cable losses in the first article and exactly the same considerations are true of microphones. We therefore aim to make the output impedance of the microphones between about 30 ohms and 600 ohms when we are dealing with studio work. A glance at any manufacturer's catalogue will show that most microphones, except those intended for public address and similar less stringent uses, are made with impedances between these limits. The most popular impedance these days is about 200 ohms. The reason for this will be gone into below.

If we connect a high impedance (say about 1M) millivoltmeter between points A and B, we can measure the open-circuit output voltage of the microphone. Since the value of Z is very small compared with the load impedance, we can neglect its effect on the output voltage and we shall measure the maximum voltage that the microphone can deliver for a given input sound pressure level.

Leaving the millivoltmeter in place and maintaining a constant sound input, if we connect a variable resistance across the points A and B, we can see by varying the resistance that the output voltage can be lowered as the resistance is lowered. A point will be reached at which the voltage level has fallen to half what it was under open-circuit conditions. At this point, the value of the resistance in ohms is equal to the microphone impedance in ohms. It can also be shown that, when the microphone is loaded with a resistance equal to its internal impedance, it will deliver the maximum *power* it is capable of. This simple experiment is a popular way of measuring the internal impedance of a signal source since the internal impedance cannot be measured directly very easily.

We therefore try to load a microphone with a resistance as near as possible to the value of the internal impedance. As well as the maximum power transfer business, this tends to keep the frequency response more even. There is a possibility of resonances in the system giving very unpleasant results under open-circuit conditions. As usual, a compromise is required. There is no point in loading the microphone with much less than its internal impedance because nothing is gained and voltage level is lost. On the other hand, there is something to be gained by loading the microphone with a higher resistance because we get more output voltage.

Here again, we reach a point where an increase in load impedance produces no useful increase in output voltage and we may run into resonance trouble. It has been found that the best compromise is to load the microphone

(*continued overleaf*)

*Walsall Timing Developments

with an impedance from three to five times the value of its internal impedance.

Consider the following situation as illustrated in **fig. 3**. Here we have two versions of the same manufacturer's microphone, one a 600 ohm and one a 200 ohm version. This difference is produced by altering the number of turns of wire on the moving coil and the impedance is proportional to the square of the number of turns (T^2). The output voltage is proportional to the number of turns (T), so we can compare the open circuit voltages of the two versions. Let us take the open-circuit conditions first.

$$\frac{Z_1}{Z_2} = \frac{600}{200} = \frac{T_1^2}{T_2^2}$$

$$\text{Thus} \quad \frac{T_1}{T_2} = \frac{\sqrt{600}}{200} = 1.732$$

Thus there are 1.732 times as many turns on a 600 ohm microphone as on a 200 ohm equivalent. This also means that the output voltages are in the same ratio; if the output voltage of a 600 ohm microphone is 1.732 mV under certain conditions, then under the same conditions a 200 ohm version of the same microphone will have an output of 1 mV. Let us suppose this is in fact the case and consider the effect of a 600 ohm load on each microphone.

The loaded output voltage v can be derived from the open-circuit voltage V by the following calculation, considering the circuit as an ordinary potential divider.

$$v = V_1 \times \frac{R_1}{R_1 + Z_1} \quad \text{and} \quad v_2 = V_2 \times \frac{R_1}{R_1 + Z_2}$$

$$\text{Thus } v_1 = \frac{1.732 \times 600}{600 + 600} = 0.78 \text{ mV} \qquad v_2 = \frac{1 \times 600}{600 + 200} = 0.75 \text{ mV}$$

This gives us the somewhat surprising result that the output voltage to the load is almost exactly the same although there is a substantial difference between the two open-circuit voltages. This very small difference would certainly be undetectable to the ear (the difference is only 0.3 dB).

Furthermore, the effect on the ear of increasing the load impedance to open-circuit conditions would be only just detectable on level since the loading loss is only 2.5 dB.

If a microphone amplifier has been made, therefore, with an input impedance of about 600 ohms, it is possible to reduce the microphone impedance to about 200 ohms with no detectable signal loss and no detectable ill-effects on the frequency response. That is why the majority of microphones on offer today are made with an impedance of about 200 ohms. This reduction in microphone impedance means that three times the cable length can be used for the same high frequency loss.

How does our amplifier of fig. 1 match up? We can see that the load presented to the microphone is about 10K which is approximately the input impedance of the amplifier. This is much too high for our purposes, for the reasons outlined above. The amplifier input impedance must, therefore, be modified to give the required load for the microphone and this could be done in several ways. One way would be to connect a resistor of the required value across the input terminals. This would fulfil two of our objects: the microphone would be correctly loaded and the source impedance seen by the amplifier would be more constant and low enough to keep the noise level good. A better way would be to reduce the input impedance by negative feedback which, besides the two improvements indicated above, would improve the self-generated noise by virtue of the feedback effect. This will be dealt with more fully later.

Balanced Line Operation

The final point to be considered with reference to fig. 1 is the effect of the noise signals induced in long cables from the microphone. We can see that one of the leads to the microphone is at earth potential and we may consider this as a reference point. The other lead to the microphone is at an impedance of 600 ohms away from earth and carries the microphone signals. Any interfering electrical or magnetic fields which influence the microphone cable will induce a potential difference between the two leads which will effectively add to the signal voltage. This will degrade the quality of the signal and the effect will be greater the higher the impedance of the microphone and the longer the cable.

The popular way to overcome this problem is called balanced line operation and the arrangement is shown in **fig. 4**. Here we see a microphone connected to a long cable with a transformer at the far end. The transformer is tapped at the centre of the winding and the tap is earthed. The cable is shown shielded by an earthed screen and one side of the load is also earthed.

As before, the microphone cable will pick up interfering signals from stray electrical and magnetic fields as it passes from microphone to transformer. This time, however, each of the connections to the microphone is at some impedance away from earth and the transformer is designed so that each is exactly the same impedance away from earth as the other. This means that exactly the same interfering signals are picked up on each wire, A and B. Now we must notice particularly that the microphone signals are used in such a way as to force a potential difference between A and B, but that the interfering signals are made to affect A and B equally. The interfering signals thus cause no potential difference between A and B and the effect on the transformer is as follows.

As far as the microphone signals are concerned, a potential difference exists between A and B and the transformer action allows this to cause a voltage to be developed across the load. The interfering signals cause each end of the primary winding of the transformer to vary in phase relative to the centre tap. The two currents induced thus cancel out and no resultant voltage due to the interference is detectable across the load. This is known as Common Mode Rejection (or CMR) and a figure of so many decibels is sometimes given on published data to indicate the amplifier's capability of handling severe interfering signals.

It is common practice to omit the centre tapping from the transformer and to rely on the inherent stray capacitances to balance the lines. Recent research has shown this to be as effective, for our purposes, as the tapped transformer and not to possess a certain disadvantage which arises if the centre tapping is not perfect. This method is known as balanced floating operation.

FIG. 3

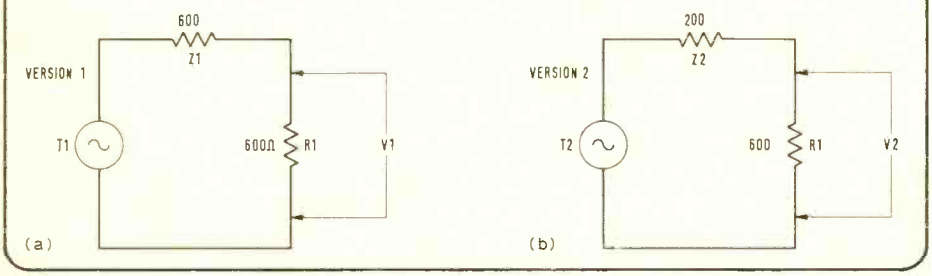
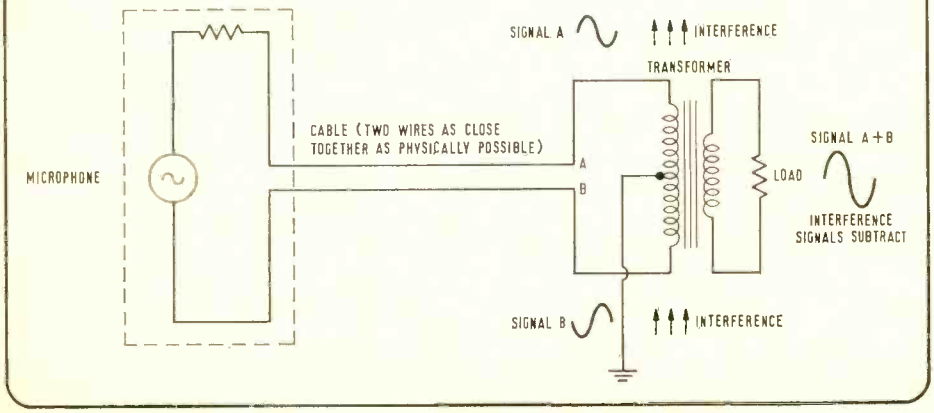


FIG. 4 BALANCED LINES



Microphone Output Voltage Levels

A microphone is defined in *Encyclopaedia Britannica* as 'a device for converting acoustic power into electrical power which has essentially similar wave characteristics'.

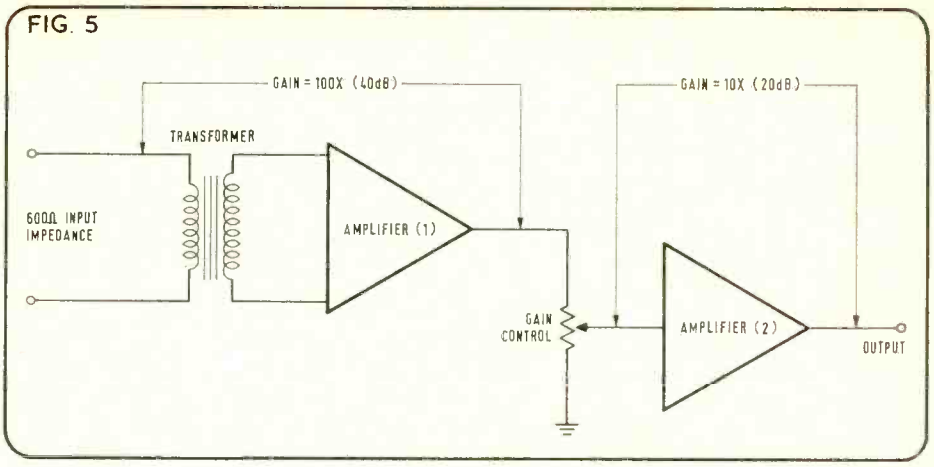
This acoustic power is presented to our ears or anything else for that matter, as minute variations in atmospheric pressure. The unit of atmospheric pressure is known as the Bar and the variations that I spoke of are of the order of one millionth of this or 1 μBar. The Bar is defined as one million dynes per square centimetre. Thus, one microbar is the equivalent of one dyne per square centimetre. All clear so far.

While researching this article, I wrote to several suppliers or makers of microphones available in Britain and I have extracted Table I showing a few examples taken straight from the catalogues. This will give us a means of obtaining a general figure for the sensitivity of the sort of microphone in which we are interested, i.e., the 200 ohm dynamic microphone.

The Shure figures are confusing since the -77.5 dB figure quoted cannot apply to both the 25 and the 200 ohm setting. I have therefore assumed that it refers to the higher figure as seems more likely. Similarly, in the case of the *55S-M*, I have taken an average which works out as 200 ohms in this case.

We can see the figures for the same type of microphone made by different manufacturers produce approximately the same output voltage for a given atmospheric pressure variation. If we take the highest output likely to be encountered from this type of microphone as being 0.2 mV/μBar, we shall have something to work on. Whatever result we arrive at on the basis of this figure, we can always remember that the Grampian microphones would have slightly less headroom than the others.

FIG. 5



Now we must consider how we can relate these figures to the sort of environment likely to be encountered in normal studio surroundings. **Table 2** shows the decibel scale as used on sound level meters which is related to the threshold of hearing for normal healthy people of about .0002 μBar. This is the internationally accepted loudness scale.

We can see from this table that we have a fairly clear picture of our microphone output in millivolts and we shall thus be able to suggest a figure for the maximum input that our microphone amplifier must handle. The maximum loudness of an orchestra as experienced by a listener at 6m distance would be about 110 dB. It is unlikely that any orchestral player would tolerate any sound level greater than discomfort level without complaining and we may, therefore, suggest that the maximum level we need to consider is about 120 dB. This, at the rate of 0.2 mV/μBar gives a figure of 40 mV and must be regarded as the sort of level which the amplifier must accept before limiting or clipping of peaks occurs.

We can easily see that the 9.5 mV figure previously mentioned was inadequate and must therefore say that, if we can estimate the maximum output of our amplifier, we can calculate the maximum permissible gain from this.

If our output as before in fig. 1 is a maximum of 9.5V, then the gain can be no more than 237 times (47.5 dB). This figure will give us no margin of safety at all and prudence would suggest setting a maximum gain of this first amplifier of 100 times (40 dB). It is quite obvious that the overall gain of the microphone amplifier must be much more than 40 dB.

If we refer once more to our Table 2, we shall see that the microphone output from the minimum normal signal to be recorded (that is speech at about 30 cm distance), is about 0.2 mV (–70 dBm). If we have to raise this signal to the 755 mV level (0 dBm), this means we are going to need an overall gain in the mixer of some 4,000 times (70 dB). In practice we usually make the overall gain of the mixer about 80 dB but, for reasons that will be gone into later, we restrict the gain of the microphone amplifier to 60 dB. These reasons are concerned with dynamic range and noise performance. The further 20 dB gain arises in the mixing and subsequent processing.

We have been very careful in the design of the front end of our microphone amplifier because it is not good practice to place any means of restricting the input signal before it. The smaller the actual input signal becomes, the more important is this consideration. In other words, the input amplifier must be able to handle any signal that the microphone is able to give it, within the limits discussed. This restricts the gain of the input amplifier to 100 times (40 dB) but this is not sufficient gain for the complete microphone amplifier. We therefore need an additional amplifier of 10 times (20 dB) gain to make up the difference. Obviously, the same arguments regarding the overall gain apply and, for maximum level input signals, we must still not exceed a gain of 100 times (40 dB). Therefore a gain control situated between the first and second amplifier is needed to allow the overall gain to be adjusted to suit the conditions in the recording situation.

The arrangement shown in **fig. 5** is one

(*continued overleaf*)

TABLE 1

Manufacturer	Microphone	Internal impedance (in ohms)	Open circuit output level (0 dB = 1V/dyne/cm²)	Open circuit output level in mV/μ Bar (corrected to 200 ohms)
AKG	*D224*	250	–78 dB	·112
	D202	300	–76 dB	·13
Grampian	*DP4X*	200	–70 dB	·316
	GC2X	200	–75 dB	·178
Lustraphone	*4–30*	200	–78 dB	·125
Shure	*548*	25–200	–77·5 dB	·133*
	55S-M	150–250	–78 dB	·125*

*See text

TABLE 2

Environment	Decibels	μ Bars	Output mV at 0.2 mV/μ Bar	dBm Scale
Pain threshold	140	2000	400	–6
Jet takeoff at 60m	130	640	128	–16
Discomfort	120	200	40	–26
Riveting machine	110	64	12·8	–36
Circular saw	100	20	4	–46
Printing press	90	6·4	1·28	–56
Inside sports car (50 mph)	80	2·0	0·4	–66
Street traffic/speech at 30 cm	70	0·64	0·128	–76
Restaurant	60	0·2	0·4	–86
Small shop	50	0·064	0·0128	–96
City house	40	0·02	0·004	–106
Country house/studio	30	0·0064	0·00128	–116
Whisper at 1·3m	20	0·002	0·0004	–126
	10	0·00064	0·000128	–136
Threshold (youth)	0	0·0002	0·00004	–146

which answers the needs of a complete amplifier as we have discussed it. Amplifier One has had its gain selected according to the principle that, since no gain control is possible before it, it must accept up to about 80 mV before clipping occurs.

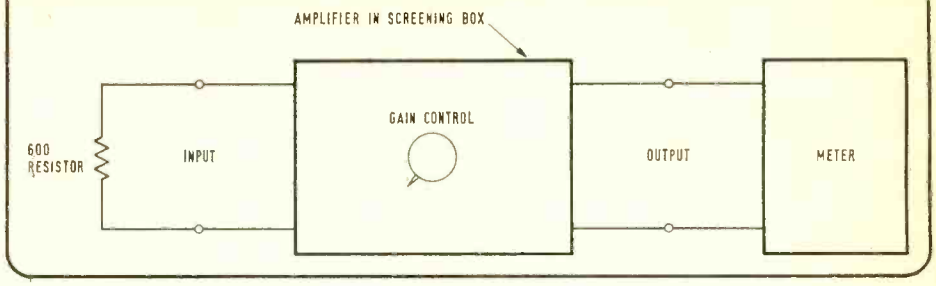
This means that Amplifier One will never overload, whatever the circumstances. The gain control enables the input to Amplifier Two to be adjusted so that this does not overload either and its setting will be dictated by the circumstances. For example, ordinary conversation will usually require more gain than an orchestral recording situation. Amplifier Two is then used to raise the signal level at the output of the gain control to a level suitable for mixing. The overall gain from input terminals to output can be smoothly adjusted to be anything from zero to 1,000 times (60 dB).

This brings us conveniently to a consideration of the internally generated noise of amplifiers and its effect on performance.

Signals and Noises

We have discussed at some length the method of calculating the maximum input that our microphone amplifier should be capable of handling. Of similar importance is the minimum signal for which the amplifier can be considered useful. We know from our experience that an amplifier cannot be used for signals below a certain level because the random noise in the system will start to be more of a nuisance. It is not possible to give a hard and fast rule about this since the acceptable noise level depends very much on the application, but there will be a minimum signal-to-noise ratio for any application. We also know that the higher we make our amplifier gain, the greater will be the actual noise that we measure at the amplifier output. Since the noise output depends on amplifier gain, in the same way that the signal output does, we can think of the output noise as being due to the amplification of a noise generated at the input terminals. We can speak of an equivalent input noise voltage, of so many microvolts, and the actual measured equivalent input noise will set the lower limit to our input signal.

FIG. 6



In any real environment the microphone will respond to the intelligence it is intended to accept and to the ambient noise level. Generally speaking, there is little point in expecting a microphone amplifier to have an equivalent noise input of much less than the input signal due to the studio ambient noise.

If we have another look at Table 2, we can see that the sort of microphone output signal we shall get due to background noise in a studio designed for speech recording will be about 1.28 μV. If we ensure that the input noise level of the amplifier is about 10 dB less than this, say 0.4 μV, we shall have a satisfactory amplifier.

Really the equivalent input noise method of expressing amplifier noise performance is the most satisfactory way of relating the signal to the noise. How can this be measured on a practical amplifier? The usual method is shown on **fig. 6.**

An amplifier, similar to that shown in **fig. 5** has been put inside a metal screening box to shield it from stray electric or magnetic fields. The input has been loaded with a resistor equal to the microphone internal impedance while a millivoltmeter has been attached to the output terminals.

When the gain control has been set to maximum, we know that the gain of the amplifier from input to output is 1,000 times (60 dB).

The first step is to measure the output noise of the amplifier. This is done by progressively increasing the sensitivity of the meter until a convenient reading, say half scale, is obtained. This reading will be a measure of the noise of the system and it might be found to be about 400 μV (–66 dBm). We can thus divide this figure by the gain of the amplifier to give us our equivalent input noise.

In this case, it works out as 0.4 μV (–126 dBm), Notice that if we specify our input noise as –126 dBm in this way, we can always know what our output noise will be for any given amplifier gain. We simply add the amplifier gain in dB to the –126 dBm and this will give us our noise level. For example, if the overall gain of the amplifier is 80 dB, then the noise level at the output will be $-126 + 80 = -45$ dBm.

Another interesting fact to note is that if the gain control on our amplifier as set up in **fig. 6** is adjusted so that the overall gain is reduced to zero, we shall find that the noise output is considerably reduced but not quite as far as we might expect. The reason is that the gain control precedes Amplifier Two and the self-generated noise of this amplifier is still able to affect the meter.

Since Amplifier Two has to provide the signals for further processing it should be designed as a power output amplifier rather than a very low noise amplifier. These is a conflict between there two requirements since low noise operation demands much lower currents to flow through the transistors than would give suitable output signals. The sort of figure likely to be obtained from Amplifier Two would be about –80 dBm with a gain of 20 dB (10 times).

Conclusion

We have seen how the major design features of a microphone amplifier are related to the requirements of the microphone itself and the following circuitry. We shall consider in our next article the design of a suitable amplifier and all relevant circuit information will be given.

SOUND MINUS SYNC

by Edward Tatnall Canby

PART TWO

A FEW weeks ago, after more than four years, I viewed once again the Super-8 film-with-sound described last month. That film, 'The Beast of Yelping Hill', still stands up remarkably well as entertainment though it was produced with relatively elementary techniques. Its combination of colour moving pictures, an enterprising recorded narrative and a background of appropriate music and sound effects is a 'natural', with an impact far beyond that of film alone. Refinements built into successive productions, and ever more reliable solutions to the problem of flexible sync, have made our present operations remarkably versatile.

To recapitulate in part, the minimum essentials for our art were well represented in that first film. An edited Super-8 film to start with. (Once the sound is added, changes become very complicated.) Then two channels of sound, via a stereo tape recorder. No physical connection whatsoever between sound and sight.

Whereas tape recorders are built to run at relatively stable speed (hopefully locked to the mains frequency) Super-8 film projector speeds vary wildly, not only in response to voltage differences in the mains but according to film load, temperature, length of operation and so on. We maintain our approximate synchronisation, therefore, via a variable speed control on our projector. (Many current models have this feature, in addition to one or more fixed speeds.) A few relatively slight adjustments during the film projection will maintain a proper relationship, if the original working-out of the timing has been well done. A projector without the variable feature may be controlled, as our first one was, with a variac. Expensive, but not as expensive as a new projector.

Our first film stuck to basics. Prepare the film first and work out an appropriate narration as the film is projected. (Set the speed control at a mid-point, as close to the correct speed as possible. You can judge this by the motion of the pictures themselves.) The narration should be rehearsed until it times reliably before any recording is undertaken. When that happy moment arrives, project the film once again and record the narration as you watch, on one track of your stereo tape, leaving the other for the accompanying music and/or sound effects. (Don't try to record the speech separately, without the picture, unless you are prepared to do a great deal of sound editing.)

For the second sound channel, project the picture with its accompanying narration on one sound track and experiment with inserts until you find not only the right music but the right lengths, to fit. When all is ready, project the film still again (it will be a bit frazzled by the time of the first performance but that is part of the risk) and record music and effects on the second track.

Some of our sound was pre-edited, then copied on to the final tape. If you can record directly without undue starting pops and slurs you may get away without any cutting at all. Whatever technique you choose, pick musical excerpts of the proper length so that smooth musical continuity can be maintained. Sudden stops in the middle of a musical phrase, rough starts with a wow or a squawk, are unfair to the whole exercise. *Fade* your music in and out, and arrange your musical endings so that they sound right.

We like to add a sound prelude at the beginning of our films, while eyes adjust to darkness, and often a postlude (during film credits or for a final mood. Easy to do, and an otherwise skimpy length of film may thus be rounded out.

Our wild-sync technique need not be crude and should never seem so, no matter how elementary the procedure. For our second and third films we ventured into more extensive mixing and overdubbing. Our second film thus featured narration that appeared to come direct from the screen. The narration was pre-recorded, then copied off equally into both stereo channels. Mixed into the same two channels along with the narration, the stereo music spread out widely from side to side of the central narration.

Our third film was a documentary on life in Ethiopia, from which country one of my photographer colleagues had just returned after a long visit. She had taken with her a Super-8 camera and reel-to-reel portable recorder, as an experiment. Our material consisted therefore of an edited film and a quantity of authentic Ethiopian sound—alas, inexecrable low-fi. No highs, no bass, staggering hiss. Yet the sounds were intrinsically interesting and I was determined to put them to some use.

It occurred to me that the technique used above could provide an effect which I have since called *sound framing*: surrounding a low-quality mono sound with a frame of stereo music. Accordingly, I fed our Ethiopian excerpts equally into both channels of the tape, mixed with a stereo background of electronic music. As reproduced, the mono documentary sounds came from the screen, directly accompanying the picturesque films on Ethiopian life, and the stereo 'surround' framed them in a wide spread of sound.

Our problem in this film was the occasional necessity for a more exact sync than we normally allow. We had a fine picture, for instance, of the Emperor accompanied by a fleet of fat Cadillacs driving past the camera. We had, too, the sound of the Ethiopian national anthem played by the Emperor's local band. We decided to put the two together but we could not afford to anticipate the Imperial entry by more than a few seconds, nor could we delay the anthem once he appeared on the screen. Eventually, we learned to line up music and picture cues well ahead of this point (via the variable-speed projector) so that his majesty received his sonic due at precisely the right instant.

Our fourth and largest project, which came to be called 'Henry' after the mythical protagonist of the poem on which it was based, was assembled during the summer of 1969. This was a fully-fledged multi-media show. After three successive Super-8 films with loose

(continued overleaf)

SOUND MINUS SYNC

by Edward Tatnall Canby

sync stereo sound, we felt that we were ready for bigger things. 'Henry' has been presented a dozen-odd times in three major cities before audiences including audio and film engineers. We survived and indeed were proud of our show's acceptance, in spite of continued use of the non-sync principle.

Most film makers at one time or another branch out into the taking of colour stills. The two media are intriguingly different, both offering important aesthetic virtues. My colleagues were no exception and it was the urge to combine Super-8 film and 35mm slides into one production that gave 'Henry' its original impetus. My colleagues already had large collections of stills and quantities of Super-8 films. 'Henry' was put together from these, plus pictures taken to round out the chosen format. A wide screen was procured, made of a loose white net material which, though almost transparent, somehow reflects pictures almost as brightly as an opaque silver screen. Stretched out and held taut by cords, this expanse of white filled up the entire front area of our projection scene. On it, for 'Henry', were projected not one but three simultaneous pictures, two stills and one moving. On each side of the wide screen, a series of slides. In the middle, the Super-8 film.

Even before I tackled the sound, the photographers had choreographed their show with these three elements according to their narration text. As the film unreeled in the middle, the slides to each side were manually changed (via push button remote control) in order to avoid the rigid fixed timing of the automatic slide projection and, of course, to allow for alignment between the still and moving pictures. The triple projections were related in subject, mood, colour and spatial design in each of the 'movements' of the work, following their contrasts of mood and tempo as determined by the sense of the narrative poem on which the whole was based. Slide changes, though, were never quite the same twice; sometimes the left slide would change first, sometimes the right, according to the feeling of the moment; occasionally one sequence would fall back a few pictures, then catch up. Visually, this was a never ending pleasure and I was immediately enthusiastic.

The big screen was always filled with colour and movement. Crowds of people on a city street, an expanse of blue ocean, field of white daisies (in the centre waving in the breeze, at the sides motionless), storm scenes in grey, close-up shots of insects, bats, spiders. A riot of colour but, at this stage, totally soundless—except, unfortunately, for the loud noise of three projectors running simultaneously. That was my first sonic problem: I had a choice of blending my added sounds with that of the machines or simply drowning them out by sheer volume. In the end, I did both.

Our previous experience allowed me to bypass most synchronisation problems without trouble, even with such a complex picture format. A variable-speed projector of course. We had learned *that* lesson. We would tie the sequences of manually-changed slides to the projected films, and in turn tie the film as before to the sound tracks via adjustments in the projector speed control.

The key to more specific procedures appeared when I found that the narration fell into discrete poetic stanzas and would be spoken not during but *between* the segments of pictures. Was that a godsend! While the narration was being heard from our tape, we could *stop* all the projectors. The still projectors would hold on a single picture. The film would turn off. Nicely re-synced, we could all start up again exactly together as the narration ended. And this we would do no less than six times! Thus our informal sync never had a chance to get very far out of whack. Not a soul in our audiences realised that these dramatic pauses for narration were actually technical necessities. They became a part of the unfolding drama.

During that summer of 1969 the first demonstrations of quadraphonic sound were held before a few members of the press. As 'Henry' was getting under way, I had just attended several of these and was very enthusiastic. Unfortunately there was no four-channel equipment yet available. Nothing deterred, I therefore decided to add another imponderable to our chain of non-synced machinery, a second and entirely separate stereo tape recorder.

We could not sync our two tapes exactly but I saw at once that I could easily set up different sounds, simultaneously, for the pair of stereo sound projections, one up front as before, the other in the rear.

I decided that one tape would have to be dominant; the up-front would contain a continuous sequence of recordings including the narrations between 'movements'. (The second tape would be passive, remaining unchanged throughout each segment of the presentation and simply faded out at its end, to be re-cued forward (via white leader tape) for the next section.

The opening movement was deliberately a shocker, a portrayal in multiple sights and sounds of that tension and confusion we all know in modern life. On the screen, a fast-paced montage of almost hysterically varied scenes—traffic, supermarkets, adverts, people on streets, bulldozers, buses, lorries, highways, in increasing multiplicity. On my front stereo tape a sonic equivalent, a mixture of American radio adverts edited into a zany montage, bombarding the ears from one side, then the other, distorted, echoed, the words rearranged, the whole thoroughly immersed in frantic electronic music.

For the rear sound channels, I recorded a long tape of automobiles and lorries at a busy city street intersection. A stretch of this dynamic tape brought moving lorries, motorbikes and cars right into our 'theatre'. Blown up via amplification, they roared back and forth directly above the audience's heads, in the midst of the visual and sonic bedlam up front.

In contrast, the programme changed to a study of beauty in nature. The emphasis was on contemplation—and quiet.

I made a recording in exaggerated stereo of night-time insects, droning in regular rhythm. The hypnotic sound, via the back speakers, blended perfectly into the rhythm of the projection machines for a lulling effect that complemented the slow succession of pictures on the screen. At our first performance, on a warm summer night with all the hall's windows wide open, we acquired a sonic dividend—live insects!

The only genuine sync problem in the entire production was that between a single pair of elements, the dominant continuously-running front stereo tape and the Super-8 projector whose operator still had to make occasional minor speed adjustments (never perceived by the audience) to keep sound and pictures together. All else depended on these two. Thanks to our half-a-dozen stops at each narration point for recueing and resync, we had less co-ordination trouble than ever before. Our narration, a crucial element in this case, came from the master front tape. It was recorded by two different voices, for variety. The edited narration tape, best of many versions, was fed mainly into one final front channel. It took five people to perform the production, one for each of the five machines.

Our only current technical problem is improving the brightness of the Super-8 projector to match the brightness of the large 35mm slide pictures. We may have found the answer in the quartz halogen projector lamps now available, which run both brighter and cooler than their earlier tungsten equivalents.

Servicing

AMPLIFIER POWER

by H. W. HELLYER

THE measurement of power is fraught with difficulties. To begin with, one has to know just what standard is being applied and how the chap who wrote the original specification intended the readings to be taken.

In theory it is simple. Power (watts) is I^2R or $\frac{V^2}{R}$. What could be easier?

Until you come to measure it, that is. Until you find that there are more ideas about power and its assessment than there are interpretations of Shakespeare. Very soon, one is bogged down in a welter of terms: RMS, sine, steady-state, music power, peak power, IHF, IEC, DIN and what have you. One salesman summed it up neatly for me by his description of a modest amplifier as '10W RMS, that's twenty watts SP'. SP it appears is 'Selling Power'.

Watts start with audio power, or, to be more accurate, acoustic power. There is a curious reluctance among service engineers to think in terms of acoustic power when talking about loudspeakers, amplifiers, or any other link of the audio chain. James Watt would have been annoyed to think that anyone could be so woolly-minded as to conceive of two different things arising from the same set of measurements. Starting at the musical instrument that produces the noise we want to measure (maybe to hear?), there is an alternating sound pressure This can be measured quite accurately and is referred to the RMS pressure level of 0.0002 dyne/cm^2. The measurement is taken at around 2 kHz, where average human hearing is keenest.

Air can be said to have an impedance. For plane waves, this is mainly resistive and can be regarded as the characteristic impedance. We can now work out a power density, arriving at a level of 10^{-16} W/cm^2.

Referring to Rex Baldock's entertaining article in the 1968 *Audio Annual*, I see this can be stated alternatively as 0.1 femtowatt/cm^2 or 100 attowatts/cm^2.

A solo violin playing softly radiates a few microwatts. Middle-range instruments like the oboe may send out around 10 mW and Berlioz fireworks on the big bass drum, with cymbals akimbo, might peak 30 (acoustic) watts. The acoustic efficiency from musicians to audience is perhaps 0.003 per cent so the hall full of people is well served with a milliwatt or so of power.

A digression . . . it is more usual to talk of sound levels in decibels. Taking the aforesaid violin as 30 dB, and the oboe as 65 dB, then the percussion peaks would be around 100 dB for very short periods. This 70 dB dynamic range represents a power ratio of ten million to one.

Sticking with transducers for the present, let's get things in perspective by stating that the output from a good magnetic pickup playing average music on a normally modulated disc is in the region of a nanowatt. (10^{-9}W).

Tracing through the audio chain, we find that the power amplifier needs its full power only for peaks. To do transients justice, when perhaps 10W will be pushed out for a short period. It is running at low powers most of its time: keeping to our previous scale, the solo violin would need only 100W. But the loudspeaker changes only around 5 per cent of the electrical power into acoustic energy, so if our peaks give us half an acoustic watt, we are lucky.

Right, we say, except for something like the climaxes in Vaughan William's *Sea Symphony*, or the *Valkyrie* at full bore, we need no more than a modest low amplifier. So what's with all this Crown and Scott output power level in the hundreds of watts? (The specification of the Scott *387* gives 270W±1 dB at 4 ohms. Even when we translate this to continuous sine wave power, we have 55W per channel into 8 ohms.)

We are able to hear power changes of around 2 dB. Some people, in the right conditions, can detect a change of 1 dB. A very gradual change will be hard to detect since our ears tend to adjust to what they hear. You can get used to anything in time, I'm told. Relate this to the fact that doubling the power is lifting it only 3 dB. And this is *electrical* power applied to the loudspeaker—which may be very different to the *acoustic* power we hear, as has already been demonstrated. So the aim of upping the power is not just to make things sound louder but to achieve the output with the minimum of coloration.

Replayed music has to be at a level our ears tell us is reasonable before it is a subjective replica of the real thing.

Note that I say subjective replica—not a true copy. That, at 110 dB of a 90-piece orchestra in full *tutti* would be asking too much of our 130 m^3 lounge. So a 20W amplifier in the domestic environment sounds very little louder—all other things being equal—than its 10W little brother. But it should—again, all other things being equated—handle the peaks and transients more closely.

The rated output power frequently quoted by British manufacturers is the RMS sinewave value at 1 kHz that we can apply for the specified distortion figure. Already it gets complicated. This signal is pushed out to a carefully measured resistive load. Resistive to give fair play at all frequencies. Most loudspeakers are far from being resistive loads and the frequencies fed to them vary from 1 kHz over the whole audio band. Vary rapidly and continuously. So what in earth, you may say, is the point of applying a 1 kHz sinewave into a resistance? It is not very interesting to listen to, to say the least.

The answer of course, refuting those gentlemen who argue an extension of the above and apply a 'music power' specification, is that the RMS test, British style, is the only true test of the power the amplifier will develop. And it is consistent, which a music power test need not always be.

Music power is defined exactly by the Institute of High Fidelity manufacturers (USA)

(*continued overleaf*)

FIG. 1

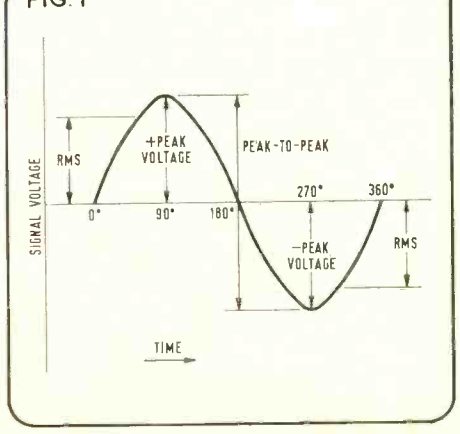


FIG. 2

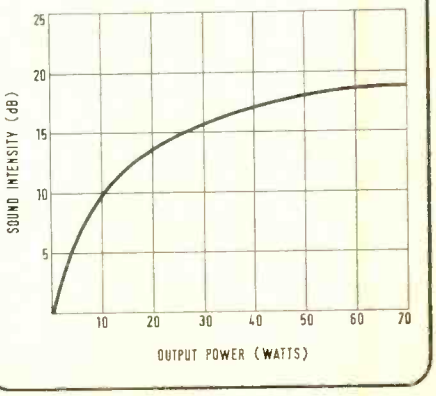
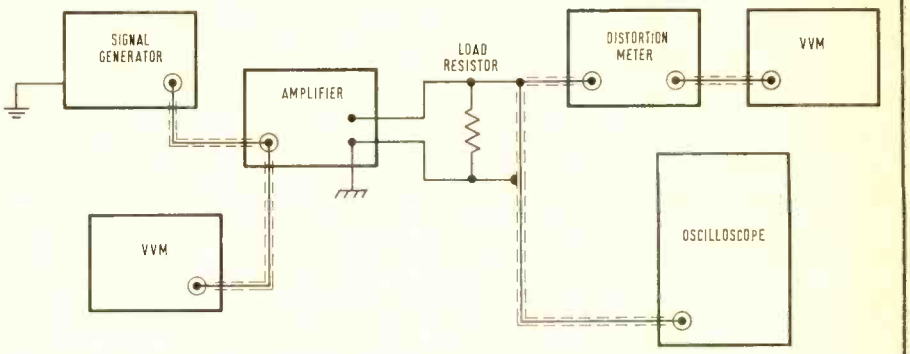


FIG. 4



as the 'greatest single-frequency power that can be obtained without exceeding the total rated harmonic distortion when the amplifier is measured under standard test conditions, except that the measurement shall be taken immediately after the sudden application of a signal, and during a time interval so short that supply voltages within the amplifier have not changed from their no-signal values'.

Which argues a perfect power supply—or the use of a completely regulated external one. Again, we are testing apparatus under conditions it will not experience. Is this valid?

The argument goes that music peaks average a great deal lower than a pure sinewave. Also that the high peaks which could cause an unregulated power supply to drop significantly (causing distortion and allowing output transistor heatsinks to saturate beyond the limit of their dissipation) are very short in time. So there is (a) no need to build a complicated power supply and (b) no need to measure with a steady-state signal.

A steady-state signal, a sinewave applied under test conditions, *will* give a consistent rating, whereas the music power rating of the same amplifier could be 10 per cent, 20 per cent, even 30 per cent higher than its RMS rating—depending on the power supply. If the music power exceeds the RMS figure by more than 30 per cent, the amplifier could hardly be much good anyway.

So our *first* test, but not our only test, is to measure steady-state power at 1 kHz into a fixed resistive load. We apply the output from a generator with as low a distortion figure as we can get—certainly lower than that of the equipment we are testing. We turn the gain control of the equipment to maximum and flatten all equaliser controls.

The load resistance can be cut from fire-element wire. Use new wire and, if you are toddling off to buy a tubular element, get the 600W type rather than the 1 kW; it will be easier to measure and cut the wire. Total resistance will be around 100 ohms, and the wire, unkinked, may stretch a couple of times up and down the room. It is possible to make up a small framework, if you are prepared to go to that trouble. The reason for the trouble is simply that the wire will get hot while you test and thus increase its resistance. We need a resistance that is capable of dissipating at least twice the power we anticipate pushing to it. If you are not prepared to go to the trouble of carefully measuring resistive wire (which needs a good instrument) then you can select appropriate values from the Radiospares range of 0.7A dropper sections, or a pair of 1A or 2A variable resistors from the British Electric Resistor Company Ltd.

Having got a standard measurement, we now relate it to the specifications. There will be a maximum power reading which, with an oscilloscope monitoring the sinewave output, is just before the onset of clipping, and a rated power output which is the maximum obtainable before the rated harmonic distortion is exceeded.

We are still operating at 1 kHz. To get a better idea of our power performance, we now need a measurement of the power bandwidth. This is more accurately described as the 'half-power bandwidth' for it comprises the limiting frequencies at which the power output of the amplifier falls by half (3 dB) relative to the maximum ouput power at 1 kHz. It is possible to check this by swinging the input frequency over the audio spectrum—but heed one word of warning. It is a pretty good generator that will deliver an absolutely constant output for the same setting of its attenuator over the range from 40 Hz to 20 kHz or more. After noting the frequency at which the output power drops by half (–3 dB voltage reading) check that the input voltage has not changed.

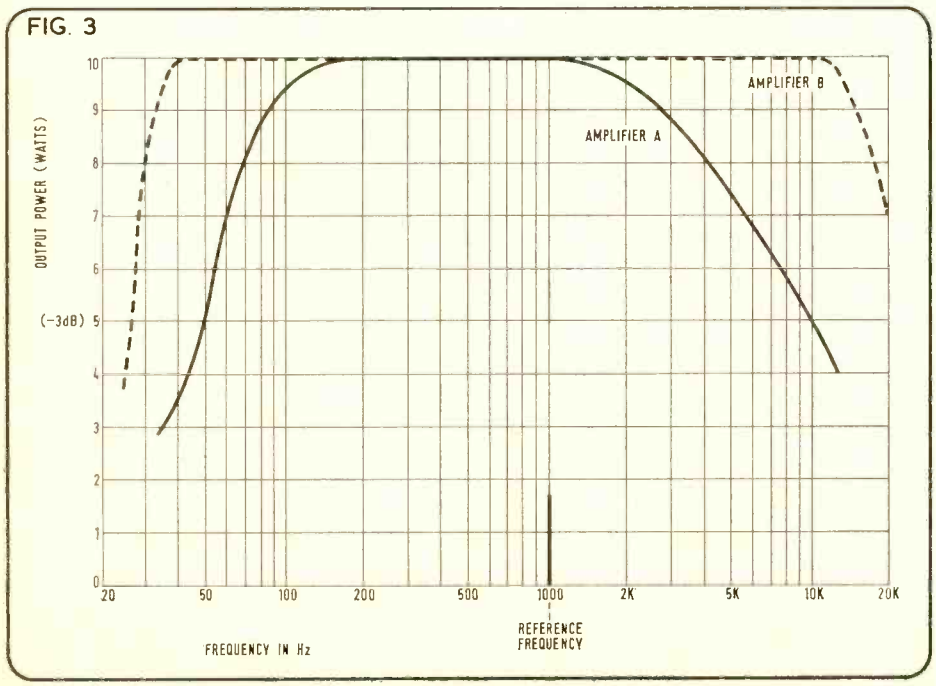
My own method of testing is to link a signal generator through a secondary lead to an accurate millivoltmeter for swift checking, leaving this meter for input level tests alone. At the output end, voltage readings are higher, and although meter accuracy is still important, a good VOM is capable of doing the job. The important things here are the scale calibration and, for distortion checks, the attenuator switching. It saves an awful lot of computation if the switch positions relate to dB steps.

Staying on power testing, however, there is a need to note an amplifiers' ability to support a continuous sinewave. BS 3860:1965 requires that '. . . the rated output power shall be applied to the amplifier for a period of not less than 30 seconds, and the level of harmonic distortion shall then be measured to determine whether or not its value exceeds that specified by the maker'. Even the more modest DIN 45-500 states 'the power must be capable of producing sinewave signals of 1 kHz for at least 10 minutes.'

My own tests are for simultaneous output, both channels; a minute at full power. Unfortunately, if an amplifier will only just achieve this, it can succumb while you are fiddling with the notch filter of the distortion analyser. Hard life for amplifier manufacturers, is it not?

As you can see, servicing requires that we look beyond the specs, and the power game is the most contentious set of measurements of all. The sooner the Audio Specification Co-ordinating Committee submit their recommendations to the British Standards Institute, the better for all of us.

FIG. 3



AES 40 CONVENTION

P. A. Lomas reports from the 40th Convention of the Audio Engineering Society

THE annual West Coast convention was held, as last year, in the Los Angeles Hilton. Simultaneously with the four-day technical sessions was the usual exhibition of professional products by some 50 companies, of which three came from England. Admirably managed by Jacqueline Harvey (how could it be anything else?) the exhibition was attended by a record number of visitors.

Firstly, the technical sessions. These were divided into 13 separate groups, covering subjects ranging from magnetic recording and reproduction through electronic music and audio and medicine to a practical recording studio workshop. Selecting a few of the highlights and European papers, we heard papers on high energy and chromium dioxide tapes for cassettes which promoted lively discussions from the various proponents. John Mosely of Command Studios read two papers, the first on the new studios themselves and the second on an interesting proposal for multi-channel home systems, well demonstrated by recordings of the Grenadier Guards marching around his studio.

High quality public address systems are becoming more and more important, and this was brought out by two sessions, one on audio measurements and one on sound reinforcement. In this latter session Ernst-Joachim Voelker from Germany read a paper on the manipulation of reverberation times in concert halls.

David Robinson of Dolby read a paper on the manufacture of Dolby cassettes, oddly placed in the electronic music session, followed by a fascinating paper on the electroencephaligraphic control of music synthesisers. This paper, preceded by an excellent film of the research programme, was an account of how brain wave-forms can be used to control a Moog, and illustrated that many of the so-called involuntary patterns can in fact be controlled. Barry Blesser and Francis Lee from MIT read a paper on a digitally operated delay-line, where audio signals are converted into digital signals, put in a computer-style store, read out after a period of milliseconds, and reconverted to audio.

The final session was devoted to a live recording session of a four-piece-plus-vocal group. This allowed discussion of the practical techniques of recording, and the mixdown which followed from the 16 track recording. The large audience was encouraged to ask questions at all times; closed circuit television gave everybody a good view of the equipment and performers. This was a most successful session.

The three UK based companies exhibiting were Dolby, Ferrograph, and Neve. Dolby were showing the *360* series of noise reduction systems, with 16 *361* units connected to an Ampex *MM1000* to show the automatic operation of these devices, each unit following the mode of the track select switches on the Ampex. The 50 mm tape on the machine was the new BASF *SP50M*, specially developed for use with the A-type noise reduction system. At one corner of the stand was a section devoted to B-type equipment which included the first sight of a new Advent cassette recorder (Model *201*) based on the excellent Wollensak tape transport. Also displayed was a list of some 22 companies who are producing B-type equipment of one form or another, including such heavyweight names as Ampex, Kenwood-Trio, Teac, and Sansui.

Ferrograph exhibited on the Elpa Industries stand, their importer, and showed their audio test set, the new Ferrograph *Super 7* (extending the *Series 7* to take 27 cm spools) and a surprise *Series 7* fitted with Dolby-B circuitry. This is also available in England and means that a Ferrograph is the second UK available open-reel machine with the Dolby, instead of the announced (but not seen) Revox.

Rupert Neve have now opened their own office and plant at Bethel, Connecticut, to cope with the increased demand for their mixing decks. They were showing a 24 input deck which is destined for their showroom studio.

European products were shown on other stands. Gotham Audio import the Mellotronics/BBC Programme Effects Generator which aroused much interest. Also on this stand were the Studer mixing consoles, Neumann lathes and microphones, and the electronic digital delay unit described already. The first Studer *A80-8* sold into the USA did not quite make it for the show. The Norelco (Philips) stand showed AKG microphones, studio recorders and a mixing desk, reporting considerable interest. B & K have their own office in the USA, where their instruments command an enviable respect, and were showing the real time analyser as the centre piece.

Revox recorders were demonstrated in both normal and HS versions; this latter is selling extremely well to small studios and radio stations, and is to be made available later on with the Dolby *A* noise reduction system—the normal machine will have the *B* version. Also on this stand were Calrec microphones.

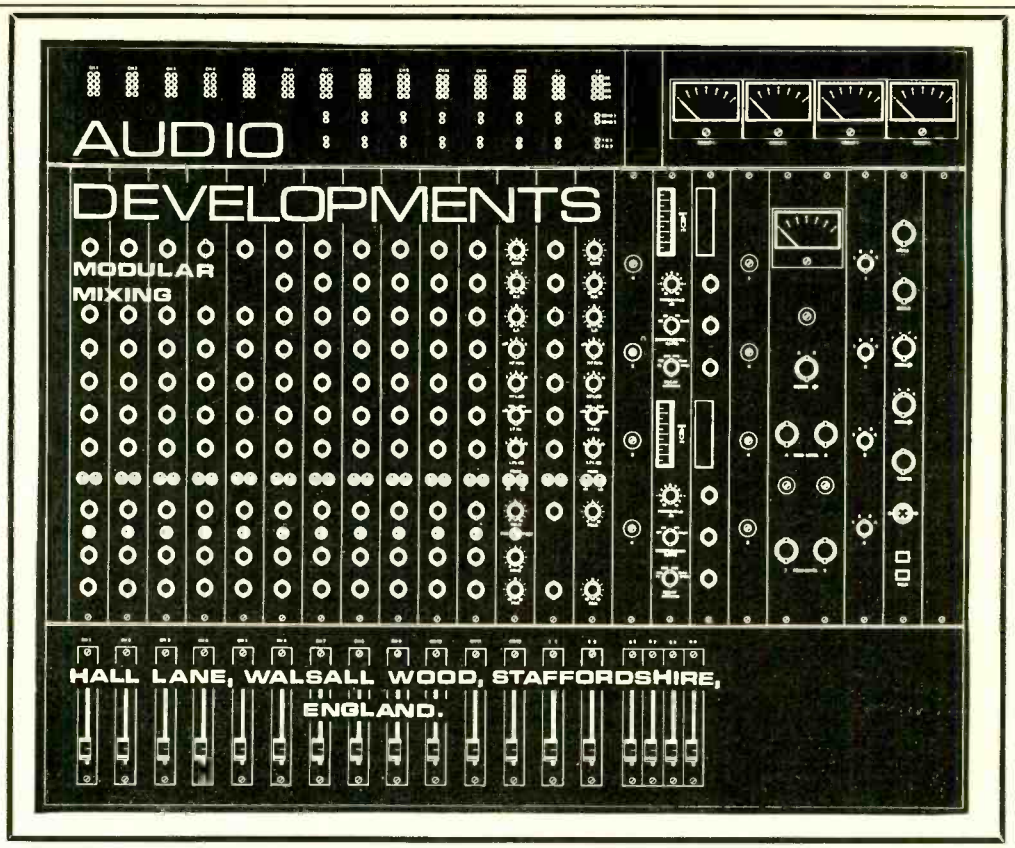
The other stands were in the main American, with all the well-known names represented. Rather than a stand by stand review, it is easier to describe trends shown up by these stands. The profusion of companies making copies of Ampex recorders seems to have diminished; in fact only one company showed them. All the major companies with 25 or 50 mm tape showed tape position indicators with digital readout but, on closer investigation, these proved to be merely turns counters on the supply spools. While undoubtedly an aid to finding a place on a tape, especially in these versions which can be programmed to find a given counter reading, it would have been more sensible to have followed European practice counting time or tape length. This was rejected by one company, MCI, as being not nearly as accurate. No doubt true, but extreme accuracy ($\pm$0.5 second) is just not required. The notable exception to this method of counting were Ampex who have coupled an *MM1000* through a random access programmer to a video recorder. The standard SMPTE access code is recorded on one of the 16 channels of the *MM1000*, which means each 1/30 second is uniquely identified and locked to the VTR picture. This gives a readout of time, even through fast spooling, with extreme accuracy. This is the most elaborate of several options, and represents a tremendous step forward for television sound. It perhaps represents the growing interest in improved quality for television.

The Scully *100* represents a departure from normal practice, with very simple electronics and a combined record/replay head and amplifier. We will have to see if studio standards decline since alignment is now made much more difficult.

Duplicating equipment is in demand, with all the manufacturers showing equipment working at 608 cm/s (32 times master speed). A new development was the introduction by Ampex and Gauss of in-cassette duplicators, the former being more elaborate while the latter is a desk-top model.

The other topic of interest was four-channel sound. The matrix systems are still very much in discussion, with the Electrovoice system in the fore. The expected Columbia announcement of *their* matrix arrangement did not appear and their paper was withdrawn at the last minute, causing speculation. The Nippon

(*continued on page 409*)



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THE WONDERFUL SOUND OF RADIO £

Keith Wicks concludes his two-part study of commercial radio and its prospects

LAST month I gave a summary of the White Paper, *An Alternative Service of Radio Broadcasting*. The paper, described in a *Times* article as 'a muddled collection of good intentions', and by MP Llewelyn-Davis of Hastoe (Labour) as 'a muddled wishy-washy document', is certainly vague, as I realised when boiling it down to a summary. The residue of information left after removing the superfluous words is very small, and as *The Times* said, 'the White Paper as a whole is very notable for the number of questions it leaves unanswered'. However, there are so many *ifs* and *buts* about the whole business that no one, the government included, really knows how, or even if, commercial radio will work in this country. The Musicians Union's needle time restrictions have to be ironed out, which may well prove to be the most difficult problem of all. Without a large dose of records, how is the service going to attract a large audience.

In New York, there are no needle time restrictions and most radio stations play music most of the time. But surprising as it may seem, over a third of the total audience is shared between three stations that do not broadcast music programmes at all. WCBS and WINS are all-news stations, and WOR, the station with the highest rating, broadcasts informal discussions with listener participation, and news and sports programmes.

Nevertheless, one must bear in mind that nearly two thirds of the New York listeners *do* want to hear constant music and this is probably what will attract most UK listeners. The pirate broadcasts of a few years ago proved that there is a large market for pop music. Judging by the way things have gone in the States, specialist stations concentrating on jazz or country-and-western could also prove successful in this country, but not until the needle time restrictions have been at least partially removed. As much as I am in favour of the trade union principle, I do feel it about time the MU accepted that its attitude is destroying, among other things, broadcast pop music. As one who sees and hears the effort that goes into the production of many pop records, I think it is a pity that needle time restrictions on BBC programmes so often make it necessary for us to hear an inferior version of a group's record, made by them in the BBC's own studios. A 'live recording' as they say these days. This is no reflection on the BBC, who do a good job with the facilities they have and in the time available, but they are not really equipped to compete with commercial pop recording studios. Worse still is being subjected to a group of second rate musicians playing a current top twenty hit. Even if the restrictions are overcome, there could be another problem for the new stations because the BBC would presumably be able to use more records too. This would result in a dramatic improvement in their Radio One and Two programmes, and serious competition for the commercial stations.

Opinion about what the new service could bring differs widely and a House of Lords debate brought various submissions. Lord Ardwick could foresee no bonanza as experienced in the early days of commercial television (nor do I). Lord Selsdon thought that local traders would gain by advertising on commercial radio, whereas Viscount Norwich saw the new service as a blow against the small shopkeeper as the advertising rates would be too high for anyone but the larger stores and supermarkets. Viscount Eccles, a self-confessed champion of local radio, went on about 'technological revolution taking away the pith and essence of the character of a place', and thought that local radio could help counteract this. The Bishop of Coventry wants to have committees to vet programmes in order to prevent our being subjected to the 'flow of trivia' experienced in the United States. Lord Denham declared that 'Today's pop is very often tomorrow's culture', and was cheered when he said that there was nothing wrong with entertaining people in the way they wanted. What *do* people want? In the Commons, Chris Chataway said they wanted a flexible service, which among other things could tell them about burst mains in the High Street and sales in the local stores. He could see no reason why the local stations should not use helicopters to provide information on traffic congestion (what about expense?). Mr Richard (Baron's Court, Labour, and therefore disapproving of the Government's proposals) said that, in order to maximise audiences, there would be as much pop 'as the Musicians Union could be persuaded to disgorge'. This would seem to imply that Mr Richard disapproves of pop but he at least acknowledged the existence of good pop by saying that it was a mistake to think that commercial radio stations would transmit it. 'An undigested diet of bad pop' would be aimed at housewives, car drivers, schoolchildren and students. He was obviously right when he said that the proposed structure could not cater for minority interests but it does not need to with the BBC around, and even the notorious White Paper managed to make this much clear.

The Conservatives, seemingly unable to defend the Paper, were rather obtuse. Mr Raison (Aylesbury) said that journalists now on hard times would find jobs in commercial radio (maybe we shall), while other MPs concentrated on attacking the BBC. Mr Critchley (Aldershot) didn't like their approach to news, and ex-pirate Proudfoot (Brighouse and Spenborough) complained that the Corporation were ignoring immigrant communities. He was concerned (though his fellow politicians appeared to be amused) lest it be left to Radio Moscow to play requests for Pakistanis in Bradford.

Hughie Green's Commercial Broadcasting Consultants are worried about the economics of the whole business, and Michael Metcalfe of Local Radio Services is worried about the effects of BBC competition on audience figures. John Gorst, secretary of the Local Radio Association, is worried about the extent to which the press might control commercial radio. Roger Sinclair and Roger Squire, both directors of London recording studios and likely to become in British commercial radio, are both worried about needle time restrictions spoiling everything. Little can be said in conclusion, except that everyone is likely to remain worried.

AES 40 CONTINUED

Columbia three-way system was demonstrated in a separate room. The situation was somewhat clarified by the announcement that an EIA committee has been set up to review the many matrix proposals and propose standards. Surprisingly the committee comprises exponents of the various systems, which promises some lively moments. John Eargle is chairman.

Discreet four-channel sound was presented by JVC, whose four-channel disc 'is the fruit of the keen pursuance carried out by Victor's audio technology staff' to quote the translated leaflet. To keep compatibility and retain all information, the record is cut with the normal groove modulations of L and R corresponding to (L_f+L_r) and (R_f+R_r). The difference information (L_f-L_r) and (L_f-L_r) frequency modulates a 30 kHz carrier. On replay the carrier is demodulated and matrixing will give all four outputs. A 15 kHz response is claimed. Broadcasting too was catered for by the first public information and demonstration of the Dorren Quadruplex system. Again compatibility is paramount. The normal carrier is modulated with $(L_f+L_r+R_f+R_r)$: as with stereo transmissions, a 38 kHz modulated signal is used. To place two channels of information here (stereo only has L-R or one channel), quadrature modulation is used (consider this as two 38 kHz carriers phased 90° apart). On one carrier is the $(L_f+L_r-R_f-R_r)$ information, and on the other is $(L_f-L_r-R_f+R)_r$. Amplitude modulation is used, and both carriers are suppressed. Finally a fourth carrier is located at 76 kHz, carrying the $(L_f-L_r+R_f-R_r)$ signal. The four channels allow four signals to be independently extracted through a proper decoder and matrixing arrangement. Mono listeners receive the sum of all channels and stereo listeners the normal stereo signal.

There was the usual banquet, with awards to prominent audio men, and guest speaker composer/conductor Lalo Shiffrin. Prominent among visitors from overseas were Mr Balster from Philips (Holland), Mr Lerhner from Barclay Studios (France), and Mr Swettenham of Helios Electronics (England). The proceedings closed on Friday May 3. The next convention will be in New York in October 1971.

equipment reviews

AKG D202

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Frequency range: 20 Hz to 18 kHz.

Sensitivity: 0.16 mV/μBar at 1 kHz (-76 dB ref 1V/dyne/cm²).

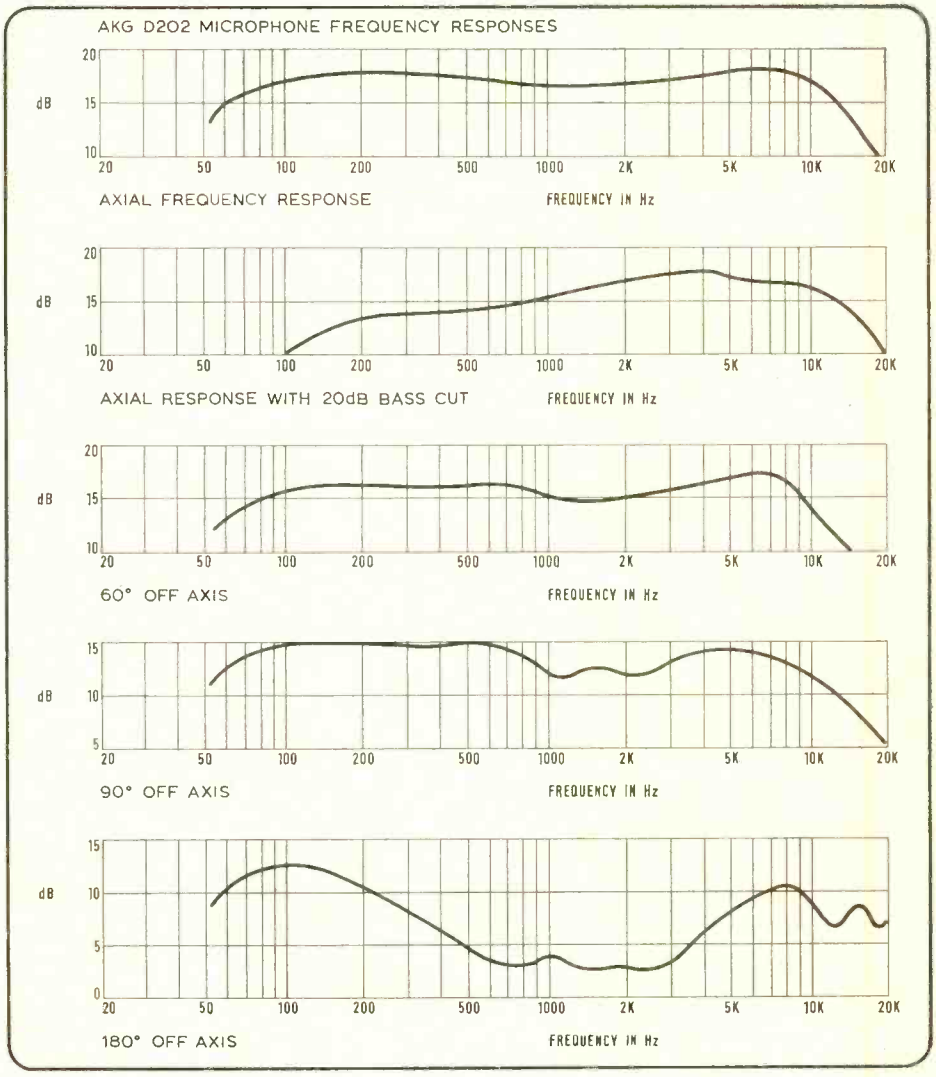
Impedance: 200 ohms at 125 Hz, 300 ohms at 1 kHz, 210 ohms at 10 kHz, ±20 per cent. 500 ohms minimum load.

Weighted noise level: 0.26 μV (CCIR T filter, DIN 45 405)

Dimensions: 51 to 31 mm diameter (taper) x 200 mm

Price: £40

Distributor: AKG Equipment Ltd, 182/186 Campden Hill Road, Kensington, London W.8.



UNTIL comparatively recently, most recording companies have restricted themselves to ribbon and capacitor microphones when handling orchestral material. Capacitor models, while capable of the highest sound quality, are expensive, fairly delicate and normally need a polarising voltage.

Ribbons are usually limited to a figure-of-eight polar response, although this can be modified with varying degrees of success; they are not usually as good on transients as capacitors, and HF response invariably leaves something to be desired. A good ribbon microphone gives excellent string sound and used fairly close, add a pleasant warmth to vocal recordings. The output level from a ribbon microphone is comparatively low and this can cause trouble in the microphone amplifier. The ribbon is also rather delicate.

Dynamic microphones can be much more robust than capacitors or ribbons and are useful for outdoor recordings. They can have a high output level but until quite recently their quality was price-for-price inferior to that of a good ribbon.

By its nature, a basic dynamic microphone has an omni-directional polar response. This is rather inconvenient in situations of high background noise, such as street interviews, and a cardioid polar response would be more useful.

AKG have set out to tackle the problem of producing a cardioid dynamic microphone suitable for studio use, as well as for outside recordings. The *D202* is the result of their efforts.

The basic dynamic microphone has an omni-directional polar response as only one side of the diaphragm is exposed to the sound. It therefore needs a pressure difference between the two sides. Since pressure is a scalar quantity (ie it does not have direction), the response is omni-directional. It can be converted to a figure-of-eight polar response by making a sound path to the rear of the diaphragm, and into a cardioid by including an acoustic resistance. By carefully choosing the sound path length and the acoustic resistance, a phase inverter element is incorporated. Sounds entering the microphone rear are subjected to the same phase shift on their way to the diaphragm as those that travel round the microphone to the front of the diaphragm. In this way sounds from the rear create no difference in pressure at the diaphragm and so do not move it. This system works over a restricted frequency range and, if this is the only modification, the polar response will be frequency dependent. It is difficult to make a dynamic microphone with a wide frequency response as the low frequencies need a large diaphragm and the high frequencies need a small easily moved one. It is therefore usual to compromise with an intermediate size unit, restricting the response at both the lower and upper ends of the spectrum.

AKG have tackled the two problems at once by making a microphone with two

(*continued on page 413*)

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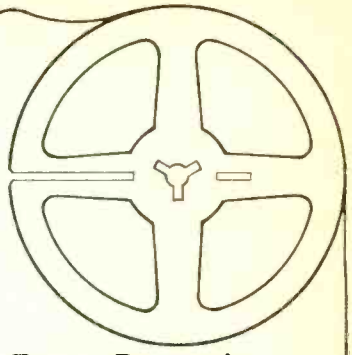

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AKG D202 REVIEW CONTINUED

systems: an HF unit with an LF coaxially arranged behind it on an elastic suspension. The HF system has a short sound bypass and the LF a long bypass. A bass attenuator is included in the crossover network. The *D202* is not unduly susceptible to wind or handling noise, being considerably better than average in this respect. As the curves taken on the review model show, it is a first class microphone by any standards. It is not susceptible to hum pickup and with its reasonably high output makes remarkably 'quiet' recordings.

The *D202* is fussy about the impedance it looks into and should not be connected to inputs designed for 30 ohm microphones. A *D202* with a Nagra *4* recorder makes a system which in versatility, reliability, and robustness must be second to none, as it could be used in situations as different as an outside interview in a noisy street and a studio recording of music.

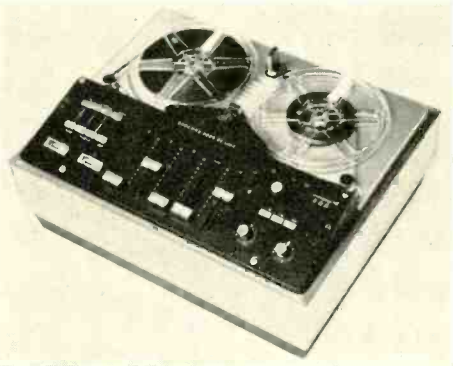
Field trials of this microphone give as favourable result as the other tests and the *D202* can be highly recommended for a wide variety of uses, both in studios and outside.

John Shuttleworth

field trial

BANG & OLUFSEN 1800* STEREO TAPE UNIT

MANUFACTURER'S SPECIFICATION (BASF 35 LH at 19 cm/s)
Tape speeds: 19, 9.5 and 4.75 cm/s.
Heads: Half-track stereo erase, record and play; ¼-track play.
Spool capacity: 18 cm.
Wow and flutter: 0.07% RMS (DIN 45.507)
Speed deviation: ±1 per cent.
Signal-to-noise ratio: 63 dB.
Distortion: 3 per cent at 0 VU, 1 kHz.
Frequency response: 20 Hz to 18 kHz ± 2 dB.
Dimensions: 225 x 440 x 356 mm
Price: £192 including £37.66 tax.
Distributor: Bang & Olufsen UK Ltd, Eastbrook Road, Gloucester GL4 7DE.



THE Bang & Olufsen *1800* has the questionable advantage of being the last cine-spool stereo domestic to be tested in this journal. Angus McKenzie has a four-channel domestic up his sleeve but, once that has left the pipeline, such equipment will be left to the tender mercies of *Hi-Fi News & Record Review*.

As you will know, if you have read the specification, the *1800* is a ½-track stereo recorder with separate record and play heads plus an additional head for playing ¼-track stereo tapes. It comes from the *2000* family which has been in production under various guises for some eight years. This particular machine omits the power amplifiers and detachable loudspeakers found on the *2000* and is clearly intended to complement a home audio system.

A single Papst motor drives the capstan and spool turntables. An idler climbs up and down the stepped brass motor spindle, driving the periphery of a 17 mm thick steel capstan of some 110 mm diameter. The rotary tape speed selector is coupled to the mains on/off switch and turns through six positions: off, 4.75 cm/s, off, 9.5, off, 19. This is a common feature on domestic recorders and accounts for the mechanical rumble emitted by certain members of the Grundig, Uher and BRC dynasties. The cure is either belt drive, polyurethane idler material, a fail-safe solenoid system, or direct drive, in ascending order of preference.

The take-up turntable is mounted above a clutch which is in turn coupled by a circular belt to the capstan. When normal tape drive is engaged, the take-up turntable descends towards the clutch. The drop is barely perceptible but causes a 1 mm packslip whenever a tape is halted from fastwind and played. Packslips on fastwind alone seem virtually non-existent and the recorder's resultant ability to 'remember' start and stop points can be helpful when searching for a particular sequence. The neat winding can be attributed to a rattle-free tape transport and a degree of back tension on the supply turntable when fast spooling. A pair of sprung rotating guides might also be thanked but spooling was just as neat without them. The right-hand sprung guide effectively damped starting wow, while the left-hand roller contributed to the remarkably low end-of-reel wow and flutter.

A separate idler over-rides the take-up clutch to effect fast forward wind. Two idlers couple the motor spindle and left turntable for fast rewind, two being needed to revert the rotation to the correct direction.

All transport mode selection is accomplished through a three-way joystick reminiscent of the late BSR. Neutral is at the bottom of the V slot, rewind at the top left, forward wind at the top right, and play/record straight up the middle. The pause control, also mechanical, simply retracts the pinch wheel a few millimetres and applies a rubber foot to the ½-track play head face. This is sufficient to halt the tape since the take-up tension is extremely light.

The head channel comprises four Bogens, arranged for straightline threading. The tape is held to the head faces by a velvet pad (against the erase) and by guides between the ½-track record and play heads and between the ¼-track play head and capstan. The tape falls clear of the heads on fast wind but remains close enough to permit some form of searching. When editing, the ½-track replay head is clear for marking; the trailing edge of the pause foot offers a convenient stencil.

The great appeal of this machine to the audio enthusiast must be the profusion of buttons and levers on the sloping front panel. The B & O has slide faders and, as last month's Grundig ad explained, 'If you've ever been in a professional recording studio, you'll know that sound control is done by means of sliders, not knobs. That's because sliding controls make it easier to make the ups and downs, highs and lows of a recording really precise'. Grundig don't mention that studios are spared midget VU meters, nor that cheap sliders are inclined to become noisy. The Preh faders used in the *1800* collected their share of dust though most of this was caught by plastic skirts above the slide tracks. No noise troubles in the three-month test period. Three pairs of sliders permit mixing of two low level and two high level signals while simultaneously copying from one track to the other. Put another way, you could feed two microphones, two high level signals, and the contents of Track Two all on to Track One. The Peter Bastins of this world, combining these facilities with their own talents, make quite a profitable hobby out of tape recording. If there's a Tatnall Canby in you, you could go one further and synchronise the lot to 35 mm slides. The *1800* incorporates a 'syncro' button which inserts a tone to activate a slide projector.

One beauty of this recorder, rarely found on other models, is a separate mains switch to activate the electronics without starting up the motor. This is one of the eight pushbuttons on the left side of the sloping panel. The other seven comprise record 1 and 2, syncro, line in/out monitor, channel 1 and 2 monitor, and sound-on-sound. Monitors 1 and 2 feed stereo when down, double mono when up, and either left or right to both channels when pressed singly.

*Photo shows similarly styled Model 2000

Piano recordings made through the B&O coincident ribbon threw doubt on the transient performance of the B&O VU meters, which seemed to have little in common with the VUs on Revox and Ferrograph equipment say. In domestic circles, it appears in order to label as a VU anything that clearly isn't a PPM. Less noisy recording (the B&O 'low-Z' input is transformerless) was achieved feeding more sensitive ribbons into a Soundex mixer and thence to the auxiliary input beneath the recorder.

Beneath. Whenever one wishes to change gram, radio or line connections, the recorder has to be lifted on its back; turn the drive off or it will scream. One has the choice of phono or DIN sockets—six of the former and three (five-pin) of the latter look down at an awkward angle. Pressure on a tight phono causes the whole socket panel to give unnervingly. The microphone sockets (five-pin DIN) are more accessible, on the left side of the sloping control panel. Even there, it is not always convenient to reach the necessary angle to align the plugs with the sockets. The result, until you memorise the necessary angle, can be likened to plugging in a valve with your eyes closed.

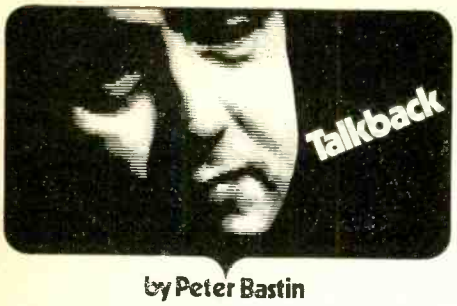
We recently derived some amusement from a cassette recorder labelled in such a way that it was anybody's guess whether the pushbuttons were in action when down or when up. The B&O A/B monitor switch is in this category, being simply a button labelled 'monitor'. The $\frac{1}{2}/\frac{1}{4}$ track replay button carries a more precise hieroglyph; upward and downward pointing arrows over the figures 2 and 4 respectively. When recording on the *1800*, the $\frac{1}{4}$-track head is silenced.

If I seem to be carping unduly, I must apologise. The ergonomics of all elaborate domestic recorders leaves a little to be desired. If a designer can teach his wife to multitrack in one evening, then on that count he is home and dry.

It is embarrassing to report that I was unable to hear wow on this machine even at its slowest speed (4.75 cm/s) and at what is normally the most difficult part of a reel, the last few metres. A/B comparison of steady open-string electric guitar tones, listening on headphones, revealed little more than the inevitable increase in hiss. A slight unhappiness about the 4.75 cm/s tones might have been due to the equally inevitable dropout or to a very low level low frequency wow. I have never before experienced so steady a machine at this speed. This confirms the lesson taught by the *Chilton* and Philips *Pro 12* that a machine designed for small cine spools will often handle them better than one optimised for NABs. Several manufacturers are currently working on NAB domestics (including B&O) and it is to be hoped that they will recognise the merits of reel tension servos.

Conclusion

Wow and flutter, it seems, are no longer a problem at 19 cm/s. Tape hiss and dropout have still to be overcome, however, and until Dolby, Cobaloy or what have you accomplish this I'm sticking to 38. **David Kirk**



by Peter Bastin

IAN DUFF, writing in *British Kinematography Sound & Television* hits a particular nail on the head : 'If one well-known type of camera (as modified by a major broadcaster) is connected to a particular type of recorder from a well-known hirer, everything fits together without a sign of warning of trouble but, when switched on, the system destroys the electronics of the recorder.'

'When I go on location I take a bundle of manuals and diagrams three inches thick that have a briefcase to themselves.' In its basic form, this sort of thing manifests itself in plugs. One particular make of recorder I have uses four types of plugs.

DATA EFFICIENCY market an adjustable magnetic tape storage system which is claimed to cost less than conventional racking. Their system permits reels of varying diameters to be stored in the most economical manner. Free-standing uprights support plastic-coated trays which can be vertically-spaced according to requirements and the depth of trays available will accommodate reels up to 300 mm in diameter. The trays are also available to coter for canisters from 25 to 37.5 mm in thickness. Thus, a storage system of over 200 reels could be accommodated in a space of less than 1m wide by 2m high.

THE TWEETER in one of my Wharfedale speakers went for a burton. The dealer took it to bits (the case) and said look. The back of the tweeter is covered in a greenish sort of jelly or plastic. A small wire, clearly seen through the jelly stuff, had apparently broken. Didn't seem to be. Can't you mend it or solder it or something? No, it's aluminium. Result : new tweeter, about £4. What is this? A closed shop or a closed tweeter?

I REPEAT a plea that I made the very first time this column appeared : a plea for advertisers to tell us how much their beautiful goods cost. In the June issue, out of over 25 major advertisements, only five gave any idea of the cost—one microphone, one recorder and three miscellaneous items. I know that makers of mixing consoles and the like cannot specifically list all their products, but people like STC, with illustrations of microphones and headsets, could very easily give a recommended price. Akai, with three full-page ads, give not a hint of how much their recorders and VTRs cost. Even the purveyors of equipment by the ton don't escape : Francis of Streatham list some 64 decks, recorders and associated equipment without a single price. Just, I suppose, to let you know that they have them. I can only assume that the reason they don't give prices is that they could be out of date before the reader has even opened the magazine. And that, of course, is another very irritating, very frustrating and very mysterious matter.

FROM AUSTRALIAN HI-FI : A model *1212* Encel amplifier was shipped to a customer in the British Solomons. Some time later, it was returned to Encel's service department with a note simply stating that it wouldn't work. The service department found the corpse of a rat, which had apparently electrocuted itself on a switch, which, in turn, had blown part of the circuit. What a ratten shame.

The same magazine, in its third appearance, tells us that most audio equipment sold in Australia is imported from America, Europe and Japan. Advertisements seem to indicate that the Japanese are way ahead ; no British goods are apparent. Fully-assembled goods carry an import duty of 45% plus a sales tax of 27½%. On the other hand, locally-made equipment is subject only to the sales tax. The magazine comments 'Whilst we agree that our tariff system protects Australian industry generally, what local industry are we protecting with the high tariff on hi-fi gear?

KJ ENTERPRISES (now KJ Leisuresound Ltd.) of Watford have just issued their spring and summer catalogue. This is a 128 page publication rich in illustrations, many of them in colour. It is significant to note the commercial trend in sales, by the fact that the first sixteen pages of the catalogue are devoted to hi-fi (!) systems. In previous catalogues, these things were somewhere at the back, then in the middle, then in the front-middle. Now they have achieved the ultimate : front page, as it were. Nevertheless, KJ are a commercial enterprise and I have no doubt at all that they sell more hi-fi and low-fi outfits than Revoxes. The catalogue contains a very large range of equipment, including such things as 8-track stereo recorders, Wharfedale Dolby decks, Beyer, Calrec and AKG microphones and most of the equipment in use by the amateur and semi-professional. There is also a credit scheme called Paybonds, by which method you pay on the never-never against 'credit prices'. Cash prices for goods work out at approximately 10 per cent less than list price : credit prices attract a 10 per cent service charge. For example, a Ferrograph *713* costs £188.50 list, £157.50 cash and £170.00 credit. Worth thinking about.

FROM THE *Radio Times*, April 18, BBC One : 'The Man from Cheju . . . Since the arrival of a Columbian Father, 15 years ago, it (the island) is also known for its abundance of pigs'.

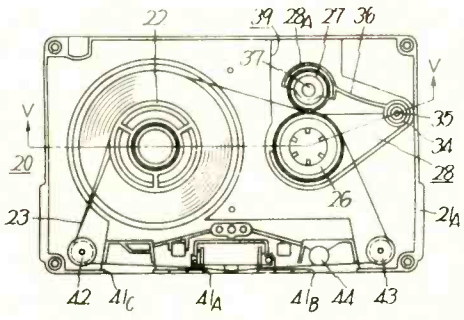
INDEX TO ADVERTISERS

PATENTS REVIEW

ADRIAN HOPE

TWO different ways of handling endless tapes. The first, from the Sony Corporation, turns up in the BP 1,217,806. Sony explain the problems inherent in converting 'the so-called Philips type tape cassette' to hold an endless tape loop. Particular difficulties arise when a fast forward facility has to be provided. Also, because, in practice, the endless tape is intended to be driven only in one direction, the whole thing will foul up if Joe Public tries to drive it in the reverse direction.

The Sony patent is directed towards producing a foolproof endless loop cassette compatible with the Philips. The new cassette has a roll from which the tape is drawn at its innermost winding, the same tape being wound back on to the outermost convolution. The tape roll is only a loose fit on the reel shaft and so not driven. When the tape comes off the roll centre, it passes via a conical straightening roller through the usual bunch of heads and then moves between an auxiliary capstan and an auxiliary pinchroller. This capstan is driven by the other drive shaft of the tape machine and a pinchroller is pressed into rotating contact by a spring arm.

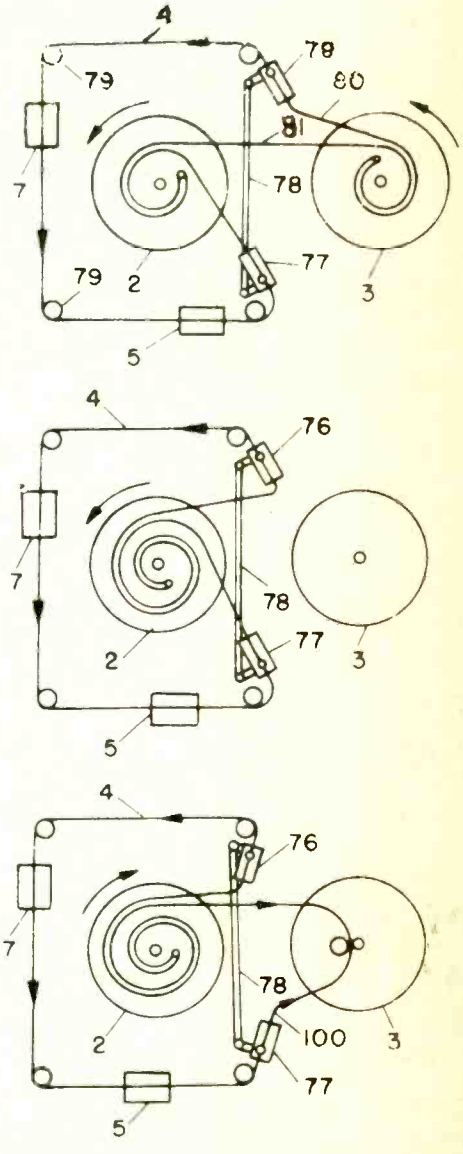


The tape is driven at constant speed by the recorder's capstan and pinchroller and also by the cassette's own capstan and pinchroller. When the tape recorder is put into fast forward, only the cassette capstan is driven. If someone forgets that there is no rewind, the reel shaft ceases to drive the auxiliary capstan. Because there is no connection between the machine and the tape roll, there can be no rewind and no disasters.

Aga Aktiebolag also have a new invention (BP 1,221,313) concerned with endless tape but their's is for tape alternately wound in doubled-back condition on a pair of spools. Tape wound in doubled-back state is taken off one spool and then wound on to the other in similar doubled-back condition.

In fairly clear sketches Aga show how their device works. To start off with, doubled-back tape is wound off a first spool through a sensing means and on to a second spool. When the first spool is empty, the tape between the sensors tightens up. This alters the sensor positions and reverses the spool drive motors. There is a short delay period and during this the tape continues past the heads by what Aga call transfer means. This produces a loop of tape which is picked up again by the first spool (now rotating in the opposite direction). The whole procedure then carries on in reverse.

Aga go farther to describe a particular system of handling the tape loop by using air under suction pressure and I'll take their word



for it that, by a bit of carefully controlled huffing and puffing, the tape can be caught in an airstream and put where it is wanted. The theories behind a few of the very best inventions (Technicolor, Xerox, Hovercraft) read like music hall jokes, so laugh in private!

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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 **SEPTEMBER 1971** issue must reach these offices by **14th JULY 1971** addressed to: The Advertisement Manager; **Studio Sound**, Link House, Dingwall Avenue, Croydon CR9 2TA.
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Audio-Visual Engineer required for varied duties primarily in London area. Preference given to applicants with documented previous experience in the operation of professional motion picture and/or audio equipment. Company supplied vehicle but clean driving licence essential. Basic salary within the range of £1,200-£1,400 according to qualifications. Age 20-35. Box No. 606 (London).

Experienced Electronics Test and Service Engineer for work on professional sound recording and film equipment. Progressive appointment, good salary and working conditions. Apply in writing stating qualifications and experience in detail to:
MR. R. M. WARDROP
Eversheds Power-Optics Limited
214 Harlequin Avenue, Brentford, Middx.

SITUATIONS VACANT — (cont.)

UNIVERSITY OF SURREY
DEPARTMENT OF LINGUISTIC AND REGIONAL STUDIES
TECHNICIANS
in Audio-Visual/Audio-Lingual Laboratory

One full-time and one part-time vacancy exist for a young man or woman in this rapidly expanding department. The successful candidate would take a prominent part in the day-to-day running of the department, especially the language laboratories. The part-time vacancy would be suitable for a married woman with a child at school or a retired person. Apart from a general adaptability and flexibility, one (or more) of the following aptitudes or skills would be an advantage.

- technical experience with tape-recording apparatus and associated equipment.
- film, slide or film-strip projection.
- library cataloguing (for the tape-recording library).
- overall operation and maintenance of language laboratories.
- cartography or map curator.

Full-time salary £1,041-£1,410 per annum with additional qualifications allowance.

Applications to the Staff Officer, University of Surrey, Guildford, Surrey.

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.

FOR SALE—PRIVATE

Uher 4000 Report-L portable tape recorder. 1970 model, barely used, excellent condition with case. 031-334 8573. £110. Rowe, 46/7 North Gyle Grove, Edinburgh, EH12 8LF.

Pair Wharfedale Super 12 RS/DD Chassis. Pair Goodmans Trebax 5K 20XL Tweeters. £25 the lot, will split. Phone: 01-229 4289 after 8 p.m.

AKG D224E 10 months old. Perfect. Cost £58, sell £38. Godstone 3106.

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

Two I.M.F. Monitor Speakers as new. £140 pair. Box No. 607 (Yorks).

V.C.S.3 Specially tuned version with modifications. 01-743 4084.

For Sale. Leevers-Rich E141 Mono Tape Recorder with half and full track headblocks £175 o.n.o. Six channel one group Elcom desk with echo send/return, VU, fully transistorised £125 o.n.o. Box No. 2182 (London).

Tapes and Spools. 97 tapes and spools, majority double play. Philips, BASF, etc. Details supplied. Mostly recorded ¼ track, many rare items which may be of interest (cost £75) £55. Box No. 609 (London).

SITUATIONS WANTED

Widely travelled young man (28) German spoken with ten years entertainment and record production experience in Germany and Switzerland, seeks position in same or similar. Assets include comprehensive knowledge of audio studio, music and photography, plus ability to sell and liaise at management level. Please contact: J. I. Duncombe, 32 Harlech Avenue, Caversham Park, Reading, Berks.

Transmitter Engineer (34) now seeks new career in studio maintenance or in audio engineering/manufacture anywhere in U.K. D. V. Ryan, 35 Fife Street, Nelson, Lancs.

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	Rec. Retail Price	Comet Price
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ALBA UA 700	34·50	26·00
ARMSTRONG 521	56·00	42·50
DULCI 207	26·00	17·50
DULCI 207M	32·00	21·95
FERROGRAPH F307	62·00	44·00
GOODMANS Maxamp	54·00	38·00
LEAK Stereo 30 Plus	56·50	43·00
LEAK Stereo 30 Plus in teak case	62·50	47·95
LEAK Stereo 70	69·00	52·00
LEAK Stereo 70, in teak case	75·00	56·95
*LINEAR LT66	21·00	17·00
METROSOUND ST20	36·00	24·95
METROSOUND ST20E	39·50	29·50
PHILIPS RH 591	79·00	61·50
PHILIPS RH 590	52·00	39·50
PHILIPS RH 580	29·00	23·00
PIONEER SA500	62·10	41·95
PIONEER SA700	98·00	68·95
PIONEER SA900	134·10	95·95
PIONEER Reverberation	45·50	31·95
ROGERS Ravensbourne	59·50	45·95
ROGERS Ravensbourne (cased)	64·00	49·50
ROGERS Ravensbrook Mk II	47·50	36·50
ROGERS Ravensbrook (cased) Mk II	52·50	41·50
SINCLAIR 2000	35·00	27·00
SINCLAIR PROJECT 60/2 x Z30/PZ5	23·90	17·50
SINCLAIR PROJECT 60/2 x Z50/PZ8/trans	34·86	23·25
SINCLAIR AFU	5·95	4·95
SINCLAIR Neoteric	61·95	46·00
SINCLAIR 3000	45·00	34·95
TELETON SAQ 206 (new release)	29·00	18·50
VOLTEX 100w. Stereo Discotheque 8 electronically mixed inputs	185·00	139·00

Starred items above take ceramic cartridges only. All others take both ceramic and magnetic cartridges.

TUNERS		
*ARMSTRONG 523 AM/FM	53·76	42·00
*ARMSTRONG 524 FM	41·89	33·00
ARMSTRONG M8 De-coder	9·50	8·00
*DULCI FMT.7 FM	26·00	22·00
DULCI FMT.75 Stereo	35·00	29·25
GOODMANS Stereomax	82·52	49·95
LEAK Stereofetic Chass.	66·50	52·00
LEAK Stereofetic in teak case	72·50	59·00
PHILIPS RH 690	47·00	38·00
PHILIPS RH 691	89·00	75·50
PIONEER TX500 AM/FM	77·94	63·50
PIONEER TX 900 AM/FM	153·69	123·00
ROGERS Ravensbourne Chassis	61·89	47·95
ROGERS Ravensbrook	45·01	38·00
ROGERS Ravensbrook (cased)	51·26	41·00
TELETON GT101	45·50	31·95
TELETON 201X FM	36·00	27·50

All above tuners are complete with MPX Stereo Decoder except where starred.

TUNER/AMPLIFIERS		
AKAI AA 8500	229·00	181·00
AKAI 6600	142·53	112·00
ARENA R500	82·00	67·00
ARENA 2400	90·30	72·00
ARENA 2700	105·00	85·00
ARENA T9000	303·45	258·00
ARMSTRONG M8 De-coder	9·50	8·00
ARMSTRONG 525	91·89	74·50
ARMSTRONG 526	104·71	84·50
GOODMANS Module 80. 35w. RMS	95·00	72·00
MIDLAND 19/542	49·56	37·50
PHILIPS RH 790	139·00	112·00
PIONEER SX770 AM/FM	160·43	126·00
PIONEER SX990 AM/FM	194·74	150·00
PIONEER 440	111·10	89·00
TANDBERG 1171 complete with decoder	110·00	94·00
*TELETON F2000	51·50	30·50
TELETON 7AT20	105·00	77·95
TELETON 10AT1 150w. RMS	160·00	103·00
TELETON TFS50	82·50	59·00
TELETON TFS50 LA MW/LW/VHF	87·50	63·50
*TELETON R.8000 with Speakers	63·25	37·50
TELETON CR55	120·00	87·00

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	Rec. Retail Price	Comet Price
TELETON GA 101	37·50	28·50
WHARFEDALE 100-1	149·00	119·00

Starred items above take ceramic cartridges only. All others take both ceramic and magnetic cartridges. All the above Tuners and Tuner/Amplifiers include MPX Stereo Decoder with the exception of Armstrong where decoder is extra as listed.

TURNTABLES		
DUAL 1219 transcription	60·40	50·00
DUAL 1209 transcription	42·62	35·00
GARRARD SP25 Mk II	16·45	11·90
GARRARD SL65B	21·25	15·90
GARRARD SL75B	39·20	26·50

GARRARD AP76 turntable, fully wired, complete with Goldring G800 Cartridge, base and cover. Special Price £30·95.
GARRARD SP25 Mk III fully wired with Goldring G800 Magnetic Cartridge. Complete with base, plinth and cover. Special Price £21·98.
GARRARD 2025 fully wired with Sonotone 9TAHC Cartridge, complete with base and cover. Special Price £15·50.
GOLDRING 705/P turntable, fully wired, complete with Goldring G850 cartridge, base cover. Rec. Retail Price £25·00. **Comet Price £15·95.**

GARRARD SL95B	50·01	35·50
GARRARD 401	38·07	29·50
GARRARD SL72B	33·11	27·90
GARRARD 3500, with GKS Cartridge	17·23	12·90
Base and cover to fit GARRARD SP25, SL55, SL65B and 3500.	Special Price	4·00
GARRARD 40B	13·84	10·97
GARRARD AP76	28·88	21·50
GOLDRING GL69 Mk II	26·63	21·25
GOLDRING GL69P Mk II	35·14	28·50
GOLDRING GL75	36·41	31·50
GOLDRING GL75P	46·94	38·50
GOLDRING Covers for 65P and 75P	4·21	3·50
GOLDRING C99—plinth and cover for G99	11·45	9·90
GOLDRING G99	26·00	22·90
GOODMANS 3025	37·74	26·90
McDONALD MP60	15·75	11·75
McDONALD 610	20·00	15·75
Base and cover for McDONALD MP60 and 610	Special Price	4·50
PHILIPS 228	20·00	17·00
PHILIPS GA146	31·50	25·00
PHILIPS 202 Electronic	69·00	54·00
PIONEER PL12A with base and cover	49·93	37·95
THORENS TX25 cover	8·85	7·00
THORENS TD125	79·04	61·95
THORENS TD125AB	120·20	98·00
THORENS TD150A Mk II	46·16	35·95
THORENS TD150AB Mk II	49·96	42·95
THORENS TXII Cover	4·43	3·95
SPEAKERS		
B & W Model 70	159·50	121·95
B & W DM3	63·00	49·95
B & W DM1	32·00	25·50
CELESTION Ditton 120	24·00	18·00
CELESTION Ditton 15	32·00	25·50
CELESTION Ditton 25	65·00	50·95
GOODMANS Minister	25·00	20·50
GOODMANS Magister	62·50	47·95
GOODMANS Maxim	20·39	16·50
GOODMANS Mezzo 3	34·00	25·95
GOODMANS Magnum K2	44·00	33·00
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KELETRON KN500 4 speaker system (pr.)	23·00	16·95
KELETRON KN700 4 speaker system (pr.)	27·50	19·95
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KELETRON KN1500 4 speaker system	24·75	18·95
KELETRON KN2000 4 speaker system	28·75	20·95
LEAK 200	24·95	18·90
LEAK 300	32·50	23·95
LEAK 600	49·50	36·90
LOWTHER Acousta (with PM6)	45·50	38·50
LOWTHER Acousta (with PM7)	53·00	46·00
LOWTHER Ideal Baffle	35·50	30·00
METROSOUND HFS 103 (pr.)	25·00	17·95
METROSOUND 202	21·50	15·95
METROSOUND HFS 20 (pr.)	39·00	25·95
METROSOUND HFS 10 (pr.)	27·44	22·95
PHILIPS RH481	11·00	8·95
PHILIPS RH482	18·00	14·95
SINCLAIR Q16	8·98	6·95
STE-MA 275 3 speaker system	23·10	15·95
WHARFEDALE Speakers		
Airedale	69·50	54·95
Denton	19·95	15·50
Super Linton	24·95	20·50
Melton	32·50	24·95
Dovedale 3	42·50	31·95
Rosedale	65·00	50·95
Triton (pr)	59·90	45·95
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TAPE RECORDERS AND TAPE DECKS		
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AKAI X200D	190·00	155·95
AKAI X5000 W/L	177·98	135·95
AKAI X330	342·57	265·95
AKAI X-330D	312·56	243·95
AKAI X-360	380·01	279·95
AKAI X-360 D-deck	318·92	243·00
AKAI 1800SD	199·42	165·95
AKAI 1710L	89·85	65·95
AKAI 1720L	97·21	77·50
AKAI CR80 8-track stereo recorder	115·03	99·95
AKAI CR80D 8-track stereo tape deck	95·00	79·95
AKAI 4000 4-track Stereo	124·90	97·95
AKAI 4000 D 4-track Stereo deck	89·95	69·50
FERGUSON 3252	104·30	83·95
FERGUSON 3245 twin-track	38·00	29·95
FERGUSON 3246 4-track	44·10	34·95
FERGUSON 3247 4-track	49·65	39·95
FERGUSON 3248 4-track	55·65	43·95
FERROGRAPH 722	266·41	219·00
FERROGRAPH 724	266·41	219·00
FERROGRAPH 702 2-track tape deck	228·71	193·00
FERROGRAPH 704/W 4-track tape deck	228·71	193·00
GRUNDIG C200L Cassette	39·90	29·95
GRUNDIG TK121 twin-track	56·85	43·95
GRUNDIG TK149 4-track	57·63	47·95
MIDLAND TC144 Cassette	18·00	13·95
PHILIPS 3302 Cassette	23·90	18·95
PHILIPS 4303	42·00	34·95
PHILIPS Cassette Stereo Tape Deck	54·00	45·95
TANDBERG 1841 4-track Stereo Tape Deck	69·75	59·95
TANDBERG 3021X twin-track stereo	109·90	93·00
TANDBERG 3041X 4-track stereo	109·90	93·00
TANDBERG 4021X twin-track stereo	180·00	150·00
TANDBERG 4041X 4-track stereo	180·00	150·00
TANDBERG 6021X twin-track stereo	195·00	165·00
TANDBERG 6041X 4-track stereo	195·00	165·00
TELETON TRC 130 cassette, with VHF/AM radio. Battery/mains twin motors	41·75	31·90
TELETON TC110 cassette, batt./mains	27·75	20·00
TOSHIBA GT 840 S	110·00	67·95
TOSHIBA GT 601v twin-track	45·15	29·95
TOSHIBA 850 5A	94·00	59·95
WHARFEDALE Dolby DC9 Cassette StereoTape Deck	115·00	97·00

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The Dolby System: June 1971

30 consumer product manufacturers 400 professional users

The Dolby A-System is the professional noise reduction system. Every major recording company uses it, and its use is rapidly increasing in motion picture studios, broadcast stations and communication networks all over the world. It is the first noise reduction system ever to achieve virtually universal acceptance among professionals.

The Dolby B-System is the compatible high-fidelity noise reduction system for consumers; it uses the same basic principles as the A-System. As a matter of policy, Dolby licenses but does not itself manufacture the consumer system. 30 companies will soon be making consumer products incorporating the B-System; others are joining the list every week.

ADVENT	KELLAR
A.G.S.	KENWOOD (TRIO)
ALLIED RADIO SHACK	K.L.H.
AMPEX	LAFAYETTE
BELL & HOWELL	LENCO
BENJAMIN	MITSUBISHI
BIGSTON	NAKAMICHI
CONCORD	PLANET
CROWN RADIO	RANK WHARFEDALE
FERROGRAPH	REVOX
FISHER	SANSUI
HARMAN-KARDON	SILVER
HIGHGATE (ALPHA)	TEAC
HITACHI	TELETON
JANSZEN	TELEX (VIKING)

Every high-fidelity and record review publication of consequence has tested the noise reduction and compatibility of the Dolby B-System. The judgment of the reviewer of the New York Times is typical: "B-Type cassettes can produce almost disk-quality sound even when played on a first-quality machine that predates the Dolby technique. If you have one of the new players with built-in Dolby, the results can be quite spectacular."

More and more B-System commercially recorded cassettes are becoming available from the 26 companies which already own the professional equipment needed for duplicating such cassettes. The universal opinion of listeners and dealers is that these cassettes are compatible – often even preferable to old-type cassettes – when played on non-Dolby equipment. The Dolby cassette is, in fact, the first high-fidelity cassette.

New tape formulations such as chromium dioxide complement the Dolby B-System and are not competitors. Their noise reduction effect is much less than that of the B-System, but they provide a useful extension of high-frequency response. Unfortunately, chromium dioxide tape is not compatible with the vast majority of cassette units in the field and on dealers' shelves today, but more and more manufacturers are providing new machines with the ability to use the new tape, along with the Dolby circuit.

The Dolby B-System is now beginning to be used in FM broadcasting with excellent results. The FCC has stated that its rules allow the broadcasting of Dolby-encoded signals; Fisher and Harman-Kardon will be the first with new receivers incorporating the B-System. The reduction in noise given by the system can increase effective station coverage to twice the area covered without the system, or more, without increase of transmitter power.

The cost of licensing the Dolby System is being reduced considerably because of the rapid growth of its acceptance by mass-market manufacturers. Major reductions in royalty rates are being announced to licensees as part of a new, simplified licensing scheme based only on quantity, not a percentage of cost as in the past. The royalty will be as low as ten cents per channel.

Integrated circuit versions of the Dolby B-System will be available in Spring, 1972, and will further reduce costs. An IC design being jointly developed by Signetics and Dolby will be made available to the entire IC industry.

Dolby Laboratories will deliver more than two million dollars' worth of professional noise reduction equipment this year. The company employs a staff of more than 100 at its London facility, and maintains offices in New York and Tokyo, all devoted exclusively to professional and consumer noise reduction system development, manufacture and sale. The size of its technical staff and the concentration of its effort enable Dolby Laboratories to provide valuable technical and marketing support for its consumer product licensees.

A further support which Dolby Laboratories offers licensees is patent protection. To date, 78 patent applications have been filed in 17 countries to cover the Dolby System; 19 patents have already been issued in 10 countries, including the United States.

Dolby Laboratories Inc.

New York	London	Tokyo
telex 66240	telex 919109	telex TK2498