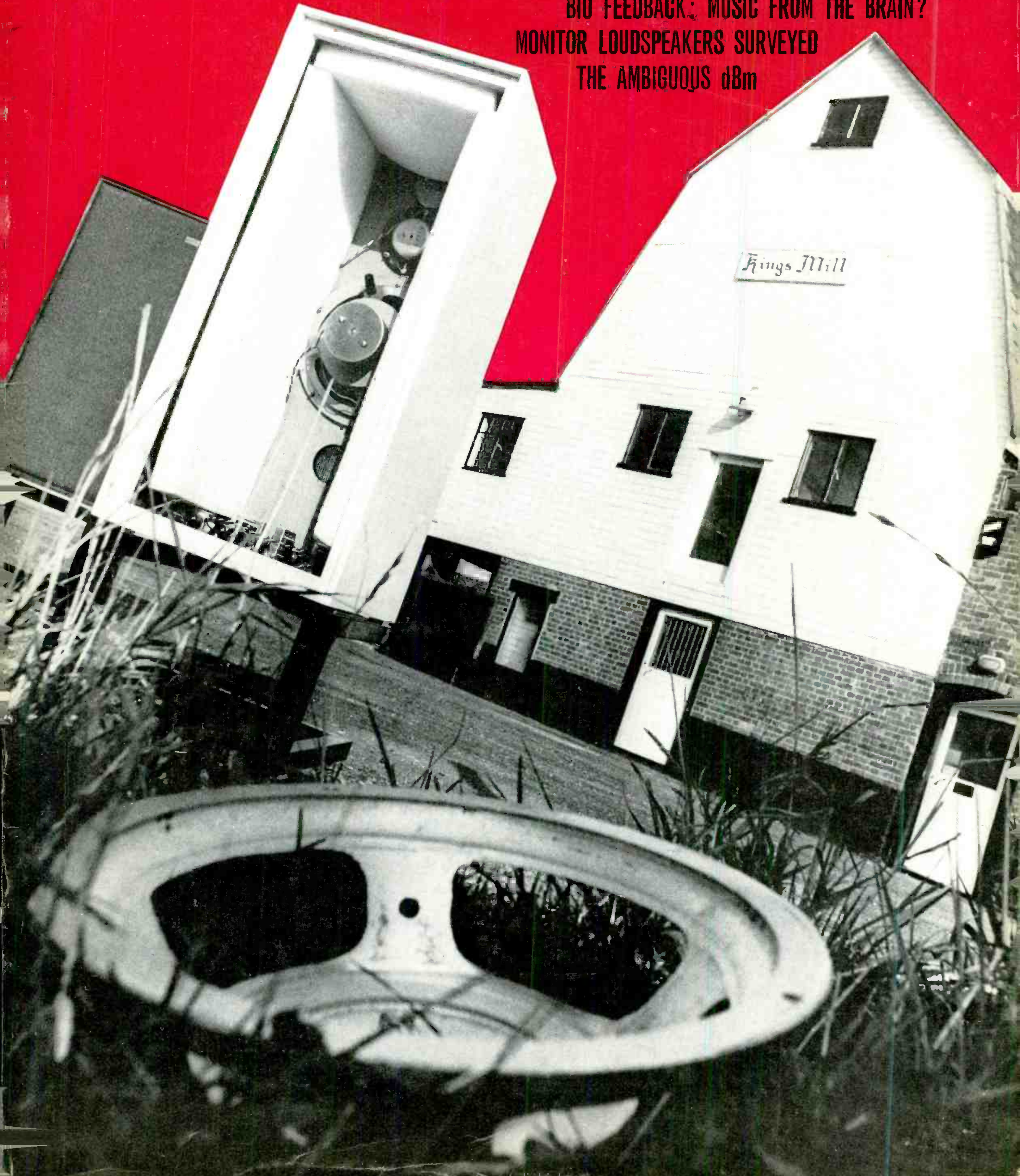
December 1972 25p

studio sound

BIO FEEDBACK: MUSIC FROM THE BRAIN?

MONITOR LOUDSPEAKERS SURVEYED

THE AMBIGUOUS dBm

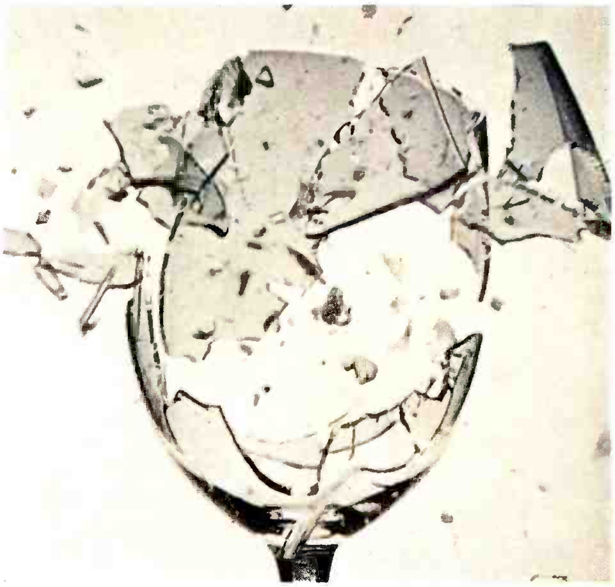


Could the audio tape you buy pass this simple test?

1 We chose a singer with a precise and powerful voice.

2 We got her to hold a certain high note long enough to actually shatter a glass.

3 We recorded that note on Memorex audio tape (the kind which is now generally available).



4 We played back the tape. When the note came up again, a similar glass shattered.

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studio sound
INCORPORATING TAPE RECORDER

DECEMBER 1972 VOLUME 14 NUMBER 12

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FEATURES

COLUMNS

REVIEWS

COVER

To the devil with 'Pub of the Year' competitions. Here we have a strong candidate for 'Loudspeaker Factory of the Year'—the recently acquired Spendor premises near Redhill, Surrey.

NO FUNNY HATS or false moustaches in this, the Premature Christmas issue of STUDIO SOUND. Instead, to cheer you on a winter evening, we offer Herman Wilms's and John Bowsher's condemnation of 'The Ambiguous dBm'. If it leaves you wondering what you ever saw in empty measurements, turn to our loudspeaker survey and make what you can of 'Bandwidth: 40 Hz to 20 kHz'.

When we prepare a survey, we present the basic data available to any potential customer who is prepared to write to all presently functioning manufacturers. The technical value of data issued by most loudspeaker manufacturers is deplorably low and this is reflected in many of the figures we are obliged to quote. Readers are spared the nonsense issued by some of the more blatant companies. One gem, curiously enough from a highly respected concern, ran as follows: Transient response—excellent; Frequency response—wide; Distortion—low.

Similarly worthless are unqualified references to power rating (new 'The Ambiguous Watt'?). Few makers offer specifications detailed enough to have any real technical value. In this respect, loudspeakers are treated more as musical instruments subject to personal taste (or hearing deficiencies) than mere electron-motion into air-motion transducers. Equipment specifications could be tied down to a single rigid presentation if manufacturers would only take the trouble. Mainland European concerns in general, German companies in particular, follow DIN formats closely enough to permit fairly easy comparison. British manufacturers might claim they lack the resources to produce such measurements but is it beyond their means to hire a consultant? If the temptation remains to follow American standards (EIA), this should be resisted if only because Britain is being tied more closely to Europe. We have made before in this column the suggestion that the American audio industry adopt DIN recommendations; heresy in 1972 perhaps but will the Atlantic always be so forbidding a barrier?

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.

SUBSCRIPTION RATES

Annual subscription rates for STUDIO SOUND are £3 (UK) or £3.30 ($8 or equivalent) overseas. Six monthly home subscriptions are £1.50. Our associate publication Hi-Fi News costs £3.24 per annum (UK) or £3.66 ($8.64 or equivalent) overseas.

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

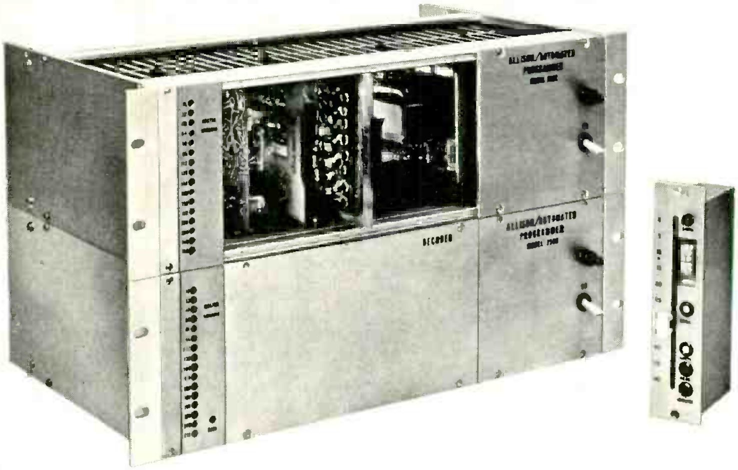
PAST ISSUES

A small number of certain past issues may still be purchased from Link House, price 31p each including postage.
Photostat copies of any STUDIO SOUND article are available at 25p including postage.

BINDERS

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

Automated Mixing is NOW!



Functional...useful automation, whether for music, film or commercials, requires that the mixing console or separate mixdown consolette, self-program all relevant control functions in real time. In other words, the equipment must be capable of normal manual operation, but with the additional capacity to remember what was done, when it was done, and how it was done. It must then be able to precisely re-create the original mix any number of times without degradation while individual controls are readjusted to alter or improve any portion of the recording.

MODEL 256 PROGRAMMING UNIT

At the heart of the system is the Programmer, designed to avoid obsolescence by being capable of encoding up to 256 channels for recording on any conventional tape recorder. The Programmer contains independent Encoder and Decoder units, each of which employs state of the art analog and digital circuitry. This approach achieves the infinite resolution (stepless) control associated with analog systems while maintaining the error detection capability of digital circuitry.

The Model 256E Encoder consists of a 5¼" x 19" card frame, and is supplied with the Master Encoder module, one Model 16E switching card for 16 functions, and the required power supply modules.

The Model 256D Decoder, a separately packaged card frame with the same dimensions as the Encoder, contains the Master Decoder module, one Model 16D switching card for 16 functions, and the required power supply modules.

Both units can be expanded at any time in multiples of 16 functions by simply plugging in additional 16E and 16D switching cards. The expanded system will continue to decode tapes made prior to expansion. No other adjustment is necessary on either the programmer or the tape machine. In fact all tapes and programmers are interchangeable without adjustment so that tapes made in one studio may be played in any other studio having similar equipment.

MODEL 256 PROGRAMMER SPECIFICATIONS

NUMBER OF FUNCTIONS: 16 to 256 expandable in groups of 16 by means of plug-in circuit cards.

UPDATING RATE: 800 Micro sec/function.

ACCURACY: ± .2 dB, 0 to −40
± 2 dB, 0 to −60
+ 0 −inf @ −80

BANDWIDTH REQUIRED: 5 kHz (35 dB S/N)

RECORDING LEVEL: −20 to −5 (actual level or level variations have no effect).

DROP-OUT AND SPLICE PROTECTION: Any such occurrence of sufficient magnitude to cause decoding error causes device to hold prior information until error signal is removed.

COMPATABILITY (System to System/Studio to Studio, etc.): Compatible within ±1 dB. Decoder automatically senses the number of encoded functions present and adjusts its cycling rate accordingly. Decoder also displays (via LED array) the number of encoded functions as an aid to determining the degree of automation on tape of unknown origin.

PACKAGING: Decoder and encoder separately packaged for remote control applications.
Decoder: 5¼" x 19" rack panel.
Encoder: 5¼" x 19" rack panel.
Both units: 10" deep. Self powered.

MODEL 940 AUTOMATED FADER

The Automated Fader is a self-contained channel level control module capable of either manually or automatically setting audio levels. It contains all the electronics and front panel controls necessary to record, play back, and update channel fader settings. In addition, it may be used as an automated master fader, or may be externally controlled for gate or mute functions. An Auto/Manual switch is provided, which allows the module to operate as a normal audio fader, bypassing the automation electronics entirely. The module incorporates a conductive plastic slide attenuator of the same quality and reliability that has made our Model 440 and 475 faders so popular.

The Model 940 Automated Fader fits in the space normally occupied by a conventional fader so that no additional console panel area is required in retro-fit applications.

Electrical performance characteristics are compatible with the Model 256 Programmer. Power requirements are as follows: ±15V @ 50mA, +5V @ 10mA, and lamp power of 5 to 6V @ 30mA.

Mounting Dimensions are: 7" high x 1½" wide x 3¾" deep over mating connector.

You can automate your studio NOW with the Model 256 Programmer and the Model 940 Fader Modules, or with a pre-wired, ready-to-use 16 or 24 channel automation consolette...and there's more to come!

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You don't need to take our word for it. Check the principal features for yourself.

Specification fully according to DIN 45 500 (Hi-Fi) Standard, with signal-to-noise ratio better than 48 dB, distortion less than 1%, wow and flutter ± 0.15% at 7½ ips, and frequency response 40-20,000 Hz at 7½ ips (within 6 dB).

10½" reel capacity. Selector switch for reel size. Metal hub reel locks.

Six heads for forward and reverse—two recording, two playback, two erase.

Three motors for perfectly smooth, silent drive and minimum wear—one Hall brushless d.c. motor for capstan drive, two d.c. motors to drive the reels.

Tape tension comparators for constant winding torque.

Automatic reverse (continuous reverse as an optional extra). Also manual reverse by pushing a button at any position on the tape.

Automatic stop at end of tape. Four-digit counter with pushbutton zero reset. Four-digit 'Auto-stop' to halt tape at predetermined point, with pushbutton on/off switch.

Genuine 2 x 20 watt (RMS) Hi-Fi amplifier, which you can use with the recorder's motors switched off. The N4450 can therefore form the heart of a top Hi-Fi system

Solenoid-controlled operation for quietness and reliability.

Illuminated tip-touch controls for transport functions and recording mode.

Optional extra unit gives full remote control of transport functions and recording mode, with the same illuminated tip-touch controls as the recorder.

Cursor-type slide switches for function selection – selected function is illuminated.

Precise sliding see-through controls for recording and playback.

Pushbutton select filters for rumble, scratch and physiology.

Mini-computer is programmed to 'remember' your instructions—prevents operational errors that might damage the recorder.

Synchronous clock with built-in device for starting and stopping the recorder at any predetermined time within a 24-hour period.

Sockets for record-deck, radio, another recorder, musical instrument, loudspeaker enclosures.

Roller blind at front conceals easily accessible sockets for microphones tape in/out and headphones.

Two calibrated, illuminated VU-type meters for recording and playback level indication.

Three speeds: 7½, 3¾ and 1⅞ ips.

Four tracks.

Three-step speed control for fast winding/rewinding.

Levers for cueing during fast wind/rewind.

Splicing device under lower head cover—both head covers easily detachable.

Suitable for horizontal or vertical operation; stereo or mono recording and playback; multiplay; echo during recording; A-B monitoring; mixing; playback and monitoring during recording by means of connected loudspeakers or headphones.

Recording stand-by (recording level adjustable with tape stationary).

Transparent lid has lower part hinged for easy access to controls.

To build the N4450, we drew on decades of experience in constructing professional recorders for computer installations, airlines and studios all round the world.

The same experience is behind a complete range of Philips Hi-Fi stereo tape recorders and a tape deck/ pre-amp.

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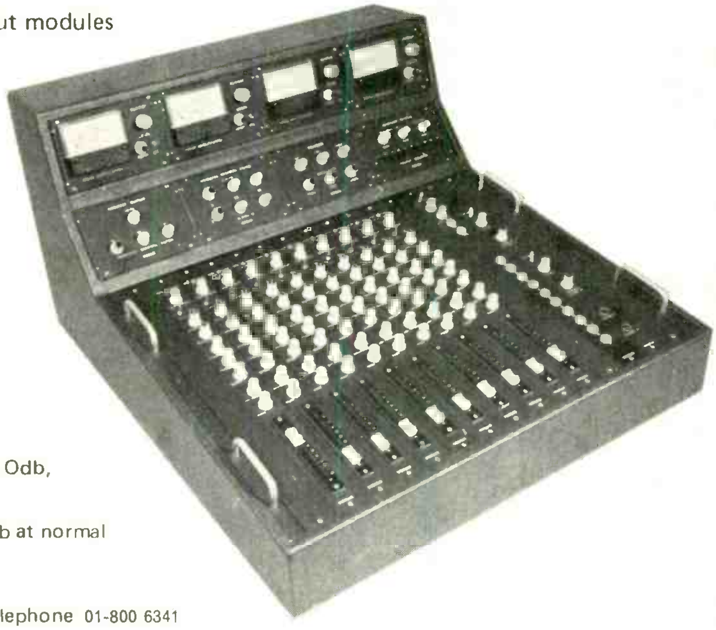
We want you to have the best.

PHILIPS

An example of the Midas modular system mixers.



Medium scale chassis, with space for sixteen inputs. The input modules shown include, sensitivity control and fader, pan and output group switch, fold back with pre-fade/post-fade switch, bass, treble, presence equalisation and reverb/echo mix.

The top level has four output modules with PPM calibrated Vu Meters and compressors.

The middle level accommodates the fold back output, talk back and headphone facilities, acoustic compensation filters and triple range crossover network. The lower level also includes a send and return panel.

Specifications

Inputs 0.2 mV into 200 ohms, 10 mV into 50K ohms.
Outputs normally OdbM into 600 ohms.
Overload range 60 db, low and high Z, channel outputs 16 db above Odb, Vu indication.
Line outputs Max level + 16 dbM
Signal to noise Ratio At maximum channel gain 66db, Typically 80db at normal gain settings
Distortion Less than 0.1% THD

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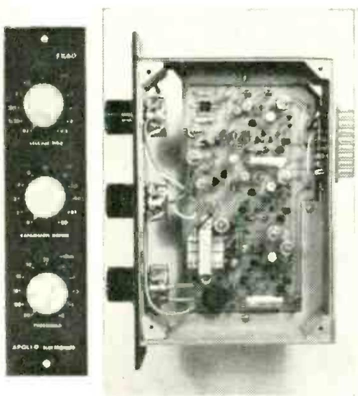

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CL36	compressor limiter, Max. compr. 36db, comp. ratio 1:1 to 1:72.
EX60	expander, for 0 to 60db reduction of noise, crosstalk and interf.
LA26	line output amplifier, Gain 0-26db, Zout. 50 ohms balanced.
PA10	monitor amplifier, 10W RMS into 8 ohms load, 32V AC supply req.
EPF4	echo send, pan-pot, foldback monitoring, for sound mixing desks.
TB90	mic. amp., Built-in dyn. mic., Gain 90db, press-to-talk switch.
M112	12 input to single output summing amplifier, unity overall gain.
MCH7	mixer input channel, for up to 24 channel portable mixers.
MGR5	mixer output group with built-in compr.-limiter, for use with MCH7
MP62	magn. P-U amplifier, 4 equalisations, sensitivity and 2 filter sw.
TH68	tape replay amplif., single NAB equal, but adj. from 1 and 7/8 to 15 IPS.
TRP1	tape replay amplif. and monitor amplif., dual NAB, A-B monitoring.
TRR1	tape record amplif. and bias amplif., dual NAB, record/safe/sync. sw.
TRE1	tape erase amplifier with erase kill switch.
TRB1	tape bias oscillator, can drive up to 24 pairs of TRR1 and TRE1.
PS24	power stabilizer, input 30V AC, output 24V DC/1A short circ. prot.
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This rationalised system allows numerous applications for mixing and amplification—the modules have been developed over the past four years and successfully used in discotheque mixers, studio mixing/recording equipment and custom-built installations. The system now features a universal Mother Board which is designed to accommodate these modules, enabling the manufacture of a wide range of equipment from standardised units.
The modules are constructed on fibre glass printed circuit boards with gold plated edge connectors. These have outstanding performance in respect of extremely low distortion, less than 0.01% at rated output, together with high overload capabilities and overall frequency responses of ± 0.5 dB.

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

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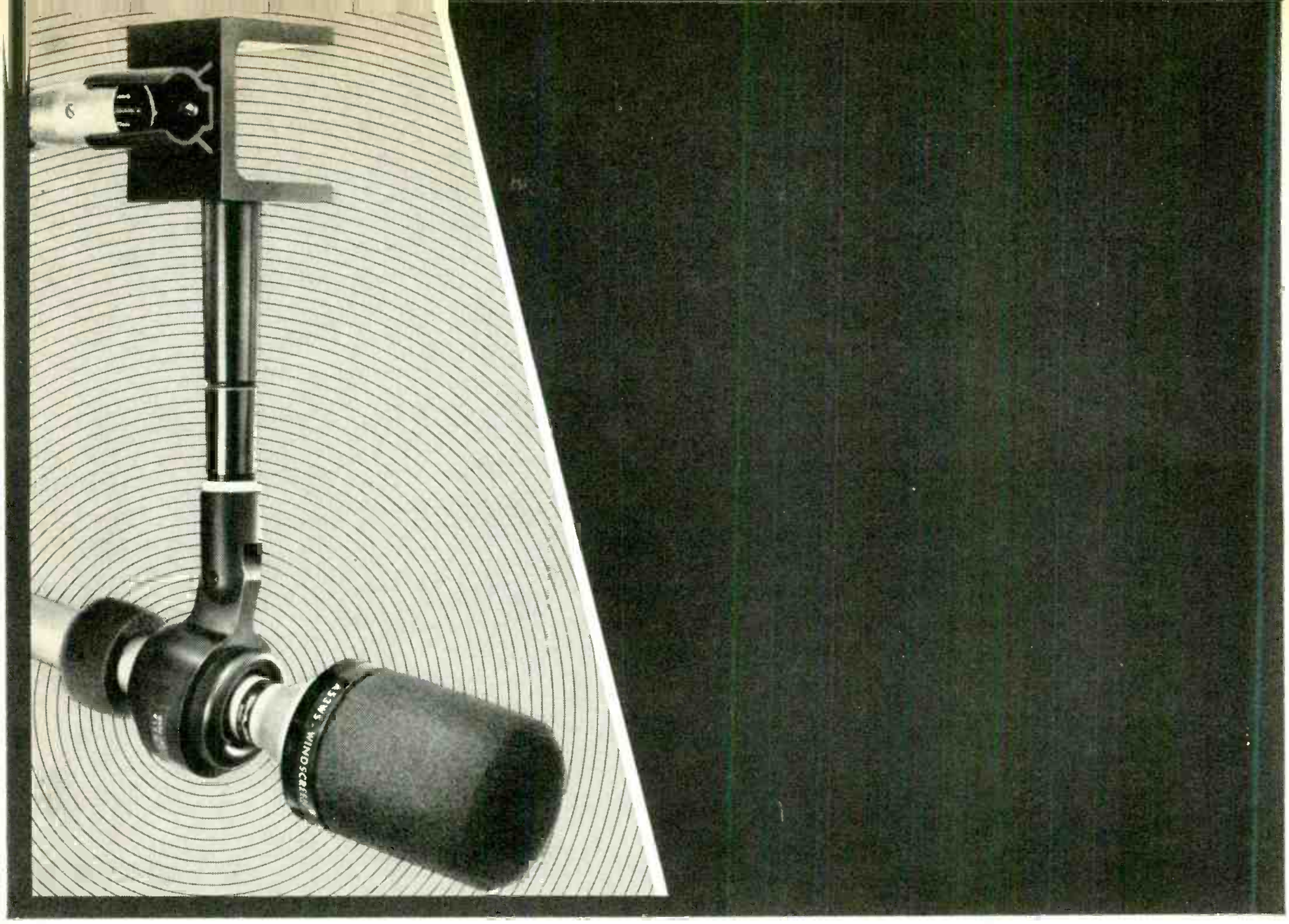
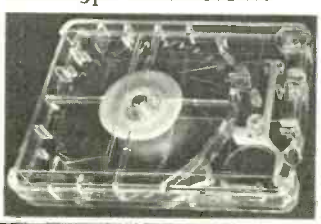




Once you decide what you want from a good receiver, choose the Sansui to match.

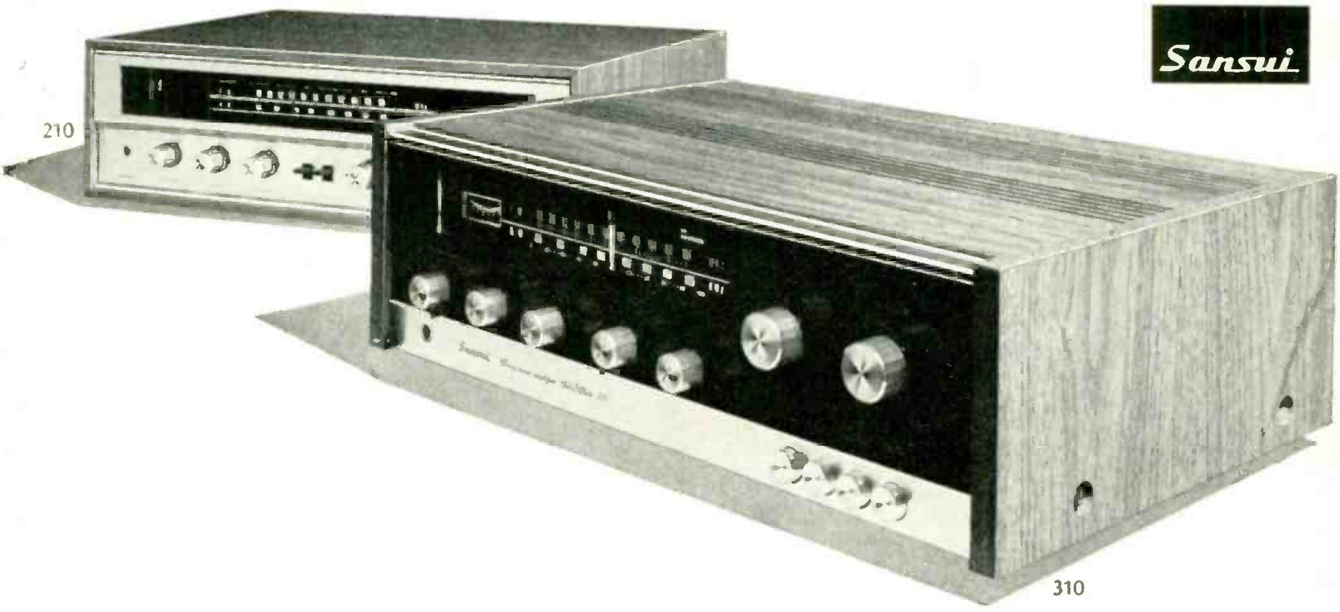
If you just want a good all-around receiver that puts out 34 watts, has top FM reception capabilities (MOS FET in frontend), holds down distortion and connects all the necessary source components including a pair of speaker systems, the Sansui 210 certainly fits the bill.

But if you're looking for something more in a receiver, say more power, and even better FM reception capabilities (MOS FET & IC), and provisions for driving up to two pairs of speaker systems, then the 44 watt Sansui 310 is your kind of receiver.

Obviously, the 310 costs more than 210 and could be a factor in your decision, but you get a good receiver no matter which way you choose. At your nearest Sansui dealer.

	310	210
Music Power (IHF)	44W at 4Ω	34W at 4Ω
THD (at rated output)	less than 1%	less than 1%
Power Bandwidth (IHF)	25 to 25,000Hz	30 to 25,000Hz
Channel Separation (AUX)	better than 55dB	better than 45dB
Hum and Noise (IHF) AUX	better than 75dB	better than 70dB
FM Sensitivity (IHF)	2.8μV	5.5μV
S/N Ratio	better than 60dB	better than 50dB

Sansui



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News

Factory news

EMI HAVE had to postpone all their new album releases for at least two months. The decision will affect about 80 lps comprising all the new classical and pop releases which were due to be issued during November and December. It follows an unexpected increase in album sales for the summer months which coincided with EMI's move to their new factory. By an unfortunate coincidence, reports about the factory's problems began to reach the press just as a press release describing the advances that the Hayes plant represented was issued by one of the factory's suppliers. The release, from Dexion and Dexion Auto Flow Systems, said: '. . . the eight-acre distribution centre has been designed and equipped with particular emphasis on distribution speed and is capable of handling up to 300,000 records a day—a 50 per cent increase on the company's previous distribution capacity'.

A spokesman for EMI said that demand for albums had been half as much again as had been expected. 'Normally July and August are completely dead,' he said. Now that the stagger introduction of new disc presses has not gone according to plan, EMI has been caught up in the usual high pre-Christmas demand for albums. Lps already in the catalogue will not be affected by the delay, but pressings which EMI has undertaken for other record companies will be. It is not yet clear whether two months will be enough to clear the backlog of new releases.

When asked if, in view of the present situation, the increase in production capacity of half would be enough, the spokesman said that that remained to be seen. 'We hope it will be,' he said.

Stellavox comments

LAST MONTH Mr R. Woolford commented on Mr Hugh Ford's review of the Stellavox *AMI* mixer. We were unable to include Mr Ford's reply, which now follows:

I am very glad to note from Mr Woolford's letter that many of my criticisms of the *AMI* mixer are resulting in modifications to improve the performance and I should be pleased to investigate a modified version in due course.

To deal with Mr Woolford's comments, I would firstly like to make it clear that I review equipment of this type from a non-engineering user's point of view. Therefore, a missing fuse is irritating and no indication of the correct value of fuse decidedly embarrassing. The APS power unit as supplied was potentially dangerous on two scores.

On the subject of distortion I am not going to disagree with the figures quoted because the output distortion is extremely critical upon the precise setting of the master and channel faders, which give a characteristic such that distortion *increases* when the input voltage is *reduced*. Also, as Mr Woolford points out there are circumstances where full mixer output is not attainable in spite of an adequate input to the mixer.

Finally, I did note the Stellavox recommendation for the setting of the faders but this has no relation to my criticisms of the poor signal-to-noise ratio when using a line input: or to the differing sensitivity of the microphone channels four and five which certainly should be mentioned in the specification.

Studio news

CTS STUDIOS, formerly of Bayswater, moved all their recording work to De Lane Lea's Wembley studios on November 10. The move was necessary because the site of the Bayswater studios is being redeveloped. As the first of a series of management changes, Peter Harris and John Richards, formerly chief engineer and senior balance engineer, have been made executive directors of CTS.

De Lane Lea have also made some management changes; Louis Elman has been appointed chief executive of De Lane Lea at Wembley. Dave Siddle has been appointed technical director, responsible for the running of the studios' technical facilities.

Studio Diary will be continued next month. Items which would have been in this month's diary will be included.

People

MR GEORGE DOUST retired from Plessey on September 30 at his own request to take up directorships with Automatic Light Controlling, Chemring and Welwyn Electric. Welwyn recently made extensive management changes. Mr Orlando Oldham, director and deputy chief executive of the Royal Worcester group, of which Welwyn is a subsidiary, has been appointed chairman of Welwyn. He succeeds A. F. Street, chairman and chief executive of Royal Worcester, to whom he will be responsible. Mr R. H. W. Burkett is resigning as managing director of Welwyn and will serve the company in a non-executive capacity as deputy chairman and consultant director. His successor is Mr J. E. Herrin. Mr C. W. Martin, director of production services, retired at the end of September after 28 years with the company.

A *BE1000* recorder undergoing final test at the Bias Electronics factory, Raynes Park. This was one of eight machines being shipped to Delta Equipment Ltd of Belgium and destined for Major Studios in Brussels.

In Brief

WESTINGHOUSE Broadcasting Company have ordered three more *ACR25* videotape cassette recorders from Ampex for their television studios in Boston, Mass., Baltimore, Ohio, and Pittsburgh, Penn. They already have one at KYW tv in Philadelphia.

SIR JOHN EDEN, Minister of Posts and Telecommunications, will open the *Marketing Communications Tomorrow* convention and exhibition at the Bournemouth pavilion on April 11 next year. The exhibition, held by Electromation Exhibitions Ltd, will feature technical papers, demonstrations and displays about marketing and communications.

THE GUILD of Health Education Officers has sponsored a record called Drug Taker. It will be released on the Young Blood label and the song, described as 'in the modern idiom', is a propaganda exercise intended to discourage young people from taking drugs. An optimistic handout from the Guild says: 'The aim is to get the record into the record charts, so that young people will be encouraged to buy it and so that it will be featured on all the record programmes produced by the mass media'.

THE THREE modern microphones shown on the stamp which commemorates the BBC's fiftieth anniversary are made by AKG. They are the *D202*, the *C451* and the *C28*.

Farnell comments

THE FOLLOWING reply has been received from Mr P. A. Lamming of Farnell regarding Hugh Ford's review of the *LFM 2* Oscillator:

We were very interested to read your review of our *LFM 2* Sine/Square Oscillator in your October issue. The review was, on the whole, a very fair assessment, although we have a few comments worthy of mention.

The meter is calibrated in volts peak-to-peak not only to give a useful indication on squarewaves but also because we feel that for its main application as an electronic engineer's test instrument the peak-to-peak voltage of the sine wave is the parameter of most interest to him.

Regarding the 600 ohm loading—this is not essential, the meter reading is still correct when the unit is unloaded on the unattenuated

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Patents

By Adrian Hope

Another video disc

Messrs Johnson, Melchrur and Hanson, all of California, USA, have patented (BP 1,285,999) a video disc system which seems surprisingly simple—so it also seems surprising that no one has thought of the system before.

A fairly ordinary looking disc has a groove cut into at least one of its sides, the groove being similar to that on an ordinary gramophone record but without any modulation. This is because the groove is intended solely to track a guide needle which controls a recording/readout head. This head is thus guided across the surface of the disc in exactly the manner of a gramophone cartridge but the head overlies the flat spiral land which is defined between adjacent turns of the groove. It is on this flat land that the information is stored (**fig. 1**).

Information storage is achieved by means of a continuous wave laser beam which is modulated with (usually video) information by for example an electro-optic Kerr cell. As the disc passes beneath the record head, the laser beam is deflected in radial scanning lines so that it produces radial streaks. The actual storage of information is by localised evaporation of the surface material of the disc.

The material of the disc is usually provided with a mirror surface so that reflective readout is achieved with a television camera or flying spot scanner which recreates the original video signal by means of a photo cell detector. Probably the easiest way of achieving this will be by a half-silvered mirror through which light is shone on to the land to produce reflected light of varying intensity.

The patent suggests various ways of achieving modulation and scanning, including a vibrating prism, an electro-optic Pockel's cell, a ferroelectric ceramic lattice shutter and an interference filter matrix. The calculations which suggest the amount of video information that can be stored which are most interesting. The inventors claim that, by using a high resolution microscope, video information in a band width of 6 MHz can be recorded and read out. They maintain that a 30 cm disc, read with a *44X* achromatic microscope lens, can store almost four and a half hours of video playback on each side.

Magnetic signal processing

Nippon Victor Kabushiki Kaisha in BP 1,285,475 claim improvements in the art of video recording with provision for slow motion or still playback. A problem with still or slow motion playback is that, if the subject is in motion between two fields of an interlaced scanning system, the reproduced still will be blurred. To avoid this, recording and playback using a single field is called for and this presents problems. Nippon suggest various processing methods including introducing regular line interlace into a video signal by adjusting the phase of appropriate fields relative to the remaining fields. This is to be under the control of a switching signal derived from associated equalising pulses, all the vertical synchronising pulses being treated identically to maintain their phase relationship.

In **fig. 2** they show a video recorder using a magnetic disc 10 driven by a motor 11 with magnetic heads 14 and 15, one on each side of the disc and moved radially relative to the disc by stepping motors 16 and 17. The disc makes one revolution for each video field, the first field being recorded on the outer circular top track by head 14 and the second on the outer circular bottom track by head 15. Simultaneously head 14 is stepped inwardly by two tracks and the third field is recorded by head 14 while head 15 is stepped inwardly by two tracks. Thus, fields are recorded alternately on the top and bottom of the disc in a similar way until the disc centre has been reached. Then recording continues by stepping the transducers alternately outwards using the tracks that were skipped during the inward motion. When the outer rim of the disc is reached again, the cycle continues with the original tracks being erased. In **fig. 3** Nippon show the block schematics for recording and playback. The video signal to be recorded is applied to fm modulator 24 and its output applied via gate 25 and amplifiers 26 and 29 to the heads 14 and 15. The gate is controlled by pulses from a generator 34, which is synchronised by frame pulses—in this way alternate fields are applied to the heads 14 and 15.

For playback the signals from the heads are applied via preamps 37 and 38 to gate 39, combining the signals to form a reconstituted channel which is applied to limiter 40 and demodulator 41. This video signal is applied to field setting circuit 44 which corrects the interlace during slow or still playback.

At 44 the video signal is applied to fm modulator 46 and the output therefrom is applied to an H/2 (half line period) delay line 47. The video signal also passes through network 48 and the delayed or undelayed signal is selected by switch 49 (noise is removed by limiter 50) and the signal applied to demodulator 51. The stepping motors 16 and 17 are controlled by pulse generator 34, which has logic circuits so arranged that the switch 39 and the motors 16 and 17 operate to reproduce each field a predetermined number of times when slow motion display is required (the actual number depending on the speed reduction ratio chosen). Because this results in consecutive fields without interlace, further logic circuitry is used to control the switch 49 and introduce an H/2 delay when necessary to produce a required interlaced signal.

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FIG. 1

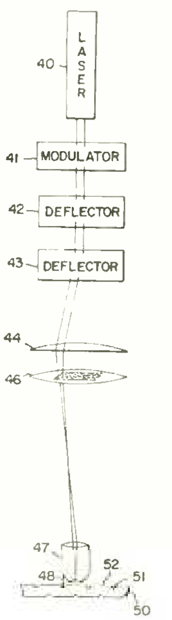


FIG. 2

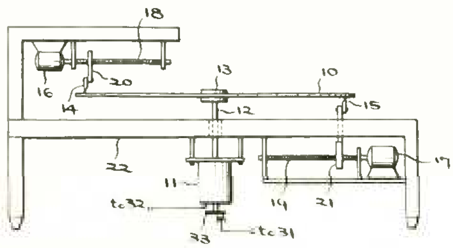
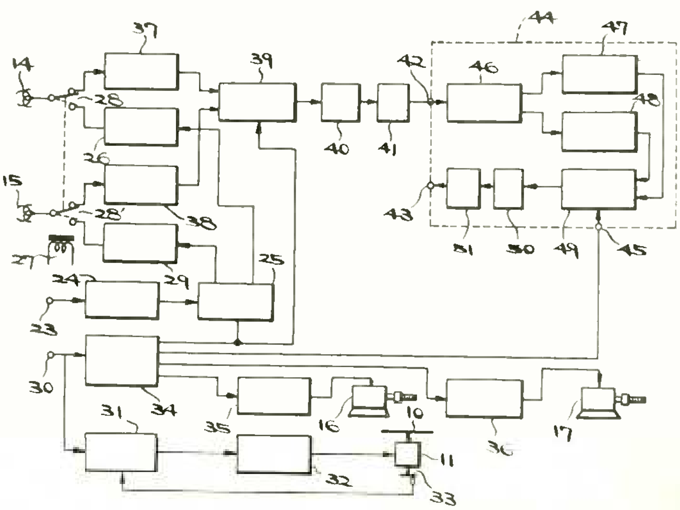
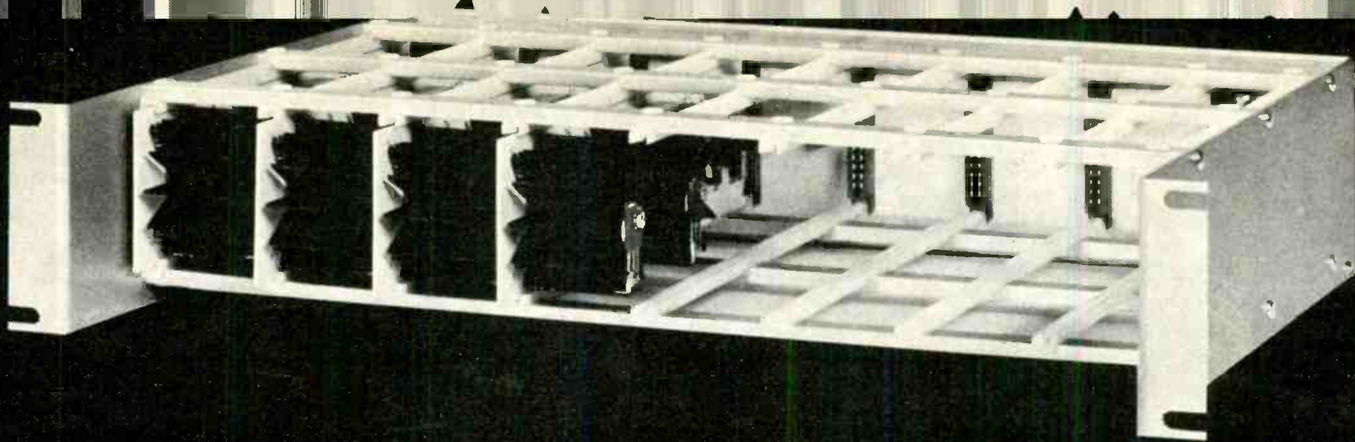


FIG. 3





Telecine

In BP 1,287,889 the BBC provide a useful brief run-down on current telecine techniques. There are two main telecine machine 'breeds'. The first is the camera-tube type in which the film is illuminated intermittently by a light source and each illuminated film frame is imaged on a camera tube. For colour transmission separate images of the film frame are formed on separate tubes via different colour filters—rather like the old Technicolor camera technique. The crucial factor is that the film is not illuminated during its pull-down period. But the BBC say that such machines tend to give noisy pictures and are expensive to maintain because camera tubes fall relatively quickly by the wayside.

The flying spot type of telecine machine uses a short after-glow crt of which the scanning spot is imaged on the film as it moves continuously, i.e. at constant rate, rather than intermittently, through a gate. Complex shuttering and double lens systems allow interlaced scanning. (I believe this technique can provide for easy electronic handling of anamorphically compressed film images, without special lenses, simply by altering the scanning.) The light passing through the film is sensed by a photomultiplier which produces signals for processing and transmission; colour transmission involves splitting this light by colour selective filters and mirrors and beaming it to different photomultipliers.

What the BBC now seem to be patenting is something of a hybrid version of telecine machine. **Fig. 4** shows a flying-spot scanning tube 10 with a lens 11 which forms an image of the spot on the film 12. Light passing through the film is collected by condenser 13 and applied to photomultiplier 14. Signal processer 15 produces a conventional tv signal.

The film is moved intermittently, frame by frame, in a manner conventional for a camera tube type telecine, this being achieved by pull-down mechanism 16. During the pull-down interval, the signal produced by the processer 15 is thus useless. For this reason the signal processer output 20 is preceded by electronic switch 21 and a delay line interpolator 22 is provided for storing the output of the processor for a predetermined number of field periods. Thus when a detector 23 senses film pull-down movement the output of processor 15 is switched out by switch 21 and interpolator 22 fills in the gap with signals from a previous field to produce a complete output signal.

But since consecutive fields are interlaced and two field periods are required to make a complete picture, the lines of one field are not exactly in the same vertical position in the picture as the lines of the next field. Instead, they fall between them. In order to correct for this, the interpolator has two stores arranged in cascade—a delay line of one field period less one half line period and a delay line of one line period. The outputs of these two delay lines correspond in picture position to lines which lie vertically immediately below and above the line from the field they are to replace. So the two delayed signals are simply averaged to provide an interpolated line to 'complete the picture' at the output.

Colouring monochrome film

THE film industry must be continually in despair at the fact that it produced so many films in black and white—when almost everything, including newsreels, now has to be in colour or people will stay at home. Only occasionally does a black and white film make money and then usually because the story line calls for a monochrome treatment. But the film industry has never been noted for its backwardness and various techniques have been tried for adding colour to monochrome films. Among unsuccessful techniques have been the individual colouring-in of picture areas frame by frame throughout the whole length of the film, rephotographing the film through carefully cut colour filters, and using overall colour washes (red for fire scenes, etc). Although at first sight it seems that the basic task is a hopeless one, it is particularly interesting to see BP 1,285,759 from Minnesota Mining & Manufacturing Company. What 3M propose at first sounds ridiculous—but on careful reading, one feels they may well be on to something.

The film is projected frame by frame via mirrors on to a table carrying white sheets of drawing paper. Also lined up via mirrors to rephotograph the projected frame is a single-shot cine camera loaded with colour film. The single frame projected on the white sheet of paper is of course in monochrome but an artist colours in the paper on which it is projected, using the picture as a guide. The crux of the whole invention is that this colouring-in technique can be crude and quick. No attention need be given to details and an astonishingly limited range of opaque colours can be used for the whole picture area. This is because the composite or final result (as seen and photographed by the colour camera) is a visual mix of carefully graded greys plus these basic opaque colours. According to 3M, even a straw and wood roof can be coloured with a single common colour but show up distinctly and unambiguously as straw *and* wood by virtue of the mix effect of the greys plus that single colour.

The system can be speeded up considerably by adopting the cartoon film maker's technique of using a transparent screen over the white paper sheet. For the first shot of a scene, the white paper screen is fully coloured up for background only. Any moving characters are painted up only on the transparent screen, which is then scrapped and replaced with a fresh cel for the next shot, with the same coloured up background underneath. As the shot pans, the background sheet of paper is moved across the picture area to coincide with the pan.

Although the technique is obviously time consuming, if it works as well as 3M claim, it could be well worth while—especially as it is far less time-consuming than cartoon work.

Transmitting vision signals direct to the brain

BP 1,286,316 from Hermann Mengeler must be reported in view of its relevance to the ZCM patent reported last month which related to the direct transmission of sound signals to the brain without the intermediary of the ear. For Mengeler has quite independently patented the video equivalent.

One theory concerning the perception of visual images is that the retina is considered as an externally placed part of the brain and the neuronal signals produced by its optical stimulation consist of electrical pulses of between 0.3 Hz and 1 kHz. The image produced on the retina is apparently quite incomplete but the cerebral cortex co-ordinates the neuronal signals to image impressions corresponding to earlier experiences.

Mengeler claims that numerous tests on totally blind persons have suggested that a high frequency image signal of suitable potential can stimulate the optic nerve to produce

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FIG. 4

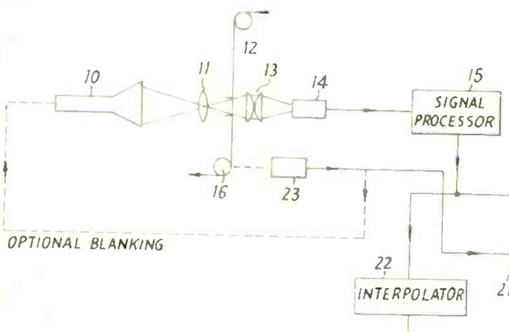
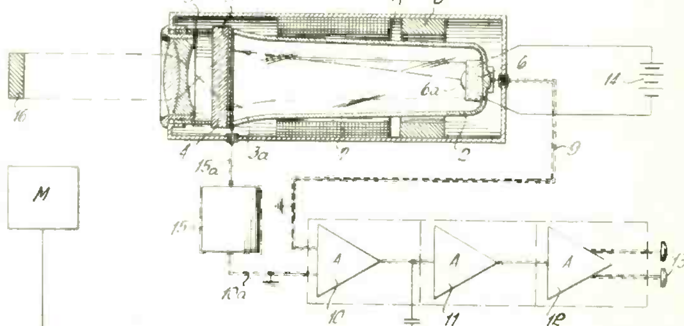


FIG. 5



The Ferrograph RTS1 has been sold to audio professionals in 48 countries since its introduction 18 months ago. It has sold because it is such an obviously good idea, and there is nothing else like it in the field.

Even so Ferrograph have not just rested on their laurels. Success has bred a successor – the RTS2.

RTS2 and the non-alternative.

The RTS2 is a small and very clever box of tricks. It provides facilities required by the audio workshop or recording studio to measure the performance of a wide range of equipment including reel to reel and cassette tape recorders, amplifiers, and disc reproducers.

The alternative is an awkward, virtually immovable selection of separate items of test gear which will actually cost far more than the neat and efficient RTS2. *Alternative?*

New specification

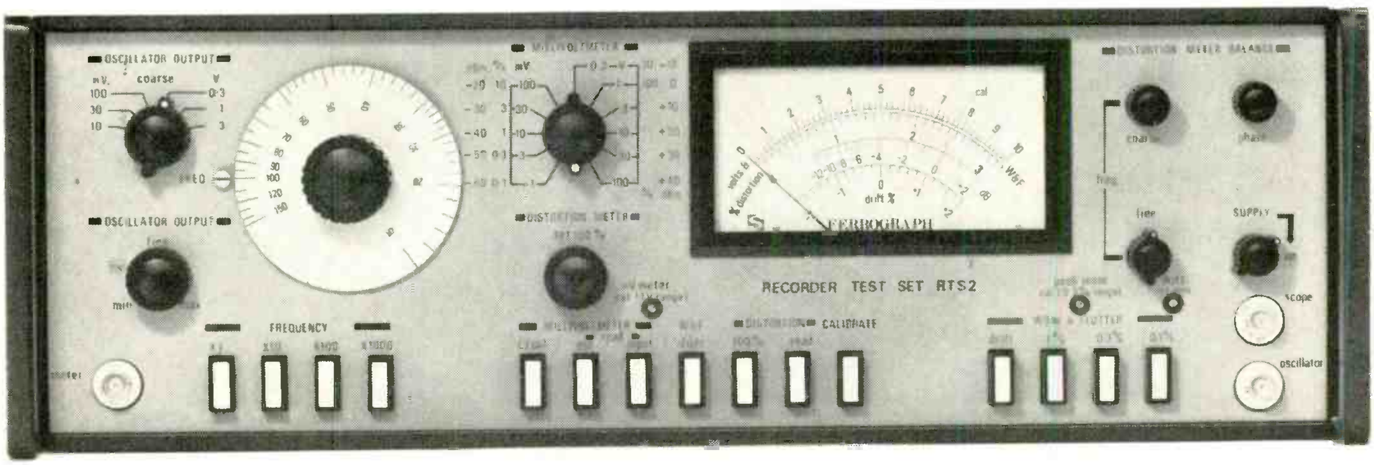
In one essential the RTS2 is unaltered. It costs exactly the same as the RTS1.

But it now has an improved stabilised power-supply, simplified distortion-meter controls, a millivoltmeter that is calibrated in dBm as well as volts. And there is now a third wow-and-flutter range, in addition to the 1% and 0.3% range the RTS2 includes a 0.1% range.

For the full specification please write or telephone for literature.

Successor to one of our successes

the new Ferrograph RTS2 audio test set



The RTS2 combines a millivoltmeter, distortion meter, peak to peak wow & flutter meter, and audio generator.

Please send me details of the Ferrograph RTS2 or telephone Burnham 62511 Telex 847297

NAME

ADDRESS

THE FERROGRAPH COMPANY LIMITED
Auriema House, 442 Bath Road,
Cippenham, Slough, Bucks. SL1 6BB. SS/LLC.

FERROGRAPH

A member of the Wilmot Breeden Group

signals which reach the visual cortex and generate adequate image impressions. This is despite the fact that the optic nerve normally passes on only internally produced frequencies of 0.3 Hz to 1 kHz, as mentioned above.

The claim is to use an optical system 5 to focus an image on a storage plate 3 with a thin coating 4 of material such as lead sulphide or magnesium sulphide. By scanning the plate 3 with an electron beam from a heated cathode 6a, there will be produced a television type signal which can either be monitored in normal manner or amplified at stages 10, 11 and 12 and fed to electrodes 13 applied to the temples of a blind person. The scanning is by magnetic or electrostatic techniques and a photoelectric intensity regulating device 15 is used so that the intensity of the light impressions can be adapted to the sensitivity of the person receiving them. According to Mengeler, voltages of around 7.5 to 10V applied to the electrodes will produce perceptions in the visual cortex of the subject which are initially uncoordinated. Mengeler claims that, with practice, the perceptions can by association be coordinated with the appropriate images in the centre of memory and formed into comprehensible image impressions.

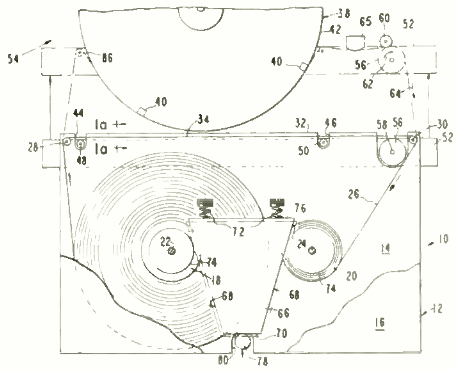
The Mengeler patent in particular should not be ignored because details, such as his comments regarding the critical placing of the feed points at the temple areas, suggest that tests really have been done and that the whole thing is not one big hopeful pipe dream.

Video cartridges

In BP 1,286,470 Cartridge Television Inc of New York provide what must be among the first of the inevitable eventual avalanche of patented details for enclosed video tape systems. This particular 'cartridge' will be kept small in dimensions because the two tape rolls are on hubs which are close together but never jam because one is decreasing in size as the other increases (fig. 5). The tape runs in a long free stretch along and outside one edge of the cassette (rather like exaggerated C60 audio cassette) and is guided in and out of the case by two rollers. When the cassette is loaded into the video machine, the bar is moved outwards towards a rotating drum and the tape is wrapped around a fairly substantial part of drum circumference.

The drum itself carries transducers at intervals around its circumference (apparently at angular spacings of around 60°). The drum (and thus the transducers) is on a tilt with respect to the cartridge and tape so the transducers scan the tape along slant tracks.

FIG. 6



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

September 6, 1972

1292863
Matsushita Electric Industrial Co Ltd
Voice clock apparatus
1292884
Xerox Corporation
Acoustical coupling apparatus
1292891
Neutra Cuatro SA
Electronic pulse generator
1292945
International Business Machines Corporation
Magnetic head assembly and method of making the same
1292976
Olympia Werke AG
Hand microphone for sound recording and reproducing equipment
1292989
Texas Instruments Inc
Light beam deflection
1292994
EG & G Inc
Stabilization circuit for a waveform of varying level
1293112
Eastman Kodak Co
Motion picture film cartridge
1293113
Storage Technology Corporation
Magnetic recording system
1293205
International Business Machines Corporation
Transducers for tape transport apparatus
1293233
Barnes Eng Co
Infrared thermograph having an automatic brightness control
1293242
General Electric Co
Method of forming single turn magnetic read/write head
1293251
Burroughs Corporation
Magnetic head actuator device
1293271
Itek Corporation
Magnetisable information storage element
1293306
Daniel Chun Chang
Amplitude sensitive magnetic marking and self-muting mark sensing system
1293315
Philips Electronic & Associated Industries Ltd
Field-sequential colour television camera including a colour filter and one camera tube
1293403
Telestrator Industries Inc
Visual display systems
1293457
RCA Corporation
Liquid device
1293459
RCA Corporation
Corporate-network printed antenna system
1293469
Lesa Costruzioni Elettromeccaniche Spa
Tape recording apparatus
1293506
Sumlock Anita Electronics Ltd
Video display systems
1293612
Thomson-CSF
Wide-band omnidirectional antennas for very short wave working
1293636
Fonofilm Industria A/S
Electromechanical transducers
1293670
Siemens AG
Electroacoustical transducers
1293688
Konishiroku Photo Industry Co Ltd
Isodensity recording system

September 13, 1972

1293737
Sperry Rand Corporation
Electromagnetic energy radiating apparatus
1293776
Ampex Corporation
Erasing signals from magnetic discs
1293799
Agfa-Gevaert AG
Cameras
1293800
Post Office
Burst synchronisation method and apparatus
1293816
Siemens AG
Radiotelephony systems
1293847
EMI Ltd
Video mixers
1293890
Deutsche Akademie Der Wissenschaften Zu Berlin
Arrangement for converting electrical signals into optical signals
1293901
Jordan, E P
Video or video and sound distribution system
1293958
Telefunken Patent-verwertungs GmbH
Colour television receivers
1293976
Hengstler KG J
Circuit arrangement for detecting deviations of pulse parameters from prescribed values
1294012
Tamura Electric Works Ltd
Tape control apparatus of tape processing machines
1294015
Agfa-Gevaert NV
Magnetic flow meter
1294024
EMI Ltd
Aerial arrangements
1294029
Leblanc Corporation G
Musical wind instruments
1294051
Hitachi Ltd
System for detecting the end of magnetic tape
1294100
Nippon Victor KK
Jitter correction system for magnetic recording and reproducing apparatus
1294108
Kudelski, S
Use of an electronic circuit forming a non-linear and variable impedance
1294118
Westinghouse Electric Corporation
Electronic imaging system
1294149
Sony Corporation
Video signal generating apparatus
1294150
Memorex Corporation
Disc data storage system
1294162
International Business Machines Corporation
Graphic display system
1294178
Normalair-Garrett (Holdings) Ltd
Feeding magnetic tape for tape recorders
1294191
Crossfield Electronics Ltd
Apparatus for reproducing coloured images
1294258
Andrew Corporation

continued 30

PATENTS

continued

Radiating coaxial cable and method of manufacture thereof
1294286
Kabel-Und Metallwerke Gutehoffnungshutte AG
High frequency line
1294305
GABR, S Z M
Station for connection to a telephone system
1294348
Marconi Co Ltd
Cathode ray tube arrangements
1294363
Hell, Dr-Ing Rudolf
Method for the dot-by-dot and line-by-line rastered recording of picture signals obtained by scanning half-tone pictures
1294368
Philips Electronic & Associated Industries Ltd
Television display apparatus
1294402
Sony Corporation
Registration system for colour television camera
1294404
Defence, Secretary of State For
Ultrasonic inspection devices
1294405
RCA Corporation
Colour television video signal processing apparatus
1294489
Solartron Electronic Group Ltd
Linearising circuit

September 20, 1972
1294506
Brown Ltd S G and Townsend, D B K
Throat microphones
1294536
Ventures Research & Development Group
Self-adaptive system for the reproduction of colour
1294572
Lanier Electronic Laboratory Inc
Tape control device
1294584
Nippon Kokan KK
Pattern measuring systems
1294616
International Business Machines Corporation
Container for holding a flexible record member
1294617
Matsushita Electronics Corporation
Synchronising signal separating circuit
1294618
Fernseh GmbH
Television apparatus
1294643
Casio Computer KK
Apparatus for synthesising characters
1294811
Barbier, P E
Audio apparatus for aiding drivers of motor vehicles
1294815
Commissariat A L'Energie Atomique
Device for producing rectangular voltage pulses of very small width between two outputs
1294825
Badische Anilin & Soda-Fabrik AG
Magnetic disc pack and arrangement for aerating same
1294831
Chu Associates Inc
Balanced tunable helical antenna
1294836
Dutton Hayward, H Schulein, J and Schulein, M A
Signalling system responsive to pulses within an amplitude range
1294892/3
RCA Corporation
Coloured light encoding filters
1294903
Pioneer Electronic Corporation
Magnetic head and method of manufacturing the same
1294914
Galtykhin, V M Gurevich, L J and Tezikov, B B
Electrical monitoring arrangements
1294942
Fernseh GmbH
Colour television
1294948
Eastman Kodak Co
Method of recording information
1294956
Bosch Elektronik GmbH Robert
Selective call evaluator and transmitter
1294960
Standard Telephones & Cables Ltd
Electro-acoustic transducer
1294963
Licentia Patent-Verwaltungs—GmbH
Time-division multiplex circuit for the transfer of sets of data from a store to one of a plurality of transmission channels
1294996
Matsushita Electric Industrial Co Ltd
Signal selecting systems
1295093
Solartron Electronic Group Ltd
Cathode ray tube circuits
1295107
International Standard Electric Corporation
Horizontal-deflection circuit for colour television receivers
1295136
Staar SA
Anti-vibration device for the movable plate of tape recording and reproducing apparatus
1295144
'Licentia' Talamanyokat Ertekesito Vallalat
Contact feeler for sensing mechanical magnitudes such as pressure changes and vibrations
1295155
International Standard Electric Corporation
Television receivers
1295161
Hammond Corporation
Keyer-synthesiser
1295172
Bosch Electronik GmbH, Robert
Selective call evaluators

September 27, 1972
1295241
Aviation, Minister Of
Methods and means for reducing reflections of electromagnetic waves
1295272
Rank Organisation Ltd
Television recording
1295466
Pioneer Electronic Corporation
Automatic record player
1295475
Pye Ltd
Intermittent carrier transmitter changeover system
1295505
Konishiroku Photo Industry Co Ltd
Method for recording a photographic density
1295602
Philips Electronic & Associated Industries Ltd
Detachable pickup cartridge
1295633
Defence, Secretary of State for
Soft valve circuits
1295646
RCA Corporation
Electronic halftone image generator
1295653
Philips Electronic & Associated Industries Ltd
Television receiver
1295663
Century 21 Film Props Ltd
Television synchronising system
1295701
Ricoh, KK
Motion picture film projectors
1295768
Borruso, S
Chord key for string instruments
1295769
RCA Corporation
Signal processor
1295845
Co-El Complementi Elettronici, SPA
Broad band electro-magnetic wave radiating system
1295919
Arvin Industries Inc
Tape transport system
1295993
Gogen GmbH, Wolfgang
Apparatus for positioning a magnetic head
1295994
Chicago Musical Instrument Co
Musical instruments

NEWS

continued

position, the 600 ohm refers to the load into which the attenuator is designed to operate exactly, but since the attenuator has a low output impedance of 60 ohms, no great error results from operating into other loads.

We accept your criticism that there are insufficient dB calibrations on the meter and on future instruments we shall have more divisions.

Apart from the fact that the distortion level is too high for the audio engineer to make useful analyses on his equipment, we feel that the *LFM 2* is a useful tool for checking and servicing audio equipment.

Boobs

IN DAVID ROBINSON'S Peak Overload Indicator article in the September issue there were two mistakes in fig. 2: R24 should be 10 ohms, and the connections to transistors Tr3 and Tr4 should be interchanged, pins 14 and 11 being reversed. The printed circuit board for the circuit is correct.

November's 'Diary' said that the film Macbeth had been dubbed at AIR. Mr Nolan Roberts, head of sound at Shepperton, has told us that it was done at Shepperton studios. We regret the mistake and apologise for any inconvenience caused.

Also in that issue, on page 81, we gave the power response of the Spectra Sonics *700* power amplifier as ±1 dB into 8 ohms. This should have read ±0.1 dB into 8 ohms.

50th birthdays for sale

AS ANOTHER spin-off from Auntie's 50th Birthday, BBC Records have introduced a new series of lps.

The launch at Bush House was a glorious wallow in nostalgia. Many of the records backtrack over 50 years of broadcasting and BBC stalwarts like Wilfred Pickles, John Snagge, Henry Hall and Sam Costa arrived to pose for photos round an aged carbon microphone.

Before tape, almost everything was live and few official recordings exist. Location recordings were made on disc, editing involving jumping the needle in the groove with a cueing device. This, together with union problems concerning the rates to be paid on extant Jazz Club recordings, has meant that the jazz is off commercial issue discs (including rare old 78s). Bang up to date is *the last Goon Show* of *all* and Steve Allen's lp of the Radio Big Band. Snatches of the latter heard through headphones while slightly inebriated suggest beautiful (as usual) engineering by Robin Sedgeley.
A.H.

Audiotek Address

AUDIOTEK HAVE moved to a new office at Farrington House, St Albans Road East, Hatfield, Hertfordshire, England. The new telephone number is Hatfield 65251 and that of the telex is 28332.

Recording Studio Techniques

BY ANGUS MCKENZIE

Further thoughts on microphone placement

Part Two

I RECENTLY recorded two symphonies by Havergall Brian in the De Montfort Hall, Leicester. It was fairly obvious from the beginning that a simple stereo pair would be unsuitable because of the hall's extremely bad flutter echo between the domed roof and the floor, and also because of the rather poor reverberation characteristic when the hall is empty. I therefore decided that in addition to a main stereo pair I would use coincidental pairs over the violins, low strings and woodwind. A *C24* was used above the violins and angled to pick up both harp and french horns. The microphone's output was panned between left and centre, and a small amount of top cut was added to offset the slight treble peak in the microphone at 10 kHz. Two *C12A* were slung above the violas, cellos and basses, and panned centre and right, the vertical angle of the microphones also being chosen to pick up trumpets, trombones and tubas. Two Beyer *M160* cardiods were placed as a pair above and looking down on the woodwind section, and angled at about 90°. The vertical angle was fairly critical, as the microphones were also used to pick up some percussion. Additional mics were used on solo violin, percussion and off-stage trumpet.

Before adding any of the extra mics to the balance, however, the polar diagram of the main stereo pair was carefully selected and widened slightly, to achieve a satisfactory sound; only a relatively small amount of the outputs from the closer mics was added to produce an overall balance. I feel that this type of balance, when listened to carefully, is heard to give a better sound on orchestral climaxes than is achieved with more spot mics panned in as single mics rather than pairs; the balance does not become so brittle and hard at climaxes, and retains more body. It was also interesting that relatively little control was necessary, although a reasonably wide dynamic range was achieved.

The choice of microphone types for this balance technique is very important, especially when noise reduction systems are used, since any noise present on the master tape is more likely to be caused by microphone or preamplifier hiss than tape hiss. To achieve results comparable with today's best standards it is essential that the overall stereo pair has very low inherent noise; for this reason capacitor mics are essential. If possible they should also be the latest types, employing field effect transistors in their front ends. The quietest mics that I have so far tested are the Neumann *SM69* fet, *U87* and *KM84*, the Calrec *1050*, the AKG *412* and their new high output *CK1* capsule; this has only recently become available, and has approximately 3.5 dB more output than the normal *CK1* capsule, while the noise level remains at a constant output level.

Quiet microphones are also of extreme importance when recording quadraphonically with coincidental or nearly coincidental techniques, since the microphones are usually at a considerable distance from the sound source. It is particularly important for the capsules feeding the rear channels to be good as, although in theory one should use the same gain on all four capsules, in practice the rear-facing ones will often be operated at a slightly higher gain than the front ones. I have tried both virtual coincidental quadraphonics and four microphones with a spacing of approximately 30 cm between capsules and, for some reason that is not yet obvious to me, the latter seem slightly preferable, giving better channel separation but without noticeable holes in the centres of the four sides.

Improved quadraphonic image

I have also found that slightly widening the front pair with the former type of quadraphonics clearly improves the image without, apparently, affecting the reverberation image from the sides and back. I can only assume that this is because human ears are mainly stereo receivers and quadraphonic information is received partly from memory of shifting sound images when the head is turned slightly and partly from the angle of incidence of reverberant sound as opposed to direct sound in the ear. It is apparent that a sound heard from behind has less high frequencies audible than a sound in front. As reverberant images tend to come primarily from the rear, these images are automatically placed at the rear.

I feel that a considerable amount of research is still necessary in the field of quadraphonic recording and that, even forgetting some producers' strange ideas about quadraphonics, there will, for a considerable time, be much disagreement about techniques. However, most musicians and engineers that I have introduced to quadraphonics—by playing to them, without comment, recordings made using different techniques—agree that they prefer a nearly coincidental quadraphonic technique.

I certainly appreciate, as I hope do engineers in general, that quadraphonics must sound commercial and must be recorded in a way that can be reproduced commercially. Possibly my main disagreement with other writers concerns the type of sound that will ultimately be felt to be commercial. It is surely our business to see that a consumer who enthusiastically purchases a quadraphonic system does not become tired of the gimmick after purchasing a few lps or tapes. In the early days of stereo consumers rapidly tired of the American spaced mic technique, which, in recordings made in the middle 1950s, frequently used only two mics placed up to 6m apart. Judging by present-day sales of records, however, the early EMI Blumlein recordings now being reissued are not only getting amazing reviews ten or 15 years after their original recording, but are also selling extremely well, in many cases better than new issues. I have been surprised that the recordings are of such good quality for their age, and it is clearly the excellent new cutting equipment employed that is responsible for the improvement in sound.

With all this in mind I have been appalled recently by the poor quality of quadraphonic sound demonstrations at some trade shows, particularly those of classical music. The entire industry is concerned at the moment with the choice of the best method of reproducing quadraphonics in the home, and there is no doubt going to be a tremendous battle between CBS's *SQ* system, Sansui's *QS* system and RCA and JVC's 'Discreet' four channel system using a sub-carrier for back channel information. I am convinced that quadraphonic tapes or cassettes will be found to be the best medium in the end, but the choice between the disc systems is not easy, and I am presently involved in evaluating these. But it is extremely difficult to do this when so very few commercially available quadraphonic recordings as offered to the public on disc even approach the standard of the average stereo lp in quality of balance and general sound. Possibly this is one of the reasons why so few recordings of classical music are available in quadraphonics.

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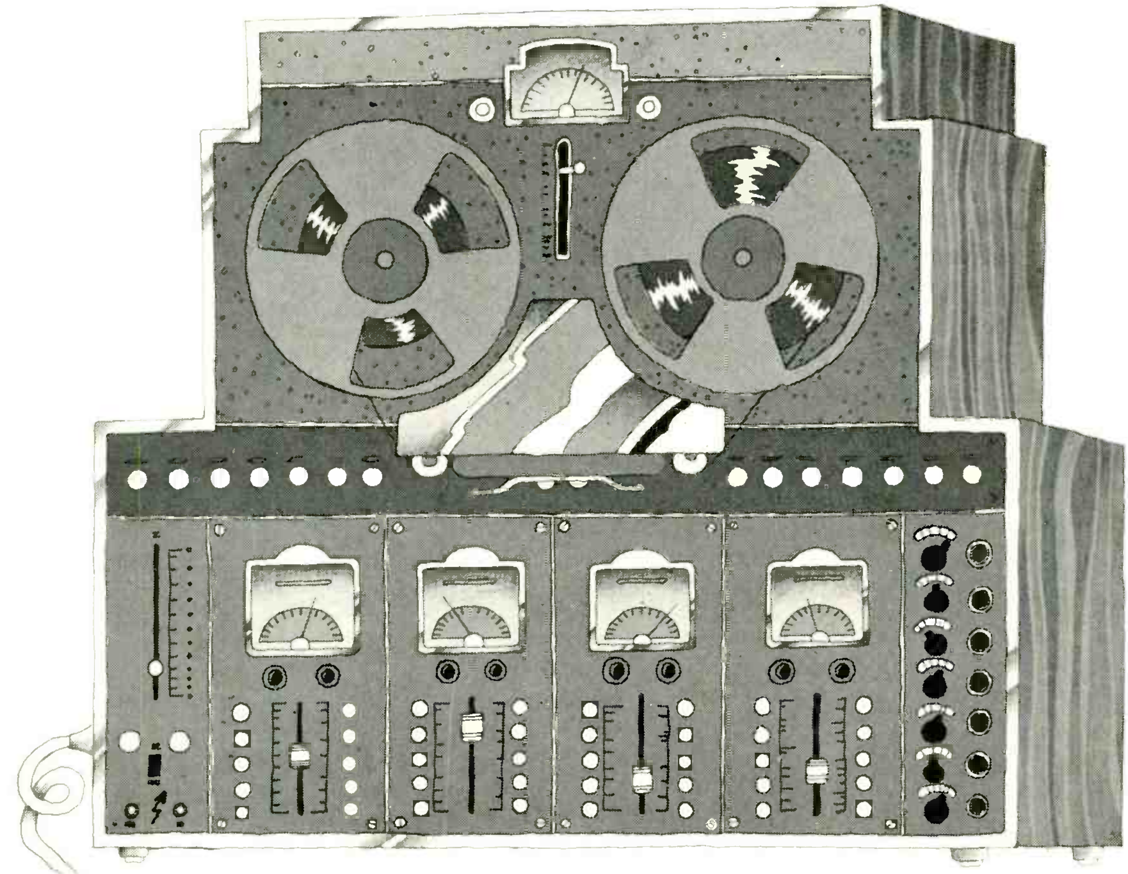

Specifications. Price. Performance. These are the factors you compare before you buy audio equipment, aren't they? But there's seldom any way of checking reliability. Which is why too many enthusiasts, who should know better, end up less than enthusiastic about the 'bargain' they've made.

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Bio Feedback

By Adrian Hope

EVERYONE it seems has brainwaves. Not just new types of tin opener that cost twice as much as those already on the market and work only half as well but electrical waves that are generated by the brain cells. These waves can be detected by moist electrodes on our head (usually between earlobe and scalp) and fall into various frequency bands—alpha, beta, delta and theta. For a while now, a school of thought has attached various vague but deep significances to the alpha range (8 to 13 Hz) and the latest objects of trendy affection are relaxation by enhanced alpha production ('more rewarding than a drug high') and the production of music by alpha waves. In fact, to get one point clear right from the start, to the best of my knowledge no one has yet actually produced any music from alpha waves. What they *have* done is alpha-modify musical sounds produced by other conventional techniques. The results can be interesting, up to a point, but it is a pity that loose and unscientific terminology is being bandied around.

Even the United States Embassy handout advertising a lecture and demonstration by David Rosenboom (classically trained musician, conductor and teaching psychologist at York University, Toronto) fell into the trap of promising that Rosenboom would 'demonstrate that we can now play music with our brain'. He did nothing of the kind; what he did do was talk at too great a length on too many aspects of bio feedback in too short a time.

Rosenboom was in London to perform at an ICES (Roundhouse) concert and was subsequently due to bewilder the Bavarians with a repeat performance as part of the Olympics experimental arts program at Munich. His London embassy talk was worth attending but, probably as a result of trying to cram too much material into one exposition, Rosenboom succeeded only in bewildering the unscientific and irritating those who could understand something of what he was talking about. Half of the audience, like my wife, sat with their jaws sagging under the onslaught of technical, philosophical and musical data read at high speed by Rosenboom from prepared notes for some two hours. Others seethed with frustration at being unable to ask questions on the numerous points that cried out for elaboration. Would it not be unreasonable, for instance, to assume that the ten minutes of tape recorded music that preceded Rosenboom's appearance had been produced by the techniques on which he was supposedly to lecture? Not so. Although it took a private question afterwards to establish the fact, the introductory music had nothing whatsoever to do with alpha and bio feedback techniques.

The human body has many functions. Some are voluntary and others involuntary. Most arm and leg movements are voluntary, we only make them if we want to. Some—reflexes—are involuntary. We cannot control them and they respond to a stimulus. A judicial thump on the knee in the right place will inevitably produce the involuntary response of a reflex kick. Likewise our hearts continue beating during the course of our lives whether we want them to or not. Heartbeat is thus a prime example of an involuntary body function.

Clearly, to control normally involuntary functions voluntarily could be of advantage—or disadvantage. If we could slow our heartbeats we could perhaps become better athletes or decide when to die. A short American film made by Jerry Murphy explains how, under certain circumstances, animals such as rats can be trained to control their heartbeat. Divers also gradually develop a degree of such control.

Another normally involuntary function is the production of alpha waves by our brains. Production is generally assumed to be random but, if an alpha wave detector is used to trigger a signal (perhaps a flashing light) when the brain of a subject is producing such waves, then gradually the subject can train himself to produce more and more alpha and less and less theta, beta and delta. From here it is a short step to use the detection of alpha waves to trigger not a light, but a tone generator. That way the production of alpha waves produces an audible tone and failure to produce alpha waves results in silence. This is the basis of bio feedback and music production under the control of bio feedback.

The subject, recognising when he produces alpha waves, is able to train himself to produce them more efficiently and, by raising the level of an alpha threshold detector, general capabilities can be pushed to high limits. An increase of alpha production capability from ten to 80 per cent is claimed readily attainable. Clearly, also, once the concept of using the waves to trigger the production of a tone has been tackled, the way is open to more complex audio effects one way or the other, dependent on alpha wave production.

Rosenboom's notes (and block schematic slides) suggest that alpha wave detection is by relatively simple band pass filter circuitry tuned to the 8 to 13 Hz alpha range. A variable threshold detector allows the detection of waves in the alpha range of only above a selected amplitude (as explained above, this is relevant to self-training techniques) and the threshold detector can be used in fairly conventional manner to produce pulses which trigger some electronic response. This can be simply the switching on and off of a light or of an audio tone produced by an oscillator. Rather more interesting, the trigger pulses can be used to control the output of some function of a synthesiser. Another technique is to use a sweeping filter which is active on a 160 Hz sawtooth tone, the filter being controlled in dependence upon the amplitude of the alpha waves. Thus a basic drone may be produced as well as the varying results.

Rosenboom performed 'live' at one of the ICES concerts and played excerpts from his bio-feedback-produced tapes during the course of his lecture. Again details of the exact techniques used for making these tapes had to be squeezed out of him afterwards by private questioning but it appears that no over-dubbing or multitracking technique is used; a bunch of musicians playing electric keyboard instruments is recorded, each musician being hooked up to an alpha detector which modifies the output of his instrument.

The whole importance, relevance and even existence of alpha waves is hotly contested, and here is neither the time nor the place to enter into that particular arena. Better to concentrate on the results which are claimed for work over recent years. Rock musicians and musicians working in the repetitive or drone type field (e.g. Eastern) have been found far more adept at producing alpha waves than their more legitimate classical colleagues. As mentioned above, the successful production of alpha waves by a subject is claimed to produce something far superior to a 'drug high' but simply hooking oneself up to an alpha detector, and gazing at its flickering light will probably produce moderate self hypnosis and a pre-sleep condition—in which state alpha production probably increases anyway. It is also claimed that those skilled in Zen and yoga techniques find alpha production easy. In attempts at the synchronous production of alpha waves (groups hooked up together with alpha coincidence detectors) musicians were proven far more successful than non-musicians.

Quite what all this adds up to is hard to crystallise. Probably the most significant fact is the correlation between alpha wave generation and creative musicianship (as opposed to simple straightforward part reading by orchestral players). One thinks immediately of the 'rapport' which exists in tightly knit jazz groups. On a more down-to-earth level, one concrete result will doubtless be the enhanced sales of alpha detectors for those looking for a new psychic craze. Some are already available on the market in the USA but anyone with a reasonable electronics background should find it easy enough to produce a detector which responds only to the 8 to 13 Hz band. Similar results incidentally can be obtained by sensing changes in body temperature and body skin resistance. With the output of such a detector, ways of controlling the functions and effects of synthesisers, mixers, amplifiers, phasers and the kitchen sink open up like a whole new world.

Jubilate!

Some personal thoughts by John Cordeaux about the British Broadcasting Corporation on the occasion of its Golden Jubilee. John Cordeaux (BBC Radio Humberside) is a senior member of one of the Corporation's latest offspring—Local Radio.

IN the introduction to the very first *BBC Handbook* (1928), the then director-general of the Corporation wrote: 'One trusts that the reader will be able to say of our five years' Broadcasting activity that it [the BBC] has steered a reasonable middle course between philosophic neutrality and over-emotiveness without falling into self-satisfaction'. The writer was Sir John Reith, perhaps the greatest director-general the Corporation ever had.

I would like to think, having been in broadcasting for over half the Corporation's lifetime, that after 50 years the BBC's audience still feel this to be true. A much later director-general, Sir Hugh Greene, dispelled the 'Auntie' image with which perhaps maturity had begun to imbue the BBC. During the 1939 to '45 war, and even for some while after, a kind of disciplined orthodoxy prevailed which is more tenuous today. Broadcasting in the '70s may be more exciting than in the BBC's 'middle period' of post-war consolidation but this era was to become the springboard for future developments and enterprise.

Broadcasting today requires (in local radio, where you're out on a limb, it *demands*) more individual initiative than ever before. In 1946, when I joined the BBC's Overseas Services as a studio manager (a Jack-of-all-trades, announcer, and master of grams, discs and mics), BBC philosophy and practice were not ours to reason why. A junior member of staff was not expected to concern himself with policy, whereas today he very often would be.

Before joining the BBC, I had for five years been in the armed forces. During my last posting in Malaya, I voluntarily 'took over' from the Japanese the radio station in Penang. Then I discovered there had been in Malaya, before the war, rigid segregation between the British occupiers and virtually the whole Asian population. Now I felt the vocation for my life's work. Over the 'Voice of Penang', Malayan and British men and women began to build bridges of communication, of understanding, across the shameful barriers between neighbouring human beings. This is what radio has always been about to me.

May 4, 1922 (the day I was born!), was the date on which the very first statement on the subject of the BBC was made in the House of Commons by the then postmaster-general. On this occasion he remarked: 'I hope that we shall be able to learn from the United States'. I'll say we have! Mercifully.

November 14, 1922, saw the first authorised broadcast, when 30,000 licence holders heard for the first time: 'This is 2LO—the London station of the British Broadcasting Company'. The Birmingham station (5IT) and Manchester station (2ZY) also opened on this day.

December 15, 1922. The British Broadcasting *Company* was registered. It is not widely known that the BBC started as a 'commercial' concern, though the only commerce it was concerned with were actual radio sets and components thereof. The British Broadcasting *Corporation* was constituted by Royal Charter (for a term of ten years) on January 1, 1927.

In April 1923 the BBC moved from Marconi House to 'new' premises at Savoy Hill.

On February 5, 1924, the Greenwich Time Signal was inaugurated. And, on July 1 of that year, the ten shilling licence fee was introduced. In January 1926, John Logie Baird first demonstrated television, not the 'high definition' sort we know today but with big revolving aluminium discs and a viewing screen the size of a match-box cover. The first broadcast of television by the BBC was on September 30, 1929. On March 25, 1927, the first racing commentary was broadcast on the Grand National from Aintree.

On July 14, 1930, the first television play was performed: Pirandello's *The Man With a Flower in his Mouth*. It wasn't much more than a mini shadow performance for one actor at a time.

In October 1930 was heard the first broadcast by the BBC Symphony Orchestra, conducted by Mr Adrian Boult 'direct from the Queen's Hall'. And my last date, which still gives us over 40 years to catch up with ourselves, is May 15, 1932, when the move to Portland Place occurred. Broadcasting House became the headquarters of the BBC.

Rex Palmer, the first London station director, broadcasting into a 'meatsafe' microphone from Savoy Hill in 1923.

Today, when merchant and advertising interests are getting up steam for commercial radio after their money-printing success in television, it pays to turn back the calendar again to 1927 when John Reith spoke his mind on the public service responsibilities of radio. 'One is sensible, sometimes, of an inclination on the part of several critics to wonder why it is necessary or desirable to insist . . . upon *public service* as the keynote of our work.' Is there not some risk of the phrase becoming a formula of vain repetition, a surrender to complacency? The answer John Reith gave was an unequivocal *No*. 'At the beginning it was an assertion—of the position that it was intended to take up, a flag to hoist over claimed territory. As time went on, it flew as a flag to which allegiance was expected of, and given by, a staff of men and women of widely varied outlook and abilities.'

It seems to be quite remarkable that the late Lord Reith could have written thus about the BBC when it was only at the tender age of some of our Local Radio stations.

Having spent three years under Lord Thomson's banner working with commercial radio stations, I write with experience when I claim that truly objective radio (or television for that matter) can only exist when the staff creating it are not subject to commercial pressures, however subtle. I remember once in the Caribbean, where I was advising the Jamaica Broadcasting Corporation, than an objective feature program on smoking was scheduled. On the day of the broadcast, the general manager of the JBC told his director of programs to kill it: an American cigarette firm who spent quite a lot of dollars at this station had apparently objected to the program 'ever so nicely'. I do not blame the general manager; his and his staff's salaries were being paid by this and many other commercial firms and agencies on the island, from the United States and the United Kingdom.

We in the BBC are taught from our first day to beware of pressures. We should never intentionally divulge personal prejudices. Nevertheless we are vulnerable; but this is as nothing to vulnerability of a commercial broadcaster.

So still without commercial radio competition, just, the BBC's 50-year cycle is complete. Where commercial viability has never had to be a criterion, the development of radio seems now to have come full circle. For technical reasons, the BBC began by serving mainly small regions, towns, specific communities. This necessity bred a homely broadcasting, a personal, friendly communication. It's back again today.

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The Shibaden 700 Series Video Tape Recorders

THIS report is longer than normal for two reasons. Firstly, four distinct models are covered. Secondly, more than the usual amount of feedback from users was available because one of the models reviewed has been in use for over five years; information could be gleaned from users that is usually lacking in this rapidly developing field.

Shibaden are now introducing a new range of monochrome and colour machines that conform to the new Japanese 12.5 mm open reel standard but this does not yet include a battery portable and production of their long established line is continuing.

The 12.5 and 25 mm vtrs, cctv cameras, monitors and accessories for which the Shibaden Electric Company of Japan are known in the UK forms only a small part of the range of professional and broadcast equipment they manufacture. In this field they probably offer a greater range than any other Far Eastern company and it was as far back as 1966 that they released their first low cost video recorders which, from 1967, were imported into the UK by Thermionic Products. These machines were remarkably advanced for their time, the only competition being the Sony 405 line skip-field recorder which, although technically more primitive and with a much lower bandwidth, was the better-known machine. Of the several reasons for this, three are worth mentioning. The quality of their transistor radios and other domestic equipment had made Sony a household name, which the well organised retail dealer network helped establish in the educational and industrial fields. Secondly, development of the tape itself prevented the early Shibaden machines from reaching their full potential; head clogging, tape jamming and other mysterious faults in damp weather detracted from the recorders' basic reliability. Although *all* v.rs, including the £30,000 broadcast models, suffered from these problems, the narrow track and head design of the Shibaden made it particularly susceptible. (When modern tapes are used with the same early machines these faults disappear.) The third factor, the degree of compatibility resulting from the mechanical format, will be considered in detail later.

The good performance resulting from the advanced original design meant that it did not need the drastic format changes and carrier frequency alterations of the Sony, Ikegami and other machines. It is this consistency which makes possible the interchange of tapes recorded on machines manufactured between 1967 and 1972. The most obvious feature of this format is the larger-than-average drum size for a 12.5 mm vtr which, at 149 mm, gives the relatively high writing speed of 1170 cm/s, making possible a high fm carrier frequency and improved resolution. The 3.3 to 4.8 MHz carrier range *is* above average and gives a correspondingly good video bandwidth. On the other hand the *linear* tape speed of 17 cm/s (or 19 cm for 60 Hz 525 line tv systems) is as slow as any open reel format and allows 70 minutes playing time on a 730m 17.8 cm reel. This slow linear speed, together with the high writing speed, is in effect a dense packing of video information which requires narrow tracks closely spaced. Close spacing, together with long length of the track resulting from the large drum diameter, places considerable demands upon the accuracy and consistency of the tape transport. To put it another way, this format allows less wear on maladjustment than, say, either the Sony *CV2100* or the new Japanese 12.5 mm format.

Comparison with Sony

Comparison with Sony vtrs is difficult to avoid and indeed is worthwhile because the two approaches to the problems of low cost video recording are both justifiable: features from *both* systems have been incorporated in later generations of vtrs of all makes.

The *SV700EC* mains transportable, the heart of the Shibaden 12.5 mm range, is a developed version of the original *SV700E* which appeared in 1967 in the UK as the first 12.5 mm vtr capable of 625 line recording. The 149 mm head drum, a capacity for 19 cm reels and a fairly open uncluttered system of tape guides make tape loading easy and the case large. The extra 1.27 cm reel size when used with tapes of the normal length prevents the delicate video tape peeling off the reels when handled but some users have spliced on extra tape to give 90 minutes playing time. The head-drum, all six tape guides and rollers, capstan and pressure roller are mounted on one heavy aluminium casting: this is Shibaden's solution to the problem of track alignment and it must be costly to manufacture.

Instead of using the large motor driving the tape transport to power the head drum via a belt, which is the usual practice for this category of machine, a separate synchronous motor of the same size is fixed on to the main casting and connected directly to the drum. It is driven from the servo electronics through a 120W amplifier using four bridge connected power transistors. The second motor, supplied with ac from the mains transformer, drives the capstan flywheel through a flat rubber belt and the spools from intermediate rubber idler wheels, all mechanical functions being selected by a single metal lever. This is the drive system used by many medium price single motor sound recorders and although some people sneer at anything less than three motors and solenoid operation, millions of these humbler systems work for years with good reliability. Technical reviewers have been wrong here. A Swedish report criticised the drive systems of both the Sony and Shibaden vtrs as being likely to give trouble with wear on these rubber idlers but, millions of machine hours later, it can be asserted that this mechanical system is rugged and reliable. Only two controls are specific to the visual working of the recorder; video gain on record and tracking on replay.

Tests were made on Shibaden 300 and 465 mm receiver/monitors using broadcast test signals and a camera with a Marconi test card. 0.4V pp minimum was needed to modulate the tape fully and the switchable agc system held the level to within ±1 dB for ±6 dB input change. The sound input sensitivity was greater than the −60 dB specified but insufficient for a 30 ohm microphone. 600 ohm microphones of average sensitivity had enough in hand for speech recording. Sound frequency response was −3 dB at 40 Hz and 11 kHz, adequate for both cctv and off-air recording, but the noise consisted mostly of field frequency buzz at −41 dB. The 0.26 per cent DIN wow (at capstan frequency) was higher than expected, so two other non-review samples were checked. They were each better than 0.15 per cent DIN and the noise, at −44 dB, was mostly tape hiss which was subjectively much quieter.

Reproduced picture quality

Reproduced picture quality was very good indeed, with an upper frequency limit of 3.7 MHz: better than any other 12.5 mm system and better than some early 25 mm vtrs. Noise was also low at −42 dB rms (noise to pp video) using Shibaden's own tape (see **fig. 1**). Slight white streaking can be seen on **fig. 1** and, although the machine was not adjusted, this effect could be removed on machines in service by adjusting the playback equalisation. When fully modulating the machine to obtain this noise performance, overloading on certain highlights containing high modulation levels at around 1.5 MHz was noticed. This caused small areas of black streaking and reducing the recording level by 1 dB eliminated the problem (providing agc was not used).

Still frame performance was also better than any other 12.5 mm machine (excepting the Sanyo *1100 SL* with its four head system) and this is mainly due to the smaller difference in

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continued

tracking angle between stationary and moving tape than other formats. The head switching noise on still frame was so slight that there was generally no need to move the tape reels by hand to get a stable picture. A typical still frame from a closed circuit camera is shown in **fig. 2**.

The mechanical function selector gave no trouble to our non-technical users, who found that this single lever for all operations made the search for a particular scene both quick and easy. This quickness produced a hazard: one could damage the tape by selecting play while the reels were still spinning from a fast wind. Rewind time for a 70-minute tape was five minutes.

Compatibility between recorders was investigated by replaying our recordings on a random sample of six other machines of different ages in four different localities. We found:

Perfect compatibilty: two machines (noise specification met and no tracking adjustments needed during program).

FIG. 2

FIG. 1

Adequate compatibility: two machines (noise varied throughout the reel but could be corrected with the tracking control).

Marginal compatibility: one machine (noise pictures and tracking had to be altered continually throughout the reel).

Not compatible: one machine (mistracking visible throughout the program as a band of white flashing across part of the screen).

Of the four less-than-perfect recorders, three were brought fully up to standard and one to adequate compatibility by an adjustment of the tape path which, although quick to carry out, is not recommended to engineers without helical scan service experience. These compatibility problems are by no means unique to Shibaden, being found to some extent in all vtrs from 50 mm quadruplex machines downwards. After all, many cctv users possessing only one recorder have no need to preserve or exchange tapes but this probably constitutes the greatest weakness of low cost tape equipment used as a means of prerecorded program distribution, whether open reel or cassette. The expensive vtrs have electronic tape tension servos, and simple back-tension regulators as well as 'skew' controls are fitted to several makes of 12.5 mm vtr as well as the new Sony 18.75 mm cassette recorders. Shibaden's use of a simple felt washer under the pay-off reel carrier has to be compensated by rather more frequent checking and adjustment. (In their report on cctv at Millfield School* Turner and Atkinson found that Millfield's three Shibaden vtrs were only really compatible if serviced at the same time.) This problem could possibly be alleviated by supplying a reference tape with each machine. These tapes can be bought but, apart from costing £35, have not been available for some time.

Due to its direct drive, the head drum runs up to speech and produces stable pictures within three seconds and the hard servo eliminates the warm-up time needed by many machines. When recording, if the drum servo was given time to synchronise with the incoming signal before the tape was started, the disturbance between sequences was never more than one second long and not too noticeable.

The instruction booklet had the proportions of a pamphlet and was considered too sparse and too badly translated to be much help to absolute beginners. Also it had no circuit diagrams or 'meat' for technicians: the Shibaden technical writers should be shown the Akai and Sony instruction manuals.

SV700ED (Electronic Editing Version)

The *SV700ED* is basically the *EC* machine examined above, and has the same electrical and mechanical performance but with the addition of special circuitry to provide true insert and assemble edit facilities not found in any other 12.5 mm equipment. The assemble feature is used for building up programmes section by section in the manner described for the *SV700EC* but this time with an 'electronic splice' as smooth on playback as the camera change on a mixer. A superficially similar

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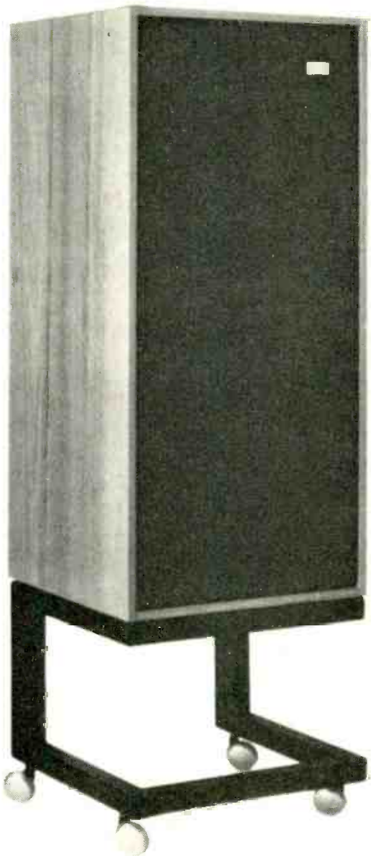
BC IA price on application

Trolleys in black, white or satin chrome. From £8.50 including P.T.



Type BC IA

A BC I loudspeaker fitted with either a Spendor 20 watt or 50 watt power amplifier.

M208 20 Watt Power Amplifier

Output Impedance 0.25 ohms
(in series with 1600 μF)

Load Resistance 8 ohms (nominal)

Input Level Max. Out 0.5 volts

Distortion Typically 0.1% to within 1 dB of full power (60 Hz to 10 kHz)

Noise and Hum −90 dB (relative to full power output voltages)

Frequency Response −1 dB at 22 Hz and 30 kHz

M508 50 Watt Power Amplifier
Specification as for M208 except:

Output Impedance 0.1 ohms (in series with 2500 μF)

Frequency Response −1 dB at 18 Hz and 30 kHz

Spendor loudspeakers are rapidly becoming the standard by which others are judged. They are used by many professional recording engineers and are in extensive use by The British Broadcasting Corporation as studio monitors.

Spendor Audio Systems Limited

Kings Mill · Kings Mill Lane · South Nutfield
Redhill · RHI 5NF · Phone Nutfield Ridge 2554

continued

facility is found on several other machines—for example the earlier Nivico, the Sanyo *1100S1* and the Sony *CV2100* (field tested in STUDIO SOUND December 1970). They all rely on driving a particular camera with pulses from the recorder, which technique cannot be applied if the source is off-air, a studio, or even a camera system not specifically designed for use with the recorder. As the *SV700ED* synchronises *itself* to the incoming signal it can assemble edit from *any* source. The insert and editing facility is more unusual and would make a sound recordist green with envy. With this, a new section can be electronically spliced into an existing program without disturbance at the beginning *or* the end. A typical educational use was the addition of the diagrams necessary to make the argument clear on a foreign language lecture which had been simply recorded with one camera.

The extra electronics needed for these editing functions are quite complex and include a large printed circuit board with 35 transistors and nine relays. This extra equipment consists basically of a capstan servo and some elaborate video switching which is fitted at the right hand side of the tape deck, increasing the recorder width by 10 cm over the *SV700EC*. The synchronous tape transport motor is replaced by a dc motor driven from the capstan servo board which compares the video output of the machine on playback with the input video and regulates the linear tape speed so that the recorder is exactly in phase with the incoming signal. The switching circuits select combinations of the three separate erase heads for video, audio and control track (depending on the editing mode chosen) and also delay the instant of changeover after the edit button is pressed, so that the change occurs *between* fields.

Both insert and assemble editing modes worked well after care had been taken in setting up the various signal sources and vision edits were as good as those on expensive 25 mm machines though there was a noticeable click on sound edits. Other samples also made the same noise. Although satisfactory with any reasonably compatible tape on normal replay, one could only rely on tapes *recorded* on the same machine for editing work: this was not made very clear in the manual.

It was found that the *SV700ED* could be used as a synchronous source feeding a studio, a use not mentioned in the instruction booklet but possibly of more value than the editing facilities to some users. By feeding the recorder with studio syncs, one could cut between cameras and videotaped inserts without field disturbance on monitors or instability on the recording vtr.

SV707E and FP-707 portable system

The *SV707E* battery vtr and *FP-707* lightweight camera form the Shibaden portable recording system. The camera weighs only 2.5 kg and is no larger than an 8 mm cine camera, despite its fully interlaced, separate mesh vidicon design which includes a 5:1 zoom lens, a built-in crt viewfinder and dynamic microphone. The recorder weighs 8 kg and is 40 cm long, which makes it heavy and awkward to move about when carried on the shoulder strap. However, the optional backpack is the complete solution and carried this way the recorder was still comfortable after two hours of dangling on a rope half way down a rock face (it was being used to make a pilot video tape for a planned 16 mm film of a rock climb). Like the Sony *DVK 2400CE* (field tested by David Kirk in November 1971), the equipment runs from rechargeable cells and has neither fast wind nor playback facilities so must be used in conjunction with a mains vtr.

In use, the recorder is kept in the standby mode with motors running and tape stationary, the camera output being visible on the miniature electronic viewfinder. The camera is synchronised to the recorder head drum and the solenoid operated capstan gives quick starts so the joins between shots are quite neat and produce little field disturbance on a monitor when replayed. During the recording of several 20-minute reels, we were once caught out by the batteries going flat mid-scene and the operator felt that the gradually deteriorating viewfinder picture was an insufficiently positive indication of battery failure.

The camera was more sensitive than expected from the specification: recordings made at light levels down to about 100 lux fully modulated the tape and, if one was prepared to accept noisier pictures, it was usable down to about 10 lux. This good low light level performance was matched by the very low noise in the recorder which, at −42 dB, was 4 dB better than the specification. Resolution, while inferior to the mains recorder, at 270 lines was in specification. For interviewing, a hand-held microphone was much preferred to the one built into the camera but it was found that trouble with the sound agc resulted if the sensitivity was not similar.

Shibaden SV700E

SV700E

As *SV700E* recorders have been advertised at a low price in this and other journals, it seemed fit to include them in this report. This machine is the earlier version of the *SV700EC* discussed above and lacks a number of improvements and refinements. The main differences are:

1. There is no sound or vision agc.
2. The record button is interlocked, so similar assemble editing is not possible.
3. The brakes are harder.
4. The multiway output socket is non-standard.
5. The video performance is not quite so good.

The lack of agc is of course no problem with 'off air' recordings as broadcast sound and vision levels are accurately controlled. As nearly all cctv cameras have built-in agc this is only a problem when making live recordings without a mixer.

2. It *is* a disadvantage not to be able to assemble edit, and it may well be worth paying the £10 or so for the addition of the editing switch.

3. The fierce brakes are all right, but can damage tapes if allowed to get out of adjustment.

4. Different outlet sockets are a nuisance if new and old machines are mixed, but outlet boxes are supplied.

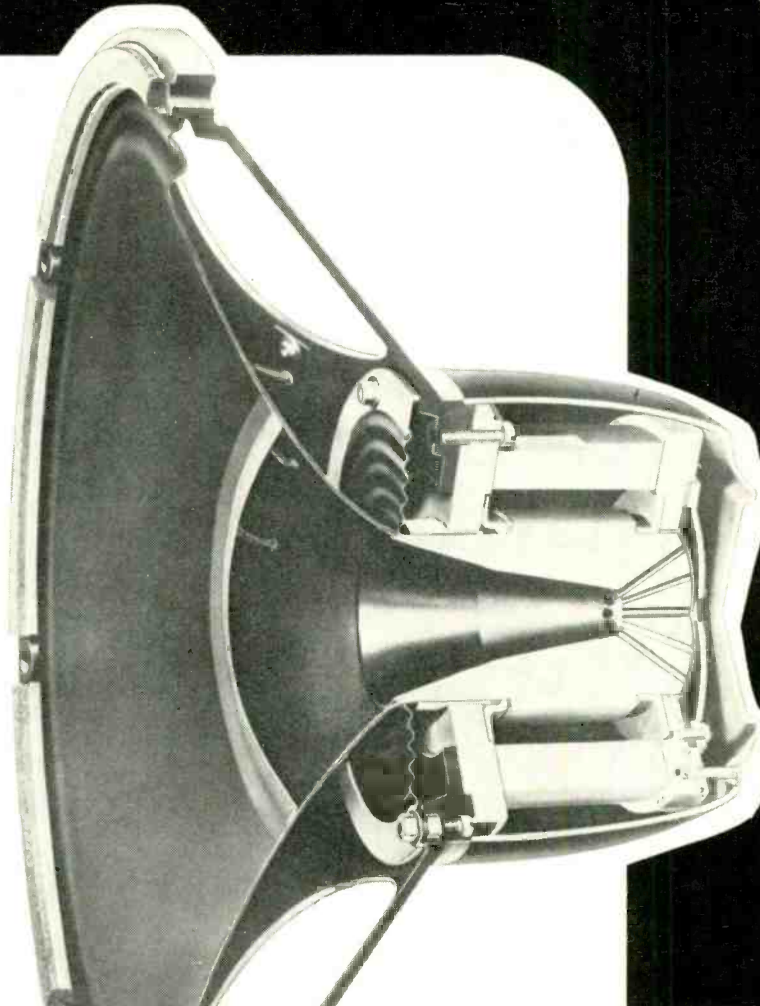
5. Recordings were slightly inferior to the *SV700E* in resolution but were still in specification at 270 lines which is as good as any other 12.5 mm vtr on the market, including latest models and cassettes. The video noise, at −36 dB, was 2 dB below the −38 dB claimed and 6 dB worse than the *EC*. This particular sample was slightly worse than a number of others tested, which were all between 2 and 6 dB below the *EC*. It was noticed that the less noisy machines had all been well 'run-in' and it was later confirmed that the performance gradually improved as the heads wore down, reaching a plateau after about 200 hours. Playing back a tape prerecorded on a new *EC* the performance was very good, the 4 MHz bass of BBC Test Card F being clearly visible and the noise being 39 dB down. This exceptional performance was good luck but none of the other samples were worse than the *EC* on *playback*, so clearly the *SV700E* is an ideal playback machine.

The range of Shibaden 12.5 mm vtrs, including as it does both a battery portable and electronic editing, gives great scope to the small studio with some technical support. The recording format necessitates more careful maintenance than some other types but, given this technical expertise, the user is certainly rewarded with the best and most economical pictures obtainable from 12.5 mm tape.

* *'An experiment in Closed Circuit Television at Millfield School' by P. Turner and CRM Atkinson. Published by the National Committee for Audio-Visual Aids in Education.*

TANNOY®

DUAL CONCENTRICS



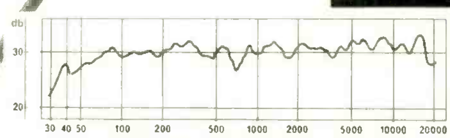
Versions of the Tannoy Dual Concentric loud-speaker have formed the basis of many of the best studio monitors for more than 25 years. The unit is incorporated in a variety of enclosures made by leading manufacturers both in the U.K. and abroad, as well as being incorporated in "package studios" produced by foremost U.K., European, U.S. and Japanese manufacturers. The unit not only has the advantages of high power handling capacity and long term consistency, but the level frequency response, good polar distribution and exceptionally low intermodulation products make it ideal for the highest quality studio monitor systems. Apart from the current range of Monitor Gold units specified below the Monitor 'Red' 15 is still in production and can be supplied upon request in its original 15Ω version.

SPECIFY TANNOY DUAL CONCENTRICS FOR YOUR STUDIO MONITOR

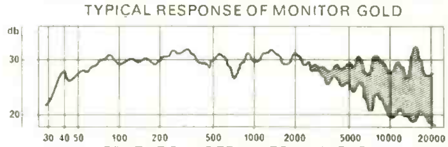
TECHNICAL SPECIFICATIONS

	FIFTEEN	TWELVE	III LZ
Frequency Response	23-20,000 Hz	25-20,000 Hz	27-20,000 Hz
Polar Distribution for 60° inc. Angle	−4dB at 10,000 Hz	−3dB at 10,000 Hz	−2dB at 10,000 Hz
Power Handling Capacity	50 watts*	35 watts*	25 watts*
Impedance Via Crossover Network	8 ohms (5 ohms min.)	8 ohms (5 ohms min.)	8 ohms (5 ohms min.)
Intermodulation Products	less than 2%	less than 2%	less than 2%
Bass Resonance	26 Hz	28 Hz	30 Hz
Crossover Frequency	1,000 Hz	1,000 Hz	1,200 Hz

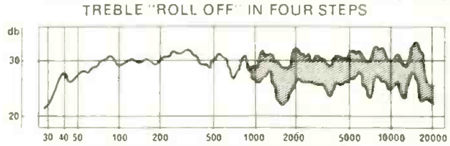
* Depending on type of enclosure.



TYPICAL RESPONSE OF MONITOR GOLD



TREBLE "ROLL OFF" IN FOUR STEPS



TREBLE "ENERGY" IN FIVE STEPS

TANNOY®

WEST NORWOOD
LONDON SE 27 9AB
TEL: 01-670 1131

Survey: Monitor Loudspeakers

ACOUSTICAL

Acoustical Manufacturing Co Ltd, Huntingdon PE18 7DB.
Tel: 0480 52561.

Quad Electrostatic*

Maximum Output: 100 dB ref. .0002 dynes/cm² from 70 Hz to 7 kHz.
Bandwidth: 45 Hz to 18 kHz, attenuation outside band being asymptotic to 18 dB/octave.
Dispersion: 70° horizontal, 15° vertical.
Impedance: 30 to 15 ohms from 40 Hz to 8 kHz, falling above 8 kHz.
Ac voltage range: 100 to 120V, 200 to 250V, 50 to 60 Hz.
Ac power consumption: negligible.
Weight: 16 kg.
Hwd dimensions: 788 x 880 x 280 mm.
Price: £54 (trade), £72 (retail).

*Specification 1.8m on axis in free space, 93 dB ref .0002 dynes/cm² in frequency range 50 Hz to 10 kHz.

ALTEC

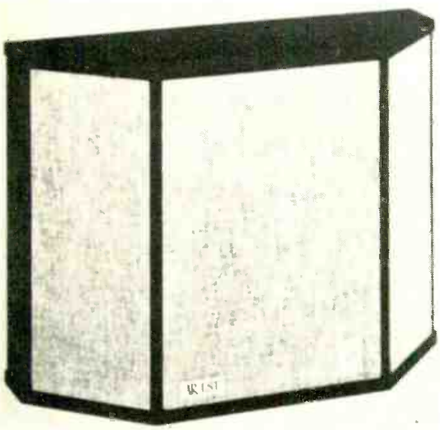
Altec Lansing, 1515 South Manchester Avenue, Anaheim, California 92803, USA.
Agent: Acoustico Enterprises Ltd, 6-8 Union Street, Kingston on Thames, Surrey.
Tel: 01-549 3471.

A7-8

Bandwidth: 30 Hz to 20 kHz.
Power rating: 50W continuous.
Impedance: 8 ohms.
Crossover frequency: 800 Hz.
Speaker components: 416-8A, 807-8A, 811B, N801-8A.
Hwd dimensions: 1067 x 762 x 609 mm.
Price: £250.

Right: Cadac SRS

Below: Acoustic Research LST



878A

Bandwidth: 20 Hz to 20 kHz.
Power rating: 60W continuous.
Impedance: 8 ohms.
Crossover frequency: 800 Hz.
Hwd dimensions: 762 x 685 x 483 mm.
Price: £250.

874A

Power rating: 60W continuous.
Impedance: 4 ohms.
Crossovers: 500 Hz and 4 kHz.
Hwd dimensions: 650 x 295 x 300 mm.
Price: £140.

ACOUSTIC RESEARCH

Acoustic Research Inc, 24 Thorndike Street, Cambridge, Massachusetts 02141, USA.
Agent: Acoustic Research International, High Street, Houghton Regis, Bedfordshire.
Tel: Dunstable 603151.

LST

Sensitivity: 89.5 dB spl average, ±1 dB, with back against rigid wall.
Efficiency: 0.8 per cent average.
Unit complement: 304 mm bass, four 38 mm mid and four 19 mm treble.
Phasing: Positive voltage applied to terminal 2 causes woofer diaphragm to move forward (out of cabinet).
Hwd dimensions: 508 x 689 x 248 mm.
Weight: 40.5 kg.
Price: £200.

BOWERS & WILKINS

Bowers & Wilkins Electronics, Meadow Road, Worthing, Sussex.
Tel: 0903 205611.

DM2

Three unit system comprising DW200 bass/mid, HF1300 treble and 25mm hf transducers.
Power rating: 60W continuous sinewave.
Sensitivity: 7W produces 95 dB spl at 400 Hz.
Bandwidth: 65 Hz to 20 kHz ±3 dB.
Hwd dimensions: 644 x 352 x 354 mm.
Weight: 23 kg.
Price: £59.90.

DM4

Three unit monitor comprising Bextrene bass/mid, HF1300/2 treble and 19 mm plastic domed hf transducers.
Sensitivity: 3.6W (8 ohms nominal impedance) produce 95 dB spl at 1m.
Hwd dimensions: 531 x 254 x 255 mm.
Weight: 11 kg.
Price: £42.50.

DM70

Power rating: 25W continuous sinewave.
Bandwidth: 40 Hz to 20 kHz ±5 dB.
Axial response: 90° horizontal arc in the order of ±2 dB at all frequencies up to 15 kHz.
Impedance: 8 ohms nominal, rising to 25 ohms at 1 kHz. 4 ohms minimum at 20 kHz.
Units: 330 mm bass radiator and 11-module electrostatic (400 Hz upwards).
Hwd dimensions: 808 x 815 x 382 mm.
Weight: 48.5 kg.
Price: £159.50.

CADAC

Cadac (London) Ltd, Stansted, Essex.
Tel: Stansted 3437 and 3132.

Sound reproduction system

A Bi-amplified sound reproducing system designed in conjunction with the research laboratories of RCA Studios, Rome, for use as control room monitors in music recording studios. The power amplifiers are included as part of the complete system.
Hwd dimensions: 1,981 x 1,016 x 610 mm.
Price: £700 ex works.

CELESTION

Rola Celestion Ltd, Ditton Works, Foxhall Road, Ipswich, Suffolk IP3 8JP.
Tel: 0473 73131.

Ditton 66

Power rating: 80W (DIN specification).
Impedance: 4 ohms minimum.
Crossovers: 500 Hz and 5 kHz.
Units: Two 304 mm bass, dome-type mid and HF2000 hf.
Price: £99 (recommended retail).

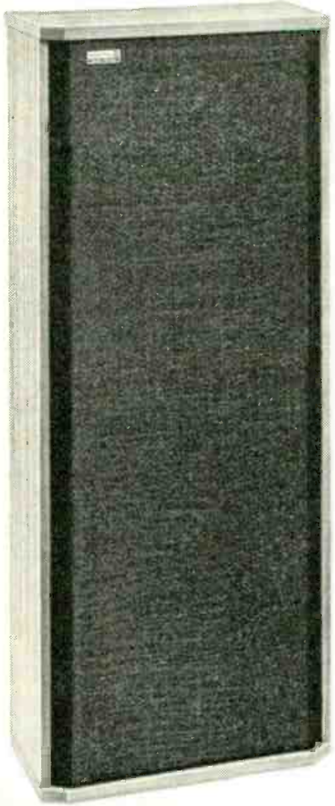
continued 45

Celestion

Loudspeakers for the Perfectionist

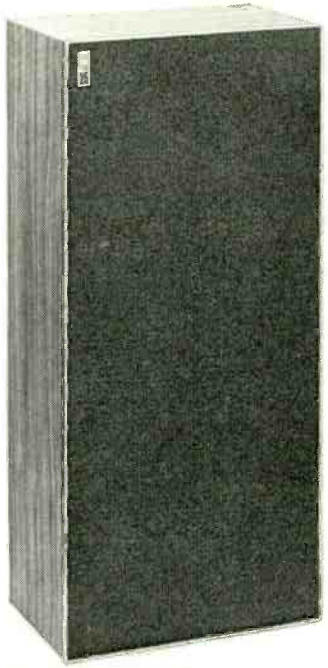
TELEFI

A remarkable innovation exclusive to Celestion for use in conjunction with Hi-Fi and Audio systems for providing high quality television sound reproduction from 625 line television receivers.
*No direct connection to the TV is required, the coupling being effected by an inductive pick-up.



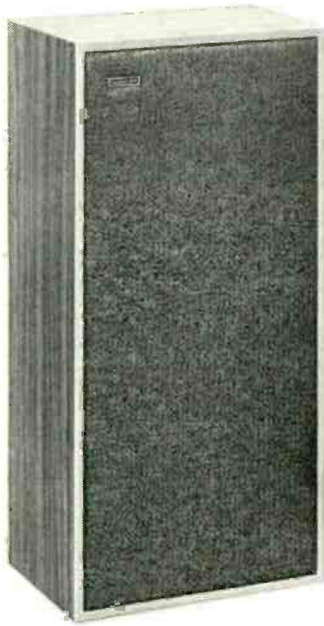
DITTON 66 STUDIO MONITOR

A new Loudspeaker of advanced design suitable for studio use and for home installations of the highest quality.
UNITS: HF 2000 (dome 'pressure' type) MF 500 (Mid-range Dome 'pressure' type) Ultra linear 12" bass driver and 12" A.B.R. The crossover has resulted from considerable research and crossover points are at 500 Hz and 5000 Hz 80 Watts Maximum, 4-8 ohm. This monitor loudspeaker system has an exceptionally wide and flat frequency response. Very low order harmonic and inter-modulation distortion. Precise response to transients. Beautifully maintained polar response ensures absence of unwanted directional effects and provides a highly satisfactory stereo image throughout the listening area. Matched pairs.
SIZE $40 \times 15 \times 11\frac{1}{2}$ Natural Teak or Walnut Cabinet



DITTON 25

Recommended for luxury Domestic Hi-Fi Installations. A system having extremely low harmonic distortion and high sensitivity. This well established loudspeaker is excellent value and will delight the most fastidious audiophile. Noted by reviewers for complete absence of 'listener fatigue'; smooth and effortless in performance.
UNITS: HF 2000, HF 1300 MK II (two), long throw 12" bass driver plus 12" A.B.R. (auxiliary bass radiator). Substantially level response from 25 Hz to 30 kHz 60 watts maximum 4-8 ohms. Matched pairs.
SIZE $32 \times 14 \times 11$ Natural Teak or Walnut Cabinet

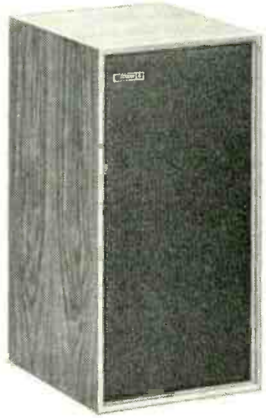


DITTON 44 MONITOR

Designed for the discriminating listener . . . wide, smooth frequency response. Exceptional transient performance, superb controlled bass, accurate mid-range—and smooth extended highs.
UNITS: HF 2000, MF 6 and Ultra linear 12" long throw bass speaker. Crossover system of superior design at 500 Hz and 5000 Hz. Substantially level response from 30 Hz to 30 kHz 44 watts maximum—4-8 ohms.
SIZE $30 \times 14\frac{1}{2} \times 10$ Matched pairs
Natural Teak or Walnut Cabinet

DITTON 15

The world famous high performance 'bookshelf' loudspeaker 30 watts maximum. 4-8 ohms.
UNITS: HF 1300 MK II, heavy duty 8" long throw bass speaker plus A.B.R. (auxiliary bass radiator). Substantially level response 35 Hz to 15 kHz.
SIZE $21 \times 9\frac{1}{2} \times 9\frac{1}{4}$
Matched pairs
This truly remarkable loudspeaker never fails to impress.
Natural Teak of Walnut Cabinet



'COUNTY'

Designed for budget Hi-Fi systems but without sacrificing quality.
UNITS: HF 1300 MK II and special 8" long throw speaker. Substantially level response from 45 Hz to 15 kHz, 25 watts.
SIZE $19 \times 10 \times 9\frac{1}{2}$
Natural Teak or Walnut Cabinet. Matched pairs

DITTON 10 Mk II

True Hi-Fi Sound from a tiny precision speaker 20 watts, 4-8 ohms.
UNITS: HF 1300 MK II and heavy duty 6" long throw bass speaker. Substantially level response from 45 Hz to 15 kHz.
SIZE $12\frac{3}{4} \times 6\frac{3}{4} \times 8\frac{1}{2}$
Matched pairs
Natural Teak or Walnut Cabinet

Write for details of Celestion sound equipment. **ROLA CELESTION LTD.** DITTON WORKS, FOXHALL ROAD, IPSWICH, SUFFOLK IP3 8JP

continued

CROWN (now Amcron)

Crown International, 1718 West Mishawaka Road, Elkhart JA3-4919, Indiana, USA.
Agent: Macinnes Laboratories Ltd, Stonham, Stowmarket IP14 5LB.
Tel: 044 971 486.

CS64
Bandwidth: 35 Hz to 20 kHz.
Power rating: 60W.
Units: Four.
Matching amplifier: Crown D60.
Dimensions: 635 x 356 x 305 mm.
Price: £99.

CS158
Bandwidth: 25 Hz to 20 kHz.
Power rating: 150W.
Units: Eight.
Matching amplifier: Crown D150.
Dimensions: 686 x 457 x 305 mm.
Price: £155.

ES60-5
Bandwidth: 30 Hz to 32 kHz.
Power rating: 60W.
Units: One bass, four electrostatic.
Matching amplifier: Crown D60.
Dimensions: 813 x 584 x 330 mm.
Price: £186 (retail).

ES150-8
Bandwidth: 25 Hz to 32 kHz.
Power rating: 150W.
Units: Two bass, six electrostatic.
Matching amplifier: Crown D150.
Dimensions: 813 x 584 x 813 mm.
Price: £260 (retail).

ES150-14D
Bandwidth: 20 Hz to 32 kHz.
Power rating: 150W.
Units: Two bass, 12 electrostatic.
Matching amplifier: Crown D150.
Dimensions: 305 x 660 x 305 mm.
Price: £390 (retail).

ES300-26D
Bandwidth: 20 Hz to 32 kHz.
Power rating: 300W.
Units: Two bass, 24 electrostatic.
Matching amplifier: Crown DC300.
Dimensions: 991 x 660 x 305 mm.
Price: £580 (retail).

ES1000-36DA
Bandwidth: 18 Hz to 32 kHz.
Power rating: 600W.
Units: Four bass, 40 electrostatic.
Matching amplifier: Crown DC300.
Dimensions: 1,524 x 864 x 406 mm.
Price: £920 (retail).

All the above Crown models with D suffix are in two cabinets. All models have external frequency response adjustments and are 4 ohms nominal impedance. Crown Variable Electronic Crossover unit available as an option or individual item.

ELECTRO-VOICE

Electro-Voice Inc, Buchanan, Michigan.
Agent: Gulton Europe Ltd, The Hyde, Brighton BN2 4JU.
Tel: 0273 66271.

Sentry 1A
Bandwidth: 30 Hz to 20 kHz.
EIA sensitivity: 48 dB.
Sound pressure level: 110 dB (1.2m on axis, 20W).
Impedance: 8 ohms.
Power rating: 20W.
Dimensions: 552 mm high at rear, 940 mm wide, 419 mm deep at top (downfacing wall cabinet).
Weight: 38 kg.
Price: £136.

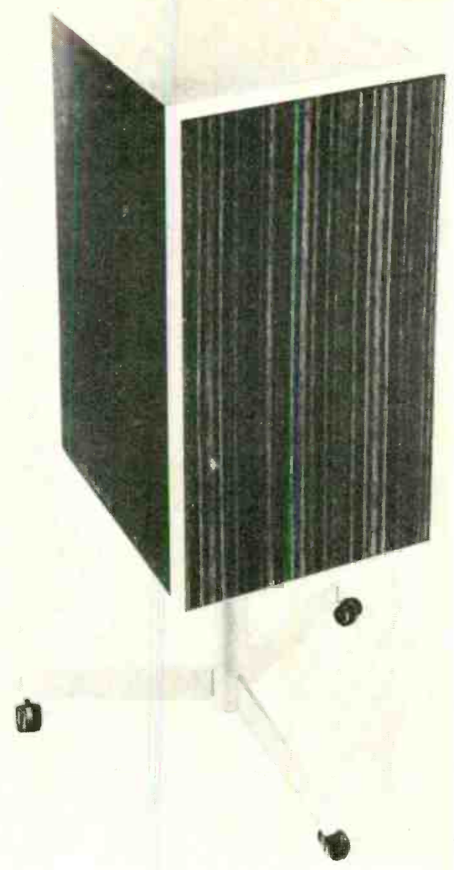
Sentry 2A
Bandwidth: 30 Hz to 20 kHz.
EIA sensitivity: 48 dB.
Sound pressure level: 110 dB (1.2m on axis, 20W).
Impedance: 8 ohms.
Power rating: 20W.
Hwd dimensions: 813 x 508 x 330 mm.
Weight: 37 kg.
Price: £136.

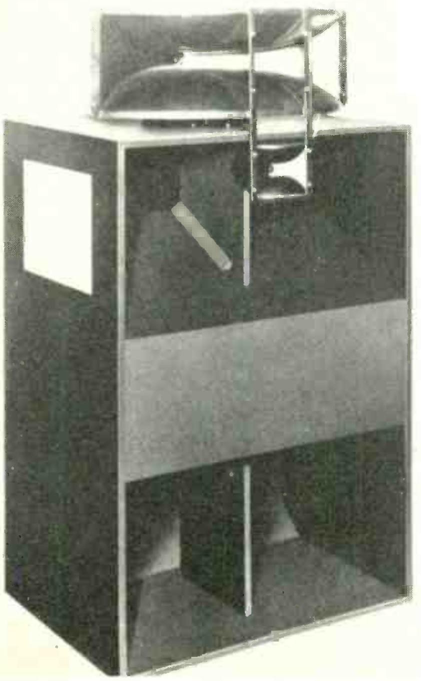
Sentry 4
Bandwidth: 50 Hz to 18 kHz.
EIA sensitivity (on axis): 52 dB.
Sound pressure level: 117 dB (1.2 m on axis, 50W).
Impedance: 8 ohms nominal.
Power rating: 50W.
Hwd dimensions: 1290 x 705 x 523 mm.
Weight: 68 kg.
Price: £345.

EMI

EMI Sound & Vision Equipment Ltd, 252 Blyth Road, Hayes, Middlesex UB3 1HW.
Tel: 01-573 3888.

LE4
Power rating: 25W rms.
Impedance: 8 ohms.
Crossovers: 1 and 5 kHz.
Units: 355 x 229 mm bass, two 127 mm mid and one 95 mm treble.
Hwd dimensions: 838 x 406 x 356. mm.
Price: £40.60.





Above: Ferrograph S1

Below left: Electro-Voice Sentry 4

FERROGRAPH

Ferrograph Co Ltd, Auriema House, 442 Bath Road, Cippenham, Slough, Bucks SL1 6BB.
Tel: 062 86 62511.

S1
Bandwidth: 45 Hz to 20 kHz ±3 dB.
Power rating: 25W continuous sinewave; 100W peak.
Impedance: 8 ohms (6 ohms minimum over audio range).
Crossovers: 400 Hz and 3.5 kHz.
Units: 330 x 241 mm bass, 102 mm mid, and 25 mm treble.
Hwd dimensions: 640 x 350 x 440 mm.
Stand height: 370 mm.
Weight: 25 kg (cabinet); 2.7 kg (stand).
Price: £95.

IMF

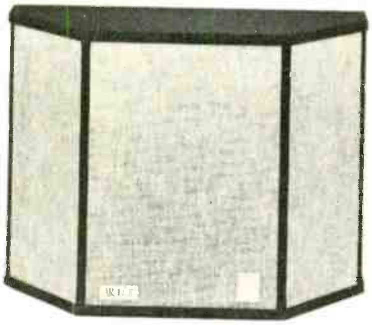
IMF Products (GB), Westbourne Street, High Wycombe, Buckinghamshire.
Tel: High Wycombe 25166.
Agent: REW Audio Visual, 146 Charing Cross Road, London WC2.
Tel: 01-836 3365.

Professional Monitor
Bandwidth: 18 Hz to beyond audibility.
Power rating: 100W speech and music.

continued 47

Some speaker systems can handle high levels of power.

A few speaker systems can reproduce sound accurately.



The AR-LST
is designed to do both.

A speaker system that can provide a flat energy profile, yet handle high levels of power, has been needed by recording engineers for many years. Acoustic Research now meet that need with the AR Laboratory Standard Transducer.

The AR-LST's flat energy-output curve gives the industry its first quantitative standard for recording and mix-down monitoring. And, the AR-LST can handle the levels of power normally required in commercial applications. An appropriate power source, for example, would be the new 700-watt Phase Linear amplifier, now available from Acoustic Research.

The AR-LST is being used in a number of recording studios.

Pictured here are James Frey and recording artist Bob Hinkle, listening to a playback of one of Bob's albums recently completed at Media Sound Studios in New York.

The AR-LST is guaranteed for 5 years from the date of purchase. The guarantee covers parts, repair labour, and freight costs to and from the factory or nearest authorised service station. New packaging, if needed, is also free.

Please return the coupon for complete information.

Please send detailed information on the AR-LST and the Phase Linear amplifier to.

Name ____________________

Address ____________________

____

Acoustic Research International
High Street, Houghton Regis, Beds.
Dunstable (0582) 603151

AR

You can see the difference

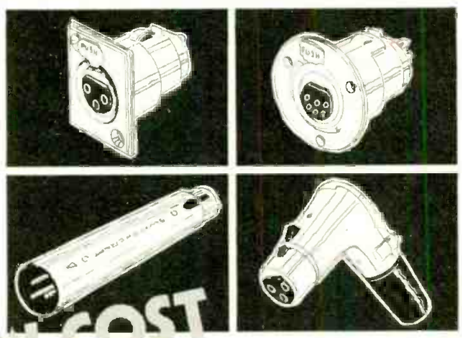
LOOKS LIKE LOCKWOOD BY THE SOUND OF IT

LOCKWOOD

HARROW · MIDDLESEX

Tel. 01-422 3704 and 01-422 0768

Switchcraft Audio Connectors



Complete range of Switchcraft audio connectors now available for all studio and ancillary equipments.

Versatile — 3, 4, 5 or 6 contacts; wide variety of plugs and receptacles; ready interchangeability with other leading makes.

Streamlined — simple positive snap-in connection; cable clamping and latch lock.

Safe — self-polarisation: captive insert screw provides rigid assembly and electrical continuity: pin and contact insulation eliminates hum and noise problems.

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Sole U.K. Agent for Switchcraft QG Connectors

F.W.O. BAUCH LIMITED
49 Theobald Street Boreham Wood Herts WD6 4RZ
Tel: 01-953 0091 Telex: 27502

continued

Efficiency: 25W produces 100 dB (pink noise, 1m on axis).
Nominal matching impedance: 4 to 8 ohms.
Crossovers: 375 Hz, 3.5 kHz and 13 kHz. ±2 dB adjustment over mid and treble.
Units: 330 x 241 mm bass, 152 mm mid, 44.5 mm treble and 19 mm hf.
Dimensions: 1,067 x 444 x 502 mm.
Weight: 64 kg.
Price: £350 (recommended retail per pair inc. tax).

Monitor two
Dimensions: 1575 x 445 x 500 mm.
Bass Unit: 330 x 240 mm (flat polystyrene diaphragm).
Mid Range unit: 152 mm (plastic cone diaphragm).
High frequency unit: 286 mm (soft dome).
Super high frequency unit: 190 mm (chemical dome).
Crossover frequencies: 375 Hz, 3 kHz, 13 kHz.
Frequency range: 18 Hz to beyond audibility.
Nominal impedance: 8 ohms.
Power requirement: 70W maximum.
Price: £275 a pair (including tax).

Studio TLS 50
Dimensions: 914 x 355 x 380 mm.
Bass unit: 203 mm (foam surround, impregnated diaphragm).
Mid-range unit: 127 mm (impregnated cone contained in separate line).
High frequency unit: 286 mm (soft dome).
Super high frequency unit: 190 mm (chemical dome).
Crossover frequencies: 375 Hz, 3 kHz, 13 kHz.
Frequency range: 23 Hz to beyond audibility.
Controls: calibrated ±2 dB level controls for mid and high frequencies.
Nominal impedance: 8 ohms.
Power requirement: 60W maximum.
Price: £195.94 a pair (including tax).

LOCKWOOD
Lockwood & Co (Woodworkers) Ltd, 63 Lowlands Road, Harrow, Middlesex.
Tel: 422 3704.

Major
Bandwidth: 30 Hz to 20 kHz.
Nominal impedance: 8 or 15 ohms (Tannoy unit) or 16 ohms (Altec 604E).
Maximum recommended amplifier power: 50W program.
Input connections: To order.
Dimensions: 1,144 x 712 x 450 mm.
Weight: 45 kg (66 kg with internal Quad 50E).
Price: £180 (£280 with Quad 50E).

JBL
James B. Lansing Sound Inc, 3249 Casitas Avenue, Los Angeles, California 90039, USA.
Agent: Feldon Audio, 126 Great Portland Street, London W1N 5PH.
Tel: 01-580 4314.

4310
Power rating: 50W program.
Crossovers: 1.5 and 7 kHz.
Nominal impedance: 8 ohms.
Dispersion: 90° horizontal and vertical.
Bandwidth: 30 Hz to 15 kHz ±5 dB.
Sensitivity: 42 dB at 9m with 1 mW input, average across 500 Hz to 2.5 kHz with controls set for flattest response.
Hwd dimensions: 604 x 362 x 305 mm.
Shipping weight: 23 kg.
Price: £117.

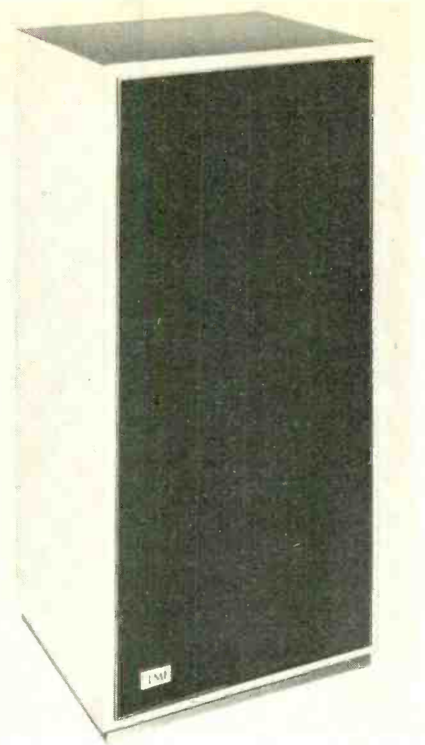
4320
Power rating: 60W continuous sinewave, 120W program.
Crossover frequency: 800 Hz.
Minimum impedance: 12.5 ohms at 175 Hz.
Dispersion: 45° and 120°.
Bandwidth: 40 Hz to 15 kHz ±3 dB.
Sensitivity (EIA): 48 dB (9m with 1 mW input).
Hwd dimensions: 762 x 584 x 508 mm.
Weight: 39 kg.
Price: £150.

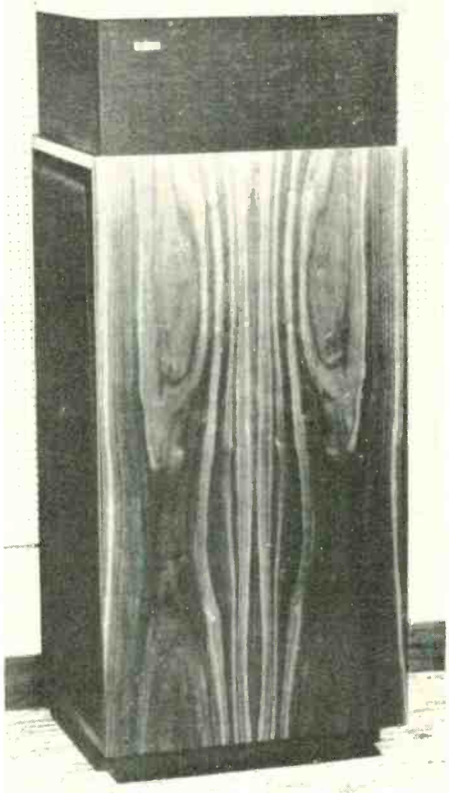
4325
Similar to 4320 but with 1.2 kHz crossover frequency and a more efficient bass driver.
Price: £150.

4326
High power version of 4320. Contains 2215 bass driver, 800 Hz crossover, 2440 high power horn driver with HL91 horn and lens. 7 kHz crossover. 2405 uhf driver.
Price: £298.50.

4326B
Similar to 4326 but with more efficient bass driver.
Price: £298.50.

4350
Bandwidth: 30 Hz to 21 kHz ±3 dB (unequalised).
Sensitivity: 120 dB spl at 1.8m, 20 Hz to 20 kHz pink noise.
Units: Two 380 mm bass, 300 mm mid, *2440/2391* treble and *2405* hf.
Presentation: Studio grey or old walnut.
Production: Commencing early 1973.
Price: £566.





Top right: IMF Professional Monitor.
Lower right: Radford 360/100.
Left: JBL 4320.

continued 49

“[illegible] itic[illegible] for producing these speakers [illegible] tic[illegible] are that no changes of any sort [illegible] the design without prior per-[illegible] obtained from the BBC. Each sp[illegible]er pr[illegible]ced must satisfy a rigid specification. Rogers have sensibly taken great care over the production of the BBC monitors and have even had a special anechoic chamber built so that each unit can be tested on completion.

They felt, however, that the response at the upper end, though perfectly adequate for BBC

the BBC tolerances, the latter give improved performance on listening tests.

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

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

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

Choir: Very natural sound with excellent tonal balance.

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

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

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

Dance Band: Very natural with excellent percussion.

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

Wind Quintet: Very natural.

Speech: Very natural with no excessive sibilants or chestiness.

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

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

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

This is not surprising as the engineers at the BBC Research Dept are very conscious of the

expected that any speaker designed by them should excel in this respect.

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

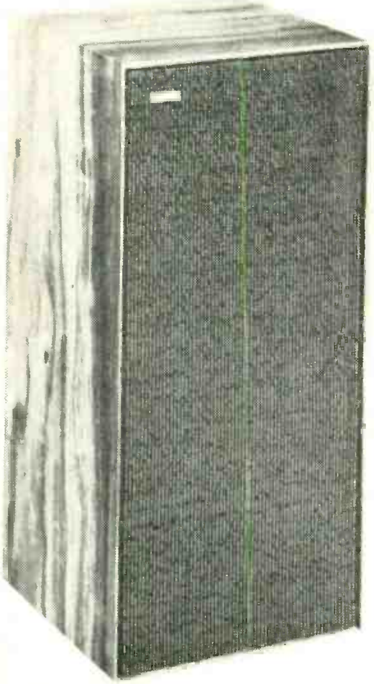
The speaker, although able to handle quite high levels of power, will not give the large sound output favoured by many engineers, and therefore is not suitable for monitoring loud pop in a large control room. For moderate levels it takes its place among the very few excellent monitor speakers that can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

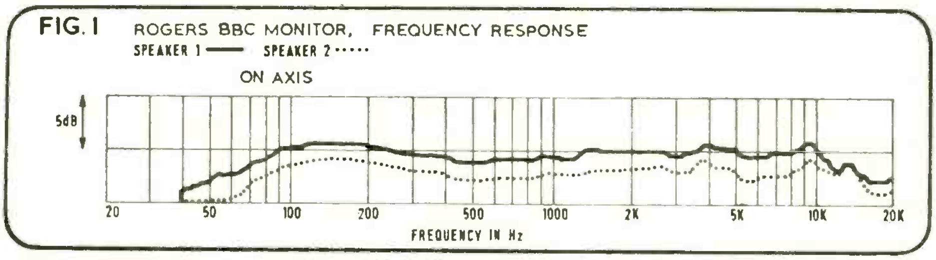
Frequency response curves were taken in an anechoic room one metre on axis, and are given for both review models. The remarkably close similarity between both sets of curves shows how closely the two speakers match—a tribute to the Rogers production team. The impedance curve shows that the speaker will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

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

An industrial version of the BB[illegible] available from Rogers. Price [illegible] excluding stand. This version [illegible] follows the BBC design by om[illegible] the [illegible]”

(The above extracts are taken from a review by John Shuttleworth in the July 1972 issue of Studio Sound)





Brief Specification: Overall Frequency Response: 40Hz-25kHz. ±3dB 50Hz-14kHz. Power Handling Capacity: 25 watts, speech and music. Impedance: Standard 15 ohms, to order 8 and 25 ohms. Drive Units: Three. Overall Dimensions: Enclosure 12″ x 12″ x 25″. Height, including stand 37″. Weight: 34 lbs. Finish: Teak. (Rosewood and other finishes available to order at extra cost.)

Distribution restricted to a limited number of carefully selected specialist high fidelity dealers and professional users.

Recommended U.K. Retail Prices: Standard Model, including stand £83.50 + £12.80 P.T., less stand £77.00 + £12.35 P.T. Professional Model (less stand and super tweeter, including wall bracket; 100 volt line matching) £45.00.

ROGERS BBC

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

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

NAME ....

ADDRESS ....

....

SS12

continued

KLEIN & HUMMEL

Klein & Hummel, 7301 Kemnat, Stuttgart, West Germany.
Tel: Stuttgart 253246.
Agent: F.W.O. Bauch Ltd, 49 Theobald Street, Boreham Wood, Hertfordshire.
Tel: 01-953 0091.

OY

Bandwidth: 40 Hz to 16 kHz ±2 dB (measured with third-octave white noise.
Sound pressure level: 107 Phons (curve B), at 1m.
Self noise level: 10 Phons at 1m.
Dynamic range: 90 dB.
Dispersion angle: ±30°.
Rise and decay times: 10 ms at 60 Hz, 5 ms from 100 Hz, 2 ms from 500 Hz, 1 ms from 1 kHz.
Total harmonic distortion: 1 per cent (mid range).
Crossovers: 500 Hz and 8 kHz (electronic); 500 Hz and 6 kHz (acoustic).
Amplifiers: Integral 2 x 30W.
Dimensions: 483 x 305 x 229 mm.
Weight: 20 kg.
Price: £245.

OZ

Bandwidth: 40 Hz to 16 kHz ±2 dB.
Sound pressure level: 110 Phons (curve B), at 1m.
Self noise level: 10 Phons at 1m.
Dispersion angle: 140° at 4 kHz, 100° at 10 kHz, 80° at 12.5 kHz.
Distortion: 1 per cent (mid range).
Crossover frequency: 800 Hz.
Amplifiers: Integral 2 x 30W.
Hwd dimensions: 700 x 900 x 420 mm.
Price: £693.

RADFORD

Radford Audio Ltd, Bristol BS3 2HZ.
Tel: 0272 662301.

90/50

Bandwidth: 55 Hz to 25 kHz.
Power rating: 50W.
Units: 305 mm bass, two 76 mm mid and two 25 mm treble.
Dimensions: 535 x 305 x 230 mm.
Price: £52.50.

180/50

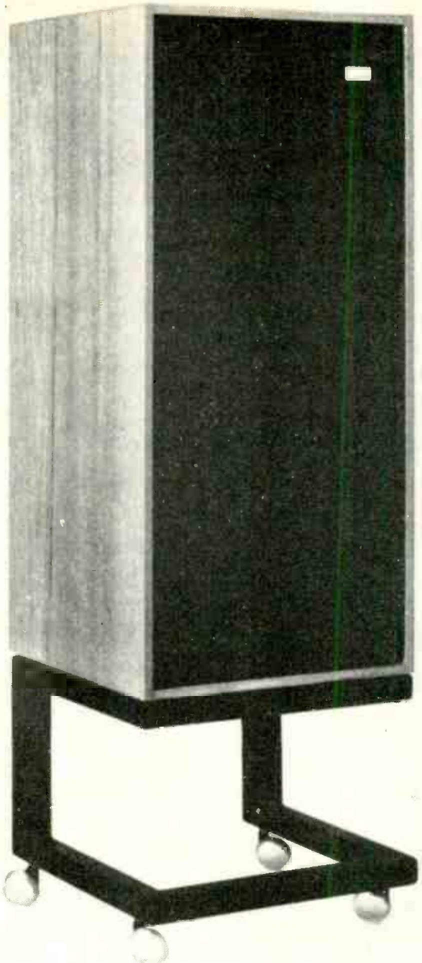
Bandwidth: 50 Hz to 27 kHz.
Power rating: 50W.
Units: As 90/50.
Dimensions: 760 x 345 x 265 mm.
Price: £75.

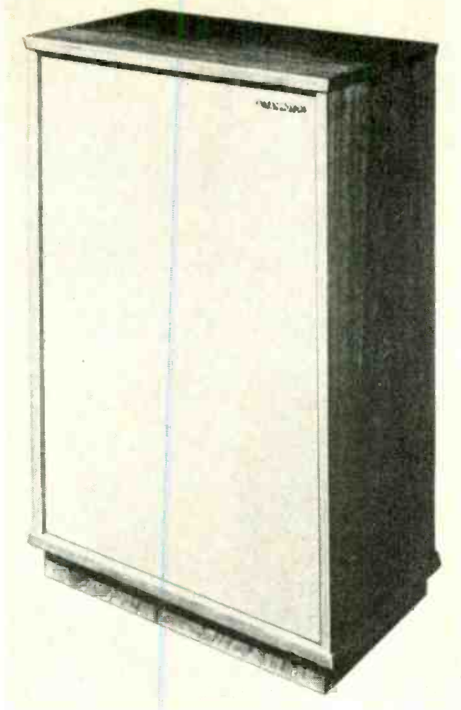
270/50

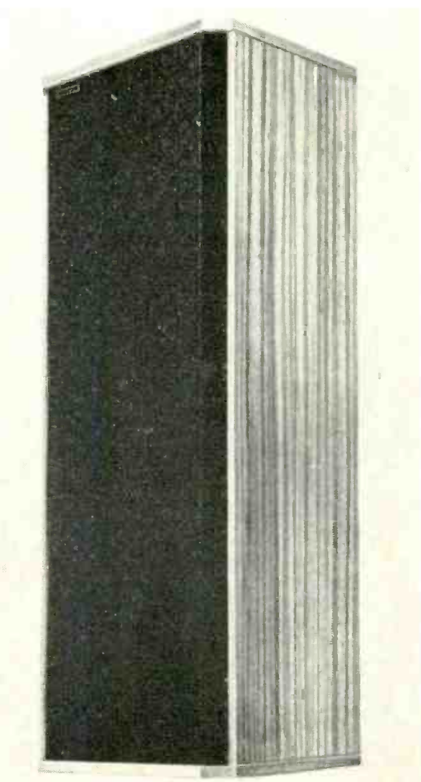
Bandwidth: 35 Hz to 25 kHz.
Power rating: 50W.
Units: 305 mm bass, three mid and three treble.
Price: £100.

360/100

Bandwidth: 30 Hz to 25 kHz.
Power rating: 100W.
Units: Two 305 mm bass, four mid and four treble.
Dispersion: 270° when against wall; 360° 1m from wall.
Dimensions: 1,145 x 475 x 380 mm.
Price: £157.50.







Above: Tannoy Lancaster (Rectangular).
Left: Spendor BC1 (trolley extra).
Below left: Celestion Ditton 66.

ROGERS

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

BBC Monitor

Bandwidth: 40 Hz to 25 kHz ±3 dB.
Power rating: 25W speech and music.
Impedance: 15 ohms standard. Eight and 25 ohms to order.
Units: Three.
Hwd dimensions: 635 x 305 x 305 mm.
Height including stand: 940 mm.
Weight: 16 kg.
Price: £96.31. Industrial version £45.

SPENDOR

Spendor Audio Systems Ltd, Kings Mill, Kings Mill Lane, South Nutfield, Redhill, Surrey RH1 5NF.
Tel: Nutfield Ridge 2554.

BC1

Bandwidth: 60 Hz to 14 kHz ±3 dB.
Power rating: 40W program.
Nominal impedance: 8 ohms.
Units: Spendor 203 mm bass (plastic cone), Celestion 1300 treble and STC 4001G hf.
Recommended amplifier: Spendor M208.
Hwd dimensions: 635 x 299 x 304 mm.
Weight: 14 kg.
Price: £71 (inc. tax).

BC1A

Specification as BC1 but with integral 20W power amplifier.
Price: on application.

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IMF

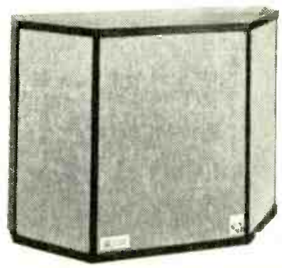
As Britain's leading IMF agents, REW are proud to be able to offer the entire new range of Monitor speakers from stock:

ALS40 Active Line Loudspeaker	£72·31
TLS50 Transmission Line Loudspeaker	99·97
Monitor MkII Transmission Line Loudspeaker	137·50
Professional Monitor Transmission Line Loudspeaker	175·00
Reference Standard Transmission Line Loudspeaker	189·00

Manufacturers Recommended Prices

The Reference Standard model is a newly developed version of the Professional Monitor, giving better low frequency response and improved power handling stability.

ACOUSTIC RESEARCH



The AR range of speakers are now available again in this country. Already widely used by studios in the USA, they are now available at new low prices due to manufacture in Great Britain. REW have been appointed central London agents. Most models available from stock, including the LST laboratory standard at £200, recommended price.

CELESTION DITTON 66

STUDIO MONITOR

REW can offer immediate delivery on this new top model from Celestion. This speaker is outstanding value owing to its high power handling, and excellent bass response from its compact dimensions.

Manufacturers recommended price **£99.00**

SPENDOR ROGERS

REW are the largest suppliers of Spendor monitors in the West End. We can normally supply from stock, although occasionally due to demand there is some delay.

BC1
Teak/white £77·00
Walnut 79·10
Rosewood 82·25

BC2
£8.75 *extra on* BC1

TROLLEYS
Black/white £8·50
Satin chrome 10·90

ROGERS BBC MONITOR
Developed from the BBC specification LS3/6, this speaker has now gained a well deserved reputation for quality reproduction of music and speech. Low impedance version for studio amplifiers **£96** including stand.

FERROGRAPH

S1 MONITOR

The S1 Monitor, which comes complete with its own trolley pedestal stand has found popularity where mobility and floor space is at a premium. The speaker gives a pleasant uncoloured sound.

Manufacturers recommended price including stand **£95.00**

TANNOY

As one of Tannoy's oldest stockists, REW always have the whole range in stock. This includes the following models which are most suitable for studio use.

Tannoy Chatsworth 12″	£57·00
Tannoy Lancaster 12″ rectangular	63·00
Tannoy Lancaster 15″ rectangular	69·00
Tannoy York 15″ rectangular	86·00
Tannoy GRF 15″ corner	140·00

Manufacturers list prices.

QUAD

ELECTROSTATIC

Always available for immediate delivery from REW, this speaker, famous for its transparent mid-range is still in great demand.

Manufacturers recommended price **£72.00**

JBL

REW are stockists for these famous American speakers. Noted for their superb transient response these speakers combine compact dimensions with high efficiency. Century L100, *recommended price* **£156.00**

Other models' prices on application.

REW are also distributors of the following range of equipment to studios and music trade at special trade terms. Most items are normally in stock.

AKG: Capacitor and Dynamic Microphones and Phones.
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TEAC: 4 Channel Recorders.
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MARANTZ: Professional Amplifiers.
ALICE: Mixers.

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Loudspeaker Measurement Parameters

By John Shuttleworth

IT is important, when considering the measurement of loudspeaker performance, to be quite clear which measurable parameters actually affect this and which do not. The colour of the front grill, for example, should be mentioned in a review but has no effect on sound that comes out. In my opinion, a speaker should be approached as a 'black box'. What goes on inside is not important; it is the sound that comes out that we should worry about.

One parameter in loudspeaker design which I suggest is of dubious value is impedance. Provided it does not at any stage become so high or low that the amplifier runs into trouble, it bears little relation to the acoustical performance of a loudspeaker.

It is strange therefore that a certain consumer audio magazine, who refuse to publish frequency response curves in their speaker reviews on the grounds that they can be misleading, regularly publish impedance curves. Many of their relatively nontechnical readers must associate the curve with the kind of sound to expect and certainly gain the impression that a good speaker should have a flat impedance curve.

Impedance curves have been published in STUDIO SOUND speaker reviews in the past but always with a note that they only indicate whether the speaker will work with a poor amplifier or not. It has been assumed that SS readers would be aware that impedance is of little importance, and that only the ill-informed 'hi-fi' customer might be misled. It came as a shock, therefore, to hear that a certain speaker designer of no mean repute goes to considerable trouble to produce devices with as flat an impedance curve as possible. To achieve this, it is necessary to use more components in the crossover network which means either an increase in the price of the complete unit or the use of inferior components. Either of these expedients might be justified if the speaker performance was improved but are undesirable if the resulting sound quality is no better. I do not suggest that it is wrong for a designer to keep the impedance of a loudspeaker within reasonable limits but these limits can be quite wide.

When designing a speaker, the ideal is a constant acoustical output for constant voltage input throughout the frequency range. One way of doing this is to design multi unit systems so that each unit works well within its range and hands over to another before it is likely to run into difficulties.

To some extent, both the bass and mid-range units will be working together. Since our design criteria require that the high bass should be well within the range of both units, the acoustic output could be higher for a given input than at other frequencies unless we take some precaution to prevent it. This correction can be made in the crossover circuitry and could well entail increasing the impedance of the system at the frequency concerned. The impedance/frequency curve for such a system would have a peak at the part we are considering but this would not be showing a fault. It would merely indicate a design technique.

It is interesting to note that the three-speaker system given a most favourable review in the consumer magazine mentioned earlier gives consistently good frequency response curves. These were not published on the grounds that they would be misleading. Three speaker systems of this kind have the most alarming load impedance curves—these were published.

To illustrate the point I am making, frequency response and impedance characteristics of the Quad *ELS*, Spendor *BC1* and Rogers *Monitor* speakers are shown. These devices have the flattest and smoothest frequency response curves of any speakers I have tested. All three come out extremely well on listening test and are arguably the three finest systems commercially available today. Could anyone judge this by their impedance curves?

AXIAL FREQUENCY RESPONSE (dB)

	Quad ELS	Spendor BC1	Rogers Monitor
50 Hz	—3	—4	—2
100	—1	0	+1
200	—1	—1	+2
500	—1	—1	—1
1 kHz	0	0	0
2	0	0	+1
5	0	0	+1
10	+1	—2	+1
15	0	—12*	—2

IMPEDANCE (ohms)

	Quad ELS	Spendor BC1	Rogers Monitor
50	20	14	15
100	39	12	13
200	25	14	12
500	16	22	15
1 kHz	13	40	40
5	10	31	23
10	5	32	17
15	3	42	11

*Hf response to BBC requirements. Later versions with additional hf unit have extended hf response.

MONITOR LOUDSPEAKERS

continued

BC2
Specification as BC1 but with 50W program power rating.
Recommended amplifier: Spendor M508.
Price: £85.75 (inc. tax).

BC2A
Specification as BC2 but with integral 50W amplifier.
Price: on application.

TANNOY
Tannoy Products Ltd, Norwood Road, West Norwood, London SE27 9AB.
Tel: 01-670 1131.

GRF (Corner)
Bandwidth: 30 Hz to 20 kHz ±3 dB.
Drive unit: 380 mm Tannoy Gold.
Power rating: 50W program.
Average conversion efficiency: 10 per cent.
Dimensions: 1,070 x 483 x 600 mm.
Price: £140.

Lancaster (Rectangular)
Drive unit: 305 mm Tannoy Gold.
Dispersion: —3 dB at 10 kHz for 60° inclusive angle.
Impedance: 5 ohms minimum.
Power rating: 30W.
Crossover frequency: 1 kHz.
Dimensions: 826 x 546 x 318 mm.
Price: £63.

THE PROFESSIONALS' CHOICE

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LOUDSPEAKERS

There are three types of monitor loudspeakers.

1. **Music** monitors used by studios for the evaluation of music and master recordings.
2. **Reference** monitors extensively used in broadcasting for evaluation of speech and general programme material.
3. Those **domestic loudspeakers** *called* 'monitors' which are rarely if ever used in professional applications.

Essentially, music monitors exhibit high efficiency combined with high power handling in order to reproduce music at realistic levels with extremely low distortion.

Whilst measured specifications are useful as a general guide, we believe that the **trained** ear is the ultimate criterion in the assessment of loudspeaker quality.

It is a fact that JBL is the overwhelming professional choice in studios, theatres and concert halls throughout the world.

Studios such as E.M.I., Decca Records, Deutsche Grammophon-Polydor, Columbia, Capitol Records, Warner Bros, MGM, Advision, Morgan, Trident, Sound Technique, IBC, Dick James Music, Strawberry, Indigo, Mayfair Sound Studios, Blue Horizon, Island Records, London Weekend TV and many others.

Theatres and concert halls as renowned as the Royal Opera House, Metropolitan Opera House, Sydney Opera House, Hollywood Bowl, Theatre Royal Drury Lane, Saddlers Wells Coliseum, National Theatre and many others.

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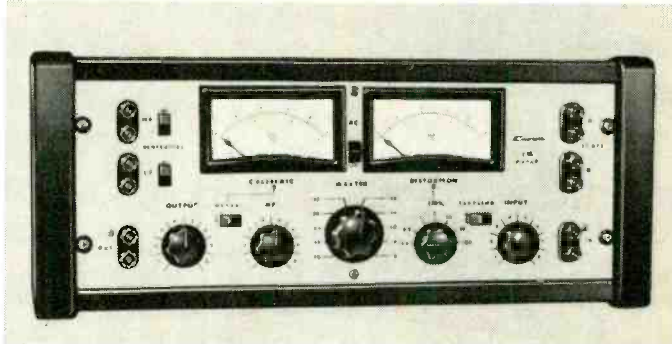
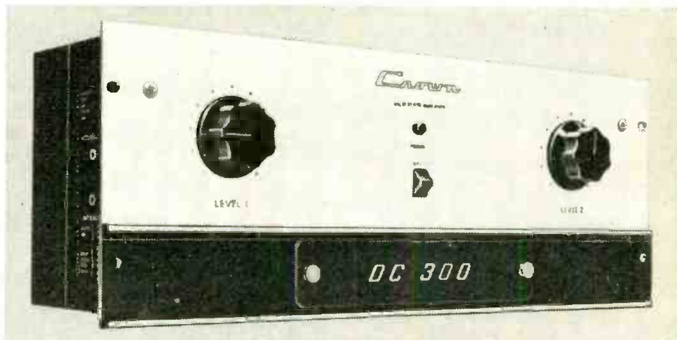


Model IMA £395
Intermodulation Distortion Analyser

A dual-meter instrument providing facilities for measuring to exceptional degrees of precision on both L.F. and H.F. ranges (10-150 Hz and 2.5 KHz to 20 KHz). Tests over a wide range of varying amplitudes can be made quickly and accurately. FET circuitry assure measurements approaching a typical residual of 0.005% and within 5% of full scale. Many original features are incorporated in this instrument whereby generator interaction is eliminated, as are microphonics through the use of FET controlled AGC. Full details appear on the leaflet which we will gladly forward on request.



Model DC 300 £360
Two channel p.a. power amplifier

This superbly engineered Crown International power amplifier combines the qualities of a precision laboratory instrument with built-in ruggedness for a hard, long working life. It will deliver a total of 800 watts RMS into two 4 Ω loads, or 420 watts RMS into 8 Ω loads. Frequency response from 0 to 20 KHz into 8 Ω is within ±0.1 dB, up to 100 KHz, it is within ±0.6 dB. There is all-over protection against overload and misuse. Signal to noise ratio is 100 dB below 150 watts RMS output (unweighted, typically 110 dB). There is minimal programme delay on switching on. For standard rack mounting if required. May we send details of this outstandingly fine unit?

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Telephone Stonham 486

Hiring Audio Equipment

By Cliff Wragg

THIS article is intended as a sequel to the article on equipment hire in the June issue, by A. Eden. That first survey studied the basic principles of hiring electronic, and in particular, audio, equipment, both from the point of view of the hirer and that of the owner. The article dealt mainly with recording companies which, as subsidiary concerns, hired out equipment. However, as was then mentioned, the market for hire equipment is a rapidly expanding one, and over the past years it has seen the birth of companies specialising in the hire of equipment.

These companies devote their full attention to the equipment for hire and are therefore better able to maintain and modernise it in keeping with the almost weekly improvements and innovations in the audio world.

Several companies not mentioned in the June article are mentioned here, and it can be seen that some specialise in a narrow field (for example, that of fashion shows) and some diversify into all related fields, thus offering a fully comprehensive service. There are arguments for both types of operation but I personally favour the comprehensive service.

On the one hand, the companies specialising in a limited field claim that by doing so they can offer greater experience and ability in their field whereas, on the other hand, companies with diverse policies can offer continuity of service, regardless of the needs of the client, while still being able to have the necessary experience and ability. This can often be of great advantage to a client. It is comforting to know that all the arrangements are being attended to by one person and that no co-ordination is required; furthermore, should anything go wrong there can be no 'buck passing' as could otherwise be the case.

Coupled with this idea of comprehensive service, these firms also offer a consultancy service whereby the entire job in hand can be passed over to the firm at the very outset. By doing this, the job would be done with a measure of guaranteed results and the client would have yet less worries to contend with.

The pricing of the hire equipment is a complex matter and is usually quite arbitrary. Generally, it has to be decided how long an article has to be on hire before it has paid for itself (maintenance and overheads excluded). When fixing this period, the likely usage of the equipment in relation to its expected life has to be taken into account.

Because of this arbitrary nature of the pricing structure, prices often vary quite substantially and it really does pay a prospective client to shop around before fixing any arrangements.

There are a few individual people who hire out equipment but generally their stock is limited and they normally operate through personal contact and experience. In some cases, the equipment belonging to an individual may suffer through a lack of maintenance facilities.

The major problem of hire companies is that of stock turnover. If equipment is kept too long it becomes obsolete, unreliable, and its capital value (resale value) rapidly depreciates. On the other hand, if equipment is bought and sold too quickly it does not have time to give value and not enough profit is made from the capital outlay. This is a narrow line which the companies have to tread, and some firms are living evidence of having diverged too far on either side of this line. Running a hire company not only requires shrewd business acumen but also a good sense of timing.

In these days of expensive and complex equipment, further problems arise. When hiring out such equipment it is advisable also to provide an engineer to install and possibly operate it. This protects the equipment from damage by mishandling and ensures that the results are satisfactory. The equipment is often blamed for poor results, instead of the inability of the operator to use it to the best advantage.

This in turn gives rise to another problem. In taking this extra care over the initial installation, the cost of such an operation inevitably arises. This is only economical when the hire term is of a sufficiently lengthy period. For a short term the problem is that installation is both desirable and uneconomical. In these cases, the charges would have to be higher to cover the expenses incurred.

This problem is particularly vital in, for example, the theatrical field, where the term of hire cannot be guaranteed and can range from two weeks to 20 years or more.

Related to this is the problem of 'one-offs'. In some cases the installation might require a special piece of equipment which has to be built specifically for that job. In this event, the cost of its manufacture, plus a reasonable working profit, would have to be guaranteed, to make it worthwhile, so the hire charge would probably be higher than one would normally have expected. As a result it might pay the client to buy outright such a piece of equipment, depending on the estimated term of hire.

It is always difficult to know what range of equipment to carry since requirements range from purely studio equipment, where results are the only criterion (appearance and the like being of no great consequence) to equipment for theatrical use which has to be sturdy and rugged to withstand the rigours of touring, and yet at the same time give high quality results.

The widest selection of hire equipment is, in fact, to be found in theatrical spheres, since their requirements cover anything and everything. Most production companies own no equipment so it all has to be hired. In this way they hedge against a possible flop.

Nowadays, sound is being appreciated more and more. Sound for a play has progressed from being a mere incidental, a few years ago, to being an important factor concerning the production. An audio consultant service can be vital during any production.

Coupled with this recognition of sound is a willingness on the part of producers to try new ideas, such as back projection, set projection, synthesised sound, and so on. These, while making a wider variety of work for the hire company to do, also create a demand for a wider range of equipment.

This expansion and growth of the market means that firms are continually being formed to satisfy the demand so any list of hire firms could never claim to be comprehensive. When looking for a hire firm to do business with, consider its reputation.

Bettersound Ltd, 33 Endell Street, London WC2.
Tel: 836 0033.
Speciality: Sound equipment and recordings.

British Films Ltd, 260 Balham High Road, London SW17.
Tel: 672 6677.
Conference and projection services.

Consolidated Sound, 47 Camden Mews, London NW1.
Tel: 485 2340.
Fashion show sound and lighting.

Donmar Productions Ltd, New Theatre, St Martins Lane, London WC2.
Tel: 240 1691.
Theatrical equipment.

Guild Sound & Vision Ltd, Kingston Road, London SW19.
Tel: 542 7201.
Sound and projection equipment.

IES Ltd, 11 Sharpleshall Road, London NW3.
High power pop and public address systems and musical instruments.

NSR, 394 Northolt Road, Harrow.
Tel: 422 1863.
Outdoor public address systems.

Orange Musical Industries, 3 New Compton Street, London WC2.
Tel: 836 7811.
Pop systems and instruments.

Theatre Sound & Lighting Services, Queens Theatre, Shaftesbury Avenue, London W1.
Tel: 437 7599.
Theatrical sound, lighting and projection equipment and consultants, recordings, conference and high power systems; special effects.

The Ambiguous dBm

By Herman A. O. Wilms[1] and John M. Bowsher[2]

IN the field of audio engineering we can consider the decibel to be the basis of our technical language. Despite the fact that the dB is already about 45 years old, this so-called 'unit' has provoked and still provokes many mistakes and much confusion when applied to the audio field as well as to the whole telecommunication field.

In international standardisation circles very good work has been done in Committee SC29B of the IEC. as has been reported earlier in the *Journal of the AES* by J. G. McKnight [01]. However, between the publication of a new standard and its wide-spread application, there is generally a gap of several years. Unfortunately the decisions taken by the IEC about the new symbols for absolute decibels, corresponding to voltage and power levels, definitely discourage voltage levels related to the 0.775V reference.

In this paper we would like to discuss the following items:

1. the explanation of the most popular mistake: incorrect use of the dBm, based on an historical background;
2. the new standard IEC 268-2 about absolute decibels;
3. a proposal of a new symbol for voltage levels re 775mV;
4. further philosophy and proposals as additions to the IEC definitions.

Very few readers will be fully aware of the evolution of the decibel so we shall start with a brief historical survey.

Brief History

The decibel was first used in one of the oldest fields of electroacoustics: telephony. In the early days of our century, the exponential losses in transmission lines were already very well known and consequently computations with logarithims of power ratios were used. First in England, and later in the USA, the term 'mile of standard cable' (msc) appeared around 1920 as a practical unit for measuring losses in telephone lines.

1 msc corresponded to a loss which was created by 1 mile of a cable having well known parameters [03]. This loss was referred to a frequency of 800 Hz, implying that this unit was not directly applicable at other frequencies.

A few years later, in 1924, Bell Laboratories created a new kind of 'unit' on a purely mathematical base, as having for 1 unit the value of a *power ratio* of

$$\sqrt[10]{10} : 1 = 10^{0.1} : 1 = 1.258\,92 : 1$$

The logarithm to base 10 of 1.258 92 has exactly the value of 0.100 000. This unit was called 'Transmission Unit' (TU) [04] [05]. Hence:

$$1\ \mathrm{TU} = 10\lg\frac{P_2}{P_1} = 10\lg(10^{0.1}:1)$$

$$1\ \mathrm{TU} = 10\lg(1.25892:1) = 10\cdot 0.1 \qquad (01)$$

The advantage of this mathematical definition was that it was independent of frequency and, important at that time, there was only eight per cent difference between the msc and the TU:

$$1\ \mathrm{msc} = 0.9221\ \mathrm{TU} \qquad \text{(at 800 Hz)} \qquad (02)$$
$$1\ \mathrm{TU} = 1.083\ \mathrm{msc}$$

Only four years later, in 1928 the 'International Advisory Committee on Long Distance Telephony in Europe' adopted the 'bel' and 'decibel', and the 'neper' as well, as units for measurements on telephone lines [34]. It is important to note that originally the dB was intended by that committee only for power ratios, while the neper was originally designated for voltage—and current ratios [09]:

$$1\ \text{neper} = 1\ \mathrm{Np} = \ln(e:1)$$

Consequently for power ratios 1 Np became ½ ln e, when no impedance changes were involved.

Strictly speaking the dB and the Np are not quite 'units'. A power ratio or any ratio of two identical quantities is dimensionless and taking X times the logarithm of that dimensionless ratio doesn't give the unit dimensions. From this point of view the dB and the Np are to be considered *names* for a dimensionless quantity and it is only the intensified use of the decibel that has given us the feeling that the dB is a unit. According to a recent paper by Mr R. Young [37], the name 'decibel' is a so-called *unit of* relative and absolute *levels*.

After the European decision in 1927, Bell Laboratories very quickly adopted this 'rebaptism' of their Transmission Unit, of which the definition was identical with that of the newly born 'decibel' [06] [07].

From this time, the dB rapidly became widely used in all fields which were directly related to telephony: electricity and electronics, acoustics and electroacoustics. On the other hand, history shows that the use of the neper was almost entirely limited to the domain of telephony, certainly in Europe [08]. At present, this unit is increasingly losing its influence.

Almost immediately the use of decibels was introduced into acoustics, on one hand because telephony has something to do with acoustics and on the other because it was a well known fact that human hearing approximately responds to a logarithmic law in relation to sound levels. It is a mere coincidence that the original mathematically chosen unit, 1 dB, more or less corresponds to a just detectable sound intensity change.

In spite of the original definition and intention, the dB came to be used more and more for voltage ratios with the formula $20\lg U_2/U_1$. In the beginning of the thirties, voltage ratios initially were only applied where identical impedances were involved, but extension of the use of $20\lg U_2/U_1$ in electronic circuits where $Z_1 \neq Z_2$ became an accomplished fact relatively quickly [09]. With this extended use, confusion around the dB was born!

With the success of the decibel in electronic and audio engineering fields it was natural that engineers would use the dB as a universal 'yardstick' for all kinds of ratios: length, permittivity, volumes, dollars, francs, number of inhabitants etc . . . [10]. In the years between about 1945 and 1955, the situation was more or less chaotic and could certainly be considered by students in electronic engineering as a real 'dB-jungle'.

EC notation: lg represents log 10

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With the intention of avoiding further confusion, proposals were made from different sides for rebaptising the dB (of which the 'decilog' was the strongest proposal) for the quantity 20 lg R_u (R_u = a ratio of voltages, currents, or equivalent quantities), in order to distinguish very clearly these kind of decibels from the others, the original ones for 10 lg R_P (R_P = a ratio of power proportional quantities) [10 to 16]. Nevertheless all such proposals died thereafter save only for a reanimation by McKnight in 1967 [17].

But this is not the complete dB story. Confusions other than between 10 lg and 20 lg are made, especially with absolute decibels in the field of electroacoustics and electronics, increasing the dB jungle with various symbols. In order better to understand the new IEC recommendations, a more technical survey will be given hereafter.

2. Power levels

2.1 Principles Considering an amplifier receiving an input power P_1 and delivering an output power P_2, one may write:

$$\text{Power gain:} \quad G_P = \frac{P_2}{P_1} \quad (04)$$

$$\text{Power level gain:} \quad L_{GP} = 10\lg\frac{P_2}{P_1} \quad (05)$$

$$L_{GP} = 10\lg G_P \quad (06)$$

Habit seems to associate the expression 'gain' with amplifiers; in other cases one can write of a 'power level difference L_{DP} [15]. The equivalent in German (D), French (F) and Dutch (NL) for 'Power level gain' is:

(D) Leistungsverstärkungspegel
(F) Niveau de gain en puissance
(NL) Vermogensversterkingspiel
and for 'Power level difference':
(D) Leistungspegeldifferenz
(F) Difference de niveau en puissance
(NL) Vermogenspeilverschil

The result of equations (05) (06) is expressed in *relative* decibels, i.e. the relative power level of P_2 in relation to the 0 dB-level of the considered input power P_1.

The 'absolute' *power level* L_P,

(D) Leistungspegel
(F) Niveau de puissance
(NL) Vermogenspeil

of a given power is taken, when for P_1 a reference value P_0 is given by standardisation:

$$L_G = 10\lg\frac{P}{P_0} \quad \text{(dB absol.)} \quad (07)$$

Taking the antilogarithm [34], this equation leads to:

$$P = P_0 \cdot (10^{1/10})^{L_P} \quad (08)$$
$$P = P_0 \cdot 10^{(L_P/10)} \quad (09)$$

If the reference for instance is taken equal to the unit value of the considered quantity, here 1W, eq. (07) simplifies into:

$$L_P = 10\lg P \quad \text{(dB absol; W)} \quad (10)$$

Thus a power of 40W corresponds to a power level of L_P = +16 dB above reference level of 0 dB ≙ 1W.

2.2 Identification To distinguish this +16 absolute decibels from relative ones of for instance a power level gain, it has been found very practical to give the dB an appendix, identifying the zero reference level directly. In other words, the added appendix can be considered as a kind of a *surname* to the *name* 'decibel', both in an abbreviated symbolic form.

Unfortunately history shows identification was not limited to only one reference value, nor to one system of identification symbols; this has lead to confusion and many misunderstandings.

About the question 'which reference value shall be chosen?' McKnight gives the following possibilities [18]:

1. The reference value is an average (mid-scale) value, giving for practical levels both a positive and negative number of decibels.

2. The reference value is taken as smaller than the smallest practical existing value; this gives practical levels always having positive dB. A typical example is the dB scale for sound intensity levels in acoustics.

3. A special case can be considered if the basic unity value of the reference quantity is taken, e.g. 1V for voltage level, 1A for current level, 1W for power level, 1 Pa for pressure level, etc.

A blend of these three principles has been used for the reference value of power levels, giving about ten references and symbols. **Table 1** gives a survey about the situation for power levels before the publication of IEC 268–2.

This table shows the three kinds of 'operating levels' in use during the period 1925 to 1960. During this period the 6 (and 12.5) mW reference disappeared in favour of the well-known 1 mW. In European telephone companies, and in the CCITT it is common practice to add a supplementary appendix '0' to the absolute dBm (and Npm as well), indicating that the given levels in 'dBm0' are related to a reference point of the transmission link. This practice of relative-absolute decibels is only limited to that use. More details are given in [20 to 22].

During the period 1950 to 1955 another international discussion arose from publications about the problem of identification of absolute decibels [10, 12, 14, 23 and 32]; some people were for, others against, adding any appendix to the abbreviation 'dB'. Just before the publication of the IEC recommendation, an American ANSI standard came out with a clear system for acoustical levels [24] by adding the reference with 're' or '//'. Thus for P = 2W we have

L_P = +3 dB re 1W
or
= +3 dB // 1W;

're' or '//' stands for 'with reference to'.

Finally Committee SC29B of the IEC decided on the use of an appendix, based on an old proposal of the Dutch Committee [25]: a symbol for the value of the reference quantity—preferably a unity value—is added to the 'dB' with parentheses '( )'. Thus, following the IEC recommendation 268–2 [19], we now have to use:

$$P_0 = 1\,\text{W} = L_P = 0\,\text{dB (W)} \quad (11)$$
or
$$P_0 = 1\,\text{mW} = L_P = 0\,\text{dB (mW)} \quad (12)$$

Hence, the 33 year-old dBm for power level is now retitled:

$$X\,\text{dBm} = X\,\text{dB (mW)} \quad (13)$$

and consequently:

$$0\,\text{dB (mW)} = -30\,\text{dB (W)} \quad (14)$$

An extrapolation of this new 'IEC-philosophy' gives:

1 kW ≙ 0 dB (kW) = +30 dB (W) (14)
1 μW ≙ 0 dB (μW) = −60 dB (W) (15)
1 nW ≙ 0 dB (nW) = −90 dB (W) (16)
1 pW ≙ 0 dB (pW) = −120 dB (W) (17)

but these references are *not* explicitly mentioned by IEC 268–2.

The importance of a correct typography of dB symbols is shown by a simple application. A line amplifier receives at its input a power level L_{P1} = −50 dB (mW), and must amplify this signal to an output power level of L_{P2} = +12 dB (mW). The power level gain L_{GP} is determined by the difference of the two (absolute) power levels:

$$L_{GP} = L_{P2} - L_{P1} \quad (18)$$
$$L_{GP} = +12\,\text{dB (mW)} - [-50\,\text{dB (mW)}] = 62\,\text{dB}$$

At first sight this equation is in contradiction to the elementary rules of mathematics as a subtraction results in a different 'unit'. However, if we remember that the dB(mW) and the dB belong to the same decibel *family* [37], then everything is all right.

3. Voltage levels

3.1 Principles By analogy to eq. (04) (05) (06) for power levels, and taking into account that power is a voltage-squared quantity, one can write:

$$\text{Voltage gain:} \quad G_U = \frac{U_2}{U_1} \quad (19)$$

$$\text{Voltage level gain:} \quad L_{GU} = 20\lg\frac{U_2}{U_1} \quad (20)$$

$$L_{GU} = 20\lg G_U \quad (21)$$

Translation of the term 'voltage level gain gives:

(D) Spannungsverstärkungspegel
(F) Niveau de gain en tension
(NL) Spanningsversterkingspeil

For absolute voltage levels we have:

$$L_V = 20\lg\frac{U}{U_0} \quad \text{(db absol.)} \quad (22)$$

or this relation inverted:

$$U = U_0 \cdot 10^{(L_U/20)} \quad (23)$$

where U_0 = the reference voltage. For the choice of this quantity, the same principles as those mentioned for power levels apply. A fourth principle is to be added for voltage levels, e.g. the reference voltage U_0 can be deduced from a given reference power P_0 dissipated in a given reference impedance Z_0 (resistive part): $U_0 = \sqrt{P_0 \cdot Z_0}$.

Furthermore in this condition there is a relation between the voltage level and the power level of the *same signal* in a load Z:

$$L_P = 10\lg\frac{P}{P_0} = 10\lg\frac{U^2/Z}{U_0^2/Z_0}$$

$$L_P = 20\lg\frac{U}{U_0} + 10\lg\frac{Z_0}{Z} \quad (24)$$

or

$$L_P = L_U - 10\lg\frac{Z}{Z_0} \quad (25)$$

and also, for a given power level and impedance, the voltage level is:

$$L_U = L_P + 10\lg\frac{Z}{Z_0} \quad (26)$$

continued over

continued

Further logical thinking leads to the fact that the so-called 'impedance correction factor' 10 lg Z/Z_0 can be considered as an *impedance level* L_Z:

$$L_Z = 10 \lg \frac{Z}{Z_0} \quad (27)$$

Finally:

$$L_U = L_P + L_Z \quad (28)$$

or

$$L_Z = L_U - L_P \quad (29)$$

As a corollary of eq. (28) we can state that the number of decibels for the power and voltage levels of a given signal are identical, if that signal is measured in the reference impedance Z_0. When $Z \neq Z_0$, the difference between the two kind of levels expressed in their own absolute decibels equals L_Z as given by eq. (29).

3.2 Identification As for power levels, absolute decibels for voltage levels may have appendices too. But the situation for absolute voltage levels is sometimes even more complex than for absolute power levels. **Table 2** gives the situation of 'voltage-dBs' as it was before the publication of IEC 268–2.

Many voltage references are deduced from a reference power in a reference impedance Z_0, especially in the original use for telephone circuitry. Only the 774.6 mV = 1 mW in 600 ohms reference has been extended to the whole field of audio engineering and telecommunications. The 1V reference is used as well in electronics, and the 1 mV or 1 μV reference in the field of hf distribution networks.

IEC 268–2 recommends for voltage levels only the following two references:

$$U_0 = 1\ V = L_U = 0\ dB\ (V) \quad (30)$$

$$U_0 = 1\ mV \triangleq L_U = 0\ dB\ (mV) \quad (31)$$

And consequently

$$0\ dB\ (V) = +60\ dB\ (mV) \quad (32)$$

Again, by extrapolation other 'unity' references can be used as:

$$1\ kV \triangleq 0\ dB\ (kV) = +60\ dB\ (V) \quad (33)$$

$$1\ \mu V \triangleq 0\ dB\ (\mu V) = -120\ dB\ (V) \quad (34)$$

$$1\ nV \triangleq 0\ dB\ (nV) = -180\ dB\ (V) \quad (35)$$

On the other hand the case of the 0.775 V reference is much more complex and requires more explanation in a separate chapter.

4. The ambiguity of the dBm

In **Table 2** four different notations for the 0.775 V reference are mentioned; maybe this list is not yet complete. Originally the notation 'dBm' was only intended for power levels re 1 mW, and not for corresponding voltage levels. Misuse of the dBm for voltage levels began probably some time after 1945, especially in Europe, in sound recording studios, broadcasting organisations, film studios, etc. How this ambiguous use of the dBm started, can be shown with a few figures.

Let us refer to the same figures as in the example given in **section 2** for power levels, as power level gain = the output level—the input power level:

$$L_{GP} = +12\ dB\ (mW) - -50\ dB\ (mW) = 62\ dB$$

If power levels and voltage levels are related to each other by the reference impedance Z_0, eq (24) can be applied; for example, with 1 mW in 600 ohms = 775 mV, we have:

$$L_P = 20 \lg \frac{U}{775\ mV} + 10 \lg \frac{600\ ohms}{Z}$$

and (36)

$$L_U = 10 \lg P - 10 \lg \frac{600}{Z} \quad (37)$$

with U in mV, P in mW, Z in ohms.

Assuming a line amplifier having a rated input impedance of 600 ohms and a rated load impedance of 600 ohms also receiving that input power level of −50 dB (mW) and the output power level of +12 dB (mW), the power level gain will be of course the same 62 dB.

Usually, however, power levels are derived from voltages or voltage levels measured across a known load impedance. Using once more the *old* 'dBm' notation, the input voltage line level will be:

$$L_U = L_{P1} - 10 \lg \frac{600}{Z}$$

$$= -50\ dBm - 10 \lg \frac{600}{600} = -50\ dBm$$

Consequently an output voltage level of +12 dBm will be found, and obviously for the voltage level gain $L_{GU} = L_{U2} - L_{U1}$ a value of 62 dB will be found. As shown in the level diagram of **fig. 1**, both lines of the power level and the voltage level coincide.

Now we can talk of an input *signal* level of −50 dBm, which is amplified by 62 dB to become an output level of +12 dBm, the *signal level gain* being 62 dB. Using lines, it is common use to talk of 'line levels' (in dBm): power levels are *meant*, but they are *measured* as voltage levels. Confusion was not possible, because all measurements were made with the 600 ohm reference.

This 'special' situation in electronics where the amounts of absolute decibels for power levels and for voltage levels are equal (because $Z = Z_0$), is a general situation in acoustics:

- a *sound* level of $L_P = 80$ dB for instance, corresponds to
- an *intensity* level of $L_I = 80$ dB or I = 100 $\mu W/m^2$, and
- a *pressure* level of $L_P = 80$ dB, or p = 200 mPa,

simply because the specific acoustic impedance Z_s is in normal circumstances always the same (408 Ns/m^3 for air).

In electronic circuitry in use in the audio engineering field and other fields as well it is rather special for the measured voltage levels and/or calculated power levels to be related to the 600 ohm standard impedance; in these fields absolute decibels re 1 mW and re 0.775V are widely used in circuits with impedances mostly differing from 600 ohms.

Assume in the example mentioned above

FIG. 1 LEVEL DIAGRAM FOR AN AMPLIFIER WITH 600 OHM INPUT IMPEDANCE AND 600 OHM OUTPUT IMPEDANCE

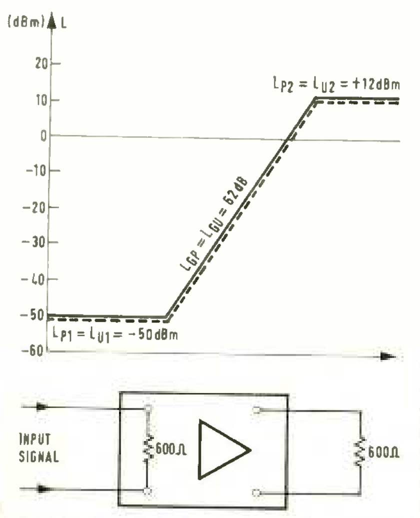
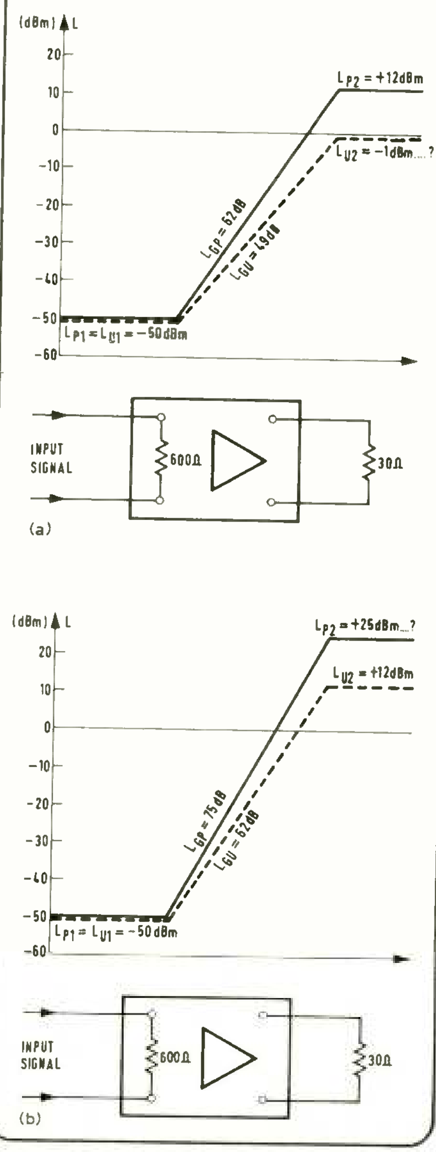


FIG. 2 LEVEL DIAGRAMS OF AN AMPLIFIER WITH 600 OHM INPUT IMPEDANCE AND 30 OHM OUTPUT IMPEDANCE



Notation		Reference P =		Application	Value in dBm
0 dBp	≙	1	pW	Acoustical power	−90
0 dBrap	≙	1	pW	Note: (Reference Acoustical Power)	−90
0 dBrn	≙	1	pW	psophometric measured noise level in telephone lines (rn = Reference Noise)	−90
0 dBa	≙	3.16	pW	Note: (a = Adjusted)	−85
0 dBm	≙	1	mW	telephony; thereafter: electroacoustics and electronics	0
0 dBTRP	≙	1	mW	telephony; measurement of line levels with a SFERT—VU—meter [42] (SFERT = Système Fondamental Européen de Référence pour la Transmission Telephonique)	0
0 dBs	≙	6	mW	telephony (USA)	+ 7.78
0 dB	≙	12.5	mW	telephony (USA)	+10.97
0 dBw	≙	1	W	electronics, transmitters	+30
0 dBk	≙	1	kW	HF—transmitters	+60

Table 1: Old notations of decibels for power levels.

that the input impedance is unchanged but the load impedance Z_2 is now 30 ohms. Let us give the output data of the amplifier as we usually find them in technical sheets:

'Output level = +12 dBm into a load of 30 ohms'

Such ambiguous data are often printed today! There are two possibilities of interpretation:

1. The meaning is: $L_{P2} \triangleq +12$ dBm = 16 mW *output power;* hence:

$$L_{U2} = L_{P2} - 10 \lg \frac{600}{30}$$

$L_{U2} = +12$ dBm − 13 dB = −1 dB . . . dBm?

Or U_2 = 690 mV. In writing −1 dBm for this voltage level and +12 dBm for the corresponding power level of the *same signal* (!) we certainly feel there is something wrong. We are using the same 'unit', the dBm, for two different kinds of levels and the level diagrams are no longer coincident: as shown in **fig. 2a.**

2. The meaning is: $L_{U2} \triangleq +12$ dBm = 3.1V *output voltage;* and:

$$L_{P2} = L_{U2} + 10 \lg \frac{600}{30}$$

L_{P2} = +12 dBm +13 dB = +25 dB . . . dBm?

or

P_2 = 316 mW in that 30 ohm load **(fig. 2B).**

continued over

Notation		Reference Uo =	Related to: Po =	Zo = [Ω]	Application	Value dB re 775 mV	Value dB re 1 V
0 dBµV	≙	1 µV	—	60	Antenne & HF Teledistribution installations (Germany [26])	−117.8	−120
0 dBmV	≙	1 mV	—	75	idem (USA [27])	−57.8	−60
0 dBm 0 Npm	≙	389.1 mV	1 mW	150	telephony, Europe	−6.02	−8.24
0 dBm	≙	774.6 mV	1 mW	600	telephone lines from 1939 [28]; thereafter in more or less general use in electroacoustics and telecommunications	0	−2.22
0 dBmv	≙	774.6 mV	1 mW	600	electroacoustics, adding 'v' to 'dBm' for distinction from power—dBm's (Benelux [29])	0	−2.22
0 dBu	≙	774.6 mV	—	—	idem, adding 'u' for distinction with power dBm's (Scandinavian countries)	0	−2.22
0 dB	≙	774.6 mV	—	—	idem, everywhere where a distinction with the dBm re 1 mW was wanted, esp. in Germany	0	−2.22
0 dBv 0 dBV	≙	1 V	—	—	general use, except telephony and studio equipment	+2.22	0
0 dBv	≙	1 Vpp	—	75	peak voltages on video lines	—	—
0 dBe	≙	1 V/m	—	—	electromagnetic field strengths [20]	—	—
0 dB	≙	1.73 V	6 mW	500	telephony (USA)	+6.99	+4.77
0 dB	≙	1.898 V	6 mW	600	telephony (USA)	+7.78	+5.56
0 dB	≙	2.739 V	12.5 mW	600	telephony (USA)	+10.97	+8.75

Table 2: Old notations of decibels for voltage levels.

continued

In both cases the interpretation of the dBm notation is ambiguous and a specification like 'Output = X dBm in X ohms' on a technical sheet is a kind of gambling for the engineer and often a rebus for a student in electronics or electroacoustics.

Furthermore, confusion increases in those countries where American and European apparatus are used simultaneously. American studio equipment is currently designed for operating in 'power-matching', while in Europe equipment is merely made for 'voltage-matching' [36].

In order to avoid confusion, some companies in Scandinavian countries use the notation 'dBu'. Others, especially in Germany, use the dB notation without any appendix [35]. In the latter case, confusion with relative decibels is not always eliminated by the context.

5. A possible way to use the dBm unambiguously

As stated above, in the United States it is quite common to find equipment designed to be used in the 'power matching' mode and this has led to a use of the dBm which one of the authors (JMB) had thought to be better known [40]. In this method of use the dBm is used as a unit of voltage level but with a reference voltage always given by the voltage needed to dissipate a power of 1 mW in a resistance of value equal to the characteristic impedance of the circuit. For example, if we are working with a 30 ohm circuit the reference voltage is given by

$$P_0 = \frac{U_0{}^2}{30} = 10^{-3}\ \text{W}$$

i.e. $U_0 = 173$ mV

In general this expression may be written as

$$U_0 = \sqrt{Z \cdot 10^{-3}}$$

and in **Table 3** we give a series of values of U_0 for various impedances in common use.

Much American equipment is designed for use with dBms calculated in this way. For example, one may have a front panel switch of a measuring device labelled 'dBm 50 ohms, dBm 600 ohms, dBV' as one has on the Hewlett Packard *8556A* spectrum analyser. One sets the switch to suit the impedance of the circuit in use or one may use the 1V reference as in eq (30). One, at first sight, strange consequence of this method of using the dBm is that if we use a transformer to match impedances the levels *do not change* as we go from one side of the transformer to the other. See 9.

If the dBm is used in the way outlined in this paragraph, *there is no* ambiguity. Let us work out the meaning of the example 'Output Level = +12 dBm into a load of 30 ohms'. From **Table 3** we have that $U_0 = 173$ mV for 30 ohm circuits and so $20 \lg U/173 = +12$ gives the output *voltage*, 689 mV. The output *voltage level* is +12 dBm; the output level +12 dBm; the output power 16 mW. No ambiguity, because here the voltage reference U_0 is not a fixed but a *gliding* value determined from eq (38) by the impedance involved. However, many people in the telecommunications field do not use the dBm except with a reference voltage of 775 mV and this is how confusions have arisen.

6. The dBm and IEC Recommendation 268-2

This was the ambiguous situation of the dBm before the publication of the IEC recommendation 268–2 in April 1971, and it's still the case! This new standard, which was published after a serious delay caused by the dBm problem, has finally taken an intermediate position between supporters and opponents of adding appendices to dB notation. As it is very important, part of the note in the IEC-publication about the dBm is quoted here:

> 'A notation in current use is dBm, intended to designate a voltage level above a reference of 0.775V (1 mW in 600 ohms). It is recommended that this reference be abandoned in favour of the 1V reference defined above. . .'

This text puts an end to the official existence of the dBm, yet it does not even recognise the original meaning of the dBm (power levels) after it has been in use for about 33 years!

Anyhow, with IEC 268–2 the case of the 'dBm' is closed.

For power levels we have now the dB (mW) but nothing has been done in the IEC publication for the dB re 0.775V. Even more, this reference has to be discarded in favour of the dB (V). For many applications we can agree, but in studio apparatus, telecommunications on lines, etc, nobody would like to drop the 775 mV reference, despite the fact that this reference differs by only 2.22 dB from the 1V reference and that computations from voltages into corresponding levels in dB (V) are easier to make as they are the same as for relative levels.

If the standard impedance of 600 ohms could be replaced by 1kΩ, then we should have $\sqrt{1\text{k}\Omega \cdot 1\ \text{mW}} = 1\text{V} = U_0$ (see **Table 3**), and the existence of the 775 mV reference would be unnecessary. But a change of the 600 ohm standard into a 1 kΩ one is as Utopic as trying to change the European 50 Hz power line frequency into the American 60 Hz. Both things are economically impossible.

We have the 775 mV reference and we must live with it, especially audio engineers.

7. New proposal for the dB re 0.775V

The IEC 268–2 has cleared up many things in the 'dB-jungle', but the 0.775V problem remains. As a contribution to this, we propose the following new notation:

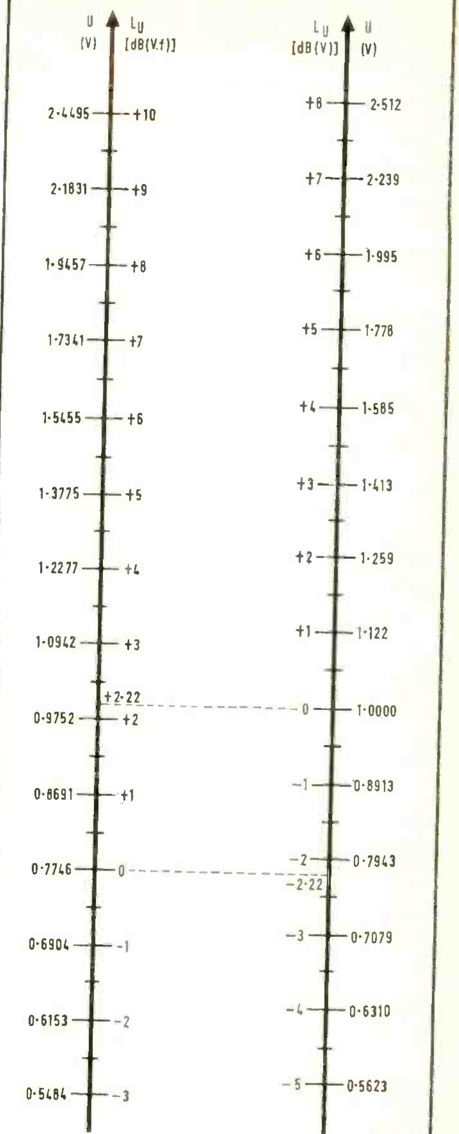
$$U_0 = 0.7746\text{V} \triangleq L_{U_0} = 0\ \text{dB (V.7)} \quad (39)$$

As a result of one of the authors' (HAOW) long experience of educating students in electronics, this proposal is justified by the following points:

1. The 'style of IEC', e.g. the parentheses, are maintained.

2. Adding the unabbreviated appendix is too long for a practical use in spoken and written language: dB (0.775V). If the unabbreviated appendix can be accepted in

FIG. 3



some circumstances, obviously this notation is completely correct.

3. The abbreviation 'V.7' is typographically easy to recognise as the 0.775V reference: as used in English '.7' means 0.7, also 'V.7' means 7/10 of 1V. If 'V.8' or '.8V' [41] were written, a rounded value which is closer to the real value, the typographic association is not so easy.

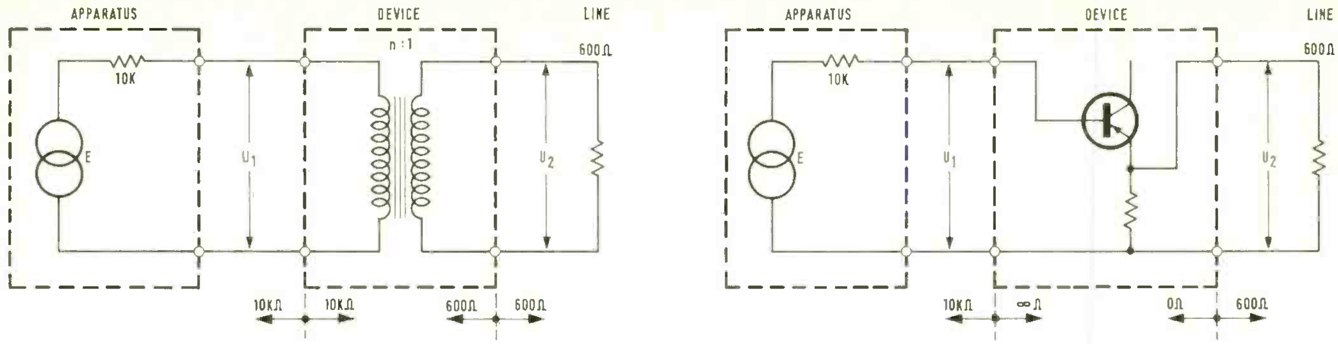
4. Pronunciation in various languages is not difficult:

(E) Deebeeveeseven
(D) Deebeevausieben
(F) Débévé-sept
(NL) Deebeeveezeven.

Consequently the units (or names) of equations (36) (28) are now as equations (40) to (47).

Application of the 'new' notations in the family of decibels in the same example gives: First possibility: Output level = +12 dB (mW) into 30 ohms.

FIG. 4



(i) CIRCUIT SHOWING USE OF A TRANSFORMER TO MATCH THE APPARATUS TO THE LINE

(ii) CIRCUIT SHOWING USE OF AN EMITTER FOLLOWER TO MATCH THE APPARATUS TO THE LINE

Table 3: Reference voltages for 'dBm' calculations in circuits of differing impedances.

Z[Ω]	3	8	15	30	50	75	100	135	150	200	300	500	600	1 000	10 000
U[mV]	55	89	122	173	224	274	316	367	387	447	548	707	775	1 000	3 162

$$10\lg\frac{P}{1\text{ mW}} = 20\lg\frac{U}{775\text{ mV}} - 10\lg\frac{Z}{600} \qquad (40)$$

[dB(mW)] [dB(V.7)] [dB]

or:

$$L_U = L_P + L_Z \qquad (41)$$

[dB(V.7)] [dB(mW)] [dB]
[mV] [mW] [Ω]

with

$$L_U = 20\lg\frac{V}{775} \quad [\text{dB(V.7)} \; ; \; \text{mV}] \qquad (42)$$

$$L_P = 10\lg P \quad [\text{dB(mW)} \; ; \; \text{mW}] \qquad (43)$$

$$L_Z = 10\lg\frac{Z}{600} \quad [\text{dB} \; ; \; \Omega] \qquad (44)$$

or in antilogarithms:

$$U = 775 \cdot 10^{(L_U/20)} \quad [\text{mV} \; ; \; \text{dB(V.7)}] \qquad (45)$$

$$P = 10^{(L_P/10)} \quad [\text{mW} \; ; \; \text{dB(mW)}] \qquad (46)$$

$$Z = 600 \cdot 10^{(L_Z/10)} \quad [\Omega \; ; \; \text{dB}] \qquad (47)$$

$L_U = +12$ dB (mW) $- 13$ dB $=$
-1 **dB (V.7)**

Second possibility: Output level = +12 dB (V.7) into 30 ohms.

$L^P = +12$ dB (V.7) $+ 13$ dB $=$
$+25$ dB (mW)

Clear interpretation is guaranteed now with such data on technical sheets and other publications.

8. Relationship between the dB (V) and dB (W)

A further remark can be made with regard to the new IEC decibel notations, the dB (W) and the dB (V). Each of these references is defined *independently* of the other but, if we couple these two values, a new standard impedance Z_0 is introduced. Because the combination of 1V and 1W gives 1 ohm, equation (24) becomes very simple, if a supplementary $L_Z = 10\lg(Z{:}1)$ is introduced as the impedance level re 1 ohm.

$$L_U = L_P + L_Z \qquad (48)$$

[dB(V)] [dB(W)] [dB(Ω)]

with:

$$L_U = 20\lg U \quad [\text{dB(V)} \; ; \; \text{V}] \qquad (49)$$

$$L_P = 10\lg P \quad [\text{dB(W)} \; ; \; \text{W}] \qquad (50)$$

$$L_Z = 10\lg Z \quad [\text{dB}(\Omega) \; ; \; \Omega] \qquad (51)$$

and:

$$U = 10^{(L_U/20)} \quad (\text{U} \; ; \; \text{dB(V)}) \qquad (52)$$

$$P = 10^{(L_P/10)} \quad (\text{W} \; ; \; \text{dB(W)}) \qquad (53)$$

$$Z = 10^{(L_Z/10)} \quad (\Omega \; ; \; \text{dB}(\Omega)) \qquad (54)$$

The name or unit 'dB (Ω)' is at this time completely new, the symbol L_Z is already introduced by the American Standard ANSI SI. 8–1969 [25] for levels of mechanical impedances.

Equations (48 to 54) are very simple in practical use. This can be shown by means of a classical example.

Given: an amplifier of 40W rated power output in a load of 4 ohms, and a rated input sensitivity of 2.5 mV with an input impedance of 50 kΩ. Computation of the gain levels is required; for the power level gain the 'matched insertion gain' as defined by IEC 268–3, 18.3.2 [38], is not taken into account.

Input levels:
$L_{U1} = 20\lg(2.5 \cdot 10^{-3}) = -52$ dB(V)
$L_{Z1} = 10\lg(5 \cdot 10^4) = +47$ dB(Ω)
$L_{P1} = -52$ dB(V) $-$ [+47 db (Ω)]
$= -99$ dB(W) $\triangleq P_1 = 126$ pW

Output levels:
$L_{P2} = 10\lg 40 = +16$ dB(W)
$L_{Z2} = 10\lg 4 = +6$ dB(Ω)
$L_{U2} = +16$ dB(W) + [+6 dB (Ω)]
$= +22$ dB(V) $= U_2 = 12.6$V

Voltage level gain:
$L_{GU} = +22$ dB(V) $-$[-52 dB(V)]
$= 74$ dB

Power level gain:
$L_{GP} = +16$ dB(W) $-$ (-99 dB(W))
$= 115$ dB

Note that using

$$L_{GP} = L_{GU} + 10\lg Z_2/Z_1 \qquad (55)$$

a check of the computations is possible:
$L_{GU} = 115$ dB $+ 10\lg(4/5 \cdot 10^4)$
$= 115$ dB $- 10\lg(12.5 \cdot 10^3)$
$= 115$ dB $- 40.97$ dB $= 74.03$ dB
≈ 74 dB

As a matter of fact, voltage levels expressed in dB(V) are easily convertible to dB(V.7) and vice versa. The relationship is given by $20\lg(1/0.7746) = 2.218450$ dB:

$U_0 = 1$V $\triangleq L_U = 0$ dB(V)
$= +2.22$ dB (V.7) (56)
$U_0 = 0.775$V $\triangleq L_U = 0$ dB (V.7)
$= -2.22$ dB (V) (57)

or

$$X \text{ dB (V)} = (X + 2.22) \text{ dB (V.7)} \qquad (58)$$

$$Y \text{ dB (V.7)} = (Y - 2.22) \text{ dB (V)} \qquad (59)$$

where X and Y are the figures of the given level. The difference between the two zero levels is clearly shown in fig. 3.

Finally we stress the fact that the general symbol 'L' for levels is becoming more and more widely used. This symbol has recently been adopted by the IEC committees involved. *continued 61*

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continued

9. Two worked examples to illustrate the Differing Notations

Readers of STUDIO SOUND will recognise these examples from the August issue; we make no apologies for re-using them as the possible confusions may readily be seen. Since we have more space at our disposal than was available in a letter, the effect of circuit loading will also be considered.

The problem consists of connecting a piece of apparatus with an output impedance of 10 k Ω to a line of 600 ohms impedance. We shall either use a perfect transformer (i) or a perfect emitter-follower (ii) to do the job.

Let the open circuit voltage of the apparatus be E volts.

Case A let the level of E be given as 0 dBm; this is ambiguous as any of the interpretations in sections **4** or **5** may be used. We shall use all of them.

Before continuing with the calculations, we must work out the turns ratio of the power matching transformer. This is given by $\sqrt{10^4/600}$ and is 4.08 or 12.22 dB by eq (44).

(i) When we add the power matching transformer to the apparatus **fig. 4**(i) the voltage U_1 will be E/2 or 6.02 dB lower so the voltage level of U_1 will become −6.02 dBm. (N.B. it is necessary to use the more precise value of −6.02 rather than −6 or confusing rounding errors appear in the calculation.)

Using the interpretation of the ambiguous dBm **(4)** the given data could mean:

(a) −6.02 dBm in 10 k Ω as a voltage level, or, in new notation:

$L_{U1} = -6.02$ dB(V.7) $= U_1 = 387.5$ mV

And so

$L_{U2} = -6.02$ dB(V.7) $- 12.22$ dB

$= -18.24$ dB (V.7)

and $L_{P2} = L_{P1} = -18.24$ dB (mW),

because Z_2 is the standard value and the transformer does not dissipate any power.

(b) −6.02 dBm in 10 k Ω as a power level or $L_{P1} = -6.02$ dB (mW) in new notation; and:

$L_{U1} = -6.02$ dB (mW) $+ 10 \lg Z_1/600$

$= -6.02$ dB (mW) $+ 12.22$ dB

$= +6.20$ dB(V.7) $\triangleq U_1$

$= 1581$ mV

Using the unambiguous −dBm interpretation of **5**, we have

(c) −6.02 dBm in 10 kΩ = 'signal' level, whence

$L_{P1} = -6.02$ dBm or dB re 1 mW

and

$L_{U1} = -6.02$ dBm or dB re 3162 mV

Where the reference voltage U_0 is gliding to the value of 3.162 V for Z = 10 kΩ **(Table 3** and section **5)**.

Summarising we get:

(4) $U_1 = 387.5$ mV (a) or 1581 mV (b)

(5) $U_1 = 1581$ mV (c)

Note that the second interpretation in **4** and that in **5** agree.

Using the **4** interpretation we have for U_2 and P_2 either that the voltage level is 12.22 dB lower i.e. −18.24 dBm or 95 mV(!), or that the power is still −6.02 db (mW) as the perfect transformer does not dissipate any power, i.e. $U_2 = 387.5$ mV. Using the **5** interpretation we have that U_2 is given by $1581 \div 4.08 = 387.5$ mV. When we convert this to decibels using the reference voltage for 600 ohm circuits given in **Table 3** we find that the level is −6.02 dBm. Note that this is the same *level* as we had for U_1. What has happened is that the change of reference level has exactly matched the change of voltage produced by the matching transformer.

To summarise again

(4) $U_2 = 95$ mV [a] or 387.5 mV [b]

(5) $U_2 = 387.5$ mV [c]

Note the agreement again between the second interpretation in **4** and that in **5**.

(ii) Now we use the perfect emitter-follower of infinite input impedance, zero output impedance, and voltage gain 'times one'. **fig. 4** (ii), $L_{GU} = 0$ dB.

U_1 is now equal to E and so we get the following results for U_1 [the arithmetic is similar to case (i)].

(4) $U_1 = 775$ mV or 3162 mV

(5) $U_1 = 3162$ mV

U_2 is also equal to U_1 and E since the emitter-follower is perfect so all we have to do is calculate the appropriate levels.

(4) $L_{U2} = 0$ dBm or $+12.22$ dBm

(5) $L_{U2} = +12.22$ dBm

Case B. Let the level of E now be given as 0 dB(V), this is not ambiguous so the problem is easier

(i) $L_{U1} = -6.02$ dB(V) [see fig. 4 (i) again].

$L_{U2} = -6.02$ dB(V) $- 12.22$ dB

$= -18.24$ dB(V)

From eq (48) we have $L_{P2} = -18.24$ dB(V) $- 10 \lg (600{:}1)$

$= -18.24$ dB(V) $- 27.78$ dB (Ω)

$L_{P2} = -46.02$ dB(W)

$= -16.02$ dB (mW)

Note that, because the impedance Z_2 has the standard value, the result can be found more easily the following way:

From eq (58) we have $L_{U2} = -18.24$ dB(V) $+ 2.22$ dB $= -16.02$ dB(V.7) and from eq (41) with Z = 600 Ω, $L_{P2} = L_{U2} = -16.02$ dB(mW).

(ii) $L_{U1} = 0$ dB(V) [see fig. 4 (ii) again].

$L_{U2} = 0$ dB(V) $= +2.22$ dB (V.7)

$L_{P1} = -\infty$ dB(mW) or $P_1 = 0$

because a perfect-emitter follower is considered, with $Z_1 = \infty$

$L_{P2} = 0$ dB(V) $- 27.78$ dB(Ω)

$= -27.78$ dB(W) $= +2.22$ dB (mW)

If the level of E were given as 0 dB(V.7), the same figures would ensue. The only differences occur when we convert back to voltages.

(i) [dB(V)]	$U_1 = 500$ mW	
	$U_2 = 122$ mV	
[dB(V.7)]	$U_1 = 387.5$ mV	
	$U_2 = 95$ mV	
(ii) [dB(V)]	$U_1 = 1000$ mV	
	$U_2 = 1000$ mV	
[dB(V.7)]	$U_1 = 775$ mV	
	$U_2 = 775$ mV	

These examples illustrate very clearly that, where something approximating to power matching is used, the dBm notation can lead audio engineers into many booby traps. If levels are given with the new IEC notation and the dB(V.7) proposal, confusion is no longer possible.

10. A note about weighted levels

Weighted sound levels measured with a sound level meter and the weighting filter A are expressed in dB(A). This notation, also an IEC recommendation, is however in contradiction with the 'IEC-philosophy' as explained in this document. Writing '46 dB(A)' could mean: 46 dB above the reference level of 1 ampere, e.g. 200A! Such a mistake is generally not committed because current levels in dB(A), or in dB(mA) or dB(μA) are not in common use. However, other weighting curves are currently used for weighting sound levels (B,C,D) and still more curves for psophometric noise measurements (P,Q, [02]).

Thus another 'new philosophy' for indicating weighted levels becomes necessary. For voltage and power levels, the weighting symbol can be added after the parentheses of the reference symbol, e.g.:

Output noise level = −121 dB(V.7)Q:

this indication states that the measurement is made with the indicated filter (following CCIR 468) and that the measured voltage level is 121 dB below reference level corresponding to 0.775V.

Further thoughts and study on the actual situation are necessary to find a solution for sound levels; indeed, even 'dBA' can no longer be written as this is against the now adopted new rules with parentheses for decibel notations.

Some suggestions are:

Sound level, unweighted:

$L_S = 76$ dB; $L_{SL} = 76$ dB

L = 76 dB[S]; L = 76 dB[SL]

Sound level, A-weighted:

L = 72 dB[A]; L = 72 dB[SL]A

L = 72 dB//A

('S' stands for 'Sound', 'SL' for 'Sound Level').

A-weighted levels are almost always sound levels and, using square brackets [] for indicating the weighting reference of sound levels seems to be the best proposal that we can make.

Bibliography

[01] J. G. McKNIGHT: Audio Standards—Work in Progress: AES Standards Committee.—JAES Vol. 19—No. 3 1971, p. 240–241

[02] H. A. O. WILMS: Subjective or Psophometric audio noise Measurement: a Review of Standards. JAES Vol. 18—No. 6 1970, p. 651–656

[03] V. RAO: The decibel Notation 2nd edition, Publishing House, London—1966

[04] R. V. HARTLEY: The Transmission Unit Electrical Communication, July 1924—p. 34–42

[05] W. H. MARTIN: The Transmission Unit and Telephone reference Systems.—AIEE Trans., Vol. 42 1924, p. 797–801

[06] R. V. L. HARTLEY: TU becomes decibel Bell Lab. Review, Vol. 7—Dec. 1928, p. 137–139

[07] W. H. MARTIN: 'Decibel'—The name for the Transmission Unit.—Bell Syst. Techn. Journ. Jan. 1929, p. 1–2

[08] H. J. MÜLLENMEISTER: Pegelrechnung Neues Rohde & Schwarz No. 23, März 1967—p. 32–37

[09] R. VERMEULEN: Octaves and decibels Philips Techn. Review, Vol. 2—Feb. 1937—p. 52–53

[10] R. A. J. BOSSCHART & H. FREUDENTHAL: De decibel; Begripsvorming en dimensieleer.—De Ingenieur, Jg. 63—1951, No. 17—p. 203–208

[11] E. I. GREEN: The decilog: a unit for logarithmic measurement.—Electr. Engng., Vol. 72—1954, p. 597–599

[12] R. VERMEULEN: Decibel en decilog.—De Ingenieur, Jg. 66—1954, No. 32—p. 407

[13] W. M. HALL: Logarithmic measure and decibel. JASA May 1954—p. 449–450

[14] K. TUFFENTSAMMER: Das Dezilog, eine Brücke zwischen Logarithmen, Dezibel, Neper

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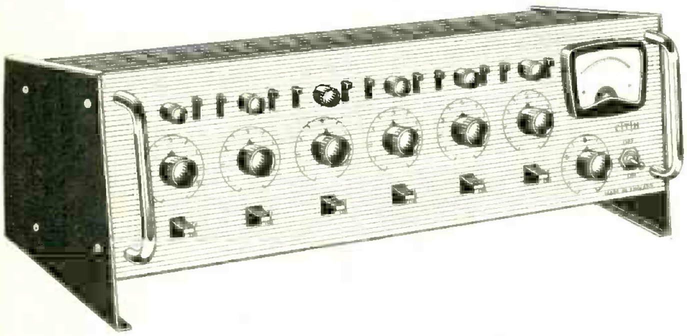

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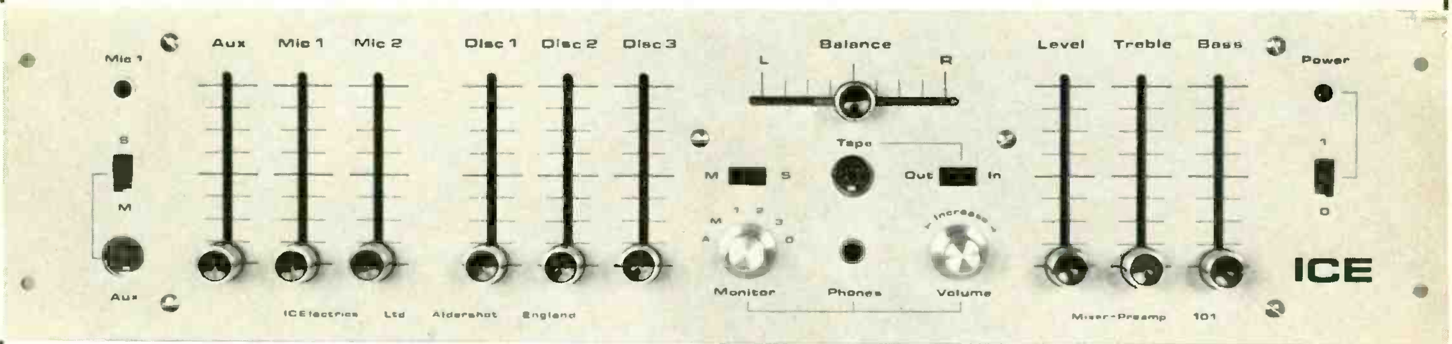

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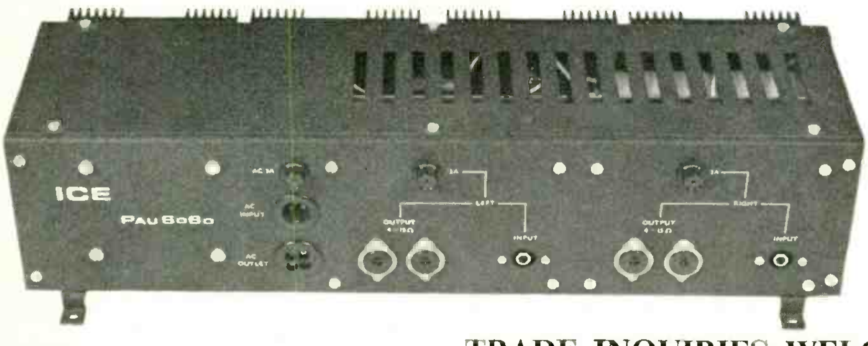

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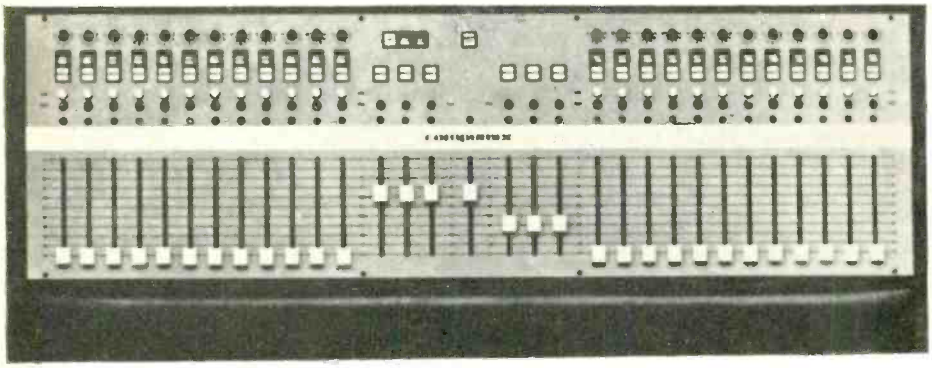


Automated mixing

QUAD-EIGHT, of California, have announced a computerised mixing system. The unit, which is called the *Compunix TM*, is described as an all electronic line level piece of equipment designed to be added to consoles or mixer for a fully automated mix-down. A recording is made of the fader and switch positions as a mix-down is made. This real time recording is made on an ordinary multitrack recorder and includes various pulses for sync and timing. The recorded information is then converted to control voltages and will re-perform all the previously used level, mixing and switch functions.

Individual errors of level or switching, the company claim, can be corrected without affecting the rest of the mix. The preceding mix is always retained. Six sub-mixing or grouping faders are provided, selectable from any channel, as well as a master fader.

Manufacturer: Quad-Eight Electronics, 11929 Vose Street, North Hollywood, California 91605. Telephone 213 764-1516.

More automatic mixing

AUTOMATED PROCESSES of New York have introduced an automatic mixing system. The equipment will repeat previously-recorded mixing positions by encoding up to 256 channels for recording on to any conventional tape recorder. The *model 256* programmer unit has independent encoding and decoding units in the form of a number of analogue and digital circuit cards in a standard frame. Additional cards are available to expand the capacity of the equipment 16 channels at a time.

The firm also produces automatic faders, *model 940*, to set the levels dictated by the recorded information. The fader can be set to manual and will fit into the same space as an ordinary fader. Ready-wired automatic consoles employing all these features are also available.

Manufacturer: Automated Processes Inc., 80 Marcus Drive, Melville, New York 11746. Tel. 516 694 9212

Mixer preamp

ICELECTRICS of Aldershot are now making a six input mixer preamp for home, recording and professional use: the *SMP101*. The stereo inputs are: an auxiliary; two mic and three disc. Each input has a slide fader and the units are fitted with a master control and treble and bass controls. They are also switchable mono or stereo and have a balance control in the centre of the front panel. All inputs can be cued except for that of mic two. Pfl is provided through a headphone socket and separate volume control. The input to the headphones is selected by a six-position switch. Each of the units can drive four power amplifiers. The price is £98.80. ICElectrics also announce two new power amplifiers: the *PAU 30+30* and the *PAU 60+60*, of 30 and 60W per channel respectively. The outputs of these amplifiers are rated for continuous operation at the stated rms values and are unconditionally stable. The *30+30* costs £66.60 and the *60+60* costs £10 more.

Manufacturer: ICElectrics Ltd, 15 Albert Road, Aldershot, Hants. 0252 28513

Uher 4000 IC

UHER introduced a fourth version of their battery portable tape recorder at this year's Audio Fair. The series is called the *4000 report IC* and has new IC output circuitry and new mechanics. The new machine has no pressure pads.

Agent: Bosch Ltd, Rhodes Way, Watford.

Tape winders

LEEVERS-RICH announce their rewind machine, the *LR500*. This will accept 25 mm tape on NAB spools with a diameter of up to 36 cm. It will rewind them in either direction at one of three selectable tensions at up to 127 m/s.

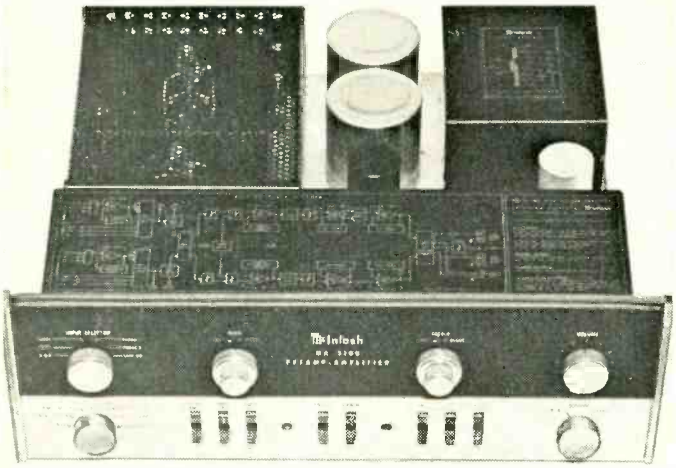
Manufacturer: Leevers-Rich Equipment, 319 Trinity Road, Wandsworth, London SW18.

Tape search system

THE EDIT *900* tape search system was first seen at the IBC exhibition. Tapes are indexed with what the firm describes as an electronic number for which the equipment will then search and stop the tape machine when the number is found. The *Edit 900* searches and edits tapes, but there are two other versions of the apparatus: the *300*, which will only edit, and the *500*, which will only search the tape. These two can

continued 69

McINTOSH IS HERE!



McIntosh MA5100 integrated amplifier.

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

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Equipment Reviews

Bruel & Kjaer 2305 level recorder

MANUFACTURER'S SPECIFICATION

Electrical

Frequency range: Ac: 2 Hz to 200 kHz ±0.5 dB (re 1 kHz) for input potentiometer in position around '0' and '10' ±1 dB for other positions. Dc: Chopped at twice mains frequency.

Maximum sensitivity: Minimum voltage to give zero deflection of stylus. Ac 10 mV rms approx dc 20 mV approx.

Resolving power: 0.25mm on scale when adjusted for 50 mm paper, 0.5 mm on scale when adjusted for 100 mm paper.

Input impedance: 16 to 18 kΩ dependent on position of input potentiometer, parallel with 100 to 120 pF approx.

Maximum input voltage: 100V

Input potentiometer: Non-calibrated, covers 0 to 12 dB continuously variable.

Input attenuator: Within ±0.25 dB, relative to position '0'. Six steps of 10 dB

Rectifier response: Selectable by a control knob: Rms ± 0.5 dB for crest factors up to 5. Arithmetic average. Peak (half peak-to-peak).

Writing speeds: Selectable by a control knob. 50 mm paper: 2 - 4 - 8 - 16 - 25 - 40 - 63 - 100 - 160 - 250 - 400 - 500 - 630 - 800 - 1000 mm/s. 100 mm paper 4 - 8 - 16 - 31.5 - 50 - 80 - 125 - 200 - 315 - 500 - 800 - 1000 - 1250 - 1600 - 2000 mm/s.

Recording system: Electrodynamic. Pulling force 1 kp approx. External arm connection possible.

Overall stability: Better than ±0.2 dB in deflection for ±10% deviation in power supply voltage.

Calibration voltage: Built-in squarewave signal at power supply frequency. 100 mV rms
Stability: Within ±1% for ±10% deviation of power voltage.

Lower limiting frequency: Selectable to 2, 10, 20, 50 and 200 Hz.

Mechanical

Paper speeds: Selectable by a control knob. 0.0003 - 0.001 - 0.003 - 0.01 - 0.03 - 0.1 - 0.3 - 1 - 3 - 10 30 - 100 mm/s derived from a reversible self-starting synchronous motor.

Types of recording: Rectilinear. Polar: Synchronous drive with B & K Turntable *3921*.

Types of transcription: Pens for ink writing, easily interchangeable for writing in different colours. Sapphire stylus for writing on wax-coated paper.

Remote control: Various, such as: Start-stop, single chart, lifting of pens and event marking, etc.

Two-channel selector: Can be used for successive recording of two signal levels, time marking, etc.

Miscellaneous

Power supply: 100 - 115 - 127 - 150 - 220 - 240 V ac (50 or 60 Hz). Specify frequency when ordering. Power consumption 45W approx. 70W with motor running.

Dimensions: (Steel cabinet) 210 x 485 x 290 mm (hwd).

Weight: 25 kg.

Price: £726.00 in steel cabinet.
£751.00 in mahogany cabinet.
£735.00 for rack mounting.

Manufacturers: Bruel & Kjaer, DK-2850 Naerum, Denmark.

Agents: B & K Laboratories Ltd, Cross Lances Road, Hounslow, Middx. or Greengate, Middleton, Manchester.

BRUEL & Kjaer is a Danish manufacturer of high quality equipment in the fields of audio analysis and vibration analysis with agents in some 44 countries, and a worldwide reputation as being the standard by which many others are judged. It follows that Bruel & Kjaer equipment is expensive, as can only be reasonably expected, with the result that many organisations do not even consider investigating its potential.

The review of equipment of this class required the ultimate in accuracy of measurements, as even the slightest deviation from the manufacturers' specification must be considered as a serious matter and receive the criticism that it deserves. As a result the laboratory facilities were specially calibrated for this review—voltage measurements are generally within 0.015 dB, attenuation within ±0.01 dB, impedances within 0.01 per cent and any critical frequencies are quoted within one part in 10^5.

Before entering into a description of the B & K Type *2305* level recorder, it must be clearly understood that this instrument is a rectifier type device which records voltage levels, and is in effect a recording meter which may be switched to record rms voltage, average voltage, half peak-to-peak voltage or dc. It must not be confused with an oscilloscope (except for a few applications), X/Y recorder or with the functions of an ultraviolet recorder. By choosing suitable accessories (range potentiometers) the recorder can be set up to have either a logarithmic scale such that 1 dB occupies an equal space throughout the deflection range, which may be 10 dB, 25 dB, 50 dB or 75 dB full scale, or can be set up for a linear scale of full scale deflection covering the range 3.5:1 or 11:1.

Unless otherwise specified, the instrument is supplied with a 50 dB logarithmic potentiometer which I have found to be the most appropriate for general use in the laboratory.

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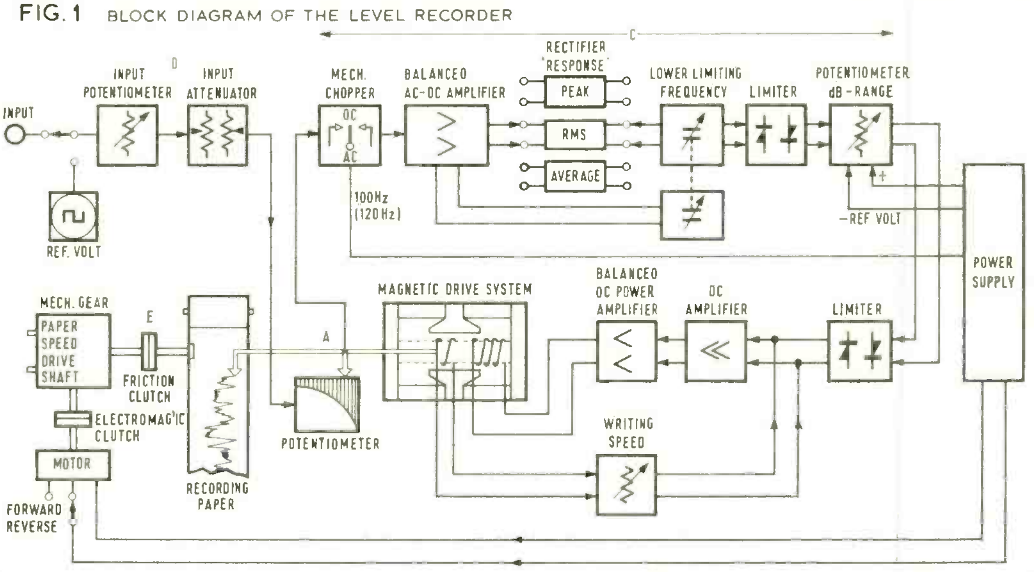
FIG. 1 BLOCK DIAGRAM OF THE LEVEL RECORDER



continued

Other potentiometers can be purchased at £61 each, and if really sensitive and accurate measurements are required a 10 dB potentiometer is an asset. With this it is easy to resolve level changes as small as 0.1 dB.

The electronics

Reference to **fig. 1** shows that the principle of the level recorder is a servo system. The input voltage is fed to the top end of the range potentiometer **b** from the input attenuator system **d**. The wiper of the range potentiometer **b** is connected to the writing arm **a** which is driven back and forth by the magnetic drive system, which in turn is controlled by the voltage on the wiper of the range potentiometer by the amplifier and rectifier system **c**.

Further reference to the amplifier and rectifier system shows that it is preceded by a mechanical chopper; this is only used when dc signals are to be recorded, and at other times is left in one of its stable positions.

When recording ac signals, any of the three rectifier characteristics, average, rms, or peak may be selected, but when recording dc the peak characteristic is automatically selected. Also associated with the rectifier and amplifier system **c** is the lower limiting frequency control which serves two functions: firstly it controls the lowest frequency to which the recorder responds correctly in that it effects the stability of the servo system in conjunction with other controls; secondly it provides a degree of attenuation of low frequencies as shown in **fig. 2**.

The output of the rectifier and amplifier system **c** is a dc signal, the amplitude of which is naturally related to the range potentiometer in use (**'b'**). In order to provide stability of the servo system it is necessary to the attenuator 'Potentiometer dB-range' at the output of the amplifier. This is an 11 position switch which is normally set for the indication of the range potentiometer in use, but may be set to other values if greater resolving power is required at the expense of system stability leading to pen overshoot.

The remainder of the electronics comprises a dc amplifier system which directly drives the writing arm magnet system, however the actual writing speed is controlled by a feedback loop which senses the writing arm speed and applies feedback to the early stages of the amplifier via a switched attenuator which is directly calibrated in writing speed.

The mechanics

The basic mechanical system of the recorder is simple, but copious additions for remote control and for the automatic operation of the recorder with other B & K instruments leads to a fairly complex collection of gears and timing switches which will not be described here.

Paper drive is derived from a synchronous motor which feeds two independent ten-ratio gearboxes via an electromagnetic clutch which is used to start or stop the paper drive.

One gearbox is used solely to provide a drive for ancillary instruments and to operate a single

FIG. 2 TYPICAL FREQUENCY CHARACTERISTICS OF THE LEVEL RECORDER FOR DIFFERENT SETTINGS OF 'LOWER LIMITING FREQUENCY' SWITCH, ACCORDING TO THE MANUFACTURER'S SPECIFICATION. THE TWO DOTTED LINES AT THE HIGH FREQUENCIES GIVE THE GREATEST DEVIATION TO BE FOUND FOR ANY SETTING OF 'INPUT POTENTIOMETER'.

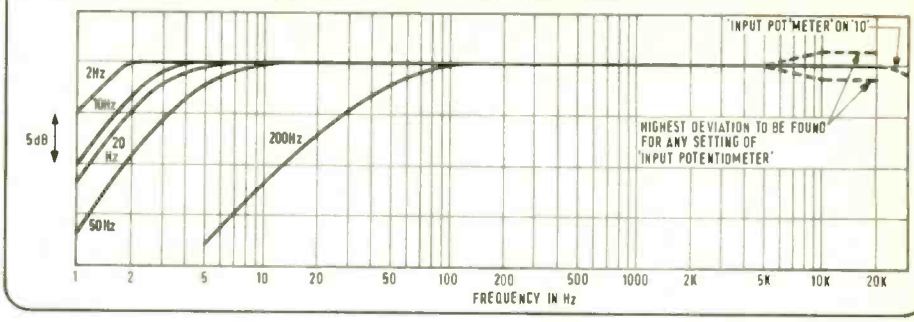


FIG. 3 SHOWING THE EXCELLENT LINEARITY OF THE 50dB RANGE POTENTIOMETER WHEN 1dB INCREMENTS OF INPUT SIGNAL ARE APPLIED TO THE B & K 2305 LEVEL RECORDER.

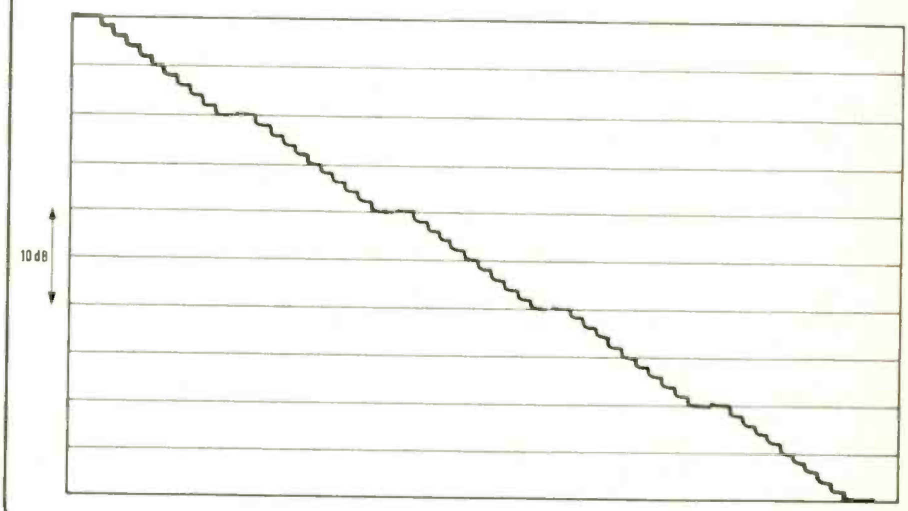
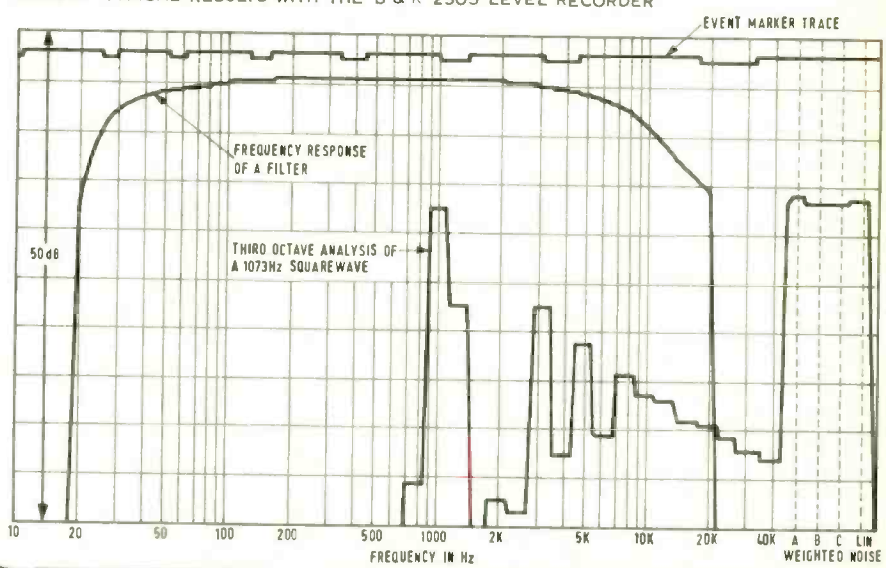


FIG. 4 TYPICAL RESULTS WITH THE B & K 2305 LEVEL RECORDER



pole two-position switch by means of interchangeable cam discs; this switch has a number of uses with ancillary instruments.

The second gearbox drives another cam disc which provides pulses for switching B & K one-third octave filters in synchronism with the recorder paper, a further cam disc for automatically stopping the recording paper at the end of pre-printed charts, and a further 10:1 gearbox which drives the paper via a friction clutch which enables the paper to be positioned manually by means of a finger wheel.

Associated with the second gearbox is another drive shaft which is used to drive B & K oscillators and spectrum analysers in synchronism with the recording paper by means of a flexible shaft. Alternatively there is a chain wheel for driving these instruments when they are rack mounted with the level recorder.

The pens and papers

As has already been said, the pen itself is driven from a writing arm which is controlled by an electromagnet driven by the servo system. The actual pen drive is by either the writing arm itself when 50 mm wide paper is used, or by a system of geared pulleys when 100 mm wide paper is used. Changing the pen drive from one paper width to the other only takes a few minutes.

A second pen assembly, which has not been mentioned, provides an event marking facility along one edge of the paper clear of the calibrated part of the paper. This event marker is operated by an electromagnet which may be either energised by means of a pressbutton on the level recorder, or by means of an external contact.

Both pens may be lifted from the paper, either by means of a manual two-position cam or by means of an internal electromagnet which may be operated by means of an external contact, and is automatically operated whenever the paper drive motor is switched for reverse paper drive.

Either ink writing or stylus writing using wax-coated paper may be used and the unit is provided with all the necessary pens which are very easy to interchange. The ink supply for the ink writing pens is accomplished by inserting the pens into small cartridges of ink, which are available coloured red, green or black—the choice of colour being influenced not only by preference for colours, but by any intended duplication of the records.

Electrostatic duplicators do not particularly like the green ink, while the black ink is far better for dye-line copiers. Ten cartridges of each colour of ink are provided together with three ink writing pens and one ink event marker pen, and of course one of each type of stylus for the writing arm and the event marker.

For the majority of purposes the ink writing system is perfectly adequate, but at very high pen speeds quite a lot of ink is shot out of the pens, providing the operator with an instant attack of measles! In these circumstances, stylus writing is to be preferred. However, the wax-coated paper for stylus writing is only available in the 50 mm width in either lined paper, or in one type of frequency calibrated paper. The same applies to 50 mm wide ink writing paper, but the 100 mm width is available in five different pre-painted types, as well as in a special circular chart which can be used for polar recording with other B & K accessories.

Because the resolution of the pen is limited by the range potentiometer, which is effectively a wirewound potentiometer with 216 turns, there is no gain in resolution by using the wider 100 mm paper, but it is generally easier to read.

Applications

In conjunction with the commoner laboratory instruments the B & K level recorder can be used for the determination of frequency response as a recording meter, for monitoring any recorded levels with a variety of effective metering characteristics, for the recording of sound levels in conjunction with suitable microphones and pre-amplifiers, for plotting wow and flutter waveforms in conjunction with a wow and flutter meter and for many other applications where a written record of voltage levels is of assistance.

However, it really comes into its own in conjunction with other B & K instruments, and a limited number of other makes of instruments where the full potential of its automatic operation can be utilised.

For instance, in conjunction with B & K oscillators fully automatic frequency response plotting is possible between 2 Hz and 200 kHz. The frequency response of pickups and tape recorders may be automatically plotted without any manual intervention except pressing the start button with other accessory instruments. Automatic narrowband spectrum analysis is possible, automatic octave or third octave analysis at the press of a button—even the polar diagrams of microphones, loudspeakers and aerials only require the single press of a button with the standard available accessory instruments.

First impressions

Simply unpacking the level recorder was a joy. It arrived airfreight from Denmark via the local branch of B & K Laboratories in Hounslow where all incoming instruments are checked before despatch to customers. The packing was a cardboard box within which the instrument was contained in a double polystyrene packing of substantial dimensions. Within the inner box there was also a further small cardboard box of standard accessories—this box was labelled with a complete list of its specified contents, which included not only the most comprehensive instruction manual and the circuit, but also writing pens, three different rolls of recording paper, all required plugs and sockets and a supply of spare lamps and fuses, plus a plastic dust cover.

The general appearance of the instrument is particularly clean with the typical Bruel & Kjaer light green colour of the main operating surface. All control knobs are clearly identified and the screen printed calibrations are particularly easy to read. The rotary controls all have knobs secured with Allen screws, and in spite of the use of only one screw, I have never known a B & K knob fall off.

The only obscure control, without identification, is a small pushbutton that injects a 100 mV reference squarewave into the system in lieu of the connected input. This facility is used for calibration of the level recorder in terms of absolute voltage, and whilst I have never found much necessity for this facility, there is no reason why it should not be properly labelled.

As expected, the review sample was delivered already fitted with a 50 dB range potentiometer (it only takes a few seconds to change this) so some paper was loaded (no complaints about this operation), the mains lead plugged into the level recorder—but the other end has one of those infernal two-pin Continental plugs—cutters, screwdriver, 13A plug and off we go!

The electrical performance

Probably the parameter of prime interest to most users is the frequency response of the level recorder, and this was investigated with the greatest care using a 10 dB range potentiometer borrowed from the author's level recorder.

Before coming to a conclusion from the following results, it must be borne in mind that the maximum resolution of the level recorder with a 10 dB range potentiometer is 0.05 dB as a result of the design of the range potentiometer.

The following are the frequency response figures with the level recorder set to 2 Hz lower limiting frequency and the input potentiometer set to indication 10:

1 kHz	0 dB	10 kHz	—0.05 dB
100 Hz	0 dB	20 kHz	—0.05 dB
10 Hz	0 dB	50 kHz	—0.05 dB
5 Hz	0 dB	100 kHz	—0.1 dB
2 Hz	+0.2 dB	200 kHz	—0.2 dB
1 Hz	—3.1 dB	300 kHz	—0.8 dB
0.5 Hz	—13.0 dB	400 kHz	—2.3 dB

Frequency response measured from 2 Hz to 200 kHz is ±0.2 dB reference 1 kHz—manufacturers' specification is ±0.5 dB — no complaints!

Further investigation with other settings of the input potentiometer gave the following high frequency deviations from a flat response, which are also well within specification

Reference 1 000 Hz	200 kHz	+0.3 dB
	300 kHz	+0.4 dB
	400 kHz	—1.3 dB

Investigation into the lower limiting frequency showed that the response has dropped by about 0.3 dB at the indicated lower limiting frequency, and fell to −3 dB at about one-fifth of the indicated lower limiting frequency.

A further factor effecting the frequency response is the accuracy of the attenuator; this was investigated by feeding the level recorder from a 600 ohm source of very accurately known voltage. At 1 kHz the attenuator accuracy was found to be within ±0.1 dB over its full range of 60 dB while at 200 kHz the accuracy fell to ±0.25 dB which is the specified limit. The input potentiometer, which is uncalibrated, was found to have approximately the specified 12 dB range, and provided the means for convenient calibration in terms of voltage when using the internal reference voltage which was found to be within one per cent of the specified voltage over an alarming range of mains input voltages.

The input impedance to the level recorder varies a small amount according to the setting of the input potentiometer and input attenuator, and was found to consist of between 16.69 kΩ and 16.84 kΩ in parallel with between 119

continued 68

continued

pF and 31 pF, the latter very low capacitance being associated with the input potentiometer position '0' and input attenuator position 10 dB. While the low capacitance of 31 pF is well below the minimum specified capacitive components of the input impedance, this is unlikely to be of any significance in practical operation.

Input sensitivity for zero deflection of the stylus was measured as 4.5 mV for ac recording or 8.7 mV for dc recording with a 50 dB range potentiometer and will be the same for the full selection of potentiometers except the 10 dB range potentiometer which requires an input 20 dB higher. It must be remembered that dc recording is achieved by chopping the input signal at mains frequency, and then recording the peak (half peak-to-peak) value—as a result the internal 100 mV reference is in fact equivalent to 200 mV dc input.

Fig. 3 shows the effect of feeding 1 dB steps in input level to the recorder fitted with the supplied 50 dB range potentiometer, while an accuracy of ± 0.3 dB is specified the only recorded deviations from perfect can be attributed to the inherent errors of the system which give an effective backlash of ± 0.5 mm with the 100 mm paper width, or ± 0.25 mm with the 50 mm paper width.

Next investigated was the rectifier characteristic. Feeding sinewaves into the input and switching between the three characteristics rms, peak and average, the error of the peak characteristic relative to the rms characteristic was 0.2 dB, and that of the average characteristic 0.05 dB.

A similar exercise with squarewaves gave an error of 0.05 dB with the average characteristic and 0.4 dB with the peak characteristic. However the latter error is intentionally increased to improve the accuracy of the peak characteristic with short duration pulse inputs —this is of course stated in the instrument's instruction book, which is a most comprehensive document containing 125 pages of valuable information.

While the paper speed is tied to the incoming mains frequency by a geared drive from the level recorder's motor, and was found to be precise, the pen speed is controlled by feedback in the servo system. The pen speed was found to be precisely correct at all speeds except 100 mm/s and 500 mm/s where it was about ten per cent too slow. It is useful to note that the pen speeds of 100 mm/s and 16 mm/s with a lower limiting frequency of 20 Hz correspond to the IEC standard 'fast' and 'slow' metering characteristics for sound level meters.

The stability of the recording system is tied to the setting of pen speed and lower limiting frequency, as well as to the setting of the potentiometer range control. The instruction manual gives clear instructions as to which combinations of settings give stable recording without overshoot, and these conditions were checked by applying very rapid changes of input level to the recorder. At all but the four highest writing speeds there was no sign of overshoot or excessive damping. At 500 mm/s there was about 0.5 dB overshoot, increasing to 1 dB at the highest writing speed which is quite reasonable and within the normal accepted limits for this type of recorder.

Variations of incoming mains voltage had very little effect upon the level recorder and it was not until the mains voltage had been changed to −16 per cent that real deterioration of performance became evident; variations of ± 10 did not have any effect on the performance. The power consumption on 240V working was measured as 65W with the motor running, and 38W with the motor switched off.

Mechanical performance

The first thing that is noticed in operation is the clean positive action of all controls, and the very good readability of control settings. Loading the recording paper is simplicity itself and no difficulty was experienced with the paper drive, even at the highest paper speed of 100 mm/s. Once a record has been made, the paper is simply torn off against a fitted paper cutting blade, which is so positioned that the paper stops in precisely the right place when the automatic stop is being used with ancillary equipment.

Fitting the pens requires a little patience but, once they are fitted, there is no chance of unwanted movement. As has been mentioned, the pens are automatically lifted when the drive motor is switched into reverse drive; this lifting action is not particularly successful because the paper tends to bow up so that it still touches the recording pen in reverse.

Range potentiometers are changed very simply by undoing one screw which is thoughtfully fitted with a normal control knob, lifting out the unwanted potentiometer, dropping in the new potentiometer, and doing-up the screw again.

Mechanical maintenance is kept to a minimum by the use of self-lubricating bearings and nylon wheels, and all that is required is the occasional oiling of the gearbox and dusting of the recording mechanism.

Summary

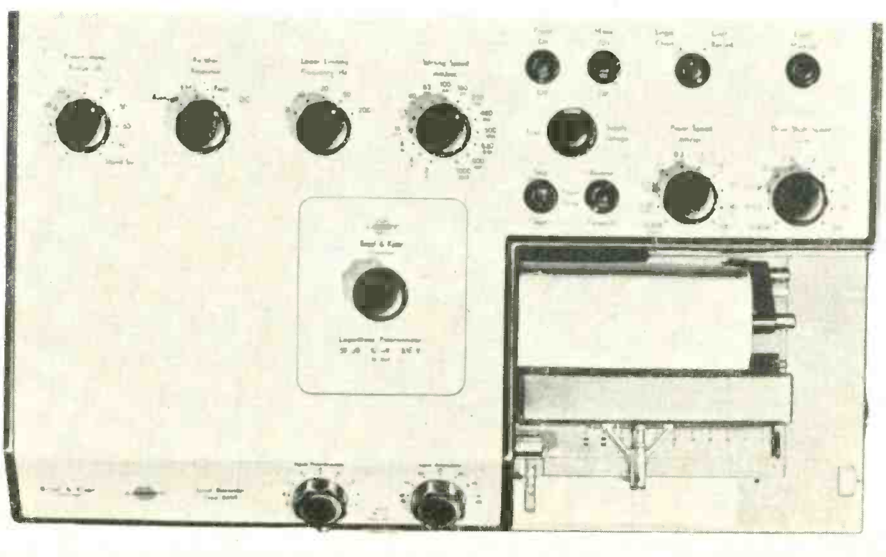
This latest version of the Bruel & Kjaer *2305* level recorder has the advantage of employing entirely transistor techniques in conjunction with a very well tried mechanical system. While it is impossible to vouch for the reliability of this equipment over just a few weeks use, the author's level recorder has been in regular use for something like six years and has only required one new valve!

As has been seen, every limit in the manufacturer's specification is pessimistic, and in many cases the sample reviewed was twice as good as the manufacturer's limits.

While minor criticisms have been made in this review (it would be surprising if one didn't find something to note) nothing of any consequence was found that would in any way detract from the accuracy and usability of this unit.

The *2305* really comes into its own with the host of other Bruel & Kjaer instruments which can be used for automatic analysis in conjunction with the level recorder but in its own right it is one of the most accurate and versatile recording instruments available and will find numerous applications in any laboratory.

£726 is a lot of money but I have no hesitation in most strongly recommending this instrument if you can afford it. There are many aspects of the level recorder which cannot be mentioned here due to lack of space, but Bruel & Kjaer do have local representatives who really are practical engineers and are always pleased to give help! **H. D. Ford**



NEW EQUIPMENT

continued

be used in conjunction to provide the same facilities as an *Edit 900*.

The number is converted to binary coded decimal and put on to the tape after it has been selected by a series of pushbuttons on the front of the machine. If the same point on the tape is needed again the number is again selected with the same buttons and the Search button is also pressed.

Manufacturer: Hodges Engineering, PO Box 26, Camberley, Surrey

Pa system

THE EA *711* PA system from EA Produkter of Sweden is built from plug-in modules. The firm claims that the system is very easy to operate and impossible to overload. They also make an *EA 31* power amplifier which will deliver 50W at less than 0.1 per cent distortion into an 8 ohm load. The frequency response is from 20 Hz to 20 kHz within 0.2 dB. One of these amplifiers was recently compared with a Quad *303* in a Swedish magazine and performed better than the *303*, according to the tests made, in many respects.

Manufacturer: EA Produkter AB, Kungsgatan 5 S 411 19 Goteborg, Sweden

Quadraphonic Encoder

TOSHIBA have introduced an IC which will decode normal stereo into four channels. The unit, type *TA7117P*, is being marketed by Erie Electronics. The amount of front to back and side to side information can be altered by choosing suitable external resistors.

Agent: Erie Electronics, South Denes, Great Yarmouth, Norfolk (0493 4911).

Transformers

GARDNERS Transformers are now producing three new ranges of miniature and sub-miniature microphone and line transformers. There are 47 transformers altogether and they can be mounted on a chassis or a printed circuit card. Gardners claim a frequency response of 60 Hz to 25 kHz ±2 dB under matched conditions with a range of input impedances from 15 ohms to 10 kΩ and output impedances 15 ohms to 2.4 kΩ. The three ranges are defined by the maximum input levels of one, two or 16 mW at 60 Hz or 25, 50 or 400 mW at 300 Hz.

Manufacturer: Gardners Transformers Ltd, Christchurch, Hampshire BH23 3PN

Connectors

F. W. O. BAUCH are now selling a six-pin audio connector in Switchcraft's Q-G range. The new connector complements the existing three, four and five contact connectors already available.

Agent: F. W. O. Bauch, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ.

THE AMBIGUOUS dBm

continued

und Normzahlen VDI Zeitschr. Bd. 98—1596, No. 7 p. 267–274

[15] J. G. McKNIGHT: Gains and Level gains (Differences) Internal Report of Ampex Corp., Dec. 1970

[16] J. G. McKNIGHT: Power and Voltage Levels Internal Report of Ampex Corp., Redwood City, 1970

[17] J. G. McKNIGHT: Absolute Flux and frequency response characteristics in Magnetic Recording: measurements, definitions and standardization. JAES Vol. 15—1967 No. 3, p. 254–272

[18] J. G. McKNIGHT: Preferred Reference Quantities for Acoustical Levels (Audio Standards-column) JAES Vol. 19—1971, No. 9—p. 804

[19] IEC 268–2 Recommendation: Sound System Equipment, Part 2: Explanation of general terms.—1st ed. 1971

[20] W. ZAISER: Pegelangaben in der Übertragungstechnik NTZ, Band 16—1963, No. 3, p. 137–142 and No. 9 p. 461–463

[21] G. SCHRÖDER: Das Dezibel und seine besondere Definitionen—Fernmeldepraxis, Bd. 40—1963—p. 249–251

[22] G. SCHÜTT & F. HAUTSCH: Gegenwärtige Stand und weitere Entwickelung der Tonleitungstechnik/Pegelangaben in der Tonleitungstechnik Rundf. Techn. Mitt. Bd. 12—1968, No. 4, p. 185–190 and No. 5, p. 243–244

[23] W. REICHARDT: 1st 1 Np = 8,6858 dB und darf man Anhängsel an dB anbringen? Frequenz, Bd. 16—1962, No. 3, p. 97–102

[24] ANSI S1.8–1969: American National Standard preferred Quantities for Acoustical levels—New York, 1969

[25] R. VERMEULEN: De decibel. De Ingenieur, Jg. 63—1951, No. 20, p. 237–238

[26] H. LICHT: Die Pegelrechnung in die Empfangsantennetechnik.—Funkschau 1967—No. 21 p. 679–680

[27] E. LESLIE: The useful decibel. Radio Electronics, Feb. 1968—p. 54–55

[28] H. M. TREMAIRE: Audio Cyclopedia. Sams & Co., Indianapolis—2nd Edition 1969. (Cfr Q25–167)

[29] H. A. O. WILMS: Microfoondynamiek (II) Radio Electronica, Jg. 16—1968, No. 7—p. 829–834

[30] H. A. O. WILMS: Microfoongevoeligheden en haar uitdrukkingsvormen (2)—Rad. Electron. Jg. 17—1969, No. 14—p. 566–569

[31] CC: Définitions de quelques expressions utilisées dans les questions de transmission téléphonique. Comité Consultatif Internat. Session Plénaire Como, Sept. 1927

[32] J. W. HORTON: The bewildering decibel Electrical Engng., Vol. 73—1954—p. 550–555

[33] A. M. SEYMOUR: dba and other logarithmic units. The Lenkurt demodulator, Vol. V—1961—No. 11

[34] R. W. YOUNG: Decibel, a Unit of Level. JAES Vol. 19—1971—No. 6—p. 512–615

[35] G. BORÉ (G. Neumann GmbH): Personal letter about absolute decibels—March 1967

[36] H. J. GRIESE: Circuits of transistorized RF condenser microphones, JAES Vol. 13—1965—No. 1, p. 17–22

[37] R. V. L. HARTLEY: New System of Logarithmic Units—J.ASA Vol. 27—No. 1, Jan. 1955 p. 174–176

[38] IEC 268–3 Recommendation: Sound System Equipment, Part 3: Sound system amplifiers, 1st edition—1969

[39] CCIR Report 292–2: Measurement of Programme level in Sound broadcasting. New Delhi, 1970

[40] J. M. BOWSHER: Studio Sound, August 1972, letter to the Editor; see also September 1972 p. 26

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Advertisements for this section must be pre-paid. The rate is **6p** per word, minimum **60p**. Box Nos. **20p** extra. Semi-display **£3.00** per inch. Copy and remittance for advertisements in **JANUARY 1973** issue must reach these offices by **17th NOVEMBER 1972** addressed to: The Advertisement Manager, **Studio Sound**, Link House, Dingwall Avenue, Croydon CR9 2TA.

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

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

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★**Assistant Maintenance Engineer** required by the Central Office of Information for their Overseas Press and Radio Division. Candidates should have had wide experience in maintenance of professional tape recording and studio equipment. Theoretical knowledge to City and Guild Intermediate level would be an advantage as would experience in sound recording. Salary according to experience and qualifications on a range £1,530 to £1,965 per annum. Five-day week of 41 hours (inclusive of meal breaks). 20 days paid annual leave. Please send postcard for application forms to Central Office of Information, Room 153, Atlantic House, Holborn Viaduct, London EC1, quoting reference number PE/290101. Closing date for completed forms 30 November 1972.

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Most of the sound control consoles built by Neve have been produced to customer stipulated requirements. Inevitably, such consoles embody modular design principles and techniques developed and perfected by Neve. Through this, the company has been able to concentrate part of its newly enlarged factory on the manufacture of the 'S' range of consoles. These are production-line models in a range of useful sizes and functions determined by experience gained in supplying so many desks to customers' specifications. Of the many advantages arising, speedy "off the shelf" delivery together with appreciable savings in costs are certain to appeal. Design, function, and quality are just as important in the long run, but because these are Neve products, such features will be taken for granted. We shall be pleased to send details on request. On site service is available when required.

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