February 1977 45p

studio sound

AND BROADCAST ENGINEERING

EQUALISATION

EDITOR RAY CARTER
TECHNICAL EDITOR FRANK OGDEN
EDITORIAL PRODUCTION DRUSILLA DALRYMPLE
CONSULTANT HUGH FORD
SECRETARY WENDY SMEETH
EXECUTIVE ADVERTISEMENT MANAGER DOUGLAS G. SHUARD
ADVERTISEMENT MANAGER TONY NEWMAN

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Editorial and Advertising Offices:
LINK HOUSE, DINGWALL AVENUE, CROYDON CR9 2TA, ENGLAND
Telephone: 01-686 2599
Telex: 947709
Telegrams: Aviculture Croydon

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

SUBSCRIPTIONS
All enquiries to: Subscription Dept, Link House, 25 West Street, Poole, Dorset BH15 1LL. Poole (02013) 71171.

DISTRIBUTION
STUDIO SOUND, published monthly, enables engineers and studio management to keep abreast of new technical and commercial developments in electronic communication. It is available without charge to qualified readers; these are directors managers, executives and key personnel actively engaged in the sound recording, broadcasting and cinematograph industries in any part of the world. Non-qualifying readers can buy STUDIO SOUND at an annual subscription of £7.60 (UK) or £7.20 (Overseas). Express air mail) as follows (extra charge over paid or free subscription): Argentina (B), Angola (B), Australia (C), Austria (X), Barbados (B), Belgium (X), Bermuda (B), Botswana (B), Brazil (B), Bulgaria (X), Canada (B), Chile (B), Colombia (B), Cyprus (X), Denmark (X), Finland (X), France (X), Ghana (B), Greece (X), Holland (X), Hong Kong (B), Hungary (X), Iceland (X), India (B), Indonesia (B), Iran (A), Israel (A), Italy (X), Jamaica (B), Japan (C), Kenya (B), Lebanon (A), Malawi (B), Malaysia (B), Mexico (B), Monaco (X), New Zealand (C), Nigeria (B), Norway (X), Peru (B), Philippines (C), Poland (X), Portugal (X), Rhodesia (B), Rumania (X), Singapore (B), South Africa (B), Spain (X), Sri Lanka (B), Sweden (X), Switzerland (X), Tanzania (B), Thailand (B), Trinidad (B), USA (B), Virgin Islands (B), West Germany (X), Yugoslavia (X), Zambia (B).

Zones
X Europe goes air mail regardless 2nd class air mail
A £18.78 (12 issues)
B £18.84 (12 issues)
C £22.56 (12 issues)

BINDERS
Loose-leaf binders for annual volumes of STUDIO SOUND are available from Modern Bookbinders, Chadwick Street, Blackburn, Lancashire. Price is £2.00 (UK and overseas) Please quote the volume number or date when ordering.

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Total average net circulation of 8899 per issue during 1975. UK: 5689 overseas: 3210. Total average net circulation of 10 030 for January 1976. UK: 6003, overseas: 4027

studio sound

AND BROADCAST ENGINEERING

Every studio manager has a short list of the most desirable qualities for any given control room; usually his own will possess more of them than the studio across the street/town/world. A consensus of opinion would most probably indicate that 'good acoustics' head that list.

However, further investigation of that particular quality would be a relatively useless exercise; the revelation that control rooms should provide a 'nice tight bass sound with lots of crisp top' isn't exactly earth shattering. In spite of such easy conclusions, one fact, albeit negative, will emerge. There are few studio people who will attempt to describe acoustics, whether talking about their own studio or generalising, in terms of Hz and dB. If they do, they are more likely to be specnologists than recording engineers. Actually, this is very surprising considering the quantity of blurb surrounding other bits which make up a control room.

On the desk, nearly every function is dutifully inscribed in dB or Hz (*pan* is about the only one that isn't). On compressor limiters, equalisers and monitoring circuits, dB and Hz abound in pro and con fusion. Loudspeaker manufacturers nearly always quote millions of dB's to add to listening pleasure. So how strange it is that real live, two eared people talk about 'tight bass and tinkly treble' rather than -4 dB at 63 Hz (ISO centre $\frac{1}{3}$-octave pink noise) and +6 dB at 12.5 kHz, etc. One can only suppose that God provided almost everybody except the spec writers with a pair of ear drums instead of B & K spectrum analysers, but such are the imperfections of Creation.

Lesser individuals such as recording engineers have to use their ears to monitor the effects of subtle changes in eq; in time, a certain adjustment to the number of dB and Hz as shown on the desk will become associated with a particular audible change but the process is never the other way round. From this, the function of desk calibrations may be understood. But what of the learned gentlemen who make their living by quantifying the acoustics of other peoples' studios—the consultants?

In this issue, George Augspurger, a much respected US acoustician tells of his approach in relating objective acoustic measurement to subjective effect. He also describes what can and can't be achieved with monitor equalisation. He would never suggest that his instruments can predict conditions for the perfect acoustic balance—that changes every time a new face sits in front of the mixing console—but they can isolate areas where problems may be expected, if not already present.

More often than not, Mr Augspurger's instruments provide the starting point for subjective discussion.

contents

It's the Compex Limiter F760X–RS.

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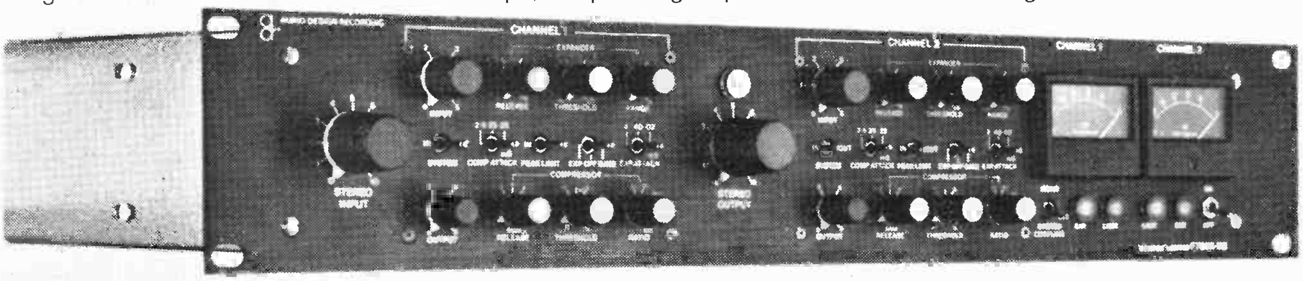

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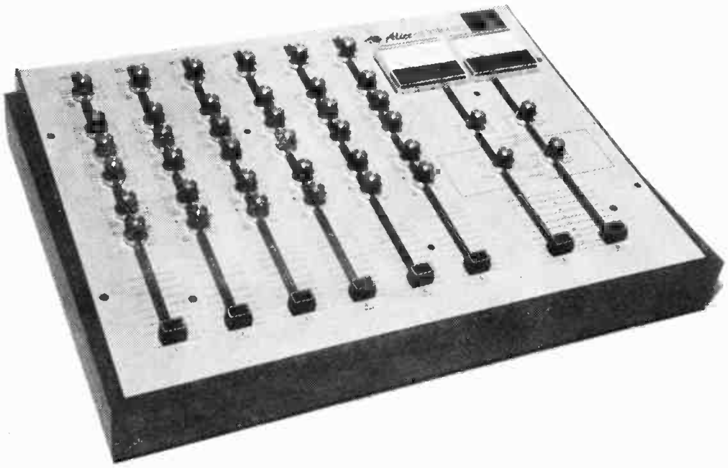

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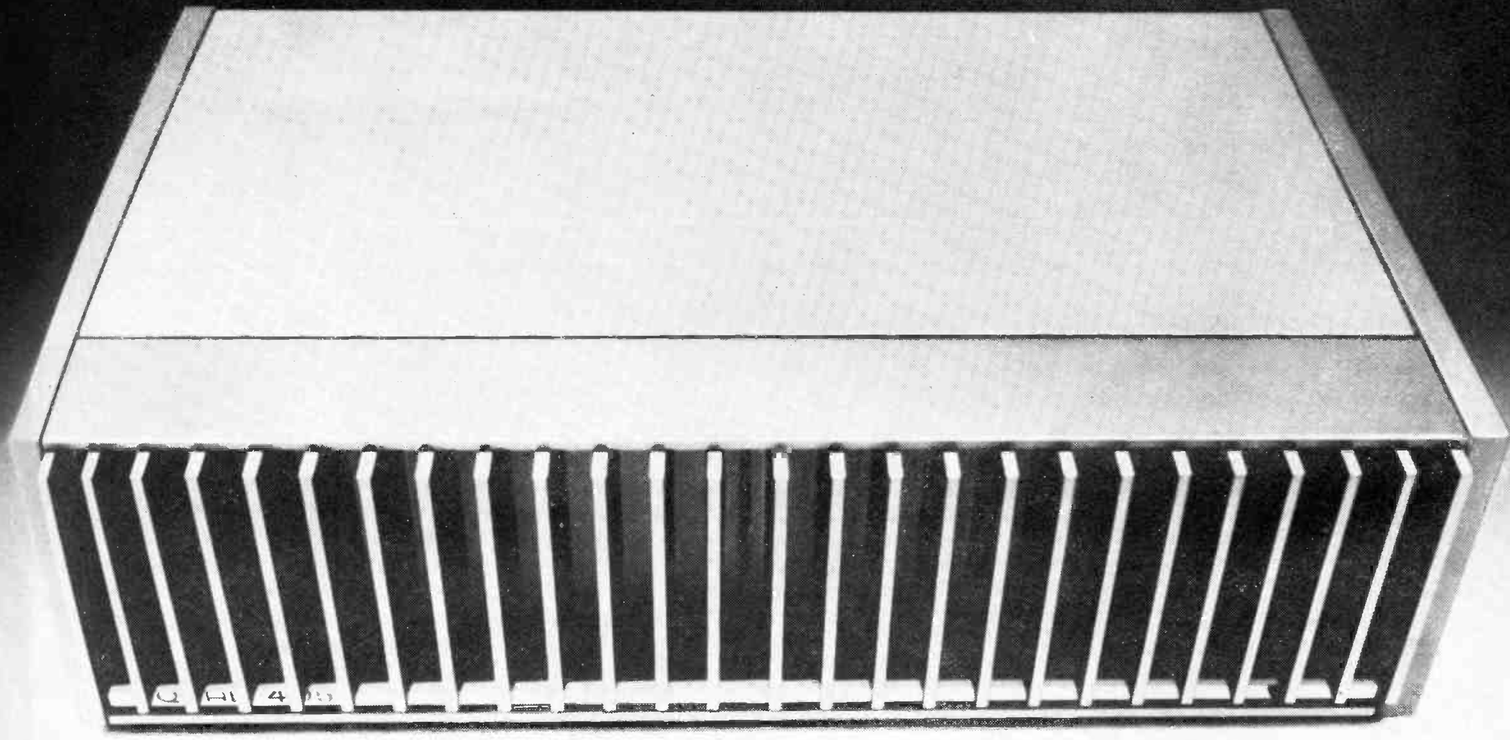

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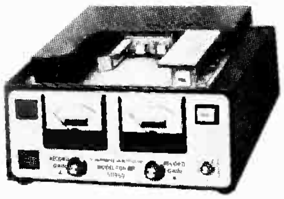

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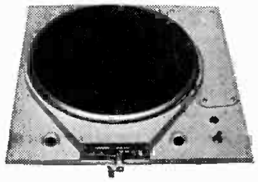

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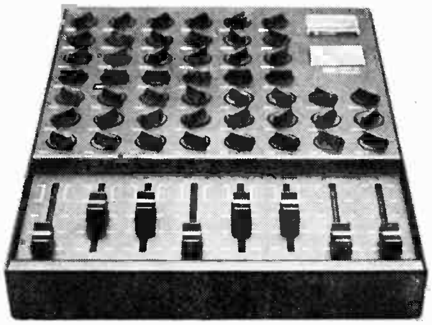

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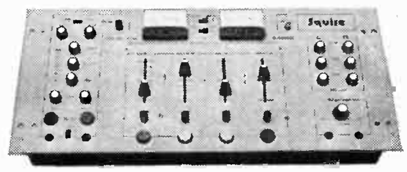

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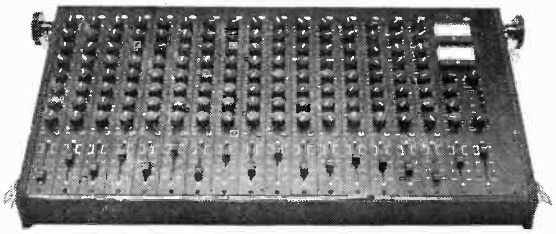

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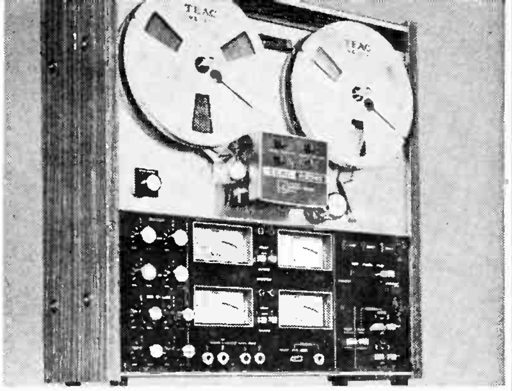

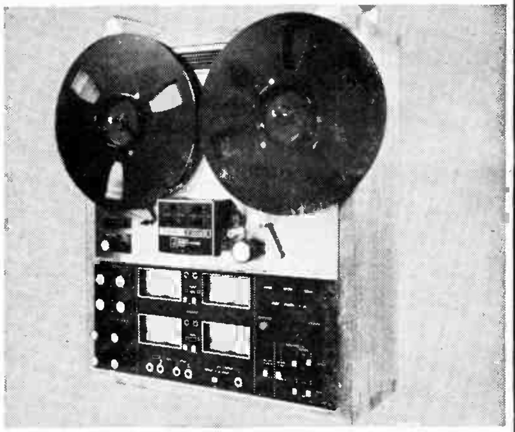

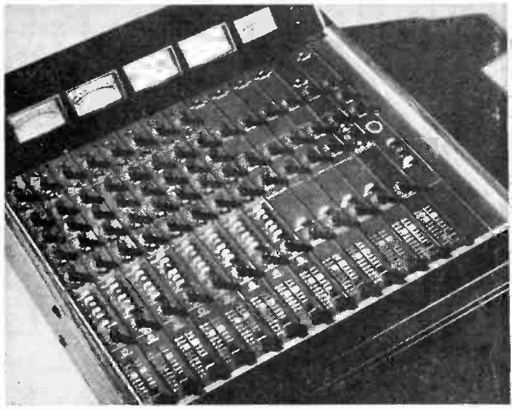

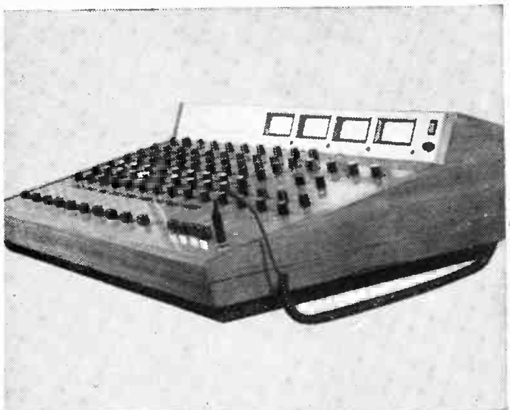

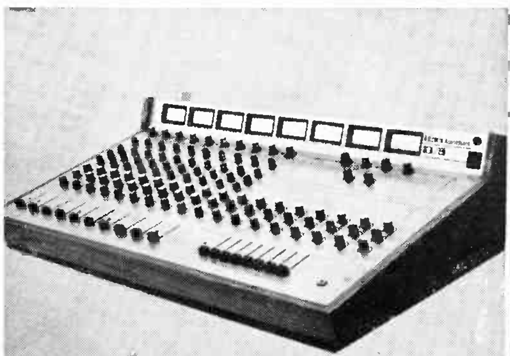

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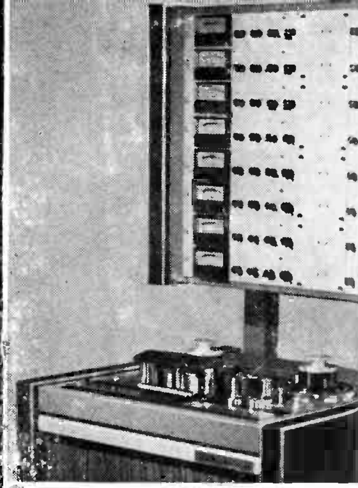

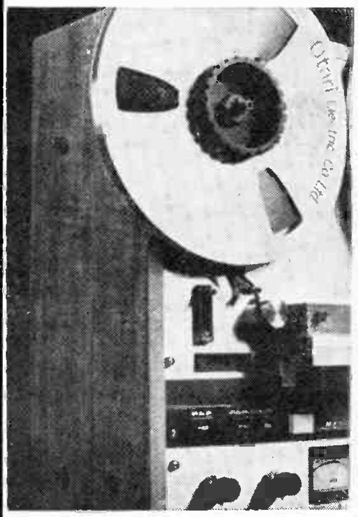

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news

Sonifex cart machine

Sonifex has brought out a new cartridge machine accommodating A size cartridges. The machine, *QFX-500*, is equipped with servo motor drive, an air damped solenoid for quiet operation and muting in the fast forward (50 cm/s) and stop position. It uses Cannons for the signal interface.

Equipped with primary cue facilities, it incorporates an equalised cue output to enable operation with external secondary and tertiary cue apparatus. Extract from manufacturer's specification:

Cart size: NAB A.
Equalisation: NAB or CCIR (to order).
Frequency response: 40 to 15k Hz ±2 dB.
Stereo phase: 45° at 100 Hz and 15k Hz reference 0° at 1 kHz.
Distortion: 2% thd ref +8 dB above standard tape reference (*NAB 19 cm/s 320 nWb/m one supposes—Tec Ed*).
Wow and flutter: less than 0.15% rms.
Start/stop time: less than 100 ms.
Dimensions: 76 x 215 x 290 mm.

Sonifex Sound Equipment, 15 College Street, Irthlingborough, Wellingborough, Northants NN9 5TU.
Phone: 0933-650700.

Teach in/sell out

At a recent symposium held at the Melodia Studios in Moscow, 3M, Sondor, White, Cadac, dbx, Master-Room *et alia* demonstrated their European and American technology to more than 200 senior engineers working within the Soviet Broadcasting, Film and Recording Industries.

At the close of the seminar, the State Committee placed orders for 3M *79* machines, dbx noise reduction, Master-Room reverb units and White Instrument products proving that capitalism isn't dead.

Rotary pot

Penny and Giles potentiometers have introduced a single axis pot with 240° turn. The manufacturer claims a combination of precision and reliability in adverse operating conditions. It offers a self centring mechanism stated to produce a rest position accuracy better than 0.5% between wiper and centre tap. Units can be supplied in fundamental resistance values between 250 ohms and 30k ohms; further, they can be fitted with or without additional taps including centre tap. Penny and Giles Ltd, Mudeford, Christchurch, Dorset BH23 4AT. Phone: 042 52-71511. *Canada*: Aviation Electric Ltd, PO Box 2140, Station 0, Montreal H4L 4XH. Phone: (514) 744 2811.

Modules

An Australian Company, Studio Electronics Pty Ltd, has entered into the encapsulated/pcb module market with a series of devices which claim a very high standard of electrical performance:

1) *SEO-1* Operational Amplifier. This offers a quoted 100 kHz power bandwidth delivering +20 dBm into 100 ohms. Distortion stated as less than 0.1% thd. Noise less than 0.7 μV equivalent input 20 to 20k Hz. Price $40.
2) *VCA-1* Voltage Controlled Attenuator. Claims 100 dB dynamic range; tracks within 2 dB between any two units over 60 dB. Distortion quoted as less than 0.01% at +4 dBm. Price $36.50.
3) *130* Peak Programme Meter. Led column scale reads from -30 to +6 dBm. Integration time quoted as 10 ms. Price $140.
4) *377* Headphone Amplifier. Produces 2W at 0.1% thd.

Studio Electronics Pty Ltd, PO Box 1055, Burwood North 2134, Australia.

Midem 77

Midem, the acronym for Marche International du Disque et de l'Edition Musicale, will be held from January 11 to 21, 1977 at the traditional Cannes venue. To provide space for an additional 105 exhibition booths, the covered car park has been turned into extra display space. The total number of stands will exceed 1090; however, nobody can state with any degree of certainty whether there will be any facilities for the *de rigeur* crop of Rolls-Royces that the event attracts.

There will be an international meeting of lawyers at the Hotel Majestic which will take place on the 20 and 21. Subjects for discussion include the legal problems set by 'videogrammes' whatever they are and 'the part played by jurists in the drafting of contract and sub contract clauses'. Quoting the Marx Bros, it should prove conclusively that 'there ain't no Sanity Clause'.

Harrison—survey omission

Inadvertently, we omitted Harrison from our survey of recording consoles (January Studio Sou
Belatedly, here are a few facts a
this company's products
should have been included:

This company's desks are b
on an input/output channel w
is mode selectable from a
button group adjacent to
channel fader. The basic capa
is either 40/32 or 32/32; the sy
organisation relies on use of
state switching matrices to elec
operational status of the va
channels from four options co
ponding to the usual mic/mac
monitor etc.

The channel panning facilitie
extensive with normal odd/even
for the routing; each cha
incorporates full quad positio
with quad mix busses for su
quent mixdown.

Vca faders allow up to nine
groups together with a read/v
update control when used
automation. The eq facilities
two-band parametric with hi
lo pass.

For further details see Multi
Review (January 77, p68) and
APRS report (August 76, p54)
Harrison Systems, PO Box 2
Nashville, Tenn 37202, U
Phone: (615) 834 1184.
UK: Scenic Sounds Equipm
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W1H 7AB. Phone: 01-935

Tannoy change of address

Tannoy has moved locatio
Buckinghamshire following
addition of Harman Kardon
Ortofon products for distr
tion by the group throughou
UK. Tannoy Rentals Ltd
remain at West Norwood.

The new address is Tannoy P
ucts Ltd, St John's Road, T
Green, High Wycombe, B
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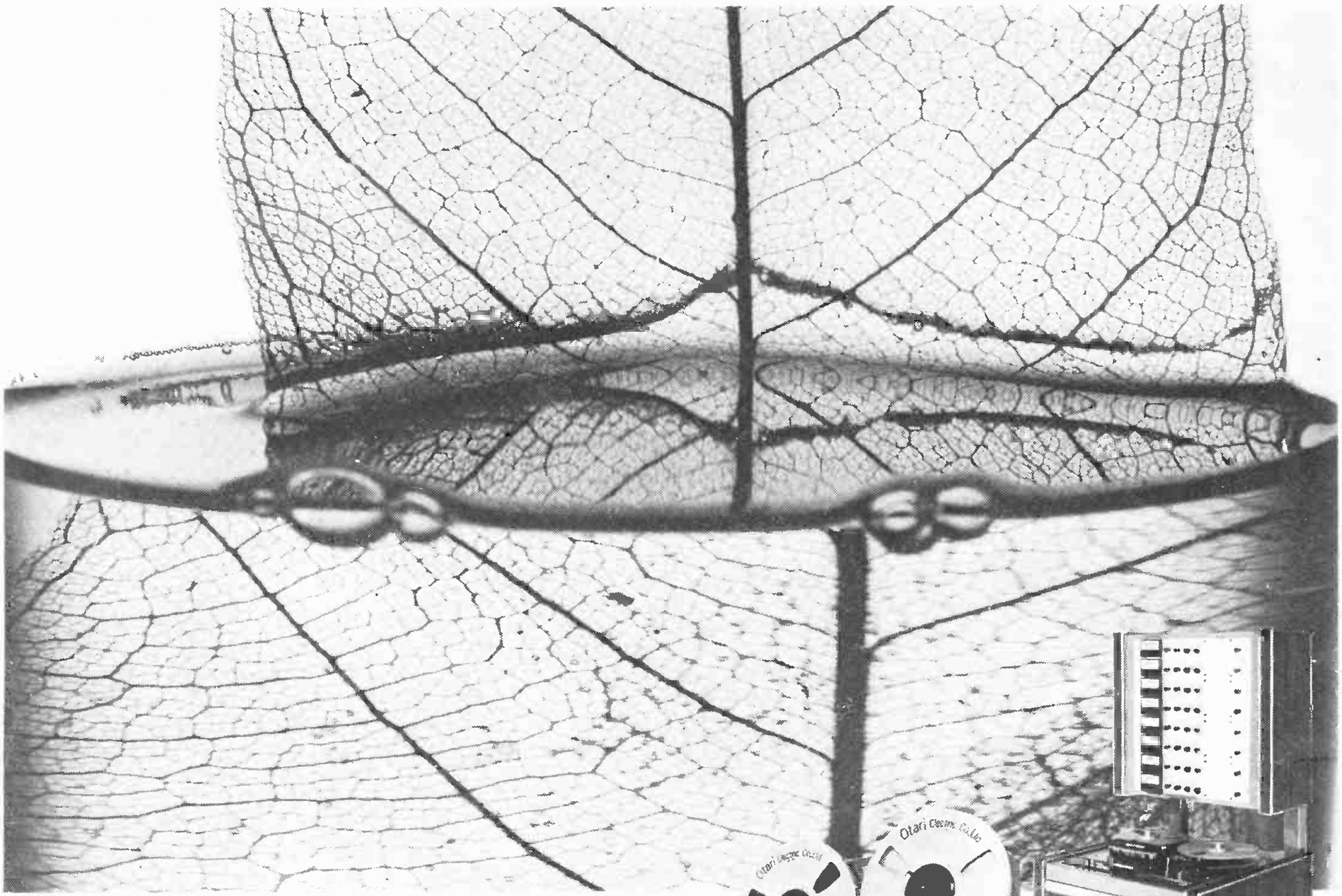
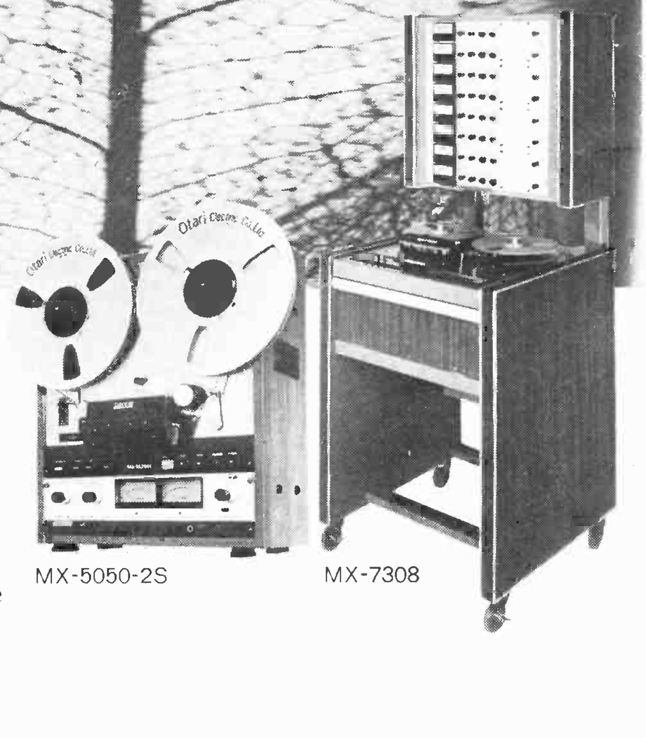
The new Harris CB-1201 professional transcription turntable—a new broadcast product

once is enough!





Water is pure and clear. Still, if we look at a leaf which is partially submerged in it, the leaf looks distorted. It is surprising how easy it is to introduce distortion, even by the simplest type of operation on the real thing. The bent leaf doesn't really bother us very much, but when distortion in sound results from the use of equipment, this bothers us a lot!

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NEWS

Delay price reductions
FWO Bauch has announced price reductions of between 10 and 15% on all Lexicon Digital Delay equipment including vco modules and the new stereo version of the *102* range.

The new prices mean that a basic delay system with 160 ms of delay and two outputs now costs £2890.

FWO Bauch Ltd, 49 Theobald Street, Borehamwood, Herts WD6 4RZ. Phone: 01-953 0091.

Level vdu
Link Electronics has produced a unit for translating audio inputs of up to 32 channels into a single signal enabling colour or monochrome tv monitors to display level information in bar form. Designated type *426*, it uses a pin board matrix to control the size of display; when showing less than 32 audio inputs, unused bars can be deleted from the display with remaining bars increased in width to enable greater clarity.

The unit is supplied with identifying buttons for location adjacent to the channel faders which modify the relevant bar in either colour or brightness for quick identification. When a channel is overdriven, a similar display change occurs. Switched ballistics simulate either vu or ppm characteristics.

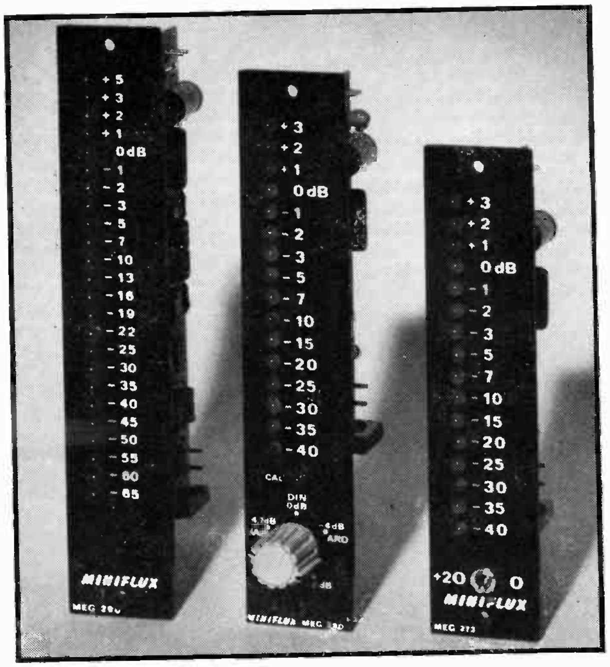
Link Electronics Ltd, North Way, Andover, Hants SP10 5AJ. Phone: 0264-61345.

New range of mixers
Gelf Electronics Ltd is a relatively new company engaged in the production of studio and allied gear. Among its products are a 16/6 monitor mixer, a studio desk with eight subgroups, full channel eq, P & G faders, XLRs etc; an auto phasing unit, electronic phaser incorporating an internal control oscillator as well as an envelope phaser, and an active crossover. The active crossover offers fixed frequency four section split combined with stereo operation.

Gelf Electronics Ltd, 38 Home Close, Bletchley, Milton Keynes MK3 6JE. Phone: 0908-77503.

Low cost Studer
Studer has brought out a master recorder, the *A80/RC*, which offers a price reduction of about £800 on the *A80/R* stereo machine. Developed from the *A81* machines supplied to the German Broadcasting Corporation, the new machines incorporate a new tape transport control, and an electronic tape timer is standard. The manufacturer claims that the price reduction has been achieved through rationalisation of production techniques and testing procedure.

Studer International AG, Althardstrasse 150, CH-8105 Regensdorf, Switzerland. UK: FWO Bauch, 49 Theobald Street, Borehamwood, Herts WD6 4RZ. Phone: 01 953 0091.



The new range of Miniflux led meters. Available in several ranges of resolution, they are said to comply with DIN, IEC or BS 4297 standards

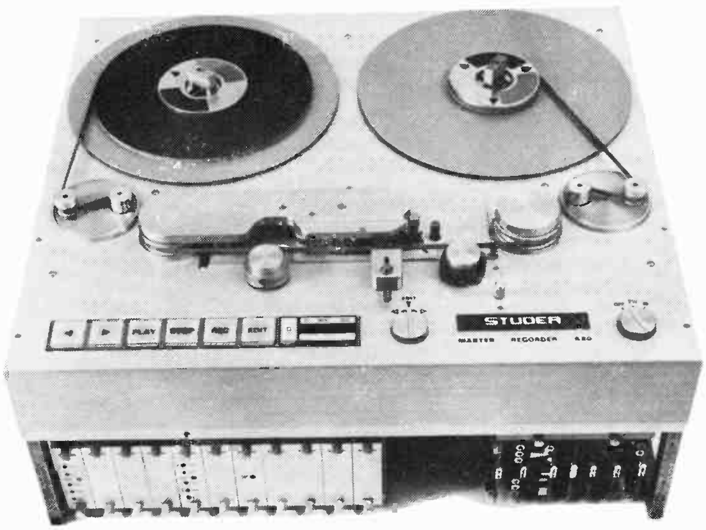
Studer address
The Swiss Studer organisation has changed address to new premises effective since December 15: Studer International AG, Althardstrasse 150, CH-8105 Regensdorf, Switzerland.

Didn't they do well . . .
ALICE—for a major revamp at Radio Clyde, John Lumsden chose variants of the AM system for the two main on-air studios. The new mixers, which should be working in the new year, will be in addition to existing Alice products situated in the music studio and the ob van. The company has recently sold an £8000 desk to CFRW in Winnipeg—'the service of high quality music to the Prairies'.

NEVE US has also sold a few more. An *8038* 24-track has turned Sounds Studio, Hawaii into the only 24-track facility in the 50th State. The chances are Hula music will never be the same again. Neve has also supplied an *8068* compact console to the Manta Sound Company of Toronto and Les Studios Marco of Montreal. These are in addition to the recent installation of the same type of desk at the Four Star Studio Complex at Nashville—not counting the five recent broadcast installations scattered round the US.

HAYDEN LABS say that they have sold untold numbers of Nagra *IS-LT* tape recorders—one size down from the classic 4.2—to the BBC film department. They will be mostly used for film location and current affairs work.

Studer low cost A80/RC stereomaster machine.



Leader available
C. E. Hammond say that they can now supply, off the shelf, the following Leader instruments: *LDC 821* digital frequency counter, the *LAG 120* audio generator, the *LMV186A* stereo millivoltmeter and the *LEM 75* electronic multimeter.

C. E. Hammond & Co Ltd, 105 109 Oyster Lane, Byfleet, Surrey KT14 7LA. Phone: Byfleet 41131.

Alignment oscillator
Barry Porter, erstwhile designer with Trident, has started his own company, Midnight Audio Ltd. One of his first products is an instrument designed to simplify routine lining up of pro tape recorders.

The Alignment Oscillator type *464* offers:

Push button selected 10 frequency oscillator with up to +20 dB output capability. A metering section which claims to give 2% accuracy at any attenuator setting when reading 0 vu.

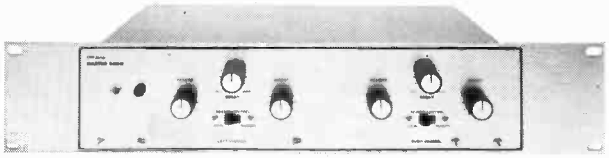
Duplicated XLRs for oscillator output and meter input.

A sum reading (whatever that means) for head azimuth alignment. The unit is mains powered and costs £165.

Another Porter-designed Midnight Audio product is an audio voltmeter type *348* for accurate

24

The New Master-Room 'C' Series



Independently variable series available with two 1–3 second channels, two 2–4 second channels or one 1–3/one 2–4 second channels.

Studio 'B' Series
Single channel series with variable decay plus equalisation. In 1–3 or 2–4 second models.

M–R Studio Series
Fixed decay time single input/ stereophonic return. Available in 2, 5 and 7 second optimised decay time models.

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27–31 Bryanston Str., London W1H 7AB
Phone: 01-935 0141 Telex: 27 939

France:
3M France SA Mincom Div.
135 Blvd. Serurier, Paris 19E
Phone: 202 8080

Holland:
Pieter Bollen
Geluidstechniek
Eindhoven
Phone: 040 512777

Denmark:
Recording Operation Co.
Artillerivej 40
DK 2300 Copenhageen S.
Phone: 01 570 600

Norway:
SIV. ING. Benum/Skovvn 22
Oslo 2
Phone: 02 56 57 53

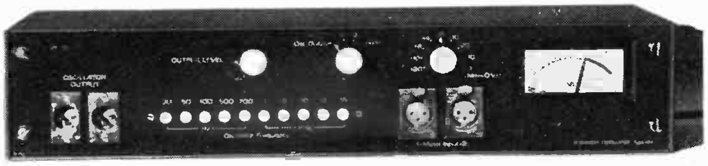
Sweden:
Ing Firma Jan Setterberg
Kungsgatan 5
S411 19 Gothenberg
Phone: 031 13 02 16

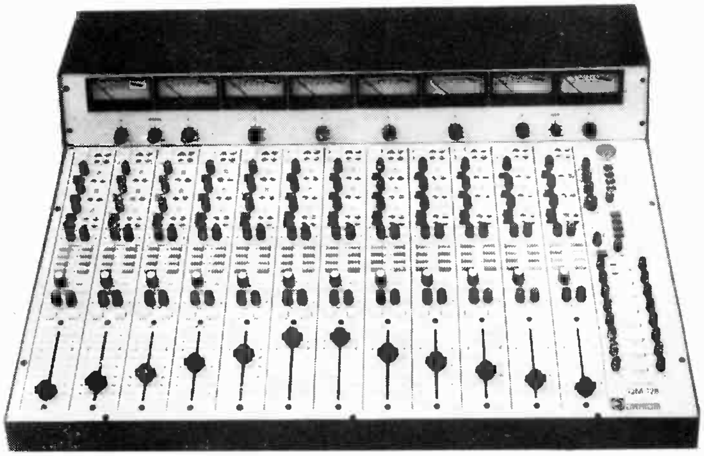
NEWS

voltage and frequency measurement. It offers an fsd range from 150 μV to 50V in 12 ranges and reads −80 to +30 dB at centre scale. Also it offers direct power reading to 250W into 8 ohms. The unit incorporates three filters: 1) 20 to 20k Hz. 2) CCIR. 3) DIN A weighting. The frequency counter is a six digit unit with gate periods of 0.1, 1 and 10 seconds. The unit costs £395.

Midnight Audio Ltd, PO Box 12, Fleet, Aldershot, Hants GU13 8EF. Phone: 02514-20143.

Midnight Audio tape machine alignment oscillator





Quantum Audio QM-128 eight bass mixer selling for only $4300

Bloodsucker

This man, the advertisement manager of Studio Sound, was given the *Dracula Award* at the recent DEAF dinner for being 'the biggest bloodsucker in the industry'. We, the magazine, feel this an award that he richly deserves; however, we should point out that this has been exacerbated by an unfortunate medical condition (see picture).

Our medical correspondent writes: It is not uncommon for ad managers to suffer pecuniary toxaemia (Itchy Palm), usually concurrent with symptoms of inflationary paranoia. Classic symptoms include a tendency to make rash statements of a promissory nature, while leaving two little puncture holes in the wallets of those who have been in close contact with the subject. The prognosis isn't very hopeful. Treatment: frequent transfusions from blood donors.

Quantum desk

Each module on the new *QM-128* has solo, mute, two independent echo sends and two independent cue sends, six frequency eq on three knobs and switchable 15 dB padding on the mic amp. Channel faders are of the conductive plastic type.

Monitoring can be selected by pushbutton to buss, line or playback; slate can be put on any of the eight output groups. They also incorporate buss metering facilities.

The desk comes in a beige colour with a textured brown chassis; all control functions are colour coded for ease of identification. Optional extras include a patch bay, phantom powering and an eight input expander. The basic price is $4300 which seems very reasonable.

Quantum Audio Labs Inc, 1905 Riverside Drive, Glendale, Ca 91201, USA. Phone: (213) 841 0970. ■

Monitor equalisation

GEORGE AUGSPURGER*

Third octave analysis can't replace a good pair of ears. However, objective analysis can provide a good starting point for subjective discussion.

*Perception Inc

Historical perspective

ELECTRICAL equalisation of loudspeakers has been practised for more than 40 years. The renowned 1933 stereophonic re-creation of the Philadelphia Orchestra made use of sophisticated equalisation, and the description of the experiment in the *Bell Laboratories Record* points out that correct equalisation of a given reproducing system is different for every hall. In the United States Dr C P Boner later pioneered the use of equalisation in sound reinforcement systems, both for suppression of acoustic feedback and to achieve natural tonal quality. In the 1940's, Ampex presented a number of 'live vs recorded' demonstrations and again the reproducing chain was equalised for natural sound quality.

In 1968, Altec's 'Acousta-Voicing' process was first used to equalise the response of recording studio monitor speakers. Since then, a variety of active and passive equalisers suitable for monitor equalisation has appeared. In US control rooms and mixdown rooms, probably more than 50 per cent make use of some degree of electrical equalisation in their monitor chains.

I became interested in equalisation of sound reproducing systems about 15 years ago. My early experiments were confined to attenuating one or two bands of frequencies in the mid-bass region, where room coloration is most apparent in typical listening rooms. Later, when $\frac{1}{3}$-octave analysis and equalisation gear became generally available, I tried to develop techniques to meet the particular requirements of recording studios.* The following paragraphs represent a personal view on the subject, based on experience in some 80 control and mixdown rooms.

Measurement—objective or subjective?

Early measurements of acoustical response were made using swept sinewaves. However, in any enclosed space, normal modes or eigentones are so closely spaced, and sound pressure changes so dramatically with the positions of ear (or microphone) and source, that sinewaves tell us a lot more than we would really like to know. Some sort of averaging is needed to correspond with our subjective assessment of tonal balance.

So, warble tones were later used to generate a 'window' of frequencies, usually 10-20 Hz wide. But the technique that has proved to give the best correlation with listening tests is the use of bands of noise, nominally $\frac{1}{3}$-octave wide.

In theory, pink noise can be filtered into $\frac{1}{3}$-octave bands either before it is fed to the loudspeaker or after it is picked up by the measurement microphone. There are practical reasons for choosing one or the other (as will be pointed out shortly) but the results should be the same.

Random noise simulates the transient characteristics of typical program material and $\frac{1}{3}$-octave bands on standardised centre frequencies give sufficient detail for most applications without introducing unnecessary complications. The reason for this happy state of affairs is that the critical bands of the human ear are fairly close to $\frac{1}{3}$-octave wide. But it is easy to jump to fallacious conclusions from this fact. Some writers imply that you can do whatever you like within a single band because the ear cannot resolve to a finer degree than $\frac{1}{3}$-octave . . . not true.

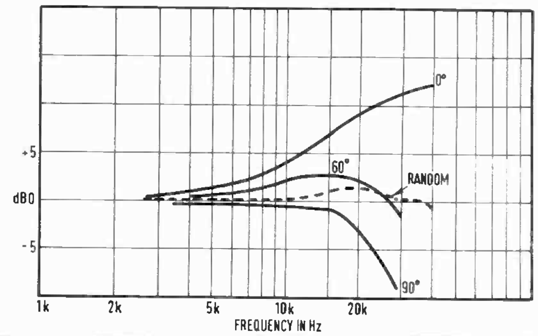
In co-operation with a Canadian associate, these are in the process of being formalised under the trade name Sonovoice.

In a similar vein, the response curve generated on the screen of a $\frac{1}{3}$-octave sound analyser is often regarded as Holy Writ . . . it is *the* frequency response of the system. Some recording engineers have become so disillusioned after hearing obvious differences between systems having identical measured response that they dismiss the whole equalisation effort as a fraud.

The fact is that the $\frac{1}{3}$-octave measuring stick is a powerful tool. However, when measuring and equalising sound reproducing systems, especially recording studio monitor systems, $\frac{1}{3}$-octave noise bands do have several limitations that cannot be ignored.

1) Because the test signal is derived from random noise, its spectral content and its level at any frequency or band of frequencies are both constantly changing. The level of confidence for any analysis based on bands of noise is something in the neighbourhood of ± 1 dB. But a trained ear can easily hear differences of 1 dB when making an A-B comparison between left and right speakers.

FIG.1 PUBLISHED FREE-FIELD CORRECTION CURVES FOR THE B & K 4134 12 mm CONDENSER MICROPHONE



A 2 dB uncertainty factor is unacceptable to the recording engineer.

The remedy is to give up that fascinating toy, the real-time analyser.* By driving the system sequentially with $\frac{1}{3}$-octave bands of noise, one can compare the relative levels of left and right speakers not only with the test microphone, but also (radical suggestion) by *listening*. If, as usually happens, there are differences in timbre between the two monitor speakers, final balancing can be done on the basis of subjective response, a single band at a time. This works in spite of the fluctuating nature of the test signal because a rapid A-B switch catches it in mid-strike, so to speak. And, by using the ear as a check against the test microphone, one can allow for subtle differences within a single band that do not show on the plotted response curve.

2) Additional uncertainty is introduced in trying to define the listening location. Even with the averaging effect of a band of frequencies, the measured sound level in any one band can vary dramatically with small changes in microphone position. The usual response curve derived from a single microphone at the centre of the console is analogous to what would be heard by a one-eared recording engineer with his head in a clamp.

One possible remedy is to move the microphone around in the general vicinity of mix centre and try to average the readings obtained. One can sit at the console with a sound level meter in one's lap, for example, and sort of wave it around slowly in a

Most $\frac{1}{3}$-octave sound analysers used for monitor testing and equalisation are not true 'real time' devices. However, the distinction is not important to this discussion.

circular pattern while noting the variations in level. But this may not be any better than accepting the limitation of a fixed measuring position. For one thing, it is not a repeatable test technique. For another, waving and watching and mentally recording allows the subconscious to insist on the figure hoped for rather than the one that would be noted by a truly unbiased observer.

A better technique is to make three or four separate sets of measurements at defined positions and then average the results. This takes time, especially when performing equalisation. The three locations can be better averaged automatically and simultaneously by using three calibrated microphones and some kind of multiplexing circuit to average (not mix) their outputs.

3) A third area of uncertainty exists because of the directional characteristics of the measuring microphone and of the ear.

With a little caution one can be reasonably certain that the microphone is responding in random-incidence fashion over most of the audible frequency range. A 12 mm microphone such as the B & K *4134* has omnidirectional response up to about 5 kHz. In the range from 5 kHz to 15 kHz random-incidence response and grazing-incidence response are within 2 dB of each other (**fig. 1**). However, if a strong directional component approaches the mic at an angle of 60° or less a bias of several dB can be introduced.

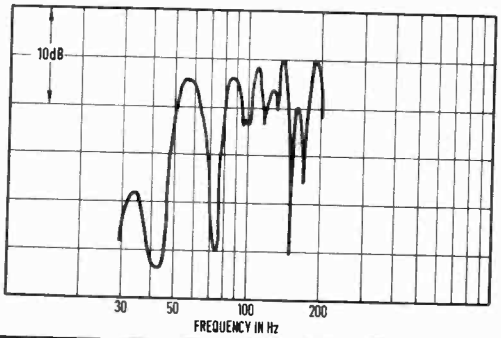
In comparing curves run with my equipment against those logged by others, I find the largest discrepancies in the frequency range above 5 kHz. In some cases the differences can be traced to ignorance of microphone characteristics. (Point a sound level meter at the loudspeaker and simply plot what it indicates.) In other instances it does not seem that my array of three *4134* mics is necessarily any more accurate than the equipment used by the studio.

I am tempted to acquire three 3.13 mm microphones. These beautiful little B & K units are truly omnidirectional up to about 20 kHz. That is, they would be omnidirectional if the associated preamplifier did not shadow the microphone at its rear. As always, nothing in life is perfect.

In any case, a non-directional pick-up pattern does not ensure correlation with the directional characteristics of the ear. The difference in perceived loudness between frontally directed and diffuse sound fields is about +3 dB at 1 kHz, −2 dB at 2.5 kHz and more than +4 dB above 8 kHz. In many control rooms the diffuse field predominates at low frequencies, the direct field predominates at high frequencies, and the two are roughly equal through the mid-range. Since different monitor speakers in different environments will produce differing ratios of direct-to-reflected sound, the notion of measuring *the* response of the system is beset with uncertainties on this basis alone.

Fortunately, from a practical standpoint the important thing is to have a test setup which correlates reasonably well with subjective evaluation and which allows repeatable measurements to be made. One learns quickly that, for engineer A in control room B, measured high frequency response should be shelved 1 dB above 2 kHz and rolled off at about 3 dB per octave above 5 kHz. Whether this curve represents the 'real' response of the system is beside the point.

FIG. 2 SINE WAVE RESPONSE OF CONTROL ROOM MONITOR AS AVERAGED FROM 3 MICROPHONE POSITIONS NEAR CONSOLE CENTRE



4) Finally, using ⅓-octave bands on standard centre frequencies gives ambiguous readings if the peaks and dips in system response, as measured with a swept sinewave source, happen to be about ⅓-octave apart. This is exactly what happens below 200 Hz or so in small rooms.

Fig. 2 shows the sinewave response of a control room monitor as measured at the centre of the console. An array of three microphones was used, so that space averaging is already included in the plot. Note that the lowest peak and following dip are close to the standard centre frequencies of 31.5 and 40 Hz and, therefore, will also show up on ⅓-octave analysis.

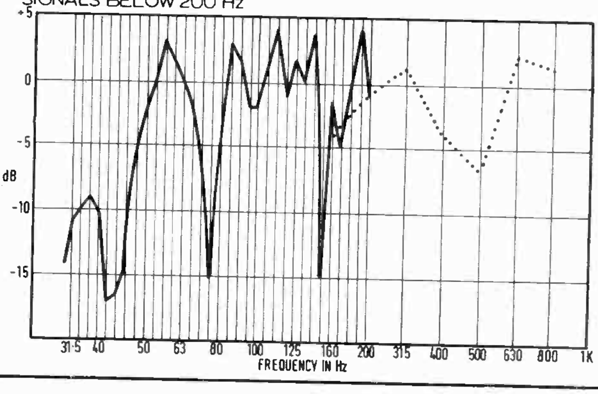
However, the peak at 56 Hz and the dip at 75 Hz fall in the 'cracks' between standard ⅓-octave bands. ⅓-octave analysis will give a misleading picture of the true state of affairs in this region.

There are a number of ways in which the resolving power of our measuring system can be improved in the low frequency range. Sinewave response can be plotted, but this takes a lot of time to do manually or a lot of money for extra equipment to do automatically. One might switch to $\frac{1}{10}$-octave analysis at low frequencies but this increases the difficulty of getting a true level average over a sufficient length of time. Even with ⅓-octave bands of noise, signal fluctuations at the lower frequencies require several seconds of averaging time and make eyeball estimate difficult.

A continuously swept ⅓-octave analysis works reasonably well, but again is time-consuming and requires additional expensive test gear.

It seems to me that a good compromise between measurement resolution, simplicity and speed is to use sequential sinewave signals at $\frac{1}{12}$-octave centres for measurements in small rooms below 200 or 250 Hz. **Fig. 3** shows what happens when the response curve of fig. 2 is replotted in the new format.

FIG. 3 THE CURVE OF FIG.2 RE-PLOTTED FROM $\frac{1}{12}$ OCTAVE SINE WAVE SIGNALS BELOW 200 Hz



Acoustical vs electrical monitor equalisation

Having measured the response of a monitor loudspeaker with some degree of accuracy, the question arises: to equalise or not to equalise? It would seem that if the loudspeaker is inherently flat and if the listening room is correctly designed, measured response should be uniform and no further adjustments should be required.

But a control room is rarely an ideal listening room. It is too small. As a result, the normal modes of the room produce audible peaks and dips at low frequencies, as we have seen. To make matters worse, the listening location is necessarily near the centre of the room, the worst possible location from the standpoint of low frequency response.

In those cases where a room can be designed from the very beginning with plenty of adjoining space for low frequency absorption, smooth bass response can be realised over a fairly large listening area. In effect, one builds a visually small room inside an acoustically large shell.

More often than not, however, even though we use all the tricks learned from previous experience, and although we spend two or three days experimenting with reflective and absorptive surfaces, the best we can manage is smooth response *except* for, say, a general hump in the 125 Hz region and excessive roll-off below 50 Hz, as in **fig. 4**.

Faced with this common situation it makes sense to introduce very simple electrical equalisation even if the client does not want a fully equalised monitor system. The equalisation required for such trimming has gentle slopes with correspondingly little phase shift. Even the most vehement anti-equalisationalist accepts a few dB of boost at 40 Hz and a few dB of attenuation at 125 Hz once he hears the improvement in listening quality.

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MONITOR EQUALISATION

If such results can be achieved with only minimal equalisation, and if one believes as I do that the best equalisation is the least equalisation, how is it possible to justify the use of complete ⅓-octave banks of equalisers, with separate filters for each band from 40 Hz to 16 kHz and 10 dB of boost and cut available at each centre frequency? . . . Easy.

The value of complete ⅓-octave equalisation lies not so much in its ability to compensate for gross problems in monitor response (which is never really satisfactory anyway) as the precision with which more subtle changes can be achieved. With today's complex multitrack mixes it takes only a dB or two in a given band of frequencies to change the balance between tracks. Only with full ⅓-octave capability is it possible to arrive at and maintain the best response curve for comfortable mixdown in a particular situation.

And only with complete ⅓-octave equalisation is it possible to achieve near-identical response from all of the monitor speakers in the control room. Even though many filters may be set at 0 during the process of equalisation, they may be needed two or three months later when the monitors have drifted slightly from their original performance characteristics; I don't know why loudspeakers should drift, but the level of stability for a typical monitor system is about that of a grand piano.

Let me emphasise that equalisation will not allow you to make a Tannoy sound like a JBL; it will not fool your ears into believing that large, dead control room A is small, bright control room B. It will not circumvent the basic limitations of the electronics, the loudspeakers and the room.

FIG.4 B & K 4134 HYPOTHETICAL ⅓ OCTAVE REPONSE OF A GOOD MONITOR SPEAKER IN A WELL-DESIGNED CONTROL ROOM

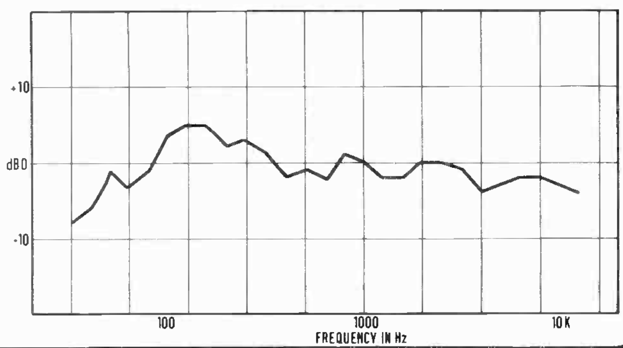
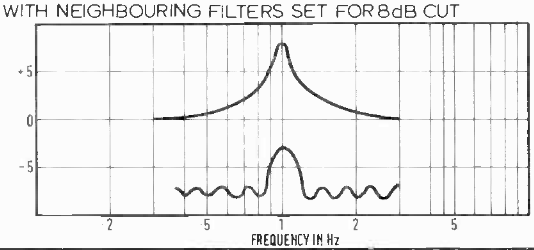


FIG.5 TYPICAL FILTER CHARACTERISTICS. UPPER CURVE: SINGLE FILTER SET FOR 8dB BOOST. LOWER CURVE: SAME FILTER SET AT 0 WITH NEIGHBOURING FILTERS SET FOR 8dB CUT



Properly done, monitor equalisation *will* allow you to mix with confidence, knowing that the balance between tracks and the special effects created at the console are accurately portrayed by the control room monitors.

Phase shift and ringing . . . ?

The filters used for sound system equalisation usually consist of single LC sections or their active equivalents. They are simple resonators with maximum phase of ±90°. As used for speaker equalisation, phase shift seldom exceeds 45°.

Moreover, such resonators are not only minimum-phase devices but their response combines in minimum-phase fashion. By adjusting individual filters in such a way that the resulting sinewave response curve is smooth and gentle, results are exactly the same as if only a few much broader filters had been used. The mistake made by many technicians is set to one knob at −6 and the next at -10 and the next at +8 in an effort to get a 'flat' response curve. The resulting curve may look flat but it sounds terrible because of the narrow peaks and notches in the electrical response of the equalisers.

Some people believe that ⅓-octave bands should never be boosted 'because boost filters ring'. This is nonsense based on a germ of truth.

In most filter sets having boost and cut capability the functions are reciprocal. At extreme settings the bandwidth is much narrower than when only a little boost or cut is inserted. If an isolated filter is set for 8 or 10 dB of boost (again in a misguided effort to make the analyser display look pretty) the band of frequencies near the centre is narrow enough to be heard as a definite tonality.

If filters are used only in the cut mode there is a built-in safeguard against this mistake (see **fig. 5**). To make use of the added flexibility of boost/cut filters without running into trouble, one simply remembers not to boost any single control more than 3 or 4 dB above the settings of its neighbours.

A more insidious problem can be encountered when filters in either the boost or the cut mode are pushed beyond the range in which their skirts combine smoothly. The amount of overlap between filters at various settings is different for different products. Most professional devices provide a range of about 8 dB of cut or boost with less than 1 dB of ripple between adjacent filters. Beyond this point the result is a comb filter instead of a smooth equalisation curve. Why then do the manufacturers provide 10 or 12 dB of boost and cut at the centre frequencies? Because 12 sounds bigger than eight.

New hardware for monitor equalisation appears every week. It is probably possible to buy an equaliser that introduces noise and distortion and makes the monitors sound worse no matter what its settings, but the same is true for any piece of electronic gear. A professional-quality filter set built by a reputable manufacturer will introduce no more noise and distortion than a line amplifier. With all filters set at zero it *is* a line amp and should perform as such.

And there are people who believe that only active filter circuits should be used for monitor equalisation because 'passive circuits have inductors and inductors ring'. I would have more sympathy for this common belief about inductors had I not discovered that the ringing observed in some low frequency passive filters originated in the capacitors! Just as inductors have distributed capacitance so can capacitors have appreciable inductance. Occasionally one finds capacitors in the 2-10 μF range which have sufficient inductance to develop self-resonance below 500 kHz. If such a capacitor is then paralleled with an inductor, two resonance frequencies can be produced. In the case that brought this effect to light, parallel LCR filters had been used in a control room to boost the 40-80 Hz region. The studio maintenance engineer called my attention to the fact that when the filters were inserted, high frequency ringing could be observed on squarewaves. The ringing was traced to a peak in the 60 kHz region, and this was found to be caused by a particular batch of Mylar capacitors. The moral is: never trust anything until you have checked it.

Given a choice between an LC resonator and its active equivalent, I would choose the passive circuit simply because it is simpler, quieter and more reliable. The fact is that the top-quality equalisers made by White Instruments, UREI and Altec all use passive LC sections suitably buffered by active amplifier stages.

Finally, there is the stubborn recording engineer who listens to all of the preceding arguments but still does not believe in monitor equalisation because he has heard equalised systems that sounded better with the equalisation switched out. Well, certainly. I have heard pianos that sounded better before an inept tuner started tinkering with them. The fault lies in the practitioner, not in the concept of tuning.

To sum up, it seems to me that monitor equalisation has value for the recording engineer only to the degree that it makes his job easier. Its purpose is to provide a more reliable sonic standard in the mixdown room. In my experience, the acceptance of equalised monitor systems by many of the most critical engineers in the recording industry has already established the validity of equalisation as a powerful tool for the studio. ■

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QUICK START aid damped solenoid with adjustable damping provides a rapid, quiet start.
CLEAR cartridge loading area with matching ready indicator, for fast simple operation.
The low noise, high performance amplifiers and logic systems are complemented by the use of Nortronics professional grade heads.
ASK FOR A DATA SHEET.
If you like the spec. you will love the price.

S 5000 VARISPEED MONO CARTRIDGE PLAYER

A compact monophonic player with SERVO motor drive, AIR DAMPED SOLENOID, professional grade heads and FEATURING . . . switched VARISPEED or NORMAL operation.
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SONIFEX LEADERS IN BRITISH CARTRIDGE EQUIPMENT
15 COLLEGE STREET, IRTHLINGBOROUGH, NORTHANTS
Telephone: WELLINGBOROUGH 0933-650 700

Survey: test equipment

Clearly it would be impossible to include full details of all equipment from every manufacturer. The following survey comprises an abbreviated directory of currently available test and calibration hardware on a manufacturer by manufacturer basis.

ADVANCED ELECTRONICS
A E Corporation, 65 Wellesly Avenue, Needham, Mass 02194, USA.
Phone: (617) 449 3142.

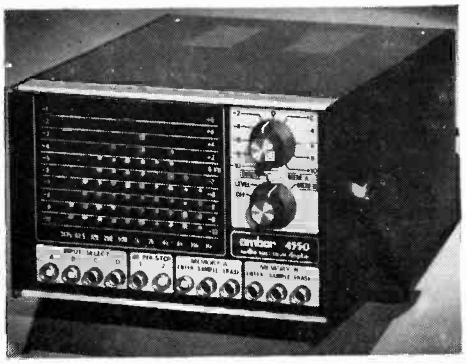
Products
FUNCTION GENERATORS
Features: available in either kit or assembled form. 1 Hz to 1 MHz, sine, square or triangle. $124 built.

ALICE
Alice Stancoil Ltd, Alexandra Road, Windsor, Berks.
Phone: Windsor 51056. Telex: 849323.

Products
NOISE MEASURING SETS
Features: ppm with calibrated amplifier and CCIR 468 filter, intended for noise measurement in accordance with the IBA code of practice. £420.

AMBER
Amber Electro Design Ltd, 1064 Chemin du Golf, Montreal, Quebec, Canada H3E 1H4.
Phone: (514) 769 2739.
Export agent: Gotham Export Corporation, 741 Washington Street, New York, 10014, USA.
Phone: (212) 741 7411.
UK agent: Scenic Sounds Equipment, 27/31 Bryanston Street, London W1H 7AB.
Phone: 01-935 0141.

Amber 4550 spectrum analyser

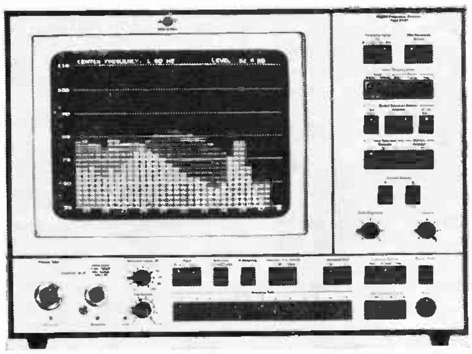


Products
AUDIO TEST SETS
Features: multipurpose instrument (see review p60).
SPECTRUM ANALYSERS

B & K
Bruel & Kjaer A/S, Naerum, Denmark.
Phone: 02 80 05 00. Telex: 37316.
US agent: B & K Instruments Inc, 5111 W 164th St, Cleveland, Ohio 44142.
Phone: (216) 267 4800. Telex: 810421.
UK agents: B & K Laboratories Ltd, Cross Lances Road, Hounslow, Middlesex.
Phone: 01-570 7774. Telex: 934150.

Products
ACOUSTIC STANDING WAVE MEASUREMENT
BEAT FREQUENCY OSCILLATORS
DISTORTION ANALYSERS
FILTERS
FREQUENCY RESPONSE MEASUREMENT
GATING SYSTEMS
IMPULSE RESPONSE TESTING
INSTRUMENTATION AMPLIFIERS
INTERMODULATION DISTORTION ANALYSERS
LEVEL RECORDERS
MEASURING MICROPHONES
MICROPHONE CALIBRATION GEAR
NARROW BAND ANALYSERS
NOISE ANALYSERS
NOISE GENERATORS
OSCILLATORS
PHASE METERS
POWER METERS
PO TELEPHONE TEST SETS
PSOPHOMETERS
REAL TIME ANALYSERS
SINE RANDOM GENERATORS
SOUND SOURCES
SPECTRUM ANALYSERS
VOLTMETERS

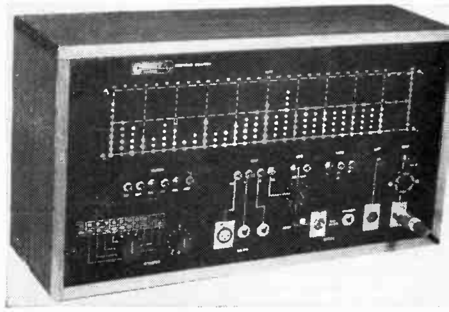
B & K digital frequency analyser 2131



COURT
Court Acoustics, 50 Dennington Park Road, West Hampstead, London NW6.
Phone: 01-435 0532.

Products
SPECTRUM ANALYSERS
Features: 29 x 11 matrix of led indicators on standard ISO centres from 28 to 20k Hz. Particularly suited to disc cutting applications.

Court Acoustics real time audio spectrum analyser



DANA
Including distribution for CUSHMAN, EXACT and EIP.
Dana Labs Inc, 2401 Campus Drive, Irvine, C 02664, USA.
UK agent: Dana Electronics Ltd, Collingdon Street, Luton, Beds.
Phone: 0582-24236.

Products
COUNTERS
FUNCTION GENERATORS
MILLIVOLTMETERS
MULTIMETERS
SWEEP GENERATORS
SYNTHESISED GENERATORS
WAVEFORM GENERATORS

DYMAR
Dymar Electronics Ltd, Colonial Way, Radle Road, Watford, Herts WD2 4LA.
Phone: Watford 37321. Telex: 923035.

Products
AUDIO POWER METERS
AUDIO SIGNAL GENERATORS
COUNTERS
DISTORTION FACTOR METERS
RF GENERATORS
SSB TEST GEAR
WAVE ANALYSERS

FARNELL
Farnell Instruments Ltd, Sandbeck Wa Wetherby, Yorkshire.
Phone: 0937-3541. Telex: 557294.
Overseas agents: in most countries.

Products
ATTENUATORS
AUDIO OSCILLATORS
FUNCTION GENERATORS
MILLIVOLTMETERS
MODULATION METERS
OSCILLOSCOPES

SURVEY: TEST EQUIPMENT

SIGNAL GENERATORS
SWEEP GENERATORS
SYNTHESISED SINE GENERATORS

HEWLETT-PACKARD

Hewlett-Packard Co, 1501 Page Mill Road, Palo Alto, Ca 94304, USA.
Phone: (415) 493 1501. Telex: 348461.
UK agent: Hewlett-Packard Ltd, King Street Lane, Winnersh, Wokingham, Berks RG11 5AR.
Phone: 0734-784774. Telex: 847178.

Products
DISTORTION ANALYSERS
Features: manual and auto null.
FOURIER ANALYSERS
Features: 80 dB range of amplitude and phase resolution for extrapolation of the transfer function.
FUNCTION GENERATORS
GROUP DELAY MEASUREMENT
NETWORK ANALYSERS
OSCILLATORS
Features: synthesised, phase locked and low distortion types available.
PO LINE INVESTIGATION EQUIPMENT
SIGNAL GENERATORS
SPECTRUM ANALYSERS
Features: H-P manufactures real time equipment suitable for use between low Hz and 40 GHz.
SWEEP GENERATORS
WAVE ANALYSERS
Features: portable and rack mounting instruments available for both af and rf.

LEADER

UK agent: C E Hammond & Co Ltd. See Sound Technology.

Products
AUDIO GENERATORS
Features: 10 Hz to 1 MHz. Facilities for external synchronisation.
FREQUENCY COUNTERS
MILLIVOLTMETERS
MULTIMETERS

LEVELL

Levell Electronics Ltd, Moxon Street, Barnet, Herts EN5 5SD.
Phone: 01-449 5028.

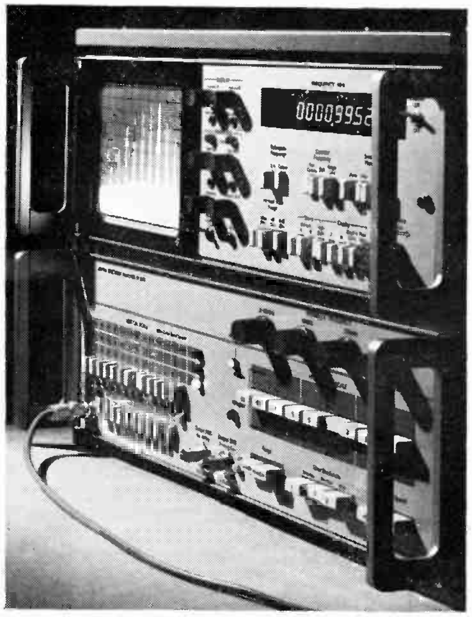
Products
AC VOLTMETERS
INSTRUMENTATION AMPLIFIERS
MULTIMETERS

MARCONI

Marconi Instruments Ltd, Longacres, St Albans, Herts AL4 0JN.
Phone: St Albans 59292. Telex: 23350.

Products
ATTENUATORS
DISTORTION ANALYSERS
FREQUENCY METERS
MILLIVOLTMETERS
MODULATION INDEX METERS
OSCILLATORS
POWER METERS
SIGNAL GENERATORS
SPECTRUM ANALYSERS
SWEEP GENERATORS
TV TEST EQUIPMENT
WHITE NOISE TEST SETS

Marconi TF 2370
110 MHz spectrum analyser



3M

Mincom Division, 3M Company, 3M Center, Saint Paul, Minnesota 55101, USA.
UK: Mincom Division, 3M United Kingdom Ltd, Whitley Works, Whitley Gardens, Southall, Middx.
Phone: 01-574 5929.

Products
TEST SET
Features: the seven integrated functions include tracking sine and square oscillators, frequency counter, wave analyser and a millivoltmeter.
WOW AND FLUTTER METER
WAVE ANALYSER
Features: low frequency unit specifically designed for flutter analysis.

NOMBREX

Nombrex Ltd, Pound Place, Wolborough Street, Newton Abbot, Devon.
Phone: 0626-68297.

Products
ANALOGUE AF FREQUENCY METERS
SIGNAL GENERATORS AF/RF

PHILIPS

Pye Unicam Ltd, York Street, Cambridge CB1 2PX.
Phone: 0223-58866. Telex: 817331.

Products
AM/FM SIGNAL GENERATORS
FUNCTION GENERATORS
LF SYNTHESISERS
MULTIMETERS
OSCILLOSCOPES
SINE/SQUARE GENERATORS

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SURVEY: TEST EQUIPMENT

SWEEP GENERATORS
TV TEST EQUIPMENT

RACAL

Racal Instruments Ltd, Duke Street, Windsor, Berks SL4 1SB.
Phone: Windsor 69811. Telex: 847013.
US agent: Racal Communications Inc, 5 Research Place, Rockville, Maryland, 20850, USA.
Phone: (301) 948 4420. Telex: 898456.

Products
FREQUENCY METERS
COUNTER TIMERS
DIGITAL MULTIMETERS
MODULATION METERS
OSCILLOSCOPES
RF MILLIVOLTMETERS
SIGNAL GENERATORS
WATTMETERS

RADFORD

Radford Audio Ltd, Ashton Vale Road, Bristol BS3 2HZ.
Phone: 0272-662301.

Products
DISTORTION MEASURING SETS*
Features: valid readings down to less than 0.002% over audio spectrum. Millivoltmeter available for external use. £250, $450.
LOW DISTORTION OSCILLATOR*
Features: claimed thd less than 0.002% rising to 0.005% at 10 Hz and 100 kHz.
NOISEMETERS
VOLTMETERS
**See reviews p50*

Radford ANM2 Psophometer

RANK

Rank Film Equipment, PO Box 70, Great West Road, Brentford, Middlesex.
Phone: 01-568 9222. Telex: 24408.

Products
WOW AND FLUTTER METER
Features: true rms meter rectifier. Measurements to CCIR and DIN standards. Max sensitivity 0.1% fsd.

RCA

RCA Distributor and Special Products Division, Camden, NJ08101, USA.
UK: RCA Ltd, Electronic Components, Lincoln Way, Windmill Road, Sunbury-on-Thames, Middx. TW16 7HW.
Phone: Sunbury-on-Thames 85511. Telex: 24246.

SURVEY: TEST EQUIPMENT

Products
SIGNAL GENERATORS
SINE/SQUARE GENERATORS

SOUND TECHNOLOGY
Sound Technology Inc, 1400 Dell Avenue, Cambell, Ca 95008, USA.
Phone: (408) 378 6540.
UK agent: C E Hammond & Co Ltd, 105/109 Oyster Lane, Byfleet, Surrey KT14 7LA.
Phone: 093 23-41131. Telex: 262525.

Products
DISTORTION ANALYSERS
Features: claimed to measure total harmonic distortion down to levels below 0.002% at settling times of less than five seconds. Incorporates an oscillator of 0.001% thd.
FM ALIGNMENT SOURCES
LOW DISTORTION OSCILLATORS
Features: less than 0.001% residual harmonic distortion over the entire audio band.

SUGDEN
J E Sugden & Co Ltd, Carr Street, Cleckheaton, West Yorks BD19 5LA.
Phone: 0274-872501.
Canada: Reference Audio, 5990 St Hubert, Montreal 326PQ.
Holland: Audioscript, Nieuw Loosdrechtsedijk 107, Loosdrecht.

Products
AF OSCILLATOR
Features: RIAA recording curve output. £60.
DISTORTION MEASURING SET
Features: 0.1% full scale deflection, £48.
MILLIVOLTMETER

Sugden distortion measuring unit Si 452

WANDEL & GOLTERMANN
Wandel & Goltermann, Reulingen, Postfach 259, West Germany.
UK agents: Wandel & Goltermann, 40/48 High Street, Acton W3 6LG.

Products
GROUP DELAY
LEVEL METERS
NARROW BAND WAVE ANALYSERS

WAVETEK
Wavetek Inc, 9045 Balboa Avenue, San Diego, Ca 92112, USA.
Phone: (714) 279 2200. Telex: 910 335 2007.
UK agent: see Wavetek Indiana.

Products
FUNCTION GENERATORS
GROUP DELAY MEASUREMENT
OSCILLATORS
PHASE METERS
PO LINE TESTING EQUIPMENT

WAVETEK (INDIANA)
Wavetek Indiana Inc, 66 North First Avenu Beach Grove, Indiana 46107, USA.
Phone: (317) 783 3221.
UK agents: Wavetek Electronics Ltd, 109 Crocl hamwell Road, Woodley, Reading, Berks.
Phone: 0734-694944.

Products
ATTENUATORS
SIGNAL GENERATORS
SWEEP GENERATORS

WAVETEK SONDMA
Wavetek Sondma Engineering Division, 16 Piner Road, PO Box 1626, Santa Rosa, Ca 9540 USA.
Phone: (707) 525 8707.

Products
MICROWAVE COMPONENTS
PARAMETRIC AMPLIFIERS
UP/DOWN CONVERTERS

WAYNE KERR/FERROGRAPH
The Wayne Kerr Co Ltd, Durban Road, Bogn Regis, Sussex PO22 9RL.
Phone: 02433-25811. Telex: 86120.

Products
AUDIO TEST SET
Features: compendium of test equipment compr ing low distortion oscillator, millivoltmeter, distorti factor meter, wow and flutter meter and long ter speed stability.
LINE TRANSMISSION TEST EQUIPMENT
Features: for use on PO lines and coaxial rf line
SPECTRUM ANALYSERS

WOELKE
Woelke Magnetbandtechnik, 8069 Schweit kirchen, Germany.
Phone: 08 444-394. Telex: 55547.
US agent: Gotham Export Corporation, 741 Was ington Street, New York, NY10014.
Phone: (212) 741 7411. Telex: 129269.
UK agent: Lennard Developments Ltd, 206 Cha Side, Enfield, Middlesex EN2 0QX.
Phone: 01-363 8238.

Products
DISTORTION TEST SETS
Features: self-nulling operation—automatic.
FLUTTER CLASSIFICATION UNITS
WAVE ANALYSERS
WOW AND FLUTTER METERS

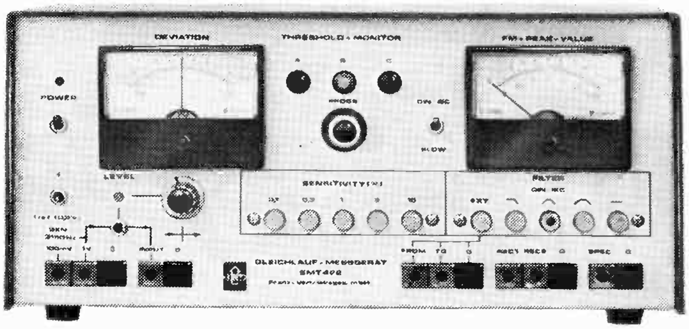
For the Flutter you can't afford

EMT have an extraordinarily versatile flutter meter at a price you can afford—the new low cost EMT 422.

Flutter and FIM (frequency inter-modulation) distortion measurement can be made in five ranges from 0.1% to 10% FSD to DIN/ANSI/IEC standards. In addition, three further filters can be selected for a rapid initial analysis of flutter frequencies. Weighted peak and slow speed deviation values are clearly displayed on separate large size meters.

A unique feature is the programmable threshold level option which provides an instant visual indication at three preset levels for simplified quality control and production line testing.

Outputs are provided for use with external filters, graphic recorders or oscilloscopes to further extend the EMT 422's unique capabilities.



Manufactured by
E.M.T.—Franz Vgmbh,
P.O. Box 1520, D—7630, LA HR1
West Germany.

F.W.O. Bauch Limited
49 Theobald Street, Boreham Wood
Herts. WD6 4RZ Tel: 01-953 0092 Telex: 27502

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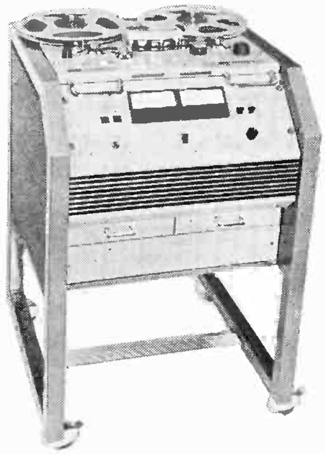

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(Incorporating Bias Electronics)
319 Trinity Road, London SW18 3SL. 01-874 9054
Cable: Leemag London SW18
Telex: 923455

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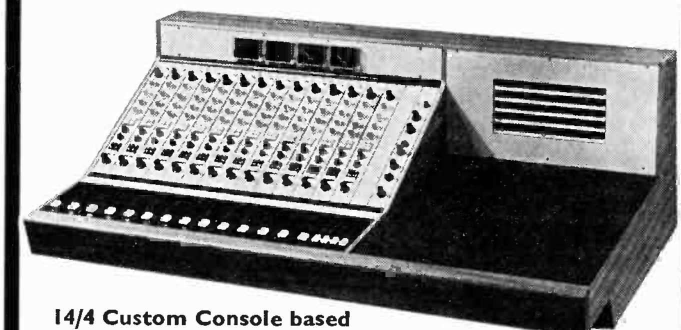
PROFESSIONAL STUDIO SPECIFICATION



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Normalled Insert Jacks.
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SOUTH AFRICA
Prosound, Musicians Sound Centre, J'burg. Tel. 642-87-21
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TELCO Sociedad Limitada
Madrid. Tel. 221-5606
HOLLAND
Pieter Bollen, Eindhoven
Tel. 040-512777

BELGIUM
ARC, SPRL, Brussels
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RAINDIRK LTD., **Downham Market, Norfolk. Tel. 2165 and 3617**

Tape machine maintenance

DAVE DEARDEN *

Maintenance engineers probably clock up more overtime while servicing tape machines than with any other piece of studio equipment. Replacement of folklore by science cuts bills and, in the end, makes life much easier for all concerned.

*MCI (UK) LTD

POSSIBLY the most misunderstood, and usually the most maladjusted piece of equipment in a recording studio, is the tape recorder. Because it is a combination of sophisticated electronics and mechanics, confusion sometimes exists as to the cause of its ailment when it malfunctions. A mechanical fault can often give electronic like symptoms, and vice versa. Also, a badly slit tape will often appear to indicate that the mechanical alignment of guides and heads is in need of adjustment. Uneven oxide coating of the tape can give bizarre modulation effects. A careful and logical approach is necessary in order to achieve optimum performance from a machine, coupled with an understanding of the basic techniques involved.

It is hoped that the following will impart some of the techniques and provide a greater understanding of the mechanical and electronic adjustments which are made.

Mechanical alignment

Tape heads require four accurate adjustments if the machine is to perform to specification.

Height. To set the track pole-pieces to the correct position on the tape.

Zenith. To set the head face perpendicular to the deck, ie parallel to the tape.

Wrap. To set the headgap at 90° to the tape, viewed from above.

Azimuth. To set the headgaps at 90° to the tape, viewed from the front.

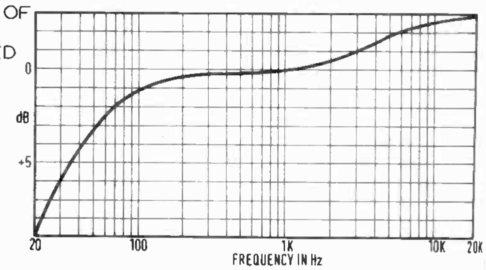
Height can normally be set by visually aligning the head for equidistant spacing between the top and bottom shield plates and the edges of the tape. If the shield plates are not visible, transparent leader tape can be used and the track pole-pieces viewed.

For the adjustment of DIN stereo heads, where the track spacing is much closer than multitrack heads, a test tape is available with signal recorded along the centre of the tape, ie in the guard-band. The head height is then adjusted for minimum signal from both tracks.

Zenith is an important and often neglected adjustment which gives equal head to tape contact across the width of the tape. This ensures even head wear across the head, and is essential in multitrack machines for good tape tracking, as the tape will tend to slide upwards or downwards across a non-vertical surface. Maladjustment is easily recognisable after the damage has been done, as the wear-pattern across the head will have non-parallel edges. Unfortunately, when it has reached this state, the cure is either relapping the head or replacement. Realignment of an asymmetrically worn head usually results in bad head contact across part of the head stack, and tape mistracking on multitrack machines. The moral of the story is to align it correctly in the first place.

The usual method is to smear a thin coat of ink across the head face, put the machine in the play mode for a few minutes and then observe the wear-pattern, adjusting until a parallel wear-pattern is obtained. Another method involves the use of a set-square to set the angle from the deck to the head face at 90°. On certain machines, this method is not possible, either because of obstruction in front of the heads, or because of deck trim plates which are not necessarily in the correct plane.

FIG.1 RESPONSE OF 38 cm/s DIN TEST TAPE REPRODUCED WITH NAB EQUALISATION



The quickest, simplest and most accurate method so far used is an aluminium block, precision ground, about 10 x 4 cm. This is bridged across from a known vertical surface to the next surface along the tape path. By holding the block against the face of the known vertical, usually a fixed guide, and gently pressing the opposite end against the next surface face, extremely small amounts of non-parallelism can be felt as the block will rock to and fro if the two surfaces are not parallel. Proceed through the tape path until all heads, guides, and the capstan, are vertical.

Wrap is another neglected adjustment, which will affect the high frequency response. This is easily checked by playing the 16 kHz band on the test tape, and slightly increasing the back tension by lightly touching the supply spool. If the signal level increases then the wrap adjustment is incorrect. Adjust the head wrap for maximum signal at 16 kHz, and minimum change when touching the supply spool. It should be possible to achieve less than 0.25 dB change. The check should be repeated for the record head, in the sync mode, or if the machine does not have a sync mode, by recording 16 kHz and observing the playback level. The erase head is much less critical, but can be adjusted for maximum depth of erasure.

Azimuth adjustment is normally achieved by playing the azimuth section of the test tape, combining all tracks at similar levels, and adjusting for maximum output as viewed on a meter. Ensure that the real maximum is found, as there will be lower level peaks on either side of the real maximum. This method gives an average value azimuth adjustment across the whole head stack.

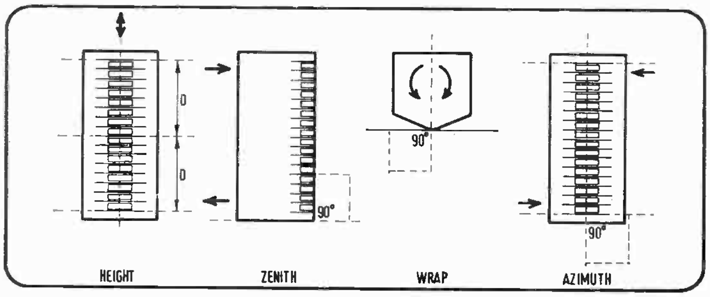
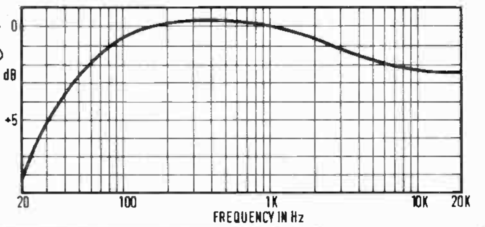


FIG. 2 RESPONSE OF 19 cm/s DIN TEST TAPE REPRODUCED WITH NAB EQUALISATION



Another method utilises an oscilloscope to display Lissajous patterns from two widely spaced tracks of the test tape, excluding the edge tracks. This is to minimise disturbance of the pattern due to dropouts. This method gives minimum phase error between two tracks, but could be in error between other tracks, due to gap scatter and inaccuracies in the manufacture of the head stack. To check this, use one track as a reference and check all other tracks against it.

A simpler method than the above is to display the two tracks on a dual beam scope and adjust for minimum phase error between the two signals. Ensure that the scope is set to the switched or chopped trace mode, not the alternate mode, which will not display phase related signals correctly.

Because of the short wavelength of high frequency signals, it is possible for the signal to appear correctly in phase while in fact being one or more complete cycles displaced. This would mean that signals at other frequencies would be in error. To guard against this, always start at a low frequency and make gentle corrections as the frequency increases, always keeping the two signals in phase. Short term phase jitter up to about $\pm 90°$ will be observed at the higher frequencies and azimuth should be adjusted to give equal positive and negative displacement. If larger amounts occur, it implies either a damaged test tape or mechanical maladjustment of guides and rollers. The latter would cause the former, of course, and should be corrected before a new tape is used on the machine.

The same method is used to align the record head when a sync mode is available. On machines without sync, record head azimuth is adjusted by recording and simultaneously observing the playback signal. The erase head azimuth is not normally critical, but can be adjusted for maximum depth of erasure.

A point which must be borne in mind, with certain head mounting arrangements, is that some of the mechanical adjustments are interactive to a degree; for instance, head height will usually affect the other parameters, which must then be re-adjusted.

Electrical adjustment—playback

Playback Level. The required playback level is set by using the 'Reference Level' of a test tape. Unfortunately, a number of different reference levels are used by different manufacturers, so leading to confusion unless the relationship between the various levels is understood. See 'Reference Levels' by Hugh Ford—STUDIO SOUND (January 1977, p 42).

Fluxivity nWb/m	Flux level (dB) ref 200 nWb/m	
185 nWb/m	-0.7	Ampex operating level
200	0	MRL reference level
250	+2	MRL elevated level
320	+4	DIN reference level

The required playback level is determined in conjunction with the type of recording tape to be used, and also the line level used in the studio. Normally the majority of studios operate at a line level of +4 dBm. The standard vu meter will read 0 vu with a +4 dBm signal applied to it.

So, if it is required to operate at 'elevated level', all that is necessary is to adjust the tape recorder playback level to give 0 vu when playing a 250 nWb/m test tape. If a test tape with a different flux level is available, then the playback level is adjusted to compensate for the difference in flux levels, for example, a 200 nWb/m test tape would read –2 vu if 0 vu were required to indicate 250 nWb/m. The difference between any two flux levels can easily be calculated by the formula:

$$\text{Difference (dB)} = 20 \log \frac{\text{Flux 1}}{\text{Flux 2}}$$

Frequency Response. The playback response is set by using the frequency response section of the test tape and adjusting the high and low frequency controls of the test tape for flattest responses. Test tapes with NAB equalisation usually have the response section recorded at the same level as the reference level. This allows response adjustments to be made using the tape machine meters. On the other hand, DIN equalisation test tapes usually have the response section recorded at –10 dB or –20 dB relative to the reference level, necessitating the use of an external ac millivoltmeter to indicate levels. When aligning a multitrack machine, this means a considerable amount of time being wasted in plugging the meter from track to track. An NAB machine can usually be aligned solely on its internal meters, allowing all tracks to be seen at the same time.

When adjusting the low frequency responses, allowance has to be made for the effect of 'fringing'. This is due to the test tape being recorded as a full track tape, instead of individual tracks across the tape. Due to the long wavelengths at low frequencies, the head picks up a certain amount of spill from either side of the track width proper. This adds to the overall signal level, ie it gives an apparent increase in flux level at low frequencies. If this level is used without due allowance, the low frequency response of the tape machine will end up deficient by the amount of fringing addition when playing a normal recorded track width equivalent to the playback track width. The amount will vary from one head manufacturer to another, and is related to the efficiency of the low frequency shielding built into the head. Certain test tapes have compensation incorporated, and care must be taken in knowing whether or not a compensated tape is being used. If an uncompensated tape is used, the low frequency response should be allowed to show a rise of approximately 3 dB at 50 Hz. A more accurate and consistent method is to leave the low frequency adjustment until the record alignment is performed. Then, by recording at frequencies between 40 Hz and 150 Hz, the flattest overall response may be obtained. It will be noticed that the response will not be flat, but will show a series of bumps and troughs. This is caused by the shape of the head pole pieces and is also influenced by tape speed.

Occasionally, it is necessary to align a machine to one equalisation standard using a test tape of a different standard. This is simple if conversion tables are available. The most common conversions are DIN 38 cm/s to NAB 38 cm/s, and DIN 19 cm/s to NAB 19 cm/s, and vice versa.

Record alignment

Bias. Bias setting can be performed in a number of ways. The most common method is to record a 1 kHz signal, and while increasing the amount of bias observe the playback level until a further increase in bias causes the playback level to decrease. At this point continue increasing the bias until the playback level has decreased by approximately 1 dB. The amount of overbias will vary from tape to tape, and should ideally be found by measuring the distortion produced by the tape at different bias levels. The point of minimum distortion is usually taken as the correct bias point. If the decrease in the level from peak bias is now noted, this overbias point can be used to bias all other tracks, without the need for the distortion analyser. It is usually more consistent to over bias at 10 kHz, where the amount of level decrease will normally be about 3 dB. This is easier to see, and results in more accurate biasing.

Another method is to bias for minimum modulation noise, by recording a very low frequency such as 3 Hz. The bias is then adjusted for minimum noise. However, on most modern tapes, the minimum distortion point and the maximum modulation noise point are usually very close together, and it becomes a matter of

38 ▶

letters

Dear Sir, Congratulations on an excellent August 1976 issue. It contains many extremely interesting features and the 'inside information' on Abbey Road is certainly deserving of the larger exposure that you have now given it.

Perhaps it is not surprising that such an interesting issue should evoke some comments of a more or less serious nature.

The first is not so much a complaint as a serious epidemic, and it is reassuring to learn that Drs. Blair, Peckham, Davies and their professional colleagues have the antidote (literally) at their fingertips. I refer to the current resurgence of the frenetic struggle for more and more level on disc records. For those who may not be aware of the magnitude of the problem I would point out that recorded velocities greater than 50 cm/s at 10 Hz are now by no means uncommon.

Being deeply involved in the design of record playing equipment for domestic use, I would like to suggest that what the cutting fraternity are trying to do is actually self-defeating. The state of the art in low-price record players at the beginning of 1976 was that adequate overall gain and signal-to-noise ratio, together with adequate bass response, could be obtained by using a crystal pickup cartridge and a simple discrete or integrated amplifier. This could give very acceptable results for an outlay of between £40 and £50. (Just to quantify, 'adequate' gain means that the amplifier is driven to maximum by a recorded velocity of 3 cm/s at 4 kHz with the volume control at maximum; 'adequate' s/n is –60 dB ref. max. output CCIR weighted, and 'adequate' bass response is –3 dB at 50 to 70 Hz, with or without peaking.) Early last year the industry began to receive many complaints of pickup jumping and general tracking failure on products which up to then had been perfectly complaint-free. It was fairly soon clear that some labels were particularly testing, notably B££. The only practical solution was to abandon the crystal cartridge and use a ceramic, with improved tracking capability but with 3 to 4 dB less output! The gain loss had nullified the increased level on the disc, and the amplifier (believe me) cannot be modified to give more gain without compromising the cost (not recoverable due to the Price Code!), the s/n or the bass response unacceptably. Nett result—sorrow all round. Perhaps the 'friendly rivalry' and jolly japes will be tempered with a little thought along the above lines in future! One wonders whether Mr Blair has 'slapped in a V15/III' on his cheap gramophone (sic).*

Yours faithfully, J. M. Woodgate.

P.S. Very high recorded velocities cause unnecessary problems in higher quality equipment as well. In spite of the fact that many existing designs are less than adequate in this respect, it is not difficult to design a magnetic pickup (RIAA) equaliser to accept 50 mV input or even more. However, it is quite difficult to obtain a very good noise performance simultaneously, and the noise, like the poor, is always with us. Thus, either the equipment cost is increased or the increased recorded level results in an unchanged, or even reduced, dynamic range. J.M.W.

Ken Townsend replies:

We sympathise with the problems mentioned by J. M. Woodgate, but an instant remedy is not possible. Record producers naturally insist that their records are cut at the highest level possible to compete with the opposition. If one cutting room will not oblige then they will take their work to one that will. For our own part, we at Abbey Road realise that records have to be played on not only good equipment but also on the very cheapest. We have a standard 'low quality, low price, record player' which is used to check that pop records do not jump, and any which fail the test are re-cut. We therefore earnestly try to satisfy not only the needs of the record producer but also the record-buying public at large.

Mr Woodgate admits in his letter that he is having to keep the price at a minimum in order to compete with other low-priced players, and if all such manufacturers designed to a slightly better standard then the problem would be almost eliminated. We have actually purchased from customers who have complained about 'jumpers' their disc-playing equipment, in order to assess the industry minimum standard, not only in London but also in Europe and the United States.

Dear Sir, We have recently been expanding our studio facility and have purchased quite a few items of professional recording equipment from the country's major suppliers.

We wish to take this opportunity of expressing our appreciation to the following companies for their swift, efficient and polite service, as everything we ordered arrived within two weeks of ordering, and this saved us valuable down time.

B&K LABS,
DOLBY LABS,
AUDIO AND DESIGN RECORDING,
SCENIC SOUNDS,
ITA,
ALLEN & HEATH,
TANNOY,
KLARK TEKNIK,
H/H ELECTRONIC
SURREY ELECTRONICS,
FWO BAUCH.

We hope that future transactions can be done as swiftly with other companies.

Yours faithfully, P. G. Adshead, Pennine Sound Studio, Gladstone Street, Oldham, Lancs.

TAPE MACHINE MAINTENANCE

personal preference which method is used. Ideally, bias should be set independently for each speed, but certain machines do not have this facility. In this case, bias should be set for the most used speed. If the 10 kHz method is used, on DIN machines, the record level should be about –6 vu to avoid possible high frequency compression, which could give erroneous results.

Record Level. Once the bias has been set, the record level can be set. This is dependent on the type of tape to be used. The newer tapes allow a greater record level, without increasing the distortion produced, thereby giving a greater signal-to-noise ratio. The majority of studios appear to be recording at elevated level, ie 0 vu equals 250 nWb/m, although some are recording 2-3 dB higher using tapes such as Scotch *250* and Ampex *Grand Master*. This is especially common in studios running at 76 cm/s without noise reduction systems, and in general, excellent results are reported.

Record Equalisation. Record frequency response is set by recording various frequencies between 40 Hz and 16 kHz and setting the high frequency equalisers for flattest response. As mentioned earlier, the low frequency signals are used to set the playback low frequency equalisation. Again, on DIN machines, the maximum sinewave alignment level should be reduced to avoid tape compression.

The foregoing is by no means intended to be a complete guide to tape machine alignment, but to provide a degree of illumination to the unwary of the pitfalls involved in routine alignment, and to give some idea of the various methods commonly used to achieve alignment. Other methods exist, but usually require the use of test equipment not normally found in the average studio, and so emphasis has been placed on methods of alignment using the minimum amount of external equipment. ■

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Audio Developments 16-4	**£1,500**
Audio Developments 20-20 with 16 track monitor desk	**£4,500**
Sound Techniques 24-8, nice condition	**£3,750**
Sound Techniques System 12, 18-4-16 ...	**£5,000**
API 24-8-16 12 months old...	**£16,500**
3M M56 16 track	**£7,500**
6 Ampex 1100 24 track, from	**£16,000**
1 Ampex MM 1200 24 track	**£19,250**
3 MM 1100 16 track, from	**£9,000**
2 Studer A62's on trolleys with V.U. ...	**£1,100**
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Teac 3340 'S', as new	**£550**
All A.K.G. mics in stock, new and secondhand. Selection of Beyer mics in stock.	
1 Pair Lockwood Majors with Tannoy Reds	**£320**
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1 Pair Spendor BC3's	**£325**
Brand new Microphone Boom Stands with Mic. Clip, each	**£15**
2 Dolby A301 units, each	**£300**
1 Dolby M16 unit	**£3,500**
Urie Graphic Equaliser 27 frequency ...	**£320**
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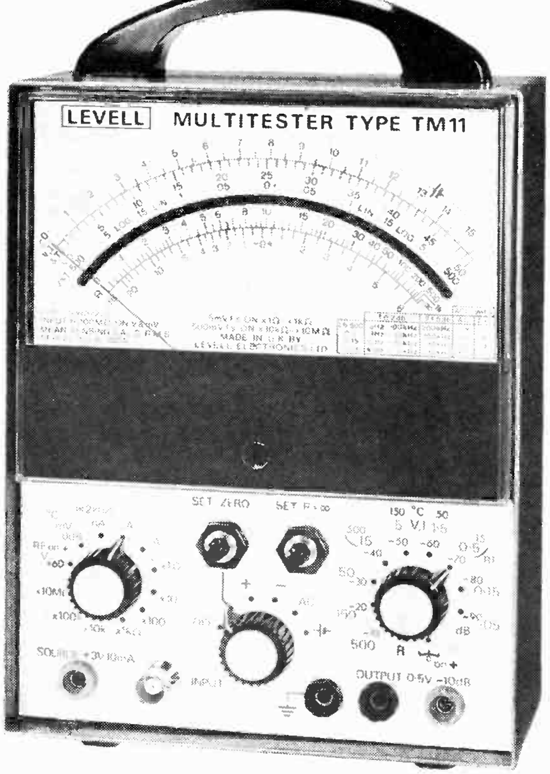

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DC V, I & NULL:	150µV/500V fsd, 150pA/500mA fsd, polarity reversible. Acc. ±1.5% fsd above 500µV & 500pA. Input R=100MΩ on volts. 5 Null ranges have centre zero lin/log scale covering ±4 decades.
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HIGH VOLTS:	1.5kV/50kV fsd, AC/DC, using HV Probe type TP1, £16 plus VAT.
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TEMPERATURE:	—150°C/+500°C fsd in 7 ranges using Temperature Probe type TP4, £38 plus VAT.
HIGH CURRENT:	1.5A/50A fsd, AC/DC, using Current Shunt type TP5, £15 plus VAT.

The instrument operates from a 9 volt battery, life 1000 hrs., or AC mains when an optional Power Supply Unit is fitted. Size is 240mm x 150mm x 80mm. Weight is 1.75kg. Meter scale length is 140mm. Leather case type LC7, £13 plus VAT is an optional extra.

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Survey: test discs and test tapes

Most test software manufacturers will provide products to a wide variety of speeds and standards. Individual combinations should be checked directly with the supplier before ordering.

PART ONE: Test Discs

B & K

Bruel & Kjaer, 23 Linde alle, DK-2850, Denmark. Phone: 01-80 05 00.
US: B & K Instruments Inc, 5111 West 164th Street, Cleveland, Ohio 44142.
Phone: (216) 267 4800.
UK: B & K Ltd, Cross Lances Road, Hounslow, Middlesex. Phone: 01-570 7774.
QR2009
Stereophonic gliding frequency recording.
QR2010
Comprehensive laboratory disc.
QR2011
Testing and adjustment of hi-fi systems with ⅓-octave pink noise.

CBS

CBS Technology Center, 227 High Ridge Road, Stamford, Conn 06905, USA.
Phone: (203) 327 2000.
UK: Feldon Audio Ltd, 126 Great Portland Street, London W1. Phone: 01-580 4314.
STR 151
Broadcast test record to RIAA standard.
STR 100
Stereo frequency test record.
STR 101
Seven steps to better listening; lining up record for domestic equipment.
STR 112
Squarewave, tracking and intermodulation test record.
STR 120
Extended frequency test record; 10 to 500 Hz, 500 to 50k Hz glide tones.
STR 130
RIAA frequency response test record for calibration of professional replay equipment.
STR 140
Pink noise tests for acoustical testing of systems and loudspeakers and for psychoacoustic tests of reproduction equipment.
STR 170
This record employs a 318 µs equalisation characteristic with constant amplitude recording below 500 Hz and constant velocity above this point.
SQT 1100
Quadraphonic test record for calibration, verification and adjustment of SQ replay systems.

DECCA

Decca Records Ltd, 9 Albert Embankment, London SW1. Phone: 01-735 8111.
SXL 2057
Stereophonic frequency response test disc with spot frequencies.

DGG

Beuth-Vertreib GmbH, 1000 Berlin 30, Burggrafenstrasse 7, Germany. Also 5000 Koln, Friesenplatz 16, Germany.
UK: Lennard Developments Ltd, 206 Chase Side, Enfield, Middlesex EN2 0QX. Phone: 01-363 8238/9.
Deutsche Grammophon Gesellschaft manufacture a family of test discs to calibrate replay equipment to the following DIN standards:
45 541 frequency response
45 542 distortion
45 543 crosstalk
45 544 rumble
45 545 wow and flutter
The company also manufactures a range of discs intended for other measurement purposes:
1001 942
17 cm disc with 5 kHz carrier for wow and flutter measurement to DIN 45 507.
1001 944
17 cm disc with 3 kHz carrier for use with wow and flutter meters such as the EMT *418.*
1101 495
17 cm disc for testing stereo replay equipment; it gives channel and symmetry information, loudspeaker phasing etc. The flip side is an assortment of everyday noises. This disc is available with announcements in French or English.
1099 008, 1099 010
30 cm versions of *1001 942* and *1001 944* respectively.
1099 011
30 cm disc with 45 rpm playing speed for measuring intermodulation distortion to DIN 45 403 sheet 4. 400 Hz + 4 kHz in the absolute velocity ratio of 4:1.
1099 014
30 cm disc for demonstrating the audibility of bandwidth distortion.
1099 015
30 cm disc for demonstrating the audibility of non linear distortion.
1099 103
Level measurement at 45 and 33 rpm.
1099 106
Frequency response measurement to DIN 45 547.
1099 108
For testing intermodulation distortion of pickups by use of a gliding pair of tones with 400 Hz difference.
1099 109
Warble tone for loudspeaker tests.
1099 111
Tracking tests.
1099 112
Universal frequency measurement disc containing glide tones and spot frequencies.
1641 001
Hi-fi stereo test disc.

EMI

EMI Records Ltd, Manchester Square, London W1. Phone: 01-486 4488.
TCS 101
A stereo frequency response disc with a recorded equalisation characteristic to British Standard 1928/1960, except that the level of frequency bands above 10 kHz has been dropped by 6 dB. Spot frequencies and reference tones.
TCS 102
A series of glide tones for detecting resonances.
TCS 104
As *TCS 101* but in mono only (lateral modulation).
TCS 105
As *TCS 104* but with vertical modulation.
TS 201 and TS 202
Tracking ability to British Standard 4852: Part 1, 1972.
RLPS 22
Wow and flutter.

HI-FI NEWS

Link House Publications, Link House, Dingwall Avenue, Croydon CR9 2TA.
Phone: 01-686 2599.
QUADRAFILE
A two record set featuring the four major quadraphonic systems on successive sides; the same positional tones and musical material is recorded in SQ, QS, CD-4 and UD-4 for comparison purposes.

HI-FI SOUND

Haymarket Publishing Group, Gillow House, Winsley Street, London W1. Phone: 01-439 424
HFS 75
This test record is intended for both aural an quantative testing of turntables and cartridges.

JVC

JVC Cutting Center Inc, RCA Bldg, Suite 50 6363 Sunset Boulevard, Hollywood, California 90028, USA.
UK: JVC (UK) Ltd, Eldonwall Trading Esta Staples Corner. 6-8 Priestly Way, London NW2 7A
Phone: 01-450 2621.
TRS 1001
Mono disc for checking frequency respon mechanical resonances, etc.
TRS 1002
Stereo disc for checking frequency response, w and flutter, etc.
TRS 1003
Stereo frequency response record for testing high frequency response of CD-4 pickup cartridg
TRS 1004
A record cut for undertaking quick checks of h frequency response, crosstalk, and phase of CD cartridges. Primarily intended for checks dur production.
TRS 1005
Record for high frequency response and cross checks on CD-4 cartridges using level record such as the B & K *2305/2307.*
TRS 1300
High frequency response and crosstalk.

SHURE

Shure Bros Inc, 222 Hartrey Avenue, Evans Ill 60204, USA.
UK: Shure Electronics Ltd, Eccleston Road, M stone ME15 6AU. Phone: 0622-59881.
TTR 110
'An Audio Obstacle Course'. All sorts of nas which highlight deficiencies in cartridges.
TTR 102
Tests low frequency resonance and intermodul distortion.
TTR 103
Disc intended for disc tracking tests—for use external analysis equipment.
TTR 109
Level and crosstalk record for use with exte analysers.

PART TWO: Test Tapes

AGFA

Agfa-Gevaert AG, Vertrieb Magnetband, D-509 Leverkusen, West Germany.
US: Agfa-Gevaert Inc, 275 North Street, Peterborough, NJ 07608.
Phone: (201) 288 4100.
UK: Agfa-Gevaert Ltd, 27 Great West Road, Brentford, Middlesex TW8 9AX.
Phone: 01-560 2131.

The company manufactures a range of recording test tapes in a variety of widths and speeds to the DIN/IEC format only. No further information received.

AMPEX

Ampex Corporation, Audio-Video Systems Division, 401 Broadway, Redwood City, Ca 94063, USA.
UK: Ampex Great Britain Ltd, Acre Road, Reading, Berks RG2 0QR.
Phone: 0734-85200.

The company manufactures a range of test tapes in all size formats between 6.25 and 50 mm; these are available both in full and separate tracking. Speed standards are 76, 38, 19 and 9.5 cm/s (the last speed is available only in 6.25 mm size).

Equalisation standards are to either DIN or IEC (76 cm/s uses 17.5 µs AES).

Tapes are available in three groups: reproduce alignment tapes, flutter test tapes and level set tapes.

The first group offers operating level tones at 11 spot frequencies at operating level (38 and 76 cm/s only). The lower speed tapes use −10 dB tones at appropriately reduced frequencies. They also incorporate extended azimuth and 700 Hz reference tones recorded at operating level (lower speeds −10 dB).

Flutter tapes use tones of either 3000 or 3150 Hz recorded at −2 dB below operating level. These are guaranteed to have less than 0.03% rms unweighted wow and flutter.

Level set tapes comprise long sections of 700 Hz at various standard flux levels resulting in approximately 1% total harmonic distortion.

BASF

BASF AG, 67 Ludwigshafen-am-Rhein, West Germany.
Phone: 621 40081.
US: BASF Systems Inc, Crosly Drive, Bedford, Mass 01730.
Phone: (617) 271 4000.
UK: BASF United Kingdom Ltd, Knightsbridge House, 197 Knightsbridge, London SW7 1SA.
Phone: 01-584 5080.

The company manufactures a range of test tapes in all size formats to the IEC/DIN specification only. No further information received.

EMI

EMI Sound and Vision Ltd, 254 Blyth Road, Hayes, Middlesex UB3 1HW.
Phone: 01-573 3888.

SRT 17 and 18
Tape speed 38 cm/s and 19 cm/s respectively. Equalisation 35 µs and 70 µs DIN. Wow and flutter section with recorded 3 kHz tone at less than 0.08% rms unweighted.

A speed check of stroboscopic markings on tape backing for view with a mains 50 Hz neon lamp.

A 1 kHz tone recorded at a flux of 320 nWb/m lasting for 20s.

An azimuth adjustment tone of 16 kHz lasting for 40s.

A series of frequency response tones each of ten seconds duration preceded by an announcement.

SRT 19
This tape offers the same tests as the *SRT 17/18* but at a tape speed of 9.5 cm/s. Some tests have been modified to accommodate this speed.

The *SRT 18* test tape is available in cartridge format designated *SRT 18C*. All the above are 6.25 mm wide.

MRL

Magnetic Reference Laboratory Inc, 229 Polaris Avenue, Suite 4, Mountain View, Ca 94043, USA.
Phone: (415) 965 8187.
Export agent: Gotham Export Corporation, 741 Washington Street, New York, NY 10014, USA.
UK: FWO Bauch Ltd, 49 Theobald Street, Borehamwood, Herts.
Phone: 01-953 0091.

Standard equalisation tapes
Standard MRL test tapes have a reference fluxivity of 200 nWb/m which is appropriate to tapes such as the generation prior to the 3M *206* etc. The company also manufactures a range of test tapes corresponding to a maximum flux of 250 nWb/m for the so called 'high output' tapes.

Product line includes tapes which incorporate rapid sweep (for technical reasons, these are restricted to frequencies above 500 Hz; checks below this require standard tones at spot frequencies). There are also a range of tapes with the usual spot frequencies throughout the audio spectrum. Tape width 6.25, 12.5, 25 and 50 mm. Normal eq standard; NAB 50 + 3180 µs. Tape speed 19, 38 and 76 cm/s. IEC equalisation test tapes are available in the above tape width sizes referenced to a fluxivity of 320 nWb/m.

MRL also produces a range of azimuth correction tapes using an alternate tone difference measurement process for correct adjustment. ■

work

Well respected Konk

It used to be the done thing for an emergent Rock Star to lavish his new-found riches on a limousine for himself, a country seat for his much-loved parents, and maybe, a couple of record shops. Well times change as, thankfully, does the music industry—and the current superstar status symbol seems to be the possession of one's own studio. Among the first groups to recognise the inherent economic sense of this were the Kinks, whose career had successfully spanned nearly a decade when they decided to buy their own studio in 1971. They called it Konk, and some five years later, the name is about the only thing that's remained unchanged.

Konk started out life as a Victorian tobacco warehouse, although by the time it was converted into a studio, it had degenerated into a motley and rather dilapidated collection of garages. The original idea was that it should mainly be used for demo work by the Kinks, but an 8 track was installed from the start to leave room for expansion. After a couple of years, increasingly complex recording commitments led to the acquisition of a 16 track system, which led to the studio getting a lot more outside work. This trend was continued when, earlier this year, the studio was completely rebuilt and re-equipped, to emerge as a fully commercial 24 track operation.

Not for Konk, the bright lights and astronomical overheads of the West End. Instead, the studio lives in the less salubrious end of Hornsey. What it loses on location, it doesn't lose on accessibility though. It's within easy reach of the North Circular and M1, and the average Roadie should be able to dice his way from Konk to London Airport in under an hour.

From the outside, the only thing which distinguishes it from a street of prim, slightly decaying semis is the *de rigeur* smoked glass landscape window that hides the reception area from the gaze of the curious. On the day we turned up, the heavy oak door was opened by none other than Ray Davis, a hero of our photographer's mis-spent youth. He doesn't usually act as doorman though, he just happened to be nearer than anyone else. It turned out in fact that the Kinks were in the studio recording their next album, but a bad case of monitor dropout had called a halt to the proceedings, while the man from Neve groped around the dark and intricate recesses of the board to try and find the cause.

To get from the reception area to the studio you go through a veritable labyrinth of narrow corridors and light, airy practice rooms; and the feeling is of something between an old fashioned music academy and rambling country house. Go through the heavy double doors and into the studio proper, and it's another story. The new Konk, you see, was not just a simple refurbishing job on the existing building. Instead, a separate self-contained shell has been built up inside the structure of the old warehouse, and resting on an extremely solid poured concrete foundation.

The control room is impressively large—it will seat up to 19 people with ease—fully air-conditioned and subtly lit from overhead light tracks. Its layout and equipment reflect the ideas and experience of one man, Roger Wake; Studio Manager, Recording Engineer and general factotum at Konk. When he came to Konk, he inherited the old 16 track setup, so the change to 24 gave him the chance to set things up exactly as he wanted them. After nearly 10 years in the business, including a long spell at Phonogram and a period as an independent radio commercial producer, he had a fairly good idea of what he was after and, generally speaking, feels that he's got it with the new studio.

You can't have things 100 per cent perfect though, and in Roger's case this meant that he had to forgo the pleasures of a custom-built Neve desk, because he'd have had a wait of over a year for delivery. This would have gone way over the schedule for converting to 24 track, so he settled for a standard frame which has been considerably reworked, but only took six months to build and install. The modifications are, says Roger, designed to make the board more ergonomic in use, and they include a centralised monitoring panel which was taken from another frame, and sliding faders instead of the standard stub rotaries. Also, the standard Neve limiters have been replaced by Audio & Design units.

A Sony cassette recorder is permanently mounted on the board. This can be used to take instant run-offs of finished masters or individual takes. There are 24 input channels—although the board is wired for 32 and the others might be hooked up soon—and 24 out. The channel amplifiers are Neve's most sophisticated, with 20 presence frequencies. EMT stereo plates, and four separate echo sends, each with individual level controls, are used. Likewise, there are four separate foldbacks, each of which can be independently balanced.

One of Roger's hangups from his Phonogram days was the relatively low playback level of the resident Tannoy monitors: 'I remember a couple of Status Quo sessions where the group were playing very loud and we just couldn' get enough sheer volume on play back through the Tannoys to reproduce the original levels accu rately. I've obviously got a lot o respect for them, and I like using them—but they're really just no big enough for modern rock recording.' To make sure tha Konk doesn't have similar prob lems, a huge JBL *4350* looms a each corner of the room. Even the squawk boxes on the board are a lot bigger than normal; they'r made by Audio Shack in the States and despite their diminutive 14 cm diameter they can handle no les than 25W rms apiece. They'r driven off a compact 2 x 20W Son amp mounted in the board, and th system at full blast should b capable of giving even the deafes producer a sizeable headache.

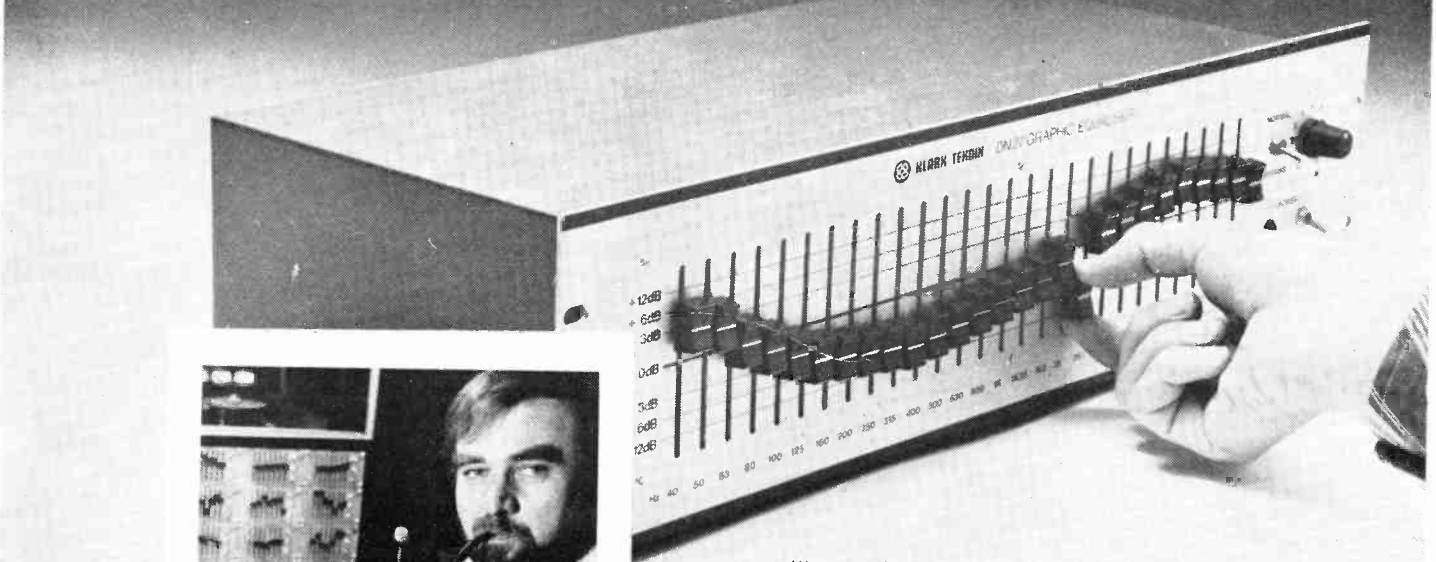
Behind and to the right of th desk, the recording equipment i grouped. There are four machines and tucked forlornly away in corner is the smallest and oldest a 2 track Ampex of somewha uncertain vintage. It's there if it' needed, but future users should b warned that Roger doesn't lik operating it one bit. Two Stude *A80s* come next, one 2 track, an the other 4 track. Both are hooke up to Dolby *361*s. The 24 trac machine is an Ampex *MM110* which has nothing but praise fro Roger, especially the tape transpo system. In fact the *1100* was some thing of an offer that Kon couldn't refuse. It previousl belonged to IES, a hire outfit, an it had only been used three times— so an asking price of £13 00 complete with an *M24* Dolb system had to be a bargain, an went a long way towards keepin capital equipment expenditu down to an £80 000 target.

Rebuilding costs for the enti

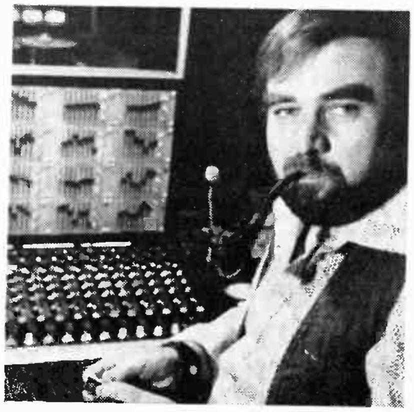
44 ▶

At the BBC, Thames Television, Capital Radio, Granada, Air Studio, Rockfield, Decca, EMI & Strawberry ... they have...

PERFECTION AT THEIR FINGERTIPS



Illustrated is our **DN27** Third Octave 27-band **Graphic Equaliser.** Also shown is our DN22, dual-channel, 11-band unit. Both have many technical plusses which our literature describes.



VIC KEARY – *Chief Engineer and Director of Chalk Farm Studios . . . .* "I use 22 Klark-Teknik Graphic Equalisers – one on every channel, and two DN27's for use on difficult tracks, or sometimes for equalising complete stereo masters. Without a doubt, these are the best Equalisers on the market today".

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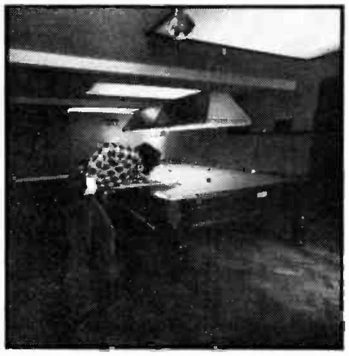
studio were in the region of £39 000, and the design work was handled by Peter Savory and Associates, an architectural practice which is gaining a considerable reputation in the recording industry. The studio environment itself is relatively long and narrow, but as Roger was surprised to find, it gives extremely clear separation. At the opposite end to the present control room is the site of the old one. This is currently being converted to a general purpose recording area, which will be used for overdubs, brass ensemble work, vocals and as an open drum trap—which should give the kind of fairly live sound which many groups are using currently. Also, at the time we were there, the old screens which were rather suspect were being gradually replaced with purpose built Sonaplan units which have far superior acoustical properties, according to Roger.

While intended primarily as a rock studio, Konk is capable of accommodating up to 25 musicians with ease, and it's fully ventilated and heated so that there's a comfortable working environment. Instruments in situ include a Fender *Rhodes*, Yamaha piano, Hammond organ and Leslie—and there's generally some of the Kinks own gear lying around if its needed. If something else is required, Konk has an extremely good working relationship with Julians the W1 hire outfit. 'We needed a Studio Fender *Rhodes* for one session, ordered it up and had it delivered within the hour.' Equipment can be loaded and unloaded without tears and strained backs because there's a fully enclosed Transit sized loading bay, which allows vans to be backed up virtually into the studio.

Technical wizardry aside, one of Konk's nicest features has to be the bar and games room which adjoins the studio. Most of the group were there waiting for the board to be repaired, and a heated darts game was in progress. It certainly beats sitting in the corridor with a lukewarm can of lager clutched in a sweaty hand between takes. The bar stocks a comprehensive range of alcoholic beverages, and while CAMRA wouldn't exactly be over the moon about the bitter, Roger pulled us a very passable pint with the sort of style that only comes with practice. Decor is authentic pub kitsch, circa Kilburn, right down to the ducks on the wall, buttoned velvet upholstery and Formica-clad bar. In a separate alcove, there's a full-size snooker table for the athletically inclined. Apparently competition is fierce, and there was hot debate as to who was the current champion among the Kinks. All the place needs for complete authenticity is a blousy barmaid, a hint of sawdust on the parquet and a couple of drunken Irishmen in flat caps sleeping it off.

The new studio opened officially on July 23 1976, but pressure of work was such that sessions were



booked even before that date. Dick Emery was one of the first people to record there, when he cut his Christmas disc in July. Other notables who've been in since include golden oldie Bert Weedon ('very professional—we mixed 11 tracks in a single working day'), Mud, who did the overdubs for their next single at Konk, and Cafe Society, a new group produced by John Miller and rated very highly by Roger Wake. When the Kinks are in doing album sessions, they generally work two to three days per week, but they're usually prepared to work their sessions in around other clients, to make Konk a paying proposition.

At present Roger is the only full-time member of staff, but the chances are that he'll be getting a junior in soon: 'now it takes about 35 to 40 minutes to set up for each take, so it would be nice to have a skivvy to take some of the work off my shoulders and generally help out around the studio.' He's fairly certain that at £34 per hour, Konk probably offers one of the

cheapest 24 track rates, in the London area. This is another benefit of the Hornsey location, because the low overheads can be passed on to the customer. 16 track is £32 per hour, 2 and 4 track is £30 and, while the studio is available on a 24 hour basis, there's a £5 per hour overtime surcharge after six in the evening.

When we left, the desk was finally back in commission (after two hours of probing, much sage nodding of heads and dark mutters about over efficient relays, the bother was traced to a single leaky capacitor!) and recording was just about to begin—which seemed like a good cue for an exit from the overworked look on Roger's face. The impression we had was of a friendly, well-equipped studio that doesn't maybe have the gloss of some of its West End counterparts —but seemed like a far nicer environment to work (and play) in. We certainly can't have been alone in this sentiment; at the time of writing the studio was healthily booked up for quite some time ahead, which can't be bad.

Dave Hamill

Invisible Sound

There are two very surprising things about *A Chorus Line* which opened some months ago at the Theatre Royal, Drury Lane. One is the fact that it actually lived up to all its advance publicity. Dedicated to 'anyone who has ever danced in a chorus or marched in step . . . anywhere', the show is a fascinating chart of the agonising course of an audition for a Broadway show, with a couple of dozen hopeful dancers giving of their best, telling their life-story to the director and finally being whittled down to a final troupe. At the time of writing, a stream of hopeful British dancers is playing exactly the same role, for real, as they audition for parts in the British company which will take over from the USA company when their work permits expire.

The second surprise is in the sound. I saw the show almost by chance and loved it, but found myself puzzling throughout the performance about how on earth the voices of the cast could be coming over the house pa so loud and clear, cutting through the amplified pit band (hidden under a gauze roof to the pit) without ever the sight of a mic or a hint of feedback. At first I was sure that they must all be wearing hidden radio mics; but soon it was physically apparent that they weren't. Then I wondered briefly about miming, but that, too, was clearly a non-starter. Mics hidden on stage? The stage set is a bare rehearsal room, and there just isn't anywhere to hide a mic. So after the show, all I could do was check to find out who was organising the sound and phone them the next day.

The show, as everyone by now knows, was already playing simultaneously in several US and Canadian cities before another performing cast came over to England. Quite atypically for such occasions, the American import team that arrived was fully rehearsed and ready to go and was accompanied by an army of technicians and advisers, only a very few of whom turned out to be freeloaders. Autograph, the production sound engineers, were promised a full sound system, and were naturally somewhat surprised to find that the 'full sound system' was missing all cables and connectors. And as they subsequently found out, no single shop in London can supply 700m of cable off the shelf. Around £1000 was spent in Wardour Street in a single day on connectors alone. Also, the imported communications system, to provide a link between the pit orchestra, off-stage chorus, lighting director and sound engineers, was of highly dubious reliability. Obviously, the Americans already realised this, because everything was duplicated, thereby doubling the cable requirements. It's now been replaced by a single, more reliable system. Even so, multiple multi-cores must snake out over the theatre roof, to provide all the necessary links.

There was no sound cue-sheet available, quite simply because there are far too many sound cues to write down, and no one could possibly look at the stage while reading a sheet and working the mixer controls.

So it was taught by word of mouth and learnt by heart to understand why the cue-sheet is so complicated; you have only to look at the method adopted of producing the heavily amplified vocal sound

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WORK

from the cast on stage, without radio mics or miming used anywhere in the whole show.

Along the front of the stage, at ground level, there are mounted five Sennheiser *802* hypercardioid mics, and slung over the stage, some 8m up, there are five Sennheiser *816* rifle mics in one line of two and another of three. In this way directional mics cover the whole area of the stage. The mics are all wired through separate faders on the mixing console which, following the old adage that the only place you can judge audience sound balance is from a seat in the audience, takes up £30-worth of stalls seats every night. The mixed mic outputs are routed in mono via Altec power amps to a bank of eight Altec *9846A* speakers, six of which, weighing close on a ton, are hung in a cluster over the front of the proscenium. As the actors move about the stage, they are at any one time always in the line of fire of at least one of the ten directional mics. Every stage movement is rigidly pre-planned, and provided the sound operator (Jonathan Deans, late of Covent Garden) knows his job (which he clearly does) it is possible to track each piece of dialogue or song at constant level. But of course the difficulties in practice are immense. Frequently there are several people talking or singing at the same time, unused mics must be killed to keep the tracked sound uncluttered with background noise, and even the slight movement of an actor's head up or down can mean a difference of several dB either way between mic channels. But, as anyone who pays a visit to *A Chorus Line* can find out for themselves, the system can and does work. Although this hypercardioid mic technique has been tried before, for instance during the *West Side Story* revival, it has never so far been really successful. This is because the sound level generated in this manner has never really been able to crowd out a stage band.

Although Autograph readily acknowledge that putting the hardware together was relatively easy (as far as anything in the theatre is ever easy), one could write a short book on the fine practical details and problems. The desk used is a Trident Fleximix, about which everyone seems to have much praise, and which certainly seems to have lived up to its name. Initial delivery, from order, took two hours, and the mods to tailor it to *A Chorus Line* took another hour. A problem over providing the necessary 48V phantom supply for the Sennheiser mics was fixed next day, and the desk layout currently stands at 35 channels in, to seven sub-groups out. When the show is over, it will remain the property of Michael White, the presenter, who to his credit seems to have spared nothing to get the show on the road without problems. The desk can then be converted into two or three separate smaller desks for future shows. The Altec speakers over the proscenium can be panned or tilted and are fed by the Altec power amps via an Altec 27-band room equaliser. This takes some fairly hefty chunks out of the sound spectrum, eg above 3 kHz, both for eq purposes and to kill the possibility of feedback altogether. A similar mix fed to the Altecs over the proscenium is fed to a stack of eight Altec and Electrovoice speakers ranged round the circle and gallery rear, but with a 25 ms delay. Although all the stage sound is mixed as mono, the 23 musicians in the pit are fairly close-miked and mixed into stereo at the desk, for reproduction along with the mono stage sound. In this way there is a stereo spread of the music with voices centre front. Mics used in the pit: two Neumann *85*s on the six woodwind, and two Electrovoice *RE20*s on the six brass. But as the pit musicians start putting deps in, as will inevitably happen as the run progresses, internal section balance is bound to deteriorate. Doubtless there will then have to be more mics, closer to the players, so that a sectional balance can be created at the desk. So far the band mics take up 15 inputs on the desk. A Master Room spring variable echo unit is used for special effects only, never sweetening; the pa is otherwise totally dry. The total power of the pa is 5.2 kW, the volume of the theatre being nearly 2 million cubic feet!

In the covered pit, musical director Ray Cook conducts with the help of foldback from the stage and a closed circuit tv monitor, showing a view from the stalls. Similar foldback, via Sennheiser *HD414* phones, and a cctv monitor is available in the offstage chorus booth, where an average of seven or eight singers are picked up (in stereo) and mixed into the band and on-stage sound for chorus numbers.

So far *A Chorus Line* has been a success story in the tradition of the hit shows like *My Fair Lady* and *Camelot* that preceded it at Drury Lane. The first main hurdle to the future will be substitution of the American cast with a British cast. No one can yet say how successful this will be. But so far seats are almost unobtainable, and people are happy to buy (often from scalpers) even those few behind the sound mixing desk that the box office will sell only with the disclaimer that they have 'restricted view'. But the sound engineers are still having to learn to live with nightly taps on the shoulder. One night it was a little old lady. 'Can you hurry up and finish fiddling with those knobs and move out of the way before the show starts?' she asked. The next night a precise German tourist begged Jonathan Deans 'to be so kind and move down in his seat by $1\frac{1}{4}$ inches'. Just how he arrived at this figure, rather than a round inch or even two, is still puzzling the Drury Lane engineers.

Adrian Hope

Ron Geesin Revisited

Several years ago I intruded on the decidedly un-ordinary world of Ron Geesin, who was then working out of a studio at his home in Ladbroke Grove. As I found out when I came to write up that studio visit, Geesin is, in many respects, a journalist's Waterloo; you just can't sum him up pithily in an introductory paragraph. He's a musician, playing more or less every keyboard and stringed instrument in his own highly individual, unclassifiable style; an electronics amateur; a creative recording professional with several short and feature film soundtracks to his credit; a record company with three lp's; a publisher with one book; and a performer of live events even less easily classifiable than his unclassifiable musical styles.

Shortly after the *Ron Geesin Unlimited* article that I finally put together, Geesin moved house to Heathfield, Sussex (home of a wild animal park) into a farm-style house that was then too smelly and gloomy for the locals to touch with a barge pole and is now everybody's dream escape from city pressures. I visited and found him still impossible to sum up, still bubbling with creative ideas, and still (somewhat surprisingly, bearing in mind the hard world of commerce) managing to make a happy living out of putting some of those ideas into practice. The enthusiasms seem more ordered; he has for instance been making some KPM discs. But the sleeve notes are vintage Geesin. 'I present some tunes, untunes, anti-tunes, delightful and undelightful sounds, for all sorts of purposes, and state that: the pieces herein displayed may be combined with themselves (as much out of sync as possible) to achieve thicker, diffuse atmosphere, and playing things at different speeds would not be wrong!' proclaims one. 'I introduce you to a world of electronic sounds, shapes and rhythms created to enhance and aggravate moving and unmoving pictures to startling effect', says the other. 'There is no point in being outgiving with ideas if there is nothing into which to put the outgivingness', he says in person, while explaining the need to save some ideas for the future.

The present is financed both by past royalties on recordings like the Pink Floyd's *Atom Heart Mother*, in which he had an arranging hand, present book and record sales and the music for a regular succession of commercial films, such as the excellent BP series on the history of motoring. The old Revox *G36*s have been replaced by *A77*s. The new machines are now being subjected to the same abuses as the old, a necessary part of the musical

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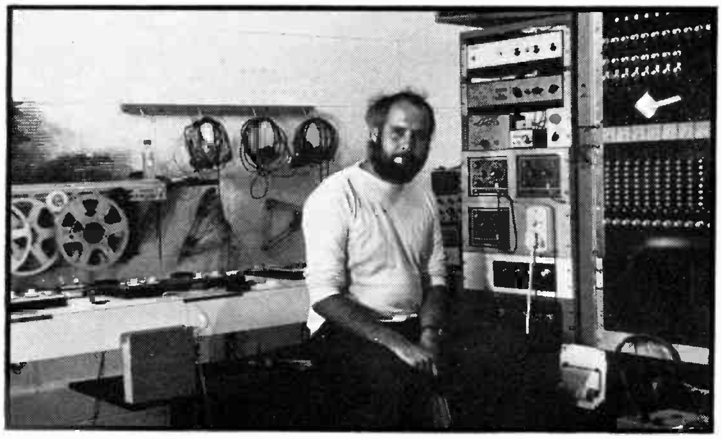
formula for instant overdubbing; this is essential to Geesin's musical and recording technique. It's damnably clever, horribly difficult to put into operation, and is even now only occasionally copied — for instance by Queen in fairly primitive fashion on their *Night At The Opera* lp.

When listening to the final results, it's only too easy to forget that the only multitrack recorder in sight is a Teac 4-track. Everything is done in stereo, often mono subsequently tricked up one way or another to produce a stereo effect, and stored in 'slabs' on the Teac or several Revoxes running in sync for short periods. In its simplest form, the system relies on running a reel of tape from the take-off spool of one machine through the heads of that machine (set in the 'record' mode) and from there, *not* onto the recorder's take-up spool but through the heads (set in the 'playback' mode) of another Revox alongside it, using that machine's take-up spool. In this way the same tape runs first through the record head of one machine and then, after a delay determined by the spacing between the two machines, through the playback head of the other machine. Geesin feeds a sound signal, for instance by direct injection from an electric guitar, through a mixer onto the tape running through the first batch of heads.

In this way the injected sound is recorded onto the tape and after the substantial delay inevitably imposed by the spacing of the two machines, the recorded sound is played back by the heads of the second machine. Audible reproduction is either over loudspeaker monitors or headphones and at the same time the mixer feeds the reproduced signal back to the first set of heads, to re-record it on the tape. Thus a single note will in this way be recorded on the tape as a repeated succession of exactly similar single notes, spaced by the fixed delay governed by the separation of the heads of the two machines.

Because the delay is considerable, the repeat may be of a musical phrase and the mixer enables Geesin to add another, different phrase to it and another, and another and so on. Thus in practice a simple bass line can be laid down by recording it on the first set of heads, heard as it passes through the second set of heads and fed back to the first set of heads again, along with a matching melody line. It sounds easy; but it's not. The main difficulty is in matching rhythm to delay so that each new phrase is in sync with those already being recycled. Geesin has now mastered the technique to such an extent so that within a matter of minutes, a musical (and I emphasise the word *musical* to distinguish from garbled *musique concréte*) orchestration can be built up in the time it takes for a reel of tape to run through the machine. Indeed, if one had to pick on a single reason why Geesin succeeds where others fail in the same field, it would be his ability at one and the same time to handle electronics, compose melodic tunes and maintain rigid tempi.



Electronics, along with all his other do-it-yourself activities, such as photography, metal and woodwork were learned the hard way. 'No one taught me; I'm doing it by doing it', he says. Geesin's ability to write catchy tunes is doubtless a gift, but a cultured gift, nevertheless. Plenty of those blessed with the ability to write melodies gradually decide it is beneath their dignity to do so. And the need for a good sense of rhythm? Well try for yourself the almost impossible task (which Geesin's delay technique requires) of tapping in time with single beats spaced all of eight or nine seconds apart!

The basic delay system is obviously under continual modification. When I arrived, Geesin had just finished making an extension arm, around which the tape is led between machines, with an old Revox stereo replay head at the apex of the triangular path which the tape is thus constrained to take. The head is on a swivel, and feeds back to the mixer. Swivelling the head alters azimuth; thereby causing phasing.

I noticed another Geesin gadget in the process of development. It's a mechanical-electrical rhythm machine which is really a clever update of the old style of music box. A gramophone turntable can carry any one of a whole range of metal platters (based on the aluminium cores stripped from old acetate masters) and into which rings of perforations have been stamped at regular intervals. On one disc the circumference is divided into eleven equal cake-like slices of perforation; on another disc twelve, and so on, up to thirty-one. Pins can be placed in these perforations, in chosen patterns to provide a porcupine disc like that of a music box. A pressure-sensitive pickup, for instance a gramophone cartridge or contact mic is then held above the disc as it rotates so that the pins strike the transducer in a continuous rhythm, dictated by the spacing of the pins. If several transducers and several rows of pins are used on each disc, they produce variations of sound, each in different rhythms but all within the same basic metre, as dictated by the number of divisions on the disc. Even in its primitive prototype form, the gadget was able to produce instant jungle drums, and create time and tempi that would make even the most modern jazz drummer wince at their impossibility.

All this isn't meant to replace musicians. It's simply another part of Geesin's scheme to make himself ever more musically independent. This is highly necessary if you work from the depths of Sussex, where you are likely to be snowed up in the depths of winter, with a deadline for a film soundtrack tape.

Also on do-it-yourself self-sufficiency basis, Geesin appears to be growing enough vegetables to weather a siege, publishing and distributing his own books and records, coping with mundane miseries like VAT, and even finding time to write two-page rude letters to the French RCA Black-and-White record label. Geesin's keener than average rhythmic ear detected that, in re-issuing cleaned-up versions of old jazz recordings, the company had erased clicks and pops by physically removing segments of tape. Geesin's answer, gleaned from his friend J R T Davies ('upholder of quality in re-issue programs' he explains) has obviously never been heard of in France. 'What you do', he says, 'is simply scratch off a little of the oxide at the point on the tape where the click appears. That way you bloop out the noise without affecting the rhythm.' The partly puzzled, and partly offended producer recently rang him from France. It remains to be seen whether future Black-and-White re-issues are rhythmically sound.

Summing up and rounding off a Geesin piece is as difficult as writing an introduction. I can't do better than quote a couple of unrelated comments verbatim, because together they do the trick.

'A man's got to use all his energy . . . the secret of creativity is to use all your energy' and 'What I want to do is innovate—not go on Opportunity Knocks and talk about it—just innovate, be challenged and continue.'

Adrian Hope

agony

■ Musicians' humour tends to be the same the world over. The cruise liner docked for a day at a tiny port in Alaska and the multinational band resident on board explored the one-horse town. Main street sported a bar, bank, barber and general store. Everywhere you looked there were snow-capped mountains. 'What could you do in a place like this?' said one musician, as they killed time before sailing. 'Open a bassoon repair shop?' said the other, without a moment's thought.

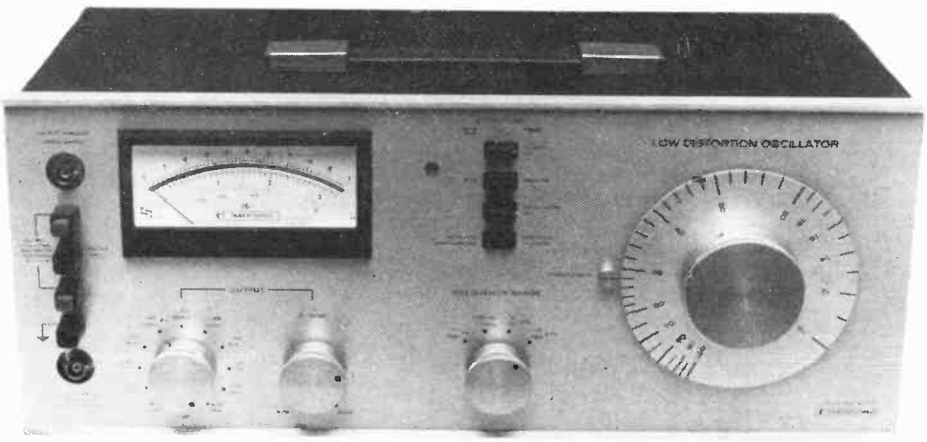
■ The radio play recording was going well, but the beheading scene wasn't quite to the producer's liking; he felt that cutting a cabbage in half sounded like . . . cutting a cabbage in half. At the direction of the studio effects manager, a pig's head was duly brought in and, with some difficulty, they hacked it in half; first with an effects sword and when that didn't work, a fireman's axe.

A mutilated pig's head is not the easiest of things to dispose of, even given the ingenuity of this production team. It was therefore probably pure coincidence that brawn appeared on the canteen menu the next day.

reviews

Radford low distortion oscillator

Hugh Ford



MANUFACTURER'S SPECIFICATION
Frequency range: 10 Hz-100 kHz (four bands).
Output voltage: 10V rms maximum
Output waveform: sine and square.
Output attenuation: 0-25 dB potentiometer and +20 dBV to —80 dBV in 10 dB steps.
Output source resistance: 151 ohms constant from 0 dBV to —80 dBV, 147-154 ohms at +10 dBV, and 100-177 ohms at +20 dBV with 25 dB change of 0-15 dB potentiometer.
Sinewave distortion: 0.002% mid audio band. Typically 0.001% rising to 0.005% at 10 Hz and 100 kHz.
Squarewave rise and fall time: 50 ns.
Output monitoring: 102 mm mirror scale meter engraved: 0-1, 0-3.2 and 0 dBV to —15 dBV (1V=0 dBV).
Calibration accuracy: 1% fsd.
Power source: 110V, 120V, 130V, 220V, 230V, 240V, 40-60 Hz, ac.
Overall size: 430 x 178 x 230 mm.
Weight: 7.2 kg nett.
Price: £300 Standard version.
£400 600 ohm balanced version.
Manufacturer: Radford Instruments Ltd, Bristol, England.

MUCH modern audio equipment has harmonic distortion specified in the third decimal place and one really does wonder how the manufacturer manages to make the measurements with any confidence, for to my knowledge there are only two makes of oscillator commercially available which have any hope of giving meaningful measurements.

The first on the scene was the Radford which has been about for many years and naturally used valves, but Arthur Radford has of course now caught-up with things in the form of the new *Series 3 Low Distortion Oscillator*, which is of course a completely 'solid-state' instrument.

Two versions of the instrument are available: the standard version has an unbalanced 150 ohm output and the B version offers a 600 ohm balanced floating output, in addition to the possibility of a 300 ohm floating output or a 150 or 300 ohm unbalanced output. As is to be expected the distortion performance of the balanced output is restricted by the addition of a drive amplifier and transformer, but as will be seen the performance is remarkably good.

The presentation of the instrument is a black crackle case with an alloy front panel with clear legends in black. There is a 11.5 cm diameter frequency tuning dial which covers one decade and operates in conjunction with a four-position range switch, thus covering the total range 10 Hz to 100 kHz.

Signal output level is controlled by an 11-position 10 dB step attenuator covering 0.1 mV to 10V maximum outputs which are incremented by a potentiometer which has in excess of 20 dB range. The actual open circuit output level is indicated by a meter scaled in volts and dBV and which is equipped with an anti-parallax mirror. Three outputs are available, a fixed level unbalanced output at a BNC socket, the attenuated unbalanced 150 ohm or 300 ohm output at a second BNC socket and the balanced output. This comprises a floating 600 ohm centre tapped output at spring-type terminals and an extra terminal which is connected to earth.

The remaining front panel facilities comprise a green incandescent power indicator lamp and four pushbutton switches. The top one of these is the power on/off switch below which there is a sine/squarewave output switch and a non-locking 'oscillator off' switch which is a very useful feature. The fourth switch controls the output routing to nominally '150 ohms unbalanced' or '600 ohms floating'. However it does not isolate the unused output and this can create problems.

At the rear of the instrument there is the fixed mains lead (I prefer IEC connectors) and the voltage selector. In addition, there is the 20 mm power fuse the value of which is a closely guarded secret! The technical instructions provided give component values, circuits and servicing information but nothing about the mains fuse.

The standard of components and printed boards used in the construction is excellent, and should board replacement ever be needed, this is a very simple matter as all connections are by slide-on tags. However, the instrument suffers from my *bête noir*, the knobs fall off the rotary switches because the shafts do not have flats and single screw fixing is used. Another small grumble is that there is no tilting foot arrangement which can make the meter awkward to read.

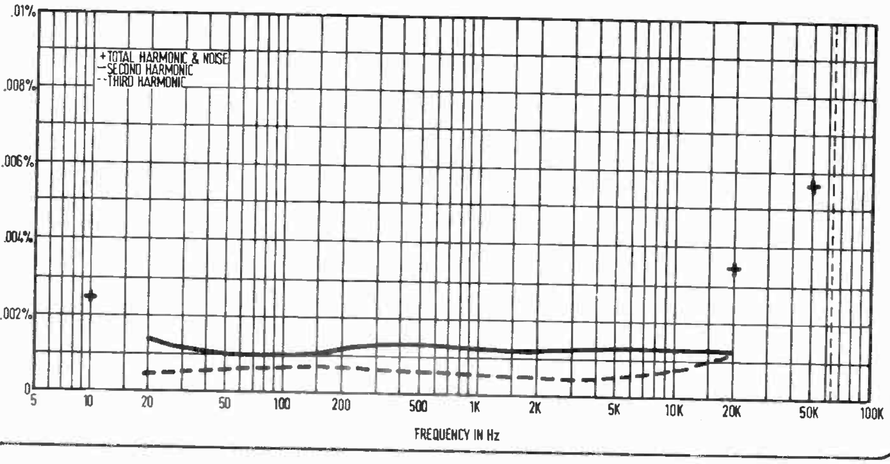
Distortion

The prime quality of the Radford Low Distortion Oscillator is that, while to my knowledge there may be one equal, there is certainly no better commercial oscillator so far as distortion is concerned in the audio frequency band.

Reference to **fig. 1** shows that the third harmonic distortion at the unbalanced output is over 100 dB down on the fundamental (0.001% distortion) over the frequency band 20 Hz to 15 kHz and that the second harmonic is not far short of this fantastic performance. The testgear required to measure individual harmonics at these low levels (with a 20 dB margin) unfortunately did not function outside the band 20 Hz to 20 kHz, so fig. 1 includes spot checks on the total harmonic distortion and noise at 10 Hz, 20 kHz and 50 kHz but in these instances the margin in hand with the testgear affects the results, all of which relate to +20 dBV output (10V rms).

Perhaps even more remarkable is the performance of the floating balanced output when driving a 600 ohm load with 5V rms which is the maximum output into a matching load. This performance is shown in **fig. 2**

FIG. 1 RADFORD L.D.O. AT UNBALANCED OUTPUT

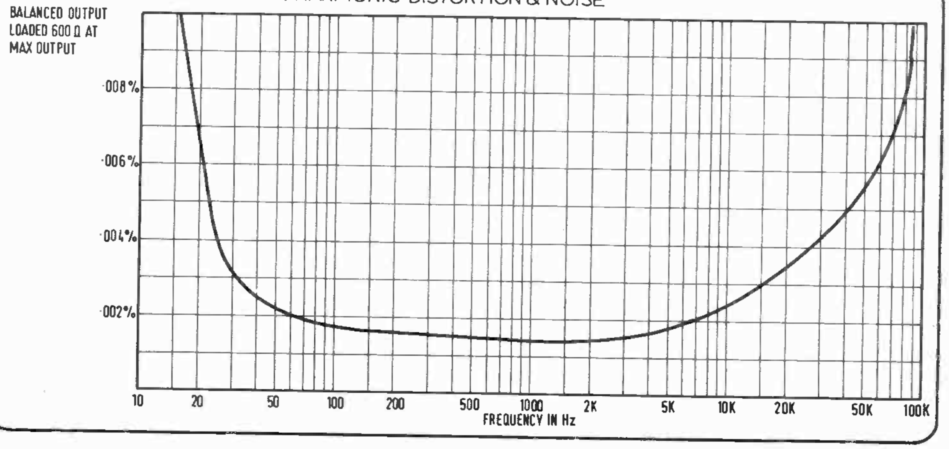


which shows the expected distortion introduced by the balancing transformer, but a total harmonic distortion of less than 0.002% from 60 Hz to 7 kHz is an achievement which deserves applause.

Noise in the output was also respectable at –107 dB over the band 20 Hz to 20 kHz with mains hum being greater than –120 dB. Investigations into the square wave performance showed that there was no overshoot or tilt or ringing at the unbalanced output which had a rise and fall time of 55 ns irrespective of the oscillator frequency.

The 'maximum output' connector has a slower rise and fall time at 100 ns and it was while investigating this output that a fault was found to occur. At frequencies below 80 Hz there was a tendency for the edge of the square wave to become unstable for a period of around 60 µs as is shown in **fig. 3.** This fault was not apparent in a second sample of the oscillator which was a modified version submitted as a result of this and other faults which were found.

FIG. 2 RADFORD LDO TOTAL HARMONIC DISTORTION & NOISE



Frequency response and calibration

The flatness of the oscillator at maximum output was generally reasonable with a boost of about 0.4 dB occurring at the high end of each range, as is shown at the top of **fig. 4.** However at low output settings of the attenuator, the unbalanced output suffered from leakage at very high frequencies, this becoming really serious on the –80 dB range the upper decade of frequency being shown in **fig. 4** for the –70 dB and the –80 dB attenuator settings.

The performance of the balanced output at maximum output level into 600 ohms is shown in **fig. 5** which, again demonstrates the peaking at the upper frequencies of each range, but as is to be expected from the transformer output the very high and very low frequencies roll off, but not to an excessive extent. However, as is shown, the response depends upon output level!

Frequency dial calibration was generally within 2% of nominal, but this did not hold on the upper frequency range where 10 kHz indication was 9.82 kHz, 30 kHz was 29.3 kHz and 100 kHz was actually 92.4 kHz with a genuine 100 kHz being available off the end of the scale.

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FIG. 3
20µs/div, 40 Hz
spurious oscillation on
squarewave, 40 Hz, 20 µs/div

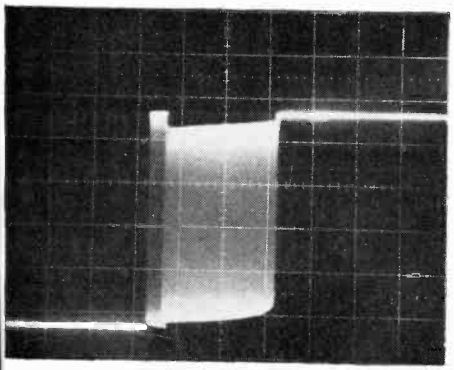
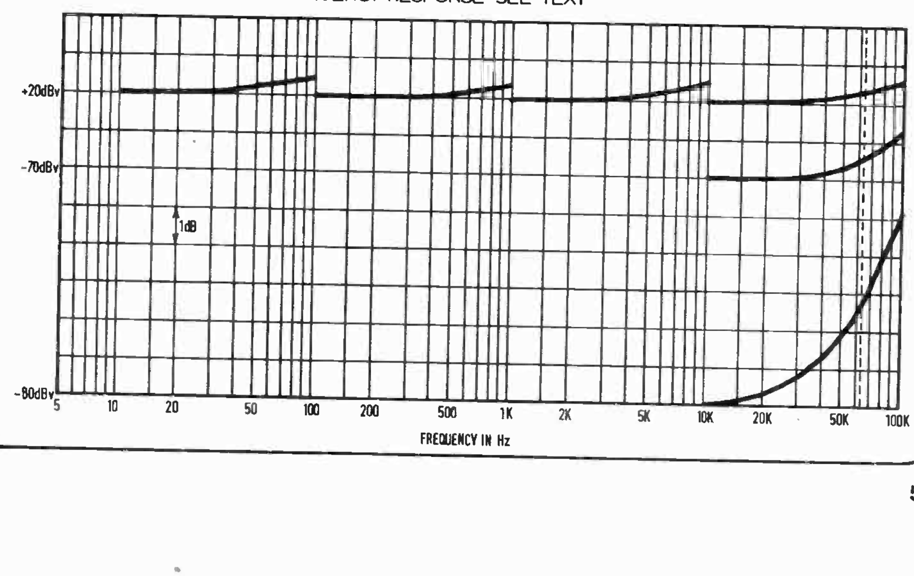


FIG. 4 RADFORD L.D.O. ATTENUATOR OUTPUT FREQUENCY RESPONSE-SEE TEXT



RADFORD LOW DISTORTION OSCILLATOR

Attenuator and outputs

The attenuator accuracy for each 10 dB step at 1 kHz is shown in **fig. 6** in terms of incremental accuracy and individual step accuracy. The step accuracy can be seen to be very good with errors only in the order of 0.04 dB, but this is unfortunately cumulative and added up to a 0.4 dB error from maximum to minimum setting.

This is a shame because the accuracy of the meter at full-scale deflection at maximum output was really excellent and within the width of the narrow pointer and also as good as it could be at 30% full-scale deflection.

It is possible to hold a long debate about the meter scaling: clearly we want the excellent voltage scale which is provided, but the question of whether the dBV scale is the right one as opposed to a dBm scale is largely a matter of personal taste. It is understood that Radford will offer an option, but I believe that the vast majority of engineers work in dBm irrespective of the loading which should of course be 600 ohms for the dBm to be strictly meaningful!

The output impedance of the 600 ohm balanced output was found to be 606 ohms on the 0 dBV range and below, rising to 611 ohms on the +10 dBV range and to 644 ohms on the +20 dBV range. Operation of the variable attenuator did not have any effect upon these impedances, but I feel that the manufacturer could make the change of output impedance clearer in his literature. As is to be anticipated, the use of half the balanced output as a 300 ohms floating output has similar output impedance characteristics.

While the attenuator output has constant impedance of either 300 ohms or 150 ohms nominal, the output is clearly identified '150 ohms source' when in fact it has a 300 ohms source impedance unless a link is inserted to joint the 'outer' connections of the floating output—I regard this as confusing as we all know that people do not read instruction books!

The output balance was found to be better than Radford's specification, being 65 dB at 10 kHz, 84.5 dB at 1 kHz and 106 dB at 100 Hz as measured with 300 ohms between the centre tap and each outer of the output with the unbalance being measured across 600 ohms between the centre tape and earth.

The internal meter claims to be average reading calibrated in terms of rms, and I have no grumble about this so far as sinewaves are concerned, but with squarewaves the meter is intended to indicate the rms value but was found to indicate 10% too low.

A further peculiarity was that the meter appeared to suffer from leakage at high frequencies, in that on all output voltage ranges at 100 kHz with sinewaves the meter spuriously indicated 10% of full-scale irrespective of the position of the fine output level control, and even worse with square waves to the extent of 62% spurious full-scale deflection. These faults due to leakage had virtually disappeared in the second modified sample of the oscillator which was submitted by Radford.

Other matters

Investigations into the frequency stability showed that there was a warm-up drift as is shown in **fig. 7** which demonstrates an initial drift of six parts in 10^4 per hour which is roughly twice that shown in the manufacturer's literature. After warm-up, the drift pattern became rather erratic with drift varying between two parts in 10^6 and 14 parts in 10^6 over five-minute periods.

These orders of stability make distortion measurement using a tuned notch filter rather tiresome, as it is impossible to retain the optimum balance without continuous knob twiddling with these orders of frequency drift. Furthermore, the oscillator frequency was rather sensitive to vibration, such that lightly tapping the instrument's case produced an undesirable frequency shift.

Summary

In terms of distortion performance this is a most excellent oscillator at a reasonable price, but it is let down by a large number of shortcomings in other directions. Giving credit where credit is due, Radford quickly submitted a second modified version of the oscillator which had added screening in the area of the attenuator and meter amplifier. This sample did not suffer from attenuator leakage or meter leakage and the low frequency squarewave problem did not exist.

It is understood from Radford that these faults are peculiar to the balanced output version of the low distortion oscillator, and that all future production will be modified. ■

FIG. 5 RADFORD L.D.O. FREQUENCY RESPONSE OF 600Ω OUTPUT WHEN FULLY LOADED

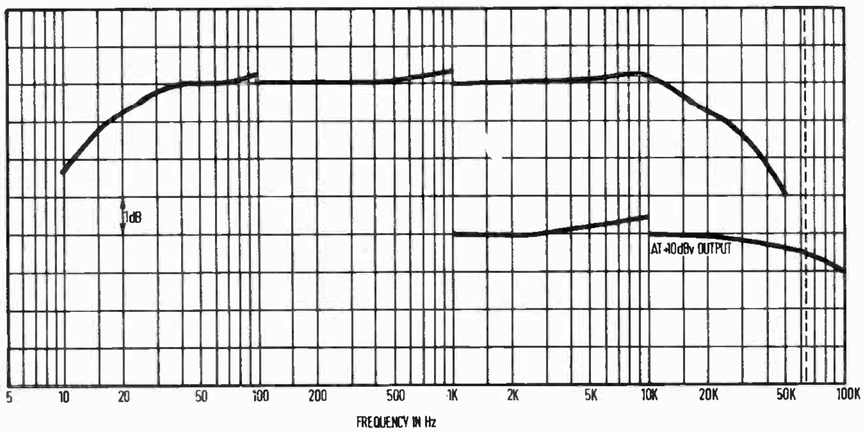


FIG.6 RADFORD LDO ATTENUATOR ACCURACY

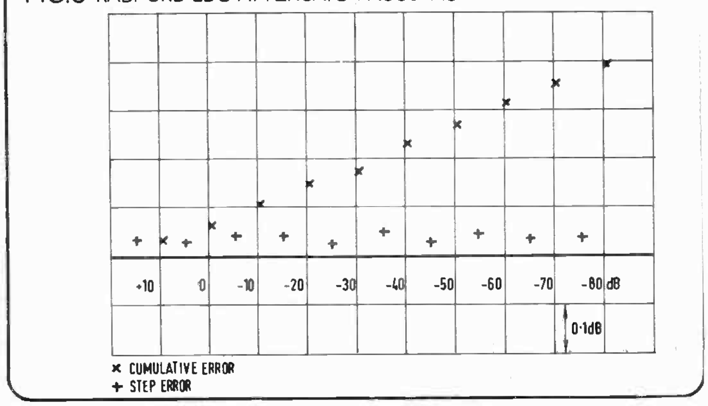
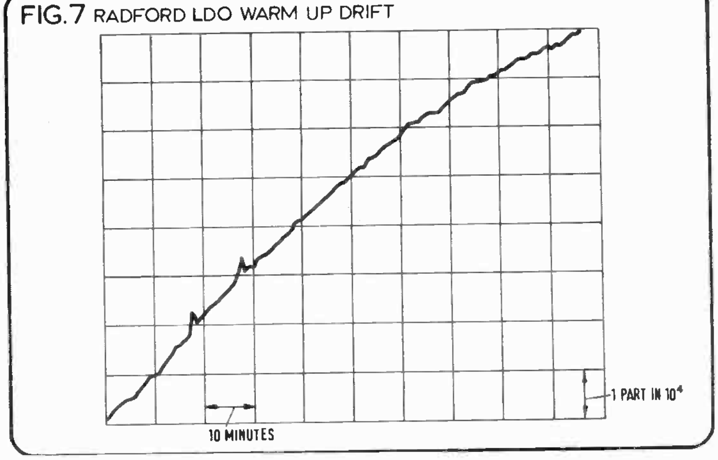


FIG.7 RADFORD LDO WARM UP DRIFT



Radford distortion measuring set

Hugh Ford

MANUFACTURER'S SPECIFICATION
Frequency range: 5 Hz to 50 kHz (four bands).
Distortion per cent range: 0.01% fsd to 100% fsd.
Attenuator accuracy: 1%.
Input voltage range: 50 mV to 50V. Three ranges 50 mV to 0.5V, 0.5V to 5V and 5V to 50V (50 mV to 0.5V range not operative on 0.01% and 0.03% fsd ranges).
Second harmonic attenuation: 0.5 dB.
Frequency response bandwidth: 250 kHz (—1 dB).
High pass filter: 500 Hz (12 dB/octave).
Input resistance: 47k ohms.
Meter: 101 mm mirror scale engraved 0-1, 0-3.16 fsd. dB and battery check—rms reading to crest factor of 3.
Power source: 2 x PP9 batteries (included).
Size (whd): 430 x 178 x 230 mm.
Weight: 7.5 kg, 11 kg packed for transport.
Price: £250.
Manufacturer: Radford Instruments Ltd, Bristol, England.

THE Radford *Distortion Measuring Set* is of course intended as a companion to the *Low Distortion Oscillator*, and as such has a similar form of mechanical and electrical construction. As with the oscillator, the printed boards and components are to the highest standards and the overall presentation is good.

An interesting point about the distortion measuring set is that it operates from two 9-volt PP9-type batteries drawing less than 7 mA from each battery. Such a low current means that the batteries should have an extremely long life, but when the time does come to change the batteries it is a fairly long-winded operation involving the removal of four slotted screws and seven Phillips screws!

The advantages of battery operation are the loss of mains hum problems, and more important, the fact that there are no longer any ground loop problems when measuring distortion of power amplifiers—that is provided that the oscilloscope monitor output is used with caution.

Battery condition is checked by depressing a front panel switch which activates the front panel meter if the instrument is switched on, thus battery condition is—as is only sensible—checked on load. The meter has a green sector for the battery check, and three scales 0-1, 0-3.2 and a decibel scale from 0 to −15 dB.

These scales cannot, as would be useful, be used as voltage scales because there is no voltage calibration; therefore a separate voltmeter is essential for normal work. Input level is controlled by a 3-position range switch with nominal level capability from 50 mV to 50V in conjunction with a concentric potentiometer for setting the 100% level on the meter in association with a 'set fsd/read distortion' pushbutton.

Distortion in the form of total harmonic distortion is read from the meter by using the 9-position 'distortion range' switch which covers full-scale deflections from 100% distortion down to 0.01% distortion in 10 dB steps.

Nulling of the fundamental is done by a twin T-network with feedback, the tuned frequency being selected in four ranges by a rotary switch and the fine frequency being tuned on a large diameter dial which covers one decade, the total instrument range being the four decades from 5 Hz to 50 kHz. The ultimate balancing of the network is done with three sets of dual concentric controls which have coarse, medium and fine action—the latter being none too fine when measuring very low total harmonic distortion.

The only remaining operator control is a pressbutton switch which inserts a 500 Hz high-pass filter for reducing the effects of hum and noise when measuring the total harmonic distortion of signals above around 1 kHz.

The input and also the distortion residual output are by means of single-ended *BNC* connectors at the front panel, which is black anodised with very clear legends. However, as the two lowest distortion ranges of 0.01% and 0.03% fsd do not operate with the input level switch on its most sensitive range of 0.05-0.5V, I would have liked to have seen this indicated on the front panel, as the likes of myself just pick up an instrument of this type and drive it without reading the instruction book.

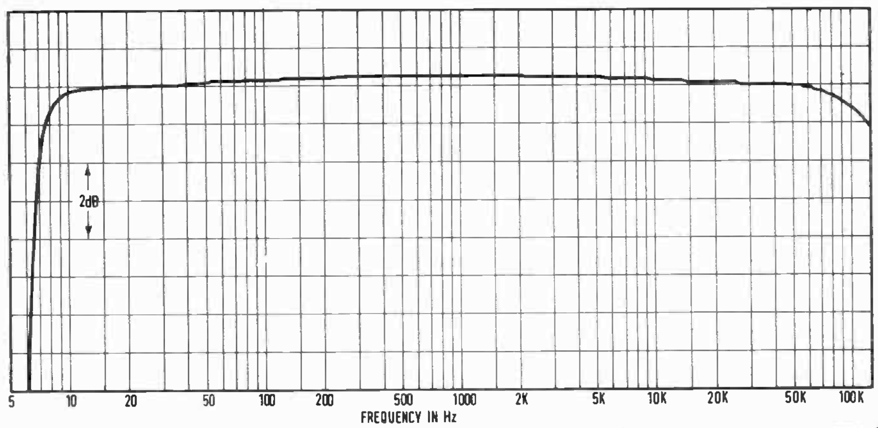
Performance

Probably the most serious error in many distortion meters is due to the rejection notch being too broad and thus lowering the level of second and higher harmonics which we wish to measure. **Fig. 1** shows the overall frequency response of the Radford instrument when it is tuned to reject 5 Hz. It should be noted that the second harmonic at 10 Hz and higher harmonic frequencies are within ±0.2 dB, which is a very good performance. At the high frequency end, the −1 dB point is at about 120 kHz and as will be seen this is a cause for complaint.

Reference to fig. 2 shows the curves for the notch filter at 10 Hz, 100 Hz, 1 kHz and 10 kHz, it being seen that at all but 10 kHz the attenuation of the harmonics is less than the specified 0.5 dB by a very good margin. However, at 10 kHz we have a curve which attenuates the second harmonic by 1.2 dB and the 3rd, 4th, 5th and 6th harmonics by 1 dB. While this performance is not bad by many standards it is not to specification, and similar results were obtained at 20 kHz and 40 kHz notch frequencies.

56 ▶

FIG. 1 RADFORD DISTORTION SET OVERALL FREQUENCY RESPONSE MEASURING DISTORTION AT 5Hz



RADFORD DISTORTION MEASURING SET

The performance of the 500 Hz high-pass filter is shown in **fig. 3,** which demonstrates that it acts at the correct frequency and its effect is minimal above 1 kHz.

The accuracy of the dial indication of tuned frequency was generally within ±2%, such that the dial can be used as a rough frequency meter. More important, the accuracy of the distortion range attenuator was within +0.08 –0.12 dB cumulative error over its entire range with a worst case incremental error of 0.2 dB —a very satisfactory performance, as shown in **fig. 4.**

Efforts to measure the maximum fundamental rejection were hampered by the instability of the instrument when used on the most sensitive range of 0.01% total harmonic distortion full scale. However a 16 dB margin below 0.01% was achieved at all frequencies, this being equivalent to a residual of only 0.0015% total harmonic distortion with inputs above 0.5V. The actual indicated residual noise without any input was 0.0018% equivalent distortion without the high-pass filter in circuit or 0.0012% with the filter in circuit.

In practice when using the companion Radford *Low Distortion Oscillator* or my laboratory oscillator, the residual distortion was found to be less than 0.002% below 20 kHz and to be limited by the Radford oscillator at higher frequencies. Measuring such low levels was tiresome, particularly at high frequencies where the balance of the distortion meter was not only very critical, but drifted. Also, the instrument was microphonic such that even abrupt operation of the distortion range switch completely upset the balance. However this is not an unusual complaint with this type of instrument—you just have to be gentle and not thump the bench in frustration, or you start again!

On the input end, the required input level for use on the most sensitive distortion ranges was 0.517V at 1 kHz with the ability to handle 50V which is adequate for most power amplifier applications. On the most sensitive input ranges where the 0.01% and 0.03% distortion ranges are not available for use, the input sensitivity was found to be 50.6 mV which is close to specification.

The input impedance was adequately high at between 55k ohms and 65k ohms in parallel with less than 20 pF at any input sensitivity setting. The distortion output offered 1V rms for full-scale meter deflection from a source impedance of 2k ohms.

While some manufacturers use an average reading meter, I was pleased to note that this instrument has a genuine rms detector as is correct when measuring total harmonic distortion.

FIG. 2 RADFORD DISTORTION NOTCH RESPONSES

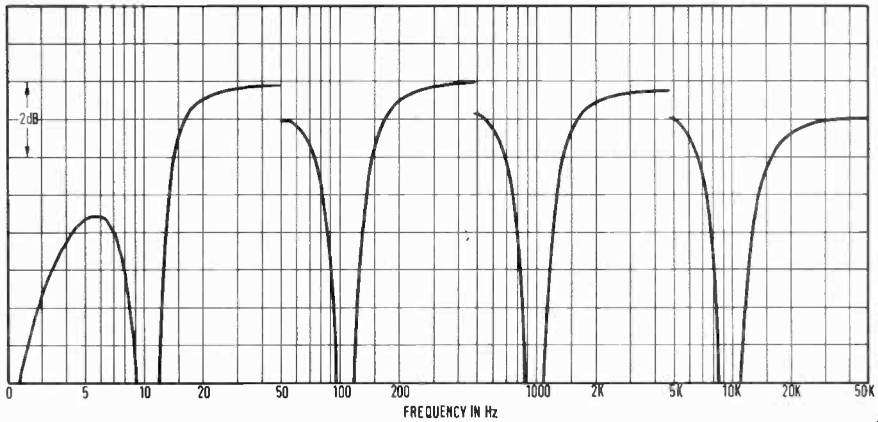


FIG. 3 RADFORD DISTORTION SET HIGH PASS FILTER

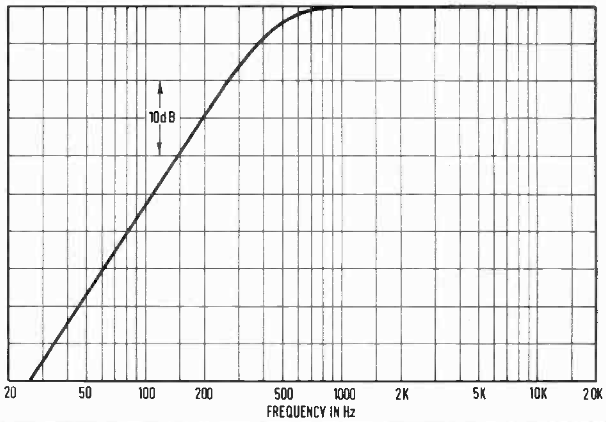
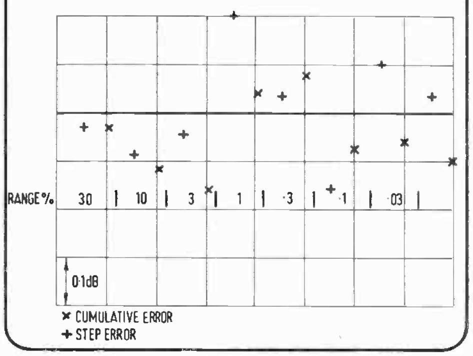


FIG.4 DISTORTION RANGE SWITCH ERRORS



Summary

While this instrument has some shortcomings it is definitely a very useful instrument when it is required to measure total harmonic distortion of audio equipment and it is one of the few that can achieve really good rejection of the fundamental. However, like so many instruments of this type the stability of the notch frequency is none too good. ■

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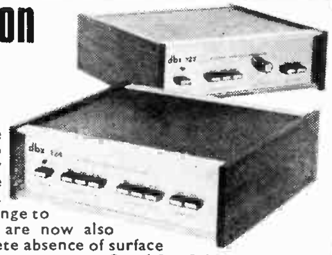

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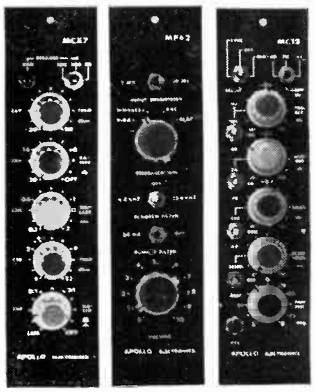

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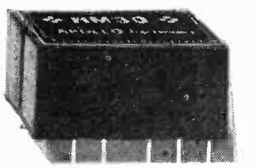

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Amber 4400 multipurpose audio test set

Hugh Ford

MANUFACTURER'S SPECIFICATION

Function Generator Section
Outputs: sine, triangle, square, pulse, asymmetrically clipped sine, asymmetrically clipped triangle.
Frequency range: 10 Hz to 150 kHz.
Output amplitude stability (20 Hz to 20 kHz): ±0.5 dB.
Sinewave distortion: 20 Hz to 20 kHz worst case 0.1%, typically less than 0.02% thd.
Triangle linearity: better than 1%.
Square and pulse rise/fall time: main output 2 µs, pulse output 100 ns.

Sweep Generator Section
Sweep: log sweep of sinewave 20 Hz to 20 kHz or 100 Hz to 100 kHz.
Sweep speed: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024 seconds.
Amplitude stability (20 Hz to 20 kHz): ±0.25 dB.

Noise Generator Section
Characteristics: pseudo random noise.
Amplitude accuracy over spectrum: ±0.5 dB.

Comb Generator Section
Frequencies generated: 31.25, 62.5, 125, 250, 500, 1k, 2k, 4k, 8k, 16k Hz.
Frequency accuracy: better than ±0.01%.
Amplitude uniformity: better than ±0.2 dB.
Distortion of each frequency: less than 1% thd.

Output Characteristics
Source impedance: 50 ohm.
Load impedance: 600 ohm nominal, 50 ohm minimum.
Maximum level: +33 dBm, 600 ohm load.
Attenuator: 11 positions, 10 dB per step —70 to +30 dBm.
Level control: 20 dB range.
Configuration: single ended or balanced.
Gating: time or period mode: In time mode, range is approximately 16 ms to 16s. In period mode, range is 1 to 1024 periods. Switching may be zero crossing.

Receiver Section
Modes: wide band sweep for use with swept sine wave; 20 Hz to 20 kHz tuned log sweep for use with pink noise; manual tune (wave analyser) band pass, band reject, high-pass, low-pass; wideband phase plot ±180°.
Tuning range: 10 Hz to 150 kHz.
Amplitude range: —120 dBm to +30 dBm.
Memory resolution: 256 x 256 in each of four memories.
X-axis: 20 Hz to 20 kHz log or 1 to 1024s linear.
Y-axis: 10, 20, 30, 40, 50 or 60 dB or ±180°.
Tuned sweep speed: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024 seconds.
Markers: 10 markers at octave intervals starting at 31.25 Hz.
Marker accuracy: ±1%.
Filter bandwidth: manually adjustable with front panel control for approximately 3% to 70%. At 3%, attenuation at ½F and 2F better than 30 dB.

Digital Display
Measures: *level:* —120.0 dBm to +30.0 dBm; *frequency:* 10 to 199 999 Hz.
Display: autoranging—reads dBm or Hz.
Accuracy: *level:* ±0.2 dB ±1 digit; *frequency:* ±1 Hz ±1 digit.
Resolution: *level:* 0.1 dB; *frequency:* 1 Hz.
Measurement time: *frequency:* 1 per second; *level:* 10 per second.

General
Power: 100, 120, 220, 240V, +5%—10%. Switchable 48 Hz to 400 Hz.
Dimensions (whd): 178 mm x 406 mm x 305 mm.
Weight: 9 kg.
Price: £2100; US $2950.
Amber Electro Design Ltd, 1064 Chemin du Golf, Montreal, Quebec, Canada.
UK agent: Scenic Sounds Equipment, 27/31 Bryanston Street, London W1.

I BELIEVE the Amber *4400* multipurpose audio test set to be a unique instrument, as it contains within one medium sized cabinet the functions of at least six conventional instruments. To start with, there is a sinewave oscillator covering 10 Hz to 150 kHz; this oscillator can be swept between 20 Hz and 20 kHz or 100 Hz and 100 kHz with a logarithmic sweep which has 11 switch selected speeds between 1 and 1024 seconds.

In addition to the sinewave output, there are function generator outputs of squarewave or triangle. It also incorporates a variable mark/space ratio pulse output and the unusual facility of producing an asymmetrically clipped sine or triangle output—very useful for amplifier overload investigations and such.

Clearly some of these functions are unusual; Amber has, unlike so many oscillator manufacturers, thought about the output requirements for testing modern audio equipment and has provided a balanced/unbalanced output capable of driving up to +33 dBm—the common +20 dBm or so is just not enough these days. Furthermore, the output can be wound down to −80 dBm for use with high sensitivity inputs.

Unusual again—I'm going to keep on using that word—there is a facility for superimposing dc on the output at a variable level which will catch those nasty designs that have dc coupled inputs.

There's much more to come, such as the tone burst facility. This provides tone bursts of either a switched number of cycles between 1 and 1024, or of a switched duration between 16 ms and 16s. By means of a 2-position switch, the bursts may be arranged to start and stop at a zero crossing or be random in amplitude at the start/stop.

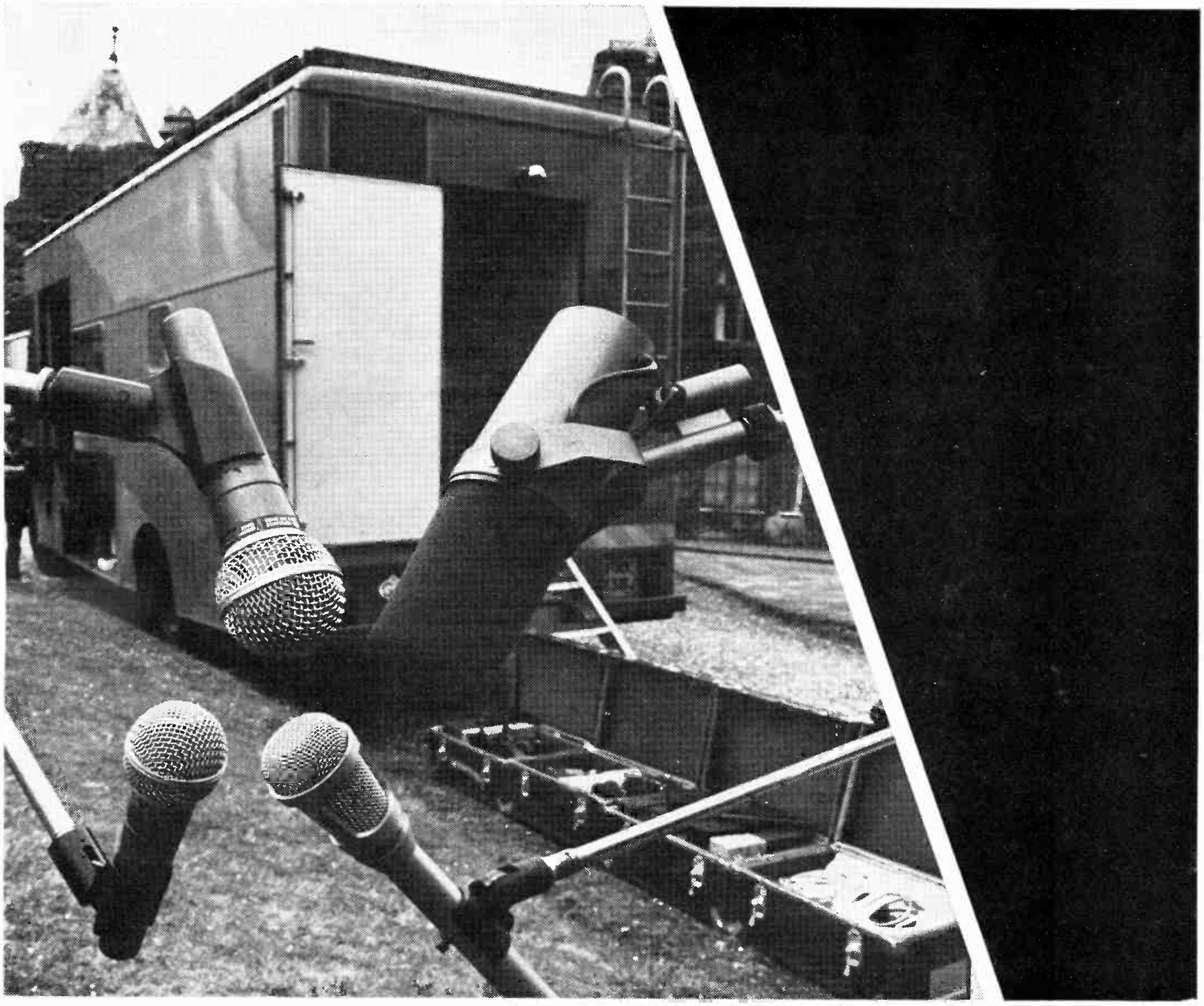
If the above isn't enough, further mention must be made of the sinewave sweeping facilities. This is intended for use in conjunction with an external oscilloscope; the latter displays the serialised contents of a set of internal digital stores overcoming the short persistence of an oscilloscope tube at long sweep times (more about this later). Sweeping may be continuous at the selected speed between 1 and 1024s, or may be single shot at the set speed. It may sweep up or sweep down and can be manually incremented up or down. An automatic variable speed function called 'base line sense' is included. This switched option increases the sweep speed when the signal being examined is below the cursor on the oscilloscope and reduces the sweep speed when the signal amplitude is of interest, thus saving much time when sharp filters are being examined.

So far I have not mentioned how the output level is monitored. The instrument contains a single decimal display which comprises 5½ digits of 7-segment display. This display can be switched to function either as a frequency display when it has a fixed range in integral cycles per second, or it can be switched to function as an autoranging voltmeter when it reads in dBm in 0.1 dBm steps between +30 dBm and −120 dBm and as a true rms reading instrument, and with 'fast' and 'slow' averaging times.

In the frequency mode the display can show oscillator frequency, input signal frequency or the tuned frequency of internal filters. In the dBm meter mode the display can read oscillator output, signal input and a number of other functions.

To revert to the remaining oscillator

60 ▶



functions, in addition to those already mentioned, there is a fast rise/fall time output at fixed level for rise-time testing. In addition to the variable frequency sinewave function a 10-frequency comb generator provides crystal controlled frequencies on the standard ISO octave centre frequencies between 31.25 Hz and 16 kHz with the ability to use any combination of these frequencies; and finally there is a digitally derived pink noise output over the audio spectrum.

And now to the receiving section. I have already mentioned the ability to measure input voltage and frequency with the digital display, but a number of other functions are available via the high impedance balanced input. To start with, there are four pushbuttons which select the metering function which may be wideband (100 kHz), rolled off at 20 kHz or weighted in addition to the fast/slow averaging time. The 'weighted' function is controlled by an internally pluggable network which can be selected to perform the normal A, B or C weightings or other filter functions.

In addition to these fixed functions there are variable frequency and variable Q filters which may be switched to bandpass, band reject, high-pass or low-pass with the ability to determine the tuned frequency from the frequency display. To assist with nulling, there is a small analogue meter with an associated variable gain control, and also a filter output socket for feeding further instrumentation.

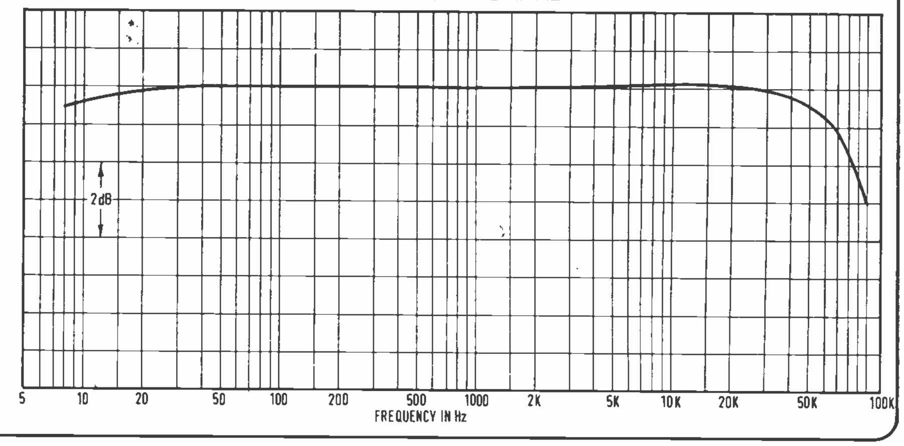
As an alternative to manual tuning, the bandpass and band reject filters may be automatically swept in frequency in the earlier-mentioned 11 steps between 1 and 1024s for sweeps, between either 20 Hz and 20 kHz or 100 Hz and 100 kHz with variable Q available. As if this wasn't enough, the final swept facility is a phase plot which is referenced to a separate phase reference input.

All swept functions which, like the oscillator sweep, may be manually or automatically swept continuously or incrementally up or down, depend upon an oscilloscope for the display. Many swept measurement instruments require the use of a special display oscilloscope, but Amber have completely overcome this requirement by incorporating a 256 x 256 bit digital store, or rather four such stores which may be selected as required. Information is continuously entered into the selected store which may have its contents continuously regurgitated to the oscilloscope at high speed to produce a flicker-free display.

Each of the four stores are identical, with a 60 dB maximum dynamic range with the facility of increasing the resolution of the display in 10 dB increments down to 10 dB full scale. Naturally only one store can, or need be, entered at any time. However the stored information is retained and any single store or pair of stores can be displayed on the oscilloscope. An added feature is that no oscilloscope calibration is required because there is a facility for displaying reference lines on the vertical linear dB axis and also a facility for displaying frequency markers on the logarithmic frequency axis. These markers are derived from the comb generator.

The contents of two stores, when displayed simultaneously, can be either superimposed for direct comparison, or may have the displays separated by a variable amount complete with separate reference lines if required.

FIG.1 AMBER 4400 SINEWAVE OUTPUT LEVEL AT 0dB NOMINAL



The complexity of this instrument makes it impossible to describe all the functions in detail in the space of this review, but it can be appreciated that a large number of controls are involved to obtain all the functions. In this context the front panel layout is a masterpiece of ergonomics with the various functions clearly identified and each functional section of the front panel divided into subtly chosen colour shades. Switches are either clearly calibrated rotary types or the 'self-illuminating' pushbutton types with well chosen colours. However, I do have to complain about the lack of brilliance of the various indicator lamps which take the form of recessed red led indicators.

Internally, the instrument is based on three large glassfibre printed boards which are of good quality and properly identified with component references. I was rather horrified to note the proximity of mains voltage conductors to other conductors which are in connection with the chassis.

The main case is of fairly solid construction and is fitted with a carrying handle/tilting foot. In the latter application (which is definitely necessary for bench use) the means of securing the foot was unreliable, with the result that the instrument descended on to the bench with a resounding crash from time to time! At the rear of the instrument, there is a very neat IEC mains connector cum fuseholder (imperial size) and mains voltage selector. In addition there are two multi-pole connectors for use with ancillary test gear which is said to be underway from Amber.

Oscillator performance

Dealing first with the variable frequency sinewave function, the flatness of the manual variable or the swept modes is shown in **fig. 1**, from which it is apparent that the performance is considerably better than specification over the audio band, but that above 30 kHz there is an undesirable droop in the output to the extent of −3 dB at 100 kHz.

Sinewave distortion was likewise far better than specification with the actual harmonic products being at an extremely low level, but as is usual with function generator type sinewave synthesisers, there being a fair amount of 'rubbish' in the output which reflects in the measurement of total apparent harmonic distortion.

frequency	second harmonic	third harmonic	apparent total harmonic
125 Hz	0·005%	0·034%	0·045%
1 kHz	0·005%	0·008%	0·038%
6·3 kHz	0·005%	0·010%	0·044%
10 kHz	0·005%	0·013%	0·052%
20 kHz	0·034%	0·045%	0·068%

The accuracy of the indicated frequency was within ±1 display digit, ±1 Hz, which is the best accuracy that can be obtained with the adequate size of display in use.

The output attenuator accuracy was within ±0.2 dB up to 100 kHz and even better at 1 kHz; but some care is required when interpreting the actual output voltage. The arrangement is such that output level metering and output monitoring to the oscilloscope is located between attenuator sections, such that the true output is neither being metered (as is common with oscillators) or observed on the monitor oscilloscope. The result is that the effects of loading do not become apparent, and, even worse, the oscillator is capable of driving its output stage into clipping at +32.5 dBm (+33.5 dBm unloaded?). A further complication of the output metering is that the level calibration is nominally arranged to indicate the output level when loaded into 600 ohms, thus giving a 0.7 dB under reading when the nominal 50 ohm source impedance output is unloaded. Personally I would have preferred the metering to have been correct when unloaded, for just how often is one working into 600 ohms?

The pink noise output level was found to be -20 dB rms relative to the sinewave output which gives more than adequate allowance for the crest factor of the pink noise, and the frequency spectrum in the audio range was adequately accurate as shown in **fig. 2.**

The remaining output waveforms had the same peak voltage as the sinewave output when the waveform was changed, with true rms metering. In the case of both the square and the triangle outputs, the symmetry was, perhaps, not as good as might be expected, this being tied to the measured 1:1.17 mark/space ratio of the square output. Squarewave rise and fall times at the main output depended slightly on frequency but remained about 3 μs with a low frequency tilt of 4% at 20 Hz which could do with improvement. At the separate 'pulse' output 4.2V peak-to-peak was available with a measured rise time of 300 ns and fall time of 500 ns; both are in excess of specification, but are anyhow quite fast enough for audio work.

Regarding the comb generator, the frequency of any selected frequency was within five parts in 10^5 with amplitude variations between individual frequencies being less than ± 0.2 dB; total harmonic distortion consistently around the 1% mark with the third harmonic predominant. Individual comb frequency outputs were set 10 dB below the normal sine output, such that when all frequencies were selected, the output was virtually the same rms output as the sinewave output. However, someone forgot the matter of crest factors! Select more than six simultaneous frequencies and something clips at any output level.

The remaining facility which can come under the heaving of the oscillator is the tone burst facility which can burst any selected waveform including pink noise. While the latter cannot be bursted for a selected number of cycles (which would be meaningless anyway) it can, like the other waveforms, be started and stopped at zero crossings if desired. No trouble was found with bursting the fixed numbers of cycles, but a logical error has crept in the burst time mode such that the time calibrations should be divided by two—this for some reason did not apply to sweep time which uses the same switch.

Digital voltmeter frequency meter performance

To take the simplest part first, the frequency meter was found to be accurate to within four parts in $10^5 \pm 1$ digit, a creditable performance. The required input voltage for correct frequency indication was a worst case of 2.5 mV at 200 kHz falling to less than 1 mV within the audio frequency band for a sinewave input.

The voltmeter section, which reads in dBm, works on a combination of autoranging over a 60 dB range and manual ranging in three overlapping 30 dB steps. The autoranging sections of the overall range were within ± 0.1 dB at 1 kHz, but errors were about 0.3 dB for the manual step 0 to –60 dBm and 0.5 dB for the –30 to –90 dBm range. Below –90 dBm the meter was too affected by noise to be useful in the wideband mode.

As is shown in **fig. 3** the frequency response was flat up to 10 kHz on all ranges and useful up to 20 kHz, above which the accuracy depended upon the range selected and became unreliable.

While the provisional instruction book gives an indication of the useful range of the voltmeter section, I suggest that the manufacturer should give clearer information in the publicity material.

In addition to the unweighted mode, two weighted frequency responses are available, a 20 kHz low-pass weighting and one of the standard weighting networks which were not in fact fitted to the review instrument. The very useful response of the 20 kHz low-pass filter is shown in **fig. 4**, which demonstrates a good characteristic for rejecting such things as tape recorder bias.

Selective measurements

Four filter functions are provided to cope with high-pass, low-pass, bandpass and band reject; the latter two functions being capable of being automatically swept in frequency. All four functions are tunable from 20 Hz to 100 kHz and are also affected by the variable Q control, the effect of this on a fixed frequency bandpass function being shown in **fig. 5**. It is to be seen that unfortunately the maximum Q setting reduces the overall gain by 9 dB, which is, to say the least, an irritating feature. However, at the maximum Q setting the second harmonic is attenuated by a good 30 dB thus providing a quite useful wave analyser function, particularly in the swept frequency mode.

A similar situation exists in the band reject function and the effect of the Q control on the high-pass function is shown in **fig. 6**, the low-pass characteristic being a mirror image of this plot.

An unusual feature of the selective section is that the tuned frequency can be read from the frequency meter, and this in conjunction with the bandpass mode is a very useful facility.

Storage and display

All that is required in the way of a display is an oscilloscope with a sweep time of 2 ms which can be externally triggered, and a vertical sensitivity which can display a 4.5V peak-to-peak signal: the output from the Amber simply being two connectors, one for the trigger and the other the signal.

In fact the only function of the Amber which cannot be used without a display is the phase measurement section, this providing plots of

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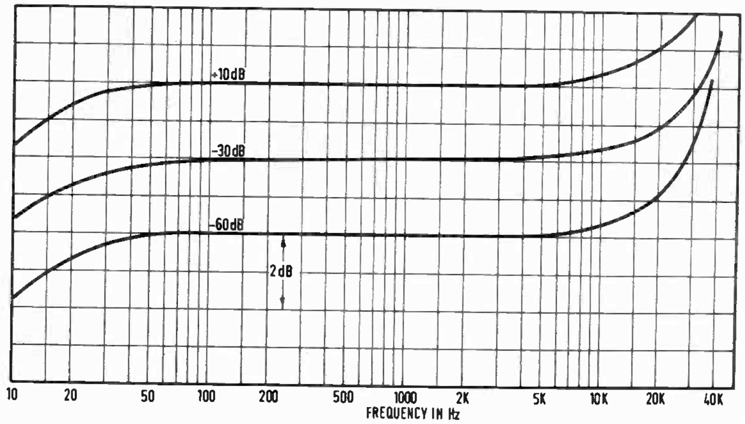
FIG. 3 AMBER 4400 METER



Response error of voltmeter section for nominal readings of +10, —30 and —60 dB:
For +10 dB error was +6·4 dB at 50 kHz and —12 dB at 100 kHz
For —30 dB ,, ,, +6·6 dB ,, ,, ,, —16 dB ,, ,,
For —60 dB ,, ,, +6·4 dB ,, ,, ,, —16·9 dB ,, ,,

FIG. 2 AMBER 4400 CONSTANT BANDWIDTH ANALYSIS OF PINK NOISE OUTPUT

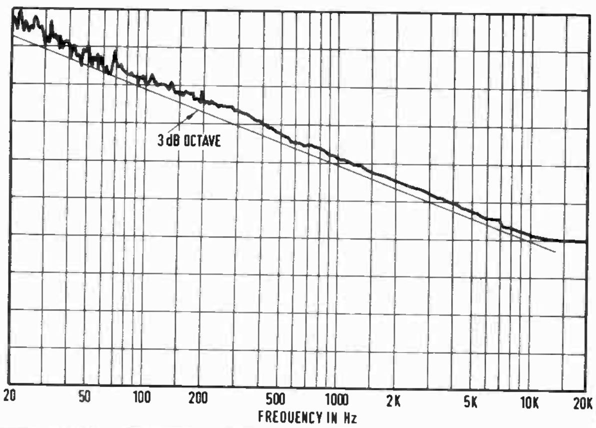


FIG. 4 AMBER 4400 20kHz FILTER AT 0dBm

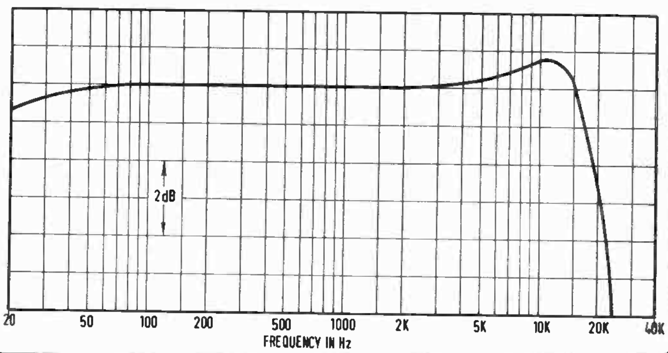


FIG.5 EFFECT OF Q CONTROL ON BANDPASS

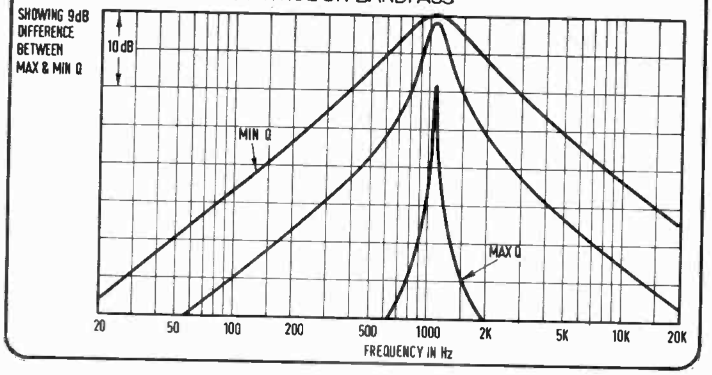
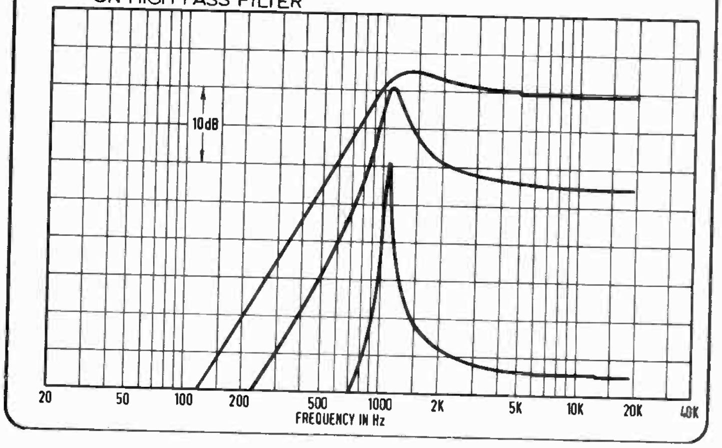


FIG.6 AMBER TEST SET EFFECT OF Q CONTROL ON HIGH PASS FILTER



AMBER 4400

phase against time or against frequency. This function was found to be of excellent accuracy, **fig. 7** showing the phase vs frequency plot and the frequency response of a 'B' weighting network as a simultaneous display of two stores.

The total of four available stores means that reference information can be permanently stored (provided the power remains on) and direct comparisons made as a result of the capability of displaying any two stores simultaneously, there being a display offset facility for overlaying the two displays.

As is shown in **fig. 7**, the comb generator provides frequency markers as desired and one of the other beauties of the display is the ability to select full-scale deflection between 10 dB and 60 dB in 10 dB increments, over the input range +30 dBm to −120 dBm. However, it was found that the accuracy of measurement was rather poor on the more sensitive settings to the extent of 1.2 dB error over full scale.

Summary

The Amber multipurpose audio test set is by far the most versatile piece of audio testgear that I have met, and at a very low price tag for the facilities included.

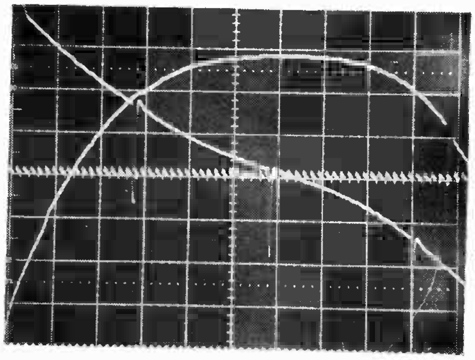


FIG. 7 30 dB: 125, 1k, 8k, 20/20k.

As a result of the complexity of the instrument, I have been unable to describe many features and applications in the space of this review, and I recommend readers to ask the manufacturer for more information if they are interested in this type of instrument.

Bearing in mind that this is a new instrument, it is not surprising that I have found a number of snags, but I am confident that Amber will pay attention to my criticisms. In particular, I would like to see a better defined manufacturer's specification as, in a few respects, the existing literature is misleading. Clearly this is not intentional, but is the result of trying to get a quart into a pint pot.

So far as performance is concerned, the instrument does not, and is not intended to, compete with the Bruel & Kjaers and General Radios of this world; but, if one considers the common testgear in use in maintenance work, the Amber is a good performer at far less cost than the equivalent facilities in the form of individual pieces of testgear. ■

With reference to this review we are pleased to have received from Amber the following comments which are generally in agreement with the technical findings of the review. There is however a divergence of opinion about some of the operational aspects and it is up to the reader to form his own opinion.

1. Capability of clipping in power amplifier output.

The output amplifier clips at just over +33 dBm. This is the specified maximum output and can be read on the instruments level meter. An indication, other than the digital readout, was not felt necessary as very few tests will involve such high levels and good measurement practice will avoid output clipping.

2. dBm level meter requiring a 600 ohm termination on power amplifier output.

In fact the meter can be very easily recalibrated to read correctly into bridging loads if these are more often encountered.

There are several ways this circuit could have been designed. The best would have provided a complex isolation and gain switched preamp across the actual output terminals and measure the actual output signal. This would have added what we felt was unwarranted cost. Another approach would have used a lower impedance output attenuator to minimise the effect of output loads. This would have caused large power dissipation in the power output stage with resulting heat generation, increased distortion etc. The approach we used, that of monitoring the input to the power amplifier and making the assumptions of the output attenuator accuracy and load impedance was felt to be the best compromise.

3. Oscillator output 3 dB down at 100 kHz.

In general the instrument is designed for 20 Hz to 20 kHz range and is provided to give an approximate 'look' at performance above 20 kHz. The design of a particular circuit always involves trading performance specifications, cost, features, etc. We felt, for example, that high output capability was more important than response beyond 50 kHz, so the power amplifier was optimised for power output over a 50 kHz bandwidth in place of a lower output capability over a larger bandwidth.

4. Front panel visibility and cosmetics.

The initial panels we received from our supplier had excessive attenuation of the led light transmission. These panels have since been improved and steps have been taken to provide better alignment of the led's with the front panel.

5. Carrying handle not sturdy.

We feel the locking knobs provided satisfactorily hold the handle and the instrument in a convenient operating position. Again, for added cost a locking mechanism similar to that supplied on oscilloscopes could be provided but the tooling costs for such a feature are formidable.

6. Gate on times one half front pane designations.

We have red faces over this one. A simple logic error which for some obscure reason went undetected until this time. Corrective action has been taken to modify all units, including those already delivered (change is a simple one).

7. Comb generator clips when more than six frequencies are selected simultaneously.

This was carefully checked on a number of production units and not found to be the case. I can only assume that the unit received had a defect—amplitude calibration controls set too high or incorrect and excessive gain in the summing amplifier.

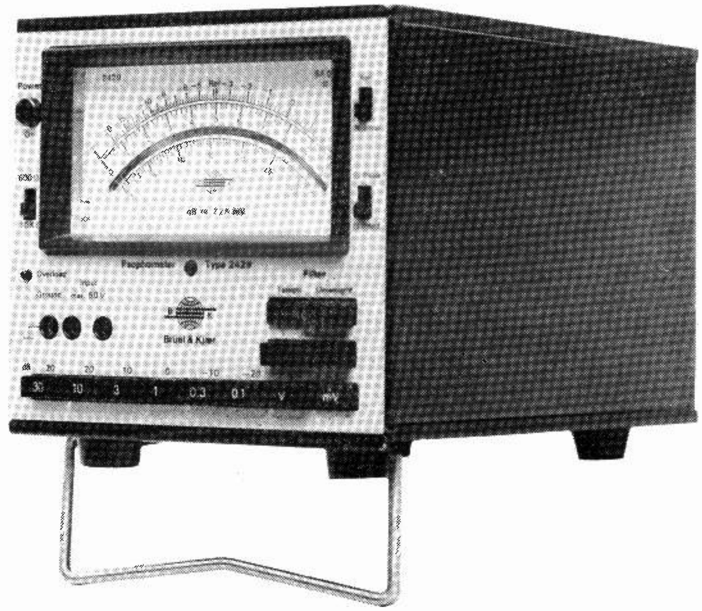
8. Square wave duty cycle not exactly 50%. Steps are being taken to correct this. The pulse wave can, of course, be set to exactly 50%.

9. Q control affects centre frequency gain.

The manual should have stated the Q control does not significantly affect passband gain. The intent was to exemplify the difference between two possible techniques for varying the Q. One has constant out of band gain with varying passband gain—the skirts remain fixed in the bandpass mode while the peak raises or lowers. The second method, the one employed in the 4400, maintains reasonably constant centre frequency gain but varies the out of band gain—the top of the peak is reasonably constant while the skirts move. This latter technique gives varying energy through the filter but avoids clipping as the Q is increased. Using the former method would necessitate reducing the input level as the Q is increased to avoid overdriving the filter or succeeding stages.

Brüel and Kjaer Psophometer

Hugh Ford



MANUFACTURER'S SPECIFICATION

Input: connector; in accordance with DIN *41 628*. Construction: symmetrical in accordance with CCITT Recommendation *P53*. Impedance: 600 ohm ±2% or greater than 10k ohm (both symmetrical).
Amplifiers: voltage range: 100 μV to 30V fsd in 10 dB steps. dB range: —78 dB to +32 dB fsd relative to 775 mV. Output: 3.16V rms corresponding to fsd (BNC). Output impedance: less than 5 ohms short-circuit protected. Gain range: +90 dB to —20 dB. Attenuator: 12 pushbutton combinations, with overload indication of illogical settings. Earphone output: 3.16V rms corresponding to fsd, 600 ohms.
Overload margins: pre-filter overload indicated by flashing led. Pre-filter: at least 30 dB. Pre-telephone filter: at least 30 dB. +20 dB per decade below 1500 Hz (approx 60 dB at 50 Hz). Post-filter: at least 20 dB in accordance with CCIR *468-1*.
Weighting networks: 1) *Unweighted* in accordance with DIN *45 405*.
2) *Telephone* in accordance with CCITT *P53* and DIN *45 405*.
3) *Radio 1* in accordance with CCITT *P53* and DIN *45 405*.
4) *Radio 2* in accordance with CCIR *468-1*.
All filters are solid state active circuits.
Noise: equivalent input noise utilising the rms detector. 1) *Unweighted* less than 8 μV. 2) *Telephone* less than 6 μV. 3) *Radio 1* less than 10 μV. 4) *Radio 2* less than 14 μV.
Detectors: Q-rms detector: in accordance with CCITT *P53*. Q-peak detector: in accordance with DIN *45 405* and CCIR *468-1*. Dc output: 3.16V dc corresponding to fsd (BNC). Impedance: 47 ohm short circuit protected. Linearity: linearity of both detectors re fsd, 0 dB to —10 dB ±0.2 dB, +10 dB to —20 dB ±0.5 dB.
Power supply: 100 to 250V ac line 50 Hz to 400 Hz or two 18V to 25V batteries.
Temperature range: 5 to 40°C.
Weight: 3.4 kg approx.
Dimensions (hwd): 132.6 x 139.5 x 200 mm.
Price (at August 1976): $2100.
Manufacturer: Bruel & Kjaer, DK-2850 Naerum, Denmark.
UK: B & K Laboratories Ltd, Cross Lances Road, Hounslow, Middx.
US: B & K Instruments Inc, 5111 West 164th Street, Cleveland, Ohio 44142.

WHAT on earth is a PSOPHOMETER? You may well ask. Well, it doesn't appear in my dictionary but is pronounced something like pissometer and it's used to measure noise . . . in communications systems.

Actually, the Bruel & Kjaer *2429* psophometer is a multi-range voltmeter equipped with noise weighting networks and rectifier characteristics fulfilling the requirements for noise measurement to the latest standards in audio equipment in the broadest context.

Until fairly recently there have been very few instruments which have been capable of measuring noise to the CCIR weighting characteristic which has been shown to give a far better correlation with the subjective effects of noise than earlier weighting curves. Furthermore, meters which comply with the DIN quasi-peak rectifier characteristic and the DIN standard *45 405* for ballistic performance have, I believe, been restricted to one manufacturer who has sold the instruments under more than one trade name.

In the interests of international standardisation, Bruel & Kjaer have taken this horrible muddle to task and produced an instrument which is up to date in conception and provides both the necessary weighting curves and the standard rectifier characteristics, but at a price which, in terms of the £ sterling, is astronomical. However, having recently visited Denmark, I have learnt that if you divide the cost of things by two to allow for the Danish cost of living, the prices become realistic. Since there is no alternative instrument yet available, you have to pay the cost if you need to make these measurements of noise.

While there are alternative instruments available with the CCIR *468-1* weighting curve, none of these have the quasi-peak reading meter which is demanded by CCIR *468-1* and which is identical to the DIN requirement as per DIN *45 405*.

The Psophometer also offers a floating input which may either be a fairly high impedance or be terminated into 600 ohms. A rear panel facility for listening to the weighted noise on headphones in included.

The form of construction is the now familiar B & K Cassette modular system with a clearly scaled and illuminated front panel meter complete with anti-parallax mirror. Meter scaling comprises a dB scale ref 0.775V from +2 dB to –20 dB and two voltage scales covering 0 to 10 and 0 to 3. These scales operate in conjunction with two pushbutton attenuators, one is a 60 dB step providing volts or millivolts scaling; the second consists of six interlocked pushbuttons which provide 10 dB steps thus providing full-scale sensitivities between 100 μV and 30V (–80 dB to +30 dB ref 0.775V).

The desired frequency response weighting is selected by four further interlocked pushbuttons which allow an unweighted function or any of three weightings which are 1) *Telephone* weighting to CCITT *P53*, 2) *radio 1* weighting to DIN *45 405* and CCITT *P53*, and 3) *radio 2* weighting to the recent CCIR proposal *468-1*. From the audio equipment user's point of view, the latter is the most valuable curve. For the cost of this instrument, it is unfortunate that the common 'A' weighting has not been included. Furthermore, as will be seen the *unweighted* condition does not follow the recommendations of CCIR *468-1* for unweighted measurements, but complies with the requirements of DIN *45 405* unweighted standards which, so far as I am aware, are little used.

I have discussed the problems of other weighting networks and alternative 'unweighted' frequency responses with Bruel & Kjaer, and I am informed that the instrument will be available with a number of alternatives which will be achieved by changing the internal printed circuit boards to alternative types.

Overload of the pre-weighted or post-weighted signal electronics is indicated by a red led on the front panel. This unusual feature is a valuable asset since it is easy to obtain false noise measurements in most meters which run into peak clipping; these may not give significant meter deflections if high crest factors are involved.

Input to the meter is via three sockets which accept standard 4 mm banana plugs or a special three-pin plug to DIN *41 628* which is probably almost unknown outside Germany! One input pin is signal ground within the electronics, while the remaining two pins are the floating input selectable to 600 ohms or high impedance by means of a front panel slide

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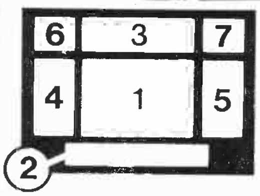
ROLAND
ROLAND SYNTHESIZER
SYSTEM 700



The complete system consists of the MAIN CONSOLE, the KEYBOARD CONTROLLER, and five optional blocks for a total of 47 modules.

MAIN CONSOLE:
The MAIN CONSOLE contains all the basic modules necessary in a professional system for the synthesizing of sound and can be used alone with the KEYBOARD CONTROLLER as a complete synthesizer in itself. Modules included are: VCO (3), VCF (2), VCA (2), LFO (2), S/H, ADSR (2 x 1), OUTPUT MODULE (which includes PANNING controls, REVERBERATION, and a PHASE SHIFTER), and others.

KEYBOARD CONTROLLER:
The 61 key (5 octave) two voice KEYBOARD CONTROLLER has PORTAMENTO and PITCH BEND controls.

OPTIONS:
Optional blocks can be chosen and arranged according to the particular needs of each studio. All of the modules in the optional blocks are interchangeable, thus the numbers and types of modules can also be changed to suit the studio. The main modules of the optional blocks are: BLOCK 3 ≪Sequencer≫: 3 channel, 12 step sequencer; BLOCK 4 ≪VCO bank≫: VCO (6), ADSR (2 x 1); BLOCK 5 ≪VCF/VCA bank≫: VCF (2), VCA (3), ADSR (2 x 2),; BLOCK 6 ≪Interface/Mixer≫: frequency-to-voltage converter interface, 9 channel audio mixer, fixed filter bank, VCA; BLOCK 7≪Phase Shifter/Audio Delay≫: 2 channel phase shifter, 2 channel audio delay.

MAIN FEATURES:
All modules are made from high quality parts to ensure high reliability and durability with circuit designs which give high stability for ease in recording perfect sounds.

All major modules contain both audio signal input and control voltage input mixers for better signal to noise ratios and ease in synthesizing sounds.

Input and outputs are designed for matching with other professional audio equipment for ease of use in the studio.

On the MAIN CONSOLE, most common connections are made internally without the use of patch cords. All modules have provisions for external patch cord connections for greater freedom in patching.

External sound sources (such as other musical instruments) can be used as a source of control.

The PULSE SHAPER and the sequencer's MASTER CONTROLLER input and output jacks allow the recording of consecutive sequences on tape without a break in rhythm.

Except for the MAIN CONSOLE, all modules are completely interchangeable and can be arranged to suit individual tastes. (The MAIN CONSOLE can be special ordered direct from the factory in other arrangements).

A complete system, the System 700 contains all the elements necessary for the synthesis of sound.

Roland's 'System' Synthesizer Series are specifically engineered for professional recording studios. The top-of-the-line 700 provides full control over all synthesizer functions, extremely stable output and a frequency range from 0.1 to 100kHz. And this revolutionary new product is one of the most competitively priced, full-feature units on the market today.

Roland

Brodr Jorgensen (UK) Ltd., Unit 6, Great West Trading Estate, Great West Road, Brentford, Middx. Phone. 01-568 4578.

switch. The final front panel facilities consist of a pair of slide switches, one of which selects the rectifier characteristic to be quasi-peak of quasi-rms and the other of which injects a fixed level 1 kHz tone for meter calibration.

At the rear of the instrument there is the IEC mains connector and a voltage selector/ fuse holder which are properly identified and provide for all the common mains voltages. There are next two banana sockets/terminals which may be linked to connect the signal ground to the chassis or may be used otherwise to avoid ground loops. While these are on standard 19 mm spacing, two similar connectors for headphone monitoring are annoyingly on non-standard spacing. Two BNC sockets provide an ac output at 3.16V rms corresponding to full-scale meter deflection and 3.16V dc on a linear scale. Finally there is a 7-pin DIN socket which duplicates these two outputs and also provides for dc powering of the instrument from ±18 to ±25V sources in addition to allowing variation of the meter time constant by means of an external capacitor.

Like the DIN sockets found in other recent B & K equipment, this is of the cheap and nasty non-locking type—I really do think that the use of such domestic quality connectors on this class of equipment is absurd.

The internal construction of the instrument is another story with the best quality printed boards, six of which plug into a mother board by means of gold plated pin-type connectors. Only good quality commercial components are used and, as is to be anticipated, the standards within the instrument are first class.

Performance

The frequency response from the input to the ac output (which is identical to the meter indication) is shown in **fig. 1** in the *unweighted* condition. It shows that the high frequency response has been rolled off very rapidly with the –3 dB point at 24.5 kHz and that the low frequency end has been cut. This response meets the DIN unweighted standard which is different from the more important CCIR *468* document.

Close examination of the CCIR and the DIN weighting networks—the broad characteristics of which are shown in **fig. 2**—showed that the instrument followed precisely the DIN curve with negligible discrepancies. In the case of the CCIR curve the mid to low frequency performance was also precise but in the early review sample a known error existed in the very rapid high frequency roll off. In the unweighted mode the overall response was not particularly flat and in my opinion rather disappointing with the following tolerances with respect to 1 kHz which are within the DIN unweighted tolerances: 30 Hz –0.4 dB, 37 Hz –0.2 dB, 1 kHz 0 dB, 10.3 kHz +0.2 dB, 16.8 kHz +0.4 dB, 20.7 kHz 0 dB.

It was pleasing to note that the frequency response was not affected by the attenuators and that, while the 60 dB attenuator was very accurate, it was again unfortunate that one step in the 10 dB selector introduced an error in excess of 0.2 dB which is excessive for this class of instrument. The attenuator errors in terms of step error and cumulative error are shown in **fig. 3**, illustrating this criticism. This defect will, I am assured, be corrected in later production.

In contrast the scaling error and readability combined as shown in **fig. 4** was minimal and the scale calibrations were well chosen for maximum resolution. The absolute accuracy of the instrument is checked by means of a 1 kHz internal reference oscillator arranged such that half scale should be indicated with all weighting networks. When the instrument was warm this level check was found to be 1.4% too low, the situation being reasonable when warm but the –2.4% error when cold is on the excessive side. Again I am told that this defect is peculiar to the pre-production batch.

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FIG.1 B&K 2429 UNWEIGHTED FREQUENCY REPONSE

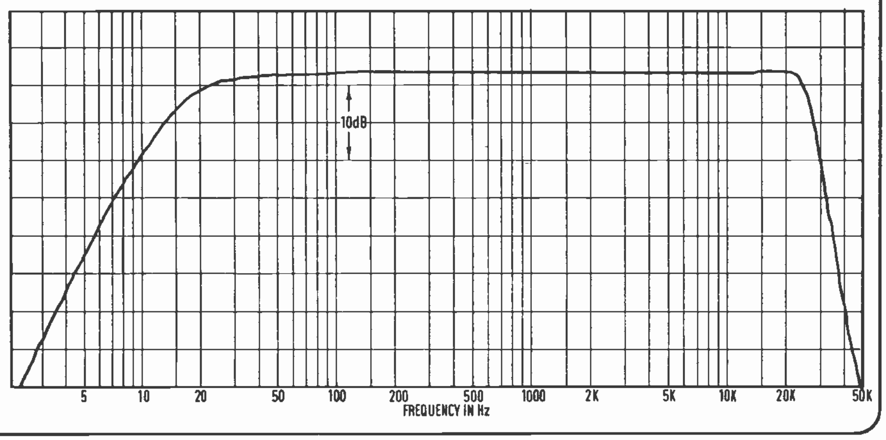


FIG.3 ATTENUATOR ERROR REF 30V RANGE

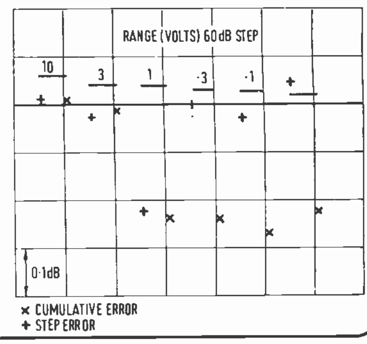


FIG.2 B&K 2429 WEIGHTING NETWORKS

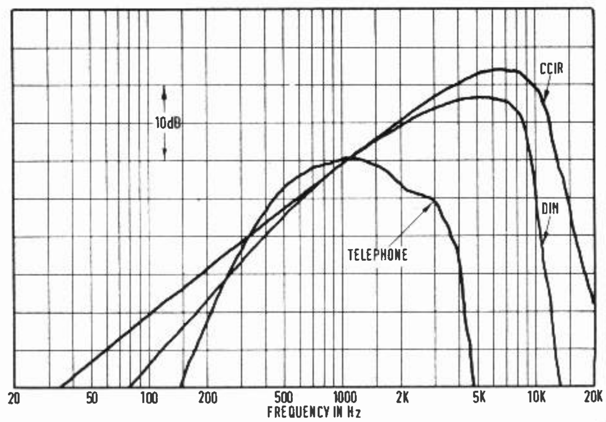
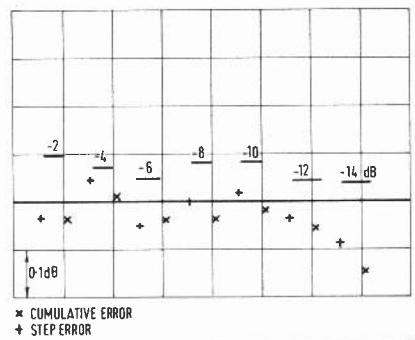


FIG 4 SCALE ERROR IN 2dB STEPS REF F.S.D



BRUEL & KJAER PSOPHOMETER

Precise checking of the overload points in the instrument were difficult without delving into the circuit, but a fairly general check showed that the input end had at least 40 dB margin for normal conditions and the post filter section in excess of 20 dB—no cause for complaint here.

Similarly the inherent noise was found to be well below the specifications, but care had to be exercised with the ac output from the points of view of headroom and of noise; the same applies to the headphone output which appeared to be in parallel. Firstly, the nominal rms output of 3.16V corresponding to full-scale deflection was accurate, but the margin above this level at the onset of output clipping was 10 dB which meant that the output could clip below full-scale deflection and without indicated overload conditions. Secondly, the minimum dynamic range did not correspond to maximum instrument gain as would normally be anticipated but occurred at relatively high input signal levels. The result was that both the ac output and the headphone output had minimum dynamic range under unexpected attenuator settings which meant that the 20 Hz to 20 kHz noise was only 50 dB below 3.16V rms corresponding to full-scale deflection. In some circumstances, these matters could create a limitation.

Output impedance at the ac output was extremely low and that at the headphone output was 560 ohms, which provided an adequate impedance and level for many types of headphone without interaction with the ac output. Furthermore neither output interacted with the meter indications.

The dc output which also gave 3.16V for full-scale deflection (with a ceiling of 14V) was proportional to meter deflection and was found to be accurate to better than 0.1 dB down to –20 dB meter indication and to have a satisfactory output impedance of 44.7 ohms.

Checking the quasi-peak meter characteristics showed that the effective ballistics complied precisely with the nominal centreline of the CCIR and the DIN standards and the meter calibration was such that switching between quasi-peak and rms detection did not alter the meter deflections, as is correct.

So far as the rms rectifier is concerned, this is a true rms rectifier but the effective meter ballistics are not to the commonly used 'fast' international standard. The effective ballistics are in fact designed to meet the requirements of CCITT *P53* to the test method suggested by the UK Post Office. This has resulted in an instrument which overshoots by 0.8 dB when a continuous level is suddenly applied, the 0 to –20 dB fall and rise times being 360 ms and 190 ms respectively.

Summary

The B & K *2429* psophometer is an instrument which fills a long-standing gap in noise measurement; however, it will also make a very large gap in your bank balance. So far as its concept is concerned, the instrument is rather restricted to fill this specialised gap in the CCIR noise weighting and quasi-peak standard meter field, in addition to the CCITT *telephone* weighting problem.

Unfortunately, with the exception of 'home made' instruments there is a distinct lack of suitable instrumentation to meet these established standards. If you tot-up the real costs of 'home made' instruments, the *2429* could be a reasonable investment and it must be remembered that Bruel & Kjaer represent an international standard as a result of the worldwide use of their measuring equipment.

Bearing in mind that the review sample was one of the first production batch of 'demonstration' instruments, one may be able to forgive the shortcomings found in this sample, but in my experience of Bruel & Kjaer, while the detailed matters may be a sample defect, the overall concept of this instrument is restricted to a limited range of specialised measurements and it will take time to change them. ■

Meet the New Leader....

S.500D Specification Features

- * Power output 340W R.M.S. into 4 ohms
  500W R.M.S. into 2.5 ohms
- * Bridged Mono output 900W R.M.S. into 5 ohms
  640W R.M.S. into 8 ohms
- * Intermodulation Distortion Less than 0.02% from 20Hz to 20KHz F1 60Hz.
- * Integral "Force Cooled Dissipators" for reliable operation into adverse loads.
- * Power Bandwidth +0, −1dB from D.C. to 20KHz.
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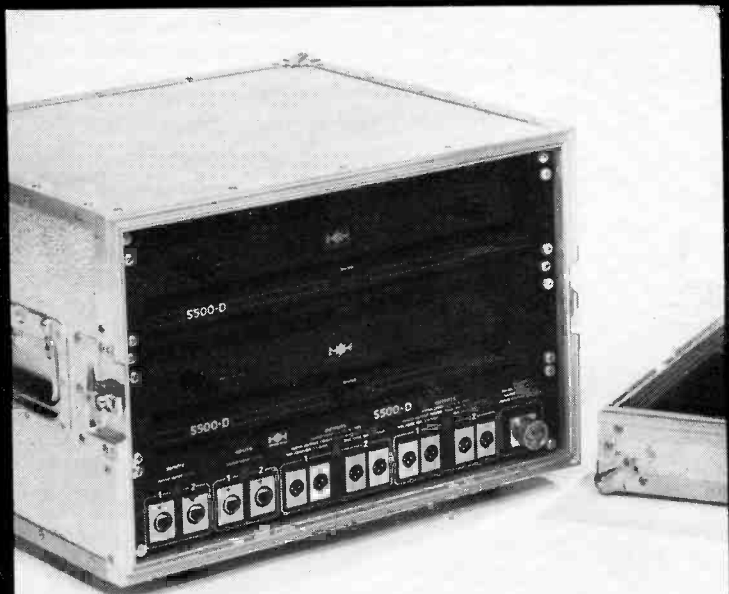

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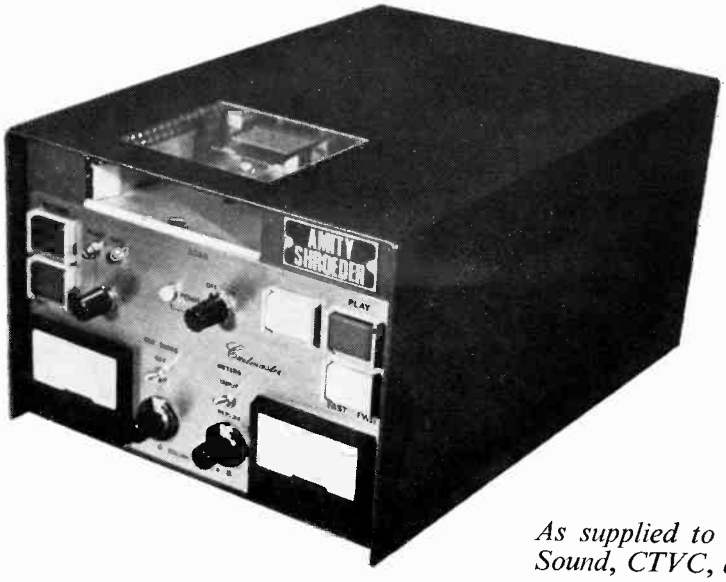

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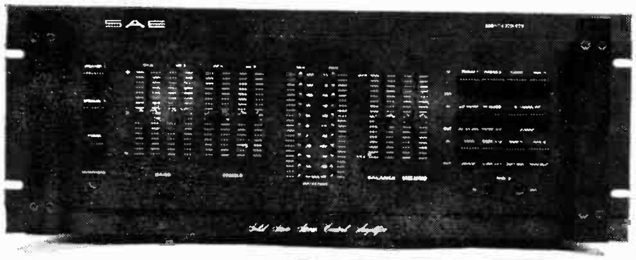

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Advertisements for this section must be pre-paid. The rate is **14p** per word, minimum **£2.80.** Box Nos. **35p** extra. Semi-display rates on application. Copy and remittance for advertisements in **March 1977** issue must reach these offices by **20th January 1977** 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. **SEX DISCRIMINATION ACT 1975:** No job advertisement which indicates or can reasonably be understood as indicating an intention to discriminate on grounds of sex (e.g. by inviting applications only from males or only from females) may be accepted, unless (1) the job is for the purpose of a private householder or (2) it is in a business employing less than six persons or (3) it is otherwise excepted from the requirements of the Sex Discrimination Act. A statement must be made at the time the advertisement is placed saying which of the exceptions in the Act is considered to apply.

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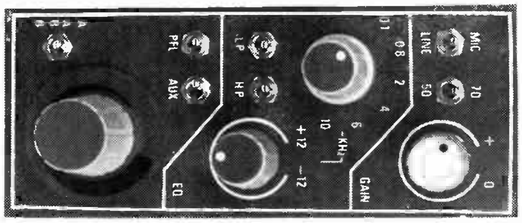

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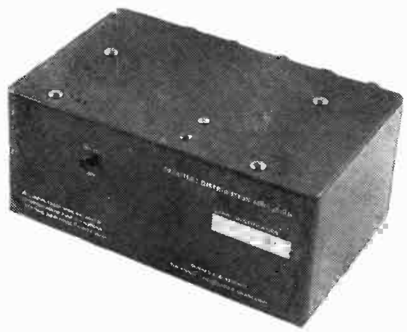

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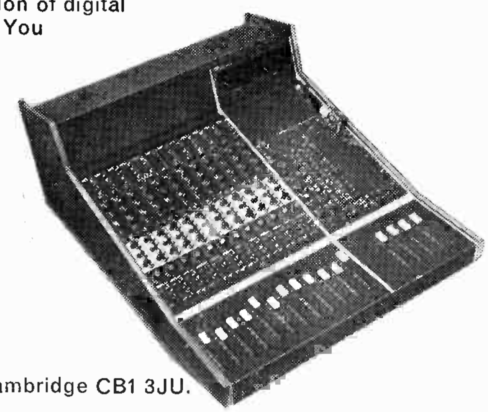

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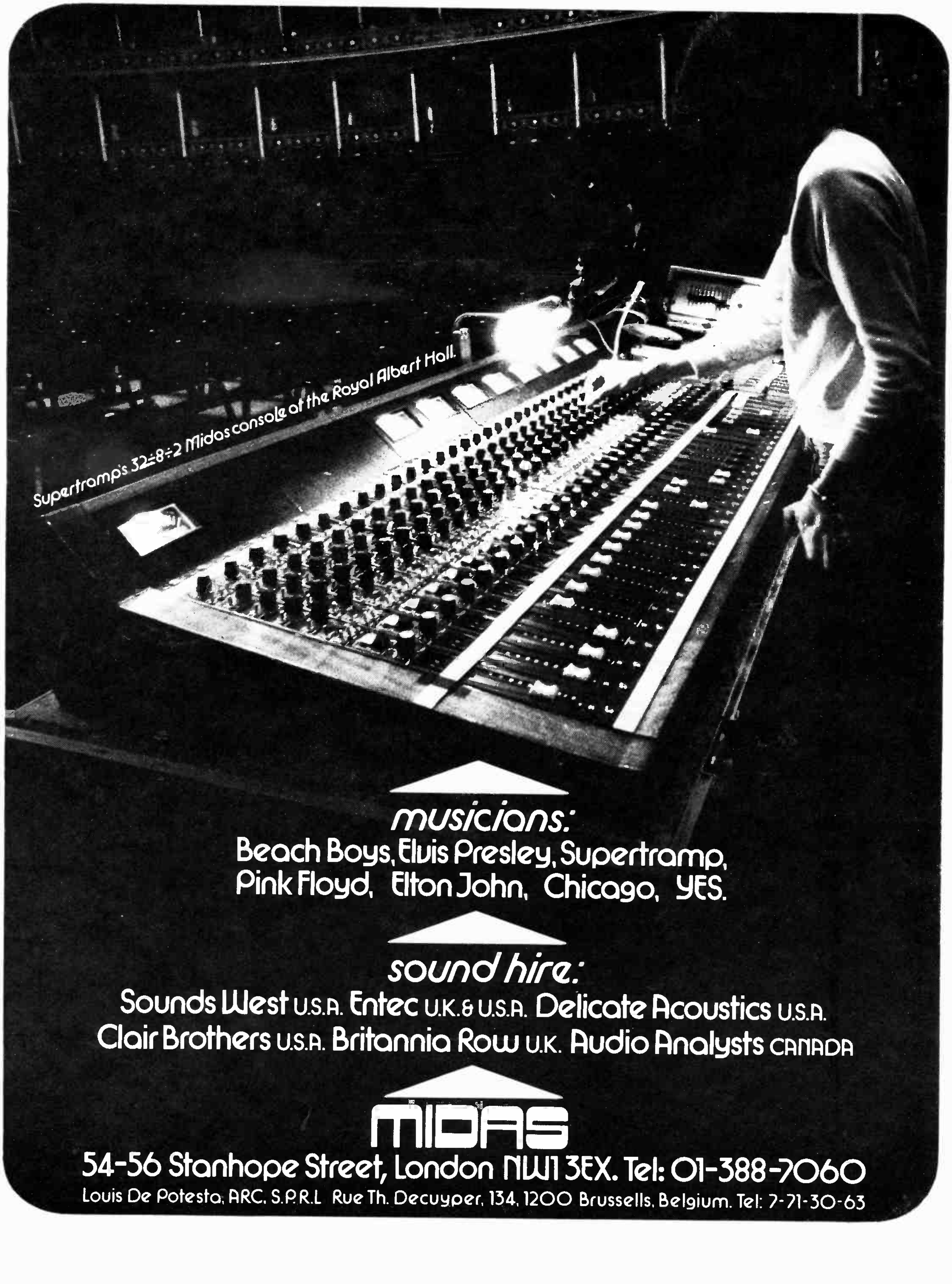
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