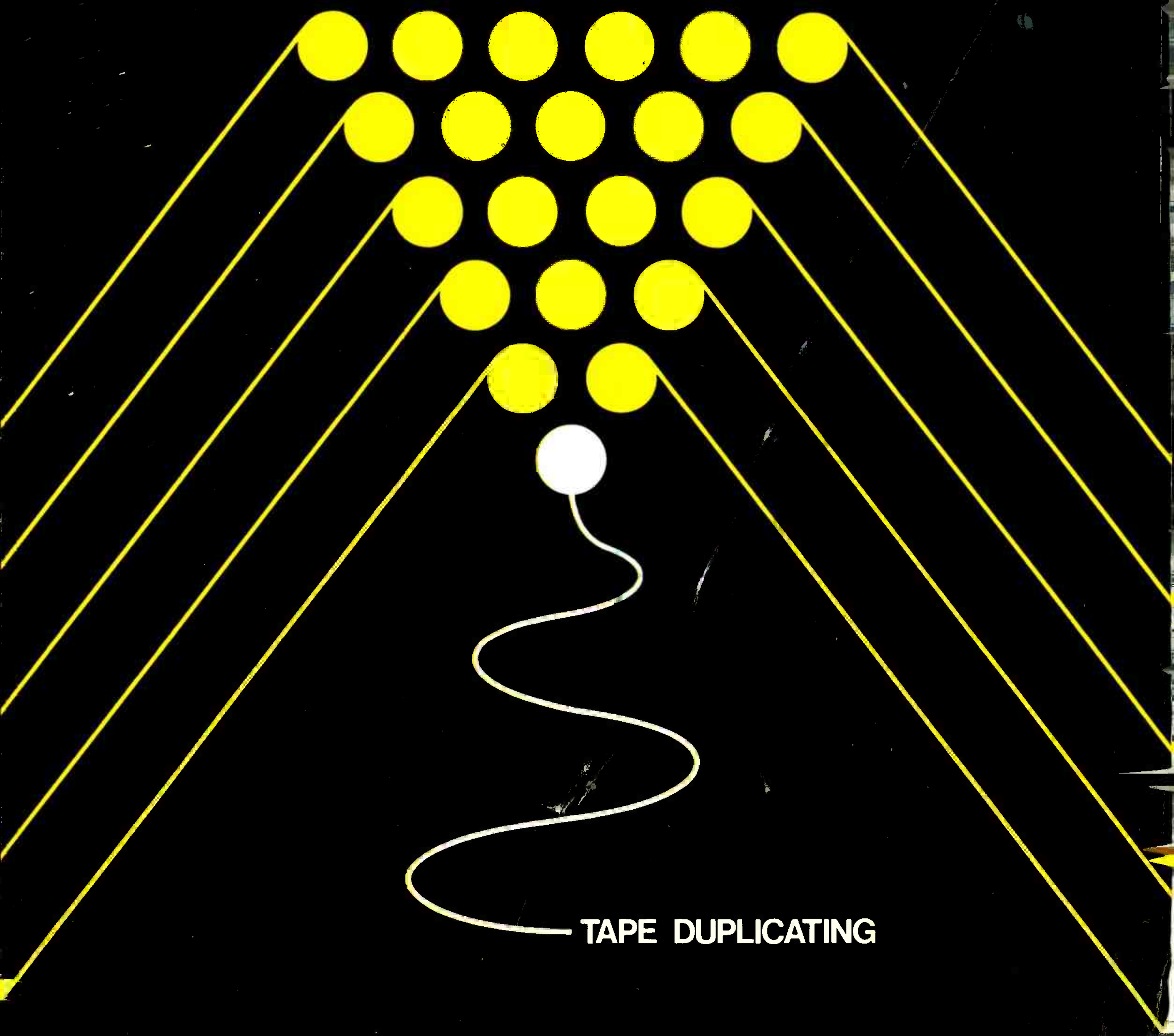
August 1977 50p

studio sound

AND BROADCAST ENGINEERING



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studio sound

AND BROADCAST ENGINEERING

Weak link in the chain

As Hugh Ford asks in his review, what would you think of a piece of gear that had the following awe-inspiring specification: 1% intermodulation distortion, 3% harmonic distortion, frequency response ±1 dB 12-15k Hz, and 70 dB dynamic range? Chuck it on the nearest tip? Sell it through this magazine's classified ads and hope the customer doesn't ever check it out?

Well you've no doubt guessed by now that what Hugh has described is something found in vast quantities in every recording studio—magnetic tape.

So what is all the fuss about? It's just that all those amazing specs we regularly publish for desks, tape machines, compressor-limiters, echo units, etc may be useless if they're not considered in respect of the total recording chain.

Be that as it may—and Studio Sound has often queried the usefulness (and validity) of technical specifications—one wonders why we still put up with a link which, in comparison to other studio equipment, is pretty horrendous. Do we make mental adjustments when listening live and off-tape; automatically re-adjusting our senses to the fact that a sound off-tape should, and by necessity does, sound worse than the original? Can we be so forgiving to the extent that subconsciously we neglect the distortion and hiss (despite the sterling efforts of Dave Blackmer and Ray Dolby), and listen 'through' them to discover the 'sound' of a recording? A very subjective question, but does it matter anyway—consider the typical equipment used by a consumer, plus the scandalous quantity of modern pressings.

On page 64 there is an extensive review of professional recording tape by Hugh Ford; but before you decide which is best/worst of the bunch, please think about what it is telling you.

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MAGNETIC TAPES
Hugh Ford 64

AUGUST 1977 VOLUME 19 NUMBER 8

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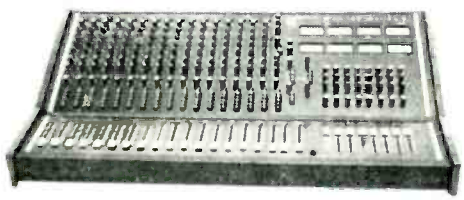

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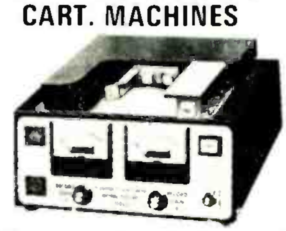

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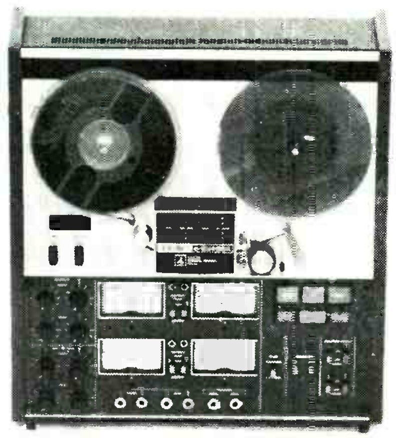

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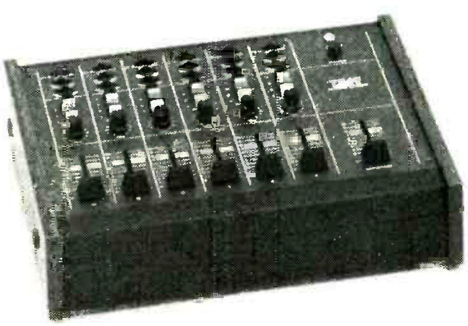

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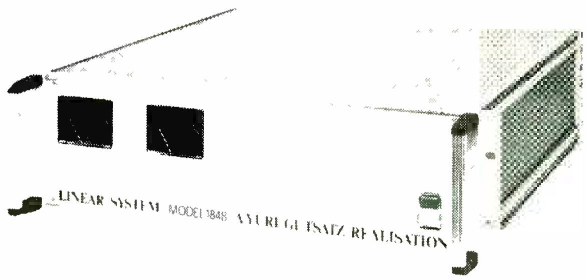

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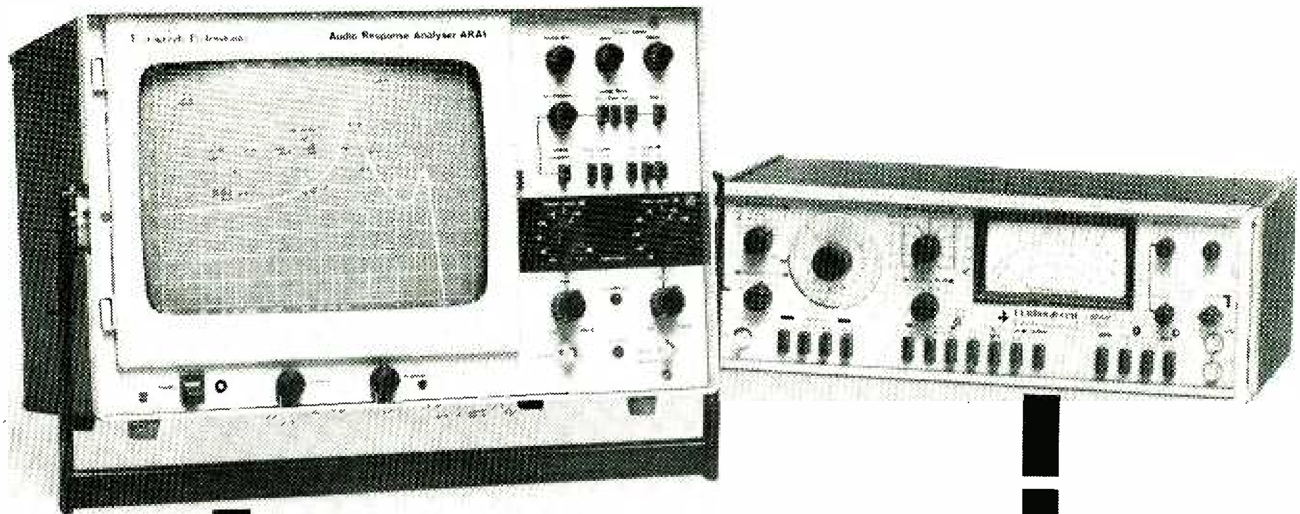

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☐ Please send full details of the ARA1 Audio Response Analyser and the RTS2 Audio Test Set.

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Wilmot Breeden Electronics Limited, 442 Bath Road, Slough, SL1 6BB SS

Ferrograph Test Equipment. For fast and accurate audio analysis.

news

Telefunken multitrack

Derived from the *M15*, the new *M15A* is now available in the UK from Hayden Labs. Eight, 16, 24 and 32-track versions are offered, and up to 24 channels of Telcom *c4* noise reduction units can be accommodated within the console. All versions can be supplied with either 19 and 38 cm/s or 38 and 76 cm/s crystal-controlled tape speeds, variable ±50% from nominal with a varispeed accessory.

Click-free and gapless timing control of the amplifiers are a claimed feature, allowing the machine to switch in or out of the record mode with 'absolutely no unwanted audible effect on any track'. All amps are accessible in sliding drawers in the front of the console, and the vu-meter panel can be tilted into any position for easy reading during line-up and adjustment.

An autolocate unit can be supplied as an optional accessory.

AEG-Telefunken, D-7750 Konstanz, Bucklestrasse 1-5, West Germany.
Phone: 862460.
UK: Hayden Laboratories Ltd, Hayden House, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW.
Phone: Gerrards Cross 88447.
Telex: 849469.

Two-channel graphic equaliser

The Soundcraftsmen model *TG 2209-600* features ±12 dB boost/cut at ten octave centres from 30 to 15.36k Hz.

Front-panel 'zero gain' controls and associated leds facilitate monitoring of optimum performance by matching the output to the input level; any substantial deviation below or above the input voltage may result in a distorted output.

Price in the UK is £515.

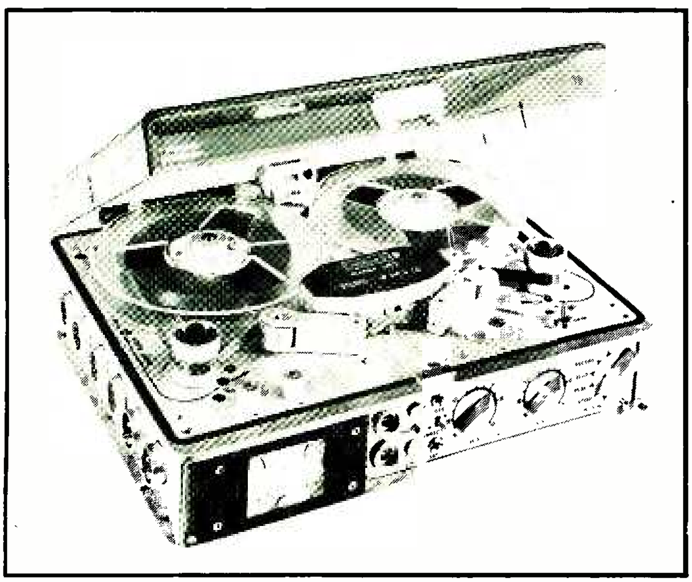
Extract from manufacturer's specification:

Frequency response: 20-20.48k Hz ±0.5 dB.
Distortion: <0.05% thd at 2V output.
Gain: unity±0.5 dB, controllable 20-20.48k Hz, range +6, −12 dB.
Noise: <90 dBm equivalent input noise, 110 dB below max output.
Input impedance/level: 600 or >100k ohm (switchable); +20 dBm max. (*XLR* connectors.)
Output impedance/level: 600 ohm, balanced or unbalanced (switchable) into high or low-impedance load; +20 dBm max into 600 ohm (8V rms), 100 ohm balanced or 50 ohm unbalanced. (*XLR* connectors.)
Shelving: low (100 Hz) or high (10 kHz), both 12 dB/octave roll off.
Dimensions: (w x h x d) 48.3 x 13.3 x 22.9 cm, suitable for rack mounting.
Weight: 4.1 kg.

Soundcraftsmen, 1721 Newport Circle, Santa Ana, Ca 92705, USA.
Phone: (714) 556 0371.
UK: REW Professional Audio, Charing Cross Road, London WC2.
Phone: (01) 836 2372.

Above: Soundcraftsmen TG 2209-600 two-channel equaliser.

Below: The new Stellavox SP8, available in a variety of track formats.



Stellavox SP8

The new battery-powered portable tape machine is now available in the UK from John Page. Electronic switching selects 9.5, 19 or 38 cm/s speeds (plus any speed from 3.8 to 61 cm/s with optional *ASV* speed variator), as well as remote-controlled stop-start mode.

Interchangeable, pre-adjusted head assemblies are available for mono full-track, mono full-track plus neopilot, mono double-track plus *Synchrotone*, stereo half-track plus *Synchrotone*, and other combinations on request.

Mic, line and mixed inputs can be accommodated, with 12V a-b or 50V phantom powering available for capacitor mics, separately switched for each input. The machine measures only 8.3 x 21.5 x 27 cm, and weighs just 4.6 kg complete with batteries, tape and carrying case.

With a mono full-track head assembly the *SP8* costs about £1700; other formats add £100-200 to the price. A wide range of accessories is also available.

Stellavox, 2068 Hauterive/NE, Switzerland.
Phone: 038 33 4233. Telex: 35380.
UK: John Page Limited, 169 Oldfield Lane, Greenford, Middlesex UB6 8PW.
Phone: (01) 878 0372/2641. Telex: 24224.

Neve for Ramport

The Who's Ramport Studios recently installed a Neve 40-channel desk for 24-track recording, described as the most luxurious custom-built console ever built by the company. Special features include a real leather front buffer, rosewood side pieces and all-black finish. Some pinball machine.

Tri-amp monitor loudspeaker

The output power of the new KLT *Triamp S30*, distributed by Kajaani, is said to be equivalent to a 250W single amp/speaker set up.

Extract from manufacturer's specification:

Input: 0 dBm, 5 kohm symmetric, *XLR* connector.
Frequency response: 40-20k Hz ±3 dB.
Harmonic distortion: ≦3% under 200 Hz; ≦1% above 200 Hz, at 90 dB spl.
Spl: 104 dB at 60 Hz; 102 dB at 1 kHz; 98 dB at 10 kHz. (All values max at 1m.)
Drive units: 20.3 cm bass driver, 12.7 cm midrange, and ribbon-horn treble driver. (Crossover at 350 and 3.5k Hz.)
Amplifiers: bass 80W (Class-A), mid 35W and treble 12W (both Class-AB).
Level controls: ±6 dB in 2 dB steps.
Dimensions: (h x w x d) 49.5 x 32 x 27.5 cm.
Weight: 18 kg.
Power: 220V 160W max.

KLT Elektronikka Oy, Linnankatu 1, SF-00160 Helsinki 16, Finland.
Phone: 906 55252.
Kajaani Oy, Nuaskatu 11, SF-87400 Kajaani 40, Finland.
Phone: 986 37311. Telex: 45148.

Sphere consoles

Following their introduction at the recent AES LA Convention, Sphere tells us that it is currently producing and has delivered several new desks from the *Eclipse* series, which is available in 4, 8, 16, 24 and 32-track systems with up to 40 inputs. Features include: a wide range of interchangeable eq types, including two styles of graphic; solo in stereo position with echo; solo of monitor channels; monitor echo and mute; two pannable effects returns; two programme mutes on each input; and stereo cue system. Light beam level displays are also available as an optional extra.

Sphere Electronics, 20211 G Prairie, Chatsworth, Ca 91311, USA.
Phone: (213) 349 4747.

20 ▶

Next to your Oscilloscope, perhaps the most powerful test instrument you can own.

Amber model 4400 Multipurpose Audio Test Set.
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The Amber model 4400 Multipurpose Audio Test Set—a powerful, comprehensive test instrument combining in a single package almost all the test and measurement facilities needed for professional audio testing.

Use it to plot the frequency response of a tape recorder, a microphone or a speaker. Look at the slope characteristics of a filter or equalizer. Equalize a monitor system, measure the crosstalk in a mixing desk, check the gain of an amplifier or plot the phase response of a preamp—the 4400 will give you a fast, concise and accurate picture of the performance of a piece of equipment.

It incorporates a function generator with low sine wave distorsion, 10 octave log sweeper, tone burst generator, noise generator and high power (over +30 dBm) output amplifier. It has an autoranging digital dBm meter with over 150 dB measurement range, a frequency counter, a multifunction filter that can be used as a spectrum analyser and four digital memories that give you X Y frequency and phase response plots on any non-storage oscilloscope.

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Tel: 01-935 0141
Telex: 27 939

Elsewhere
Gotham Export Corporation
741 Washington Street
New York New York 10014
Tel: (212) 741-7411
Telex: 12-9269

Talking books studio

The National Listening Library—a registered charity founded in 1972 that produces talking books for handicapped people who are unable to read books in the normal way—recently opened a new recording studio at its London headquarters.

Recordings are made at 19 cm/s on a 2-track Revox *A77* using *Scotch 207* tape. The master is then panel edited at double speed to obviate splicing blocks and razor blades, and sent away for dubbing onto special cartridges to be used on Clarke and Smith playback machines. Running at 2.38 cm/s, the six tracks on the cart give up to 12 hours of playback—sufficient for a standard-length book.

Studio equipment includes three *A77*s, a 4-channel Teac *A3340*, a NEAL 4-channel cassette with Dolby, a Chilton 12/4 mixer, Tannoy *Monitor Gold* monitors, an AKG *BX15* reverb and AKG *C451* microphones. For portable work a Stellavox tape machine and mixer are available.

PM-10 level meter from Wandel & Goltermann

Lightweight level meter

Believed to be the smallest of its type available in the UK, the new *PM-10* level meter from Wandel and Goltermann measures only 8.9 by 15.9 by 3.8 cm thick, and weighs less than 500g.

The meter is capable of handling levels from −50 to +10 dBm in the range 200-4k Hz. An internal 820 Hz signal generator (output impedance 600 ohm) capable of providing fixed levels at −10 and −27 dBm is also provided.

Readings, prefixed by the correct sign, are displayed on a liquid-crystal digital display with a resolution of 0.1 dB. Power is provided by an internal dry battery giving up to 100 hours continuous operation. A rechargeable NiCd cell is also available that provides up to 20 hours operation.

The meter's input impedance can be switched between 600 and 100k ohm to protect input circuitry against dc voltages.

Price in the UK is £234.

Wandel and Goltermann, Postfach 45, 7412 Eningen, UA, West Germany.
Phone: 7121 8441.
UK: Wandel and Goltermann (UK) Ltd, 40-48 High Street, Acton, London W3.
Phone: (01) 992 6791.

Delay unit survey boob

Our apologies to Industrial Research Products Inc for not only getting their name and agencies wrong, but also making rather a screw-up of their entry in our survey of reverberation and delay units (Studio Sound, April '77, p26).

They have also pointed out that 'IRPI' is an acronym entirely of our making, and that Knowles Electronics are *UK* and *European* distributors, not the company of origin as we stated in the survey. The following is how their entry should have appeared:

INDUSTRIAL RESEARCH PRODUCTS

Industrial Research Products Inc, 321 North Bond Street, Elk Grove Village, Ill. 60007, USA.
Phone: (312) 439 3600.
UK: Knowles Electronics Ltd, Victoria Road, Burgess Hill, Sussex.
Phone: Burgess Hill (04446) 5432.

DA-4000 Audio Signal Delay
This is the basic model in a range of three; models *DA-4006* and *DA-4007* have an added compander which extends their dynamic range.
Delay principle: electronic/digital.
Delay capacity: no limit by tandem connection to additional chassis.
Outputs: no limit by tandem connection to additional chassis.
Input/output impedance: 15k/600 ohm, both transformer isolated.
Frequency response: 40-12k Hz ±2 dB; 50-12k Hz for 3 dB roll-off points (*DA-4000*); 40-12k Hz for 3 dB roll-off points (*DA-4006/7*).
Dynamic range: at 400 Hz; 63 dB (*DA-4000*); 80 dB (*DA-4006*); 90 dB (*DA-4007*). Equivalent pre-emphasis: 150, 75 and 50 µs respectively.
Distortion: at 1 dB below max output at 400 Hz; <1% thd (*DA-4000*); <0.5% thd (*DA-4006/7*).
Noise: 20-20k Hz bandwidth; <-45 dBm (*DA-4000*); 80 dB below max output (*DA-4006*); 90 dB below max output (*DA-4007*).
Power: 115/230V.
Dimensions: 48 x 13 x 31 cm.
Weight: 13 kg.

DA-4003 Audio Program Delay
Similar in specification to the *DA-4008* unit.
Delay principle: electronic/digital.
Delay capacity: 240 ms max in single chassis.
Outputs: 1-5 per chassis, switchable in 10 ms steps (5 ms option available).
Input/output impedance: 15k/600 ohm, transformer isolated.
Frequency response: 40-12k Hz ±2 dB.
Dynamic range: at 400 Hz; 80 dB (*DA-4003*); 90 dB (*DA-4008*). Equivalent pre-emphasis: 75 and 50 µs respectively.
Distortion: at 1 dB below max output at 400 Hz; <1% thd (*DA-4003*); <0.5% thd (*DA-4008*).
Noise: 20-20k Hz bandwidth; <-62 dBm (*DA-4003*); 90 dB below max output (*DA-4008*).
Power: 115/230V.
Dimensions: 48 x 13 x 31 cm.
Weight: 13 kg.

DA-4009 Sound Delay Module
Similar in specification to the *DA-4010* unit.
Delay principle: electronic/digital.
Delay capacity: 50 ms max (*DA-4003*); 72 ms max (*DA-4010*); both selectable in 10 ms increments.
Outputs: one.
Input/output impedance: 25k/150 ohm, single-ended.
Frequency response: 30-12k Hz ±2 dB (*DA-4009*); 30-8k Hz ±2 dB (*DA-4010*).
Dynamic range: 80 dB at 400 Hz. Equivalent pre-emphasis: 75 µs (*DA-4009*) and 150 µs (*DA-4010*).
Distortion: <0.3% thd (no conditions).
Noise: 20-20k bandwidth; 80 dB below max output.
Power: 115/230V.
Dimensions: 48·3 x 4·5 x 21·5 cm.
Weight: 3 kg.

White rabbit?

Well . . . John Andrews has been appointed an executive director of Alice. John, who spent 11 years with the BBC, moves to his present post from EMI, where he was technical director of their a-v services division.

Rack-mount mixer

A new unit from Spectra Sonics accepts six mic or line inputs into one mono output, and features ±20 dB eq at 20 and 20k Hz plus ±14 dB at 100 and 10k Hz. Inputs and programme output are transformer isolated. A front-panel monitor jack is also provided.

Signal-to-noise ratio is claimed to be 78 dB ±1 dB with mic, and 80 dB min with line input; distortion 0.02% thd max (0.01% typical); and max continuous sine wave power +24 dBm ±0.5 dB.

The *model 1100* costs $800.

Spectra Sonics, 770 Wall Avenue, Ogden, Utah 84404, USA.
Phone: (801) 392 7531

DI blues

The new *Susan Blue* di box from Sun Recording Services features a fet front-end with an input impedance of 20M ohms. The unit can be connected to a musical instrument, or directly to an amplifier output (up to +38 dBm (50V) or 300W into 8 ohm, whichever seems more impressive). One output can be connected to a monitor or pa amplifier, while a second output provides clean feed to the desk via a *XLR* socket.

Power is either derived from the desk via 48V phantom and 6.8 kohm pads, or from an internal 9V battery. An earth-loop protection circuit prevents hum-loops occurring.

The unit costs £38.50.

Sun Recording Services Limited, 34 Crown Street, Reading, Berkshire.
Phone: Reading (0734) 595647.

Audio connectors

The Neutric range of 3-pin *XLR*-type connectors is now available in the UK from GE Electronics. Male and female line connectors incorporate self-adjusting cable clamps for 4-7 mm diameter cable. Panel-mounting versions are also available.

GE Electronics (London) Ltd, Eardley House, 182-4 Campden Hill Road, Kensington, London W8.
Phone: (01) 727 0711/3.

Cadac (Holland)

is the name of a recently-formed Dutch company now handling the following companies' products in certain parts of Europe: Acoustic Consultants, Eventide, Neumann, AKG, Cadac, JBL, ITA, RTW, Trident, Turner and Ampex. For further details of each relevant catchment area contact: Dick Swaneveld, Cadac (Holland) BV, GV Amstelstraat 97, Hilversum, Holland.
Phone: 035 17722.
Telex: 43834.

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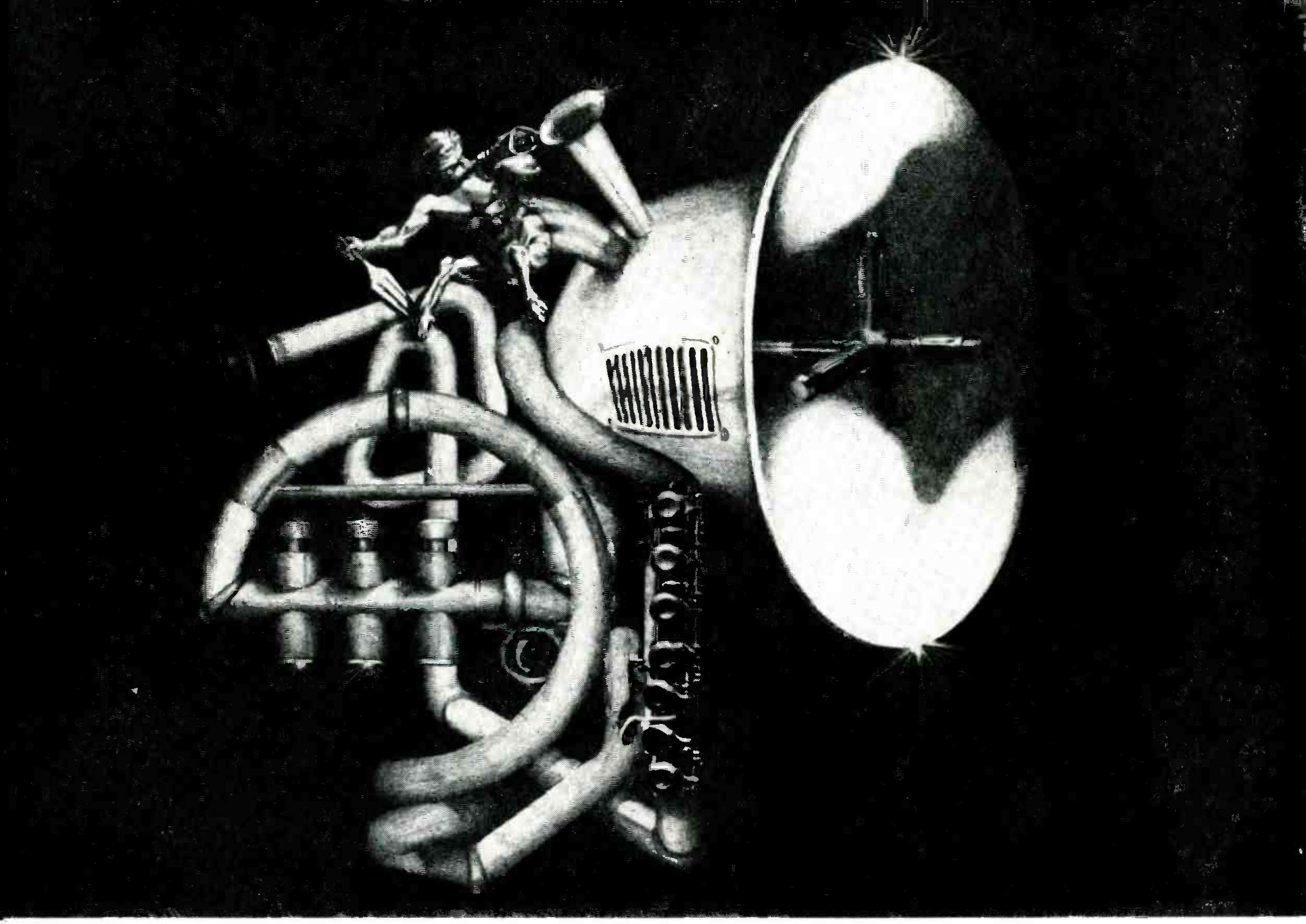

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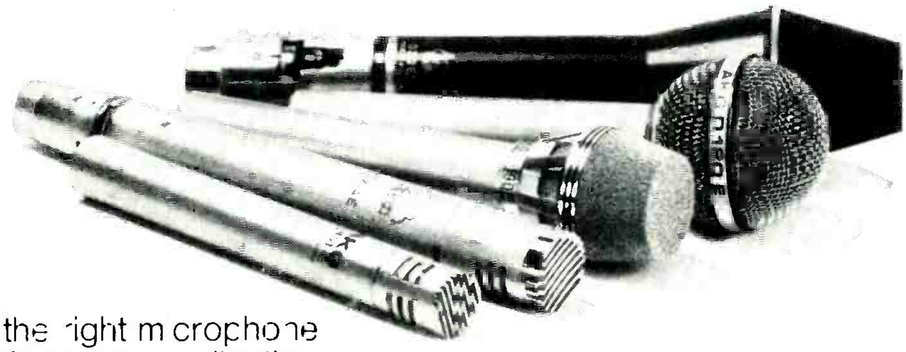

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The cheering of the spectators at the Olympic Games. The roaring of a formula I racing car. The singing of the greatest singers in the world. The capturing of those precious moments in family life, on tape. Wherever crystal clear reproducing or recording is required you will find AKG, for every application there is a specially designed AKG microphone. However high your quality requirements may be — AKG can exceed them.

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SCAMP leaflet

A new 4-page leaflet from Audio and Design describes the full complement of *Scamp* modules: *SO1* compressor-limiter; *SO3* sweep equaliser; new *SO4* parametric equaliser; *SO5* dynamic low-frequency filter-gate; *SO6* dynamic high-frequency filter gate; *SO7* octave equaliser; *S11* quad 12-section led column display; and *F300* expander-gate. Up to 17 of the modules plus power supply can be accommodated in a standard 48.3 cm rack frame.

Grampian Television are pretty well contented with their pair of *SO1* compressor-limiters. They are said to be doing sterling service in their dubbing suite/news studio, and were used extensively while covering the recent Eurofisk Bravo oil-rig blowout. Coverage went to 16 countries via Eurovision, 90 other countries via UP/ITN, and to the American ABC/NBC networks. The modules were also used on Grampian's networked documentary 'Blowout at Bravo'. The company has recently ordered two of the new *SO4* parametric equalisers, primarily for film-dubbing applications.

Copies of the leaflet can be obtained from: Audio and Design Recording, St Michael's, Shinfield Road, Reading, Berkshire RG2 9BE.
Phone: Reading (0734) 84487.

Leak for French radio

Leak *3020* monitor loudspeakers have been chosen by Radio France for its Maison de la Radio studios in Paris. Radio France operates four channels—France Inter, France Culture, France Musique and FIP-514—broadcast from 90 stations throughout France. All channels are fm mono, with the exception of France Musique, which broadcasts in fm stereo.

The re-equipped control room of Marcus Music AB, said to be the first studio in Sweden with automatic computerised mixdown. The desk is a Harrison 4032 (40-in/32-out), linked to an Allison programmer. Tape machines are all Ampex, including a 24-track MM1100. The room measures 60m², and is equipped with tri-amped JBL quadraphonic monitoring. An adjoining studio measures 130m² and can accommodate about 30 musicians. Acoustic design is by Jan Zetterberg, Gothenburg.

Trident test set

The *model CB9109* combined oscillator and digital frequency counter features:

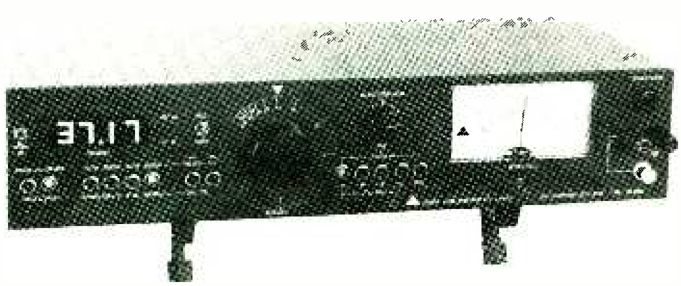
- +25 dBm output into 600 ohm
- typical distortion of 0.006% at 1 kHz
- Squarewave function with very fast rise time
- 10-100k Hz in four pushbutton ranges
- Eight preset frequencies from 10-20k Hz
- Pushbutton output attenuator in 10 dB steps (70 dB range plus fine control and mute button)
- Separate front-panel input to frequency counter.
- Price of £295.

Trident Audio Developments Ltd, 112-114 Wardour Street, London W1V 3AW.
Phone: (01) 734 9901. Telex: 27782
US: Studio Maintenance Service, 2444 Wiltshire Blvd, Suite 214, Santa Monica, Ca 90403.
Phone: (213) 990 5855.

Nashville Harrison

The Jack Clement Recording Studios, Nashville, Tenn, has gone 24-track as a result of a major renovation in studio A. They have installed a 3M *M79* tape machine coupled to a Harrison console. Previously, this studio was 16-track.

The first session in the revamped facility was at the end of January when little-known Texas recording artist Joe Eddie Goff (no offence Eddie—it's just that I have never heard of you) did a three-hour session with producer Russ Reeder. Goff had a 'regional' hit in Texas and Reeder is hoping to duplicate the success nationally by recording at Clement Studios (sic).



The new Trident CB9109 combined oscillator and digital frequency counter, capable of delivering up to +25 dBm into 600 ohm.

Monitor amps

PDG has introduced two new amps: *model 1848* featuring 2 x 200W outputs into 8 ohm; and *model 1525*, a 4 x 200W version of the *1848*. Both units are designed for standard 483 mm rack-mounting and feature full output protection. Extract from manufacturer's specification for both amps:
Frequency response: 10-25k Hz ±1 dB.
Distortion: 0.1% (no conditions).
Input impedance/sensitivity: 20 kohm/0.82V.
Signal-to-noise: −100 dB.
PDG and Co, 3 Cour Jasmin, Paris 75016, France.
Phone: 527 7031.

Speck desk

A leaflet is available from Speck Electronics describing the *SP800B* desk, which features 16 inputs, 16 outputs, 8 submix busses, 16-track monitoring, stereo master buss, three cue sends, two echo returns and 8-track metering, plus 3-band parametric eq and stereo solo. The desk costs about $4500. Copies of the leaflet can be obtained from: Speck Electronics, 11408 Collins Street, North Hollywood, Ca 91601, USA.
Phone: (213) 769 7090.

Equaliser

The company SAE mostly produces consumer audio gear for people with too much money to burn. Although rather ridiculous for domestic use, the company's *2800* 2-channel 4-band parametric equaliser looks very good value for hard-up recording studios: the price is $550, a song by professional standards.

Assuming that the manufacturer's spec is correct, then there appears to be little, if any, shortfall in performance in spite of the low price. Naturally, the signal lines are unbalanced, although they operate at normal line level. All bands heavily overlap each other; it is possible to tune up to three bands to the same frequency. More remarkably, there is a 'Q' control enabling tight control over the passband shape in addition to the normal ±16 dB boost.
Scientific Audio Electronics Inc, PO Box 60271, Terminal Annex, Los Angeles, Ca 90060, USA.
UK: REW Professional Audio, Charing Cross Road, London WC2.
Phone: (01) 836 2372.

Cable drums and mic stands

Two new cable drums are available from Keith Monks: *CD/3* capable of taking at least 60m of 12.5 mm cable; and *CD/4* for 200m of 12.5 mm cable. Both drums are finished in hard-wearing nylon coated paint.

Their range of coloured mic stands is now also available in white, light blue, dark grey and metallic grey, as well as the standard red, blue, yellow and black. Boom arms are available to fit all stands.
Keith Monks (Audio) Ltd, 26-28 Reading Road South, Fleet, Hampshire.
Phone: Fleet (02514) 7316/3566.
Telex: 858606.

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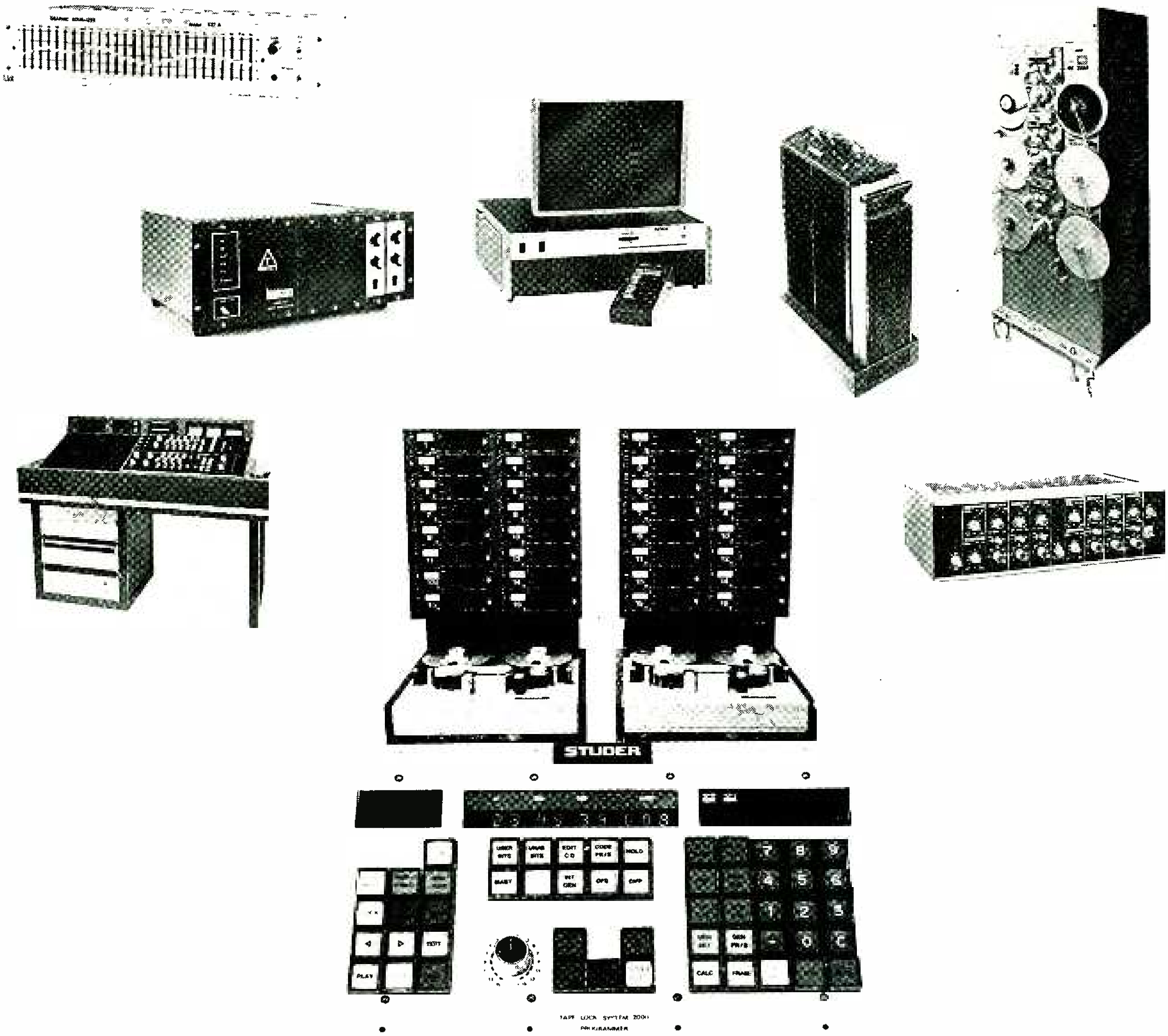

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NEWS

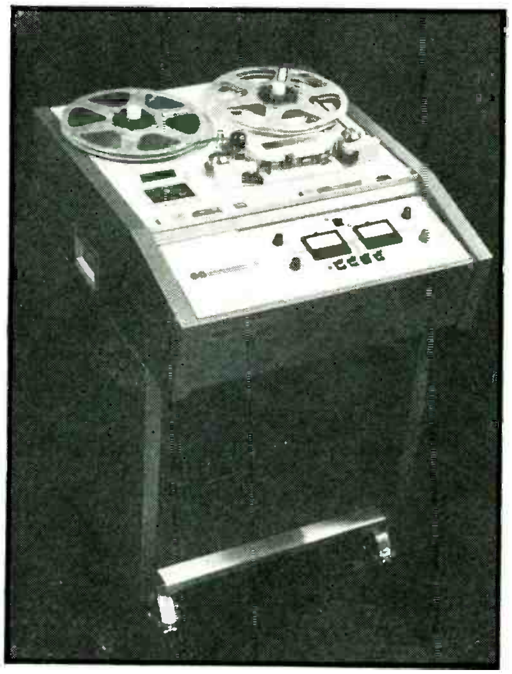
Leevers-Teknik?

Externally, it looks like a Bias. The logo on the front panel says it is a Leevers-Rich. However, the transport bears rather more than a passing resemblance to a Klark-Teknik.

In actual fact, the new *Proline 2000 TC is* a Klark-Teknik design manufactured by Leevers-Rich and housed in the ubiquitous Bias console cabinet also mentioned in the AES Report (STUDIO SOUND May '77, p45). It also represents the highest state of UK tape recorder technology. Features include solid-state switching throughout, digital constant tape tension circuits as well as full interlock to prevent operating sillies. All motors are dc servo controlled. The electronic tape timer gives a real time readout in minutes and seconds at both fixed speeds.

The manufacturing rights for the new machine were sold to Leevers-Rich by Klark-Teknik; this was a one-off deal relating to the design and development of the recorder, formerly the Klark-Teknik *SM-2*. Philip Clarke is very emphatic that the deal in no way reflects on his own company's manufacturing capability; he states that Klark-Teknik intends to move much further into the recording peripherals market such as producing digital delay lines. The first ddl was introduced at the Paris AES.

Leevers-Rich Equipment Ltd, 319 Trinity Road, London SW18 3SL. Phone: 01-874 9054.



Leevers-Rich Proline 2000 TC, which bears more than a passing resemblance to the now extinct Klark-Teknik SM-2.

Milan music fair

Three pavilions with a total area of 23 000m² have been allocated for the forthcoming Salone Internazionale della Musica exhibition, to be held in Milan from September 8-12, 1977. Equipment on show from some 280 manufacturers includes recording and pa gear, musical instruments and amps, discotheque equipment and radio transmitters. Quite a mixture.

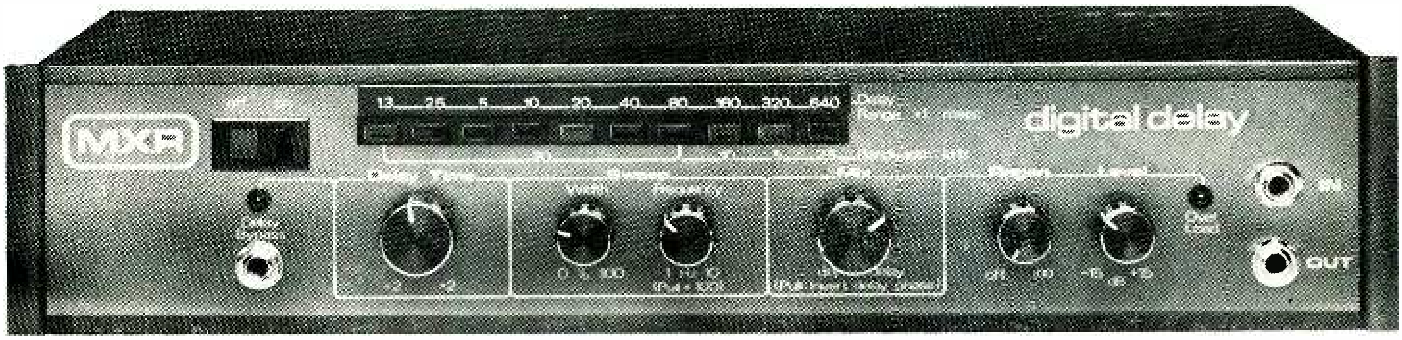
Further information from: Segreteria Generale, SIM, 20124 Milano, Via Vitruvio 38, Italy. Phone: 202113 or 2046169.

Berlin radio and tv exhibition

Equipment on show at the forthcoming International Radio and TV Exhibition, to be held in Berlin from August 28 to September 4, ranges from domestic hi-fi to tv transmitters. For details contact: Gesellschaft zur Förderung der Unterhaltungselektronik (GFU) mbH, Postfach 700320, D-6000 Frankfurt 70, West Germany. Phone: 630 2289. Telex: 0411035.

Calrec in West Germany

Their range of microphones is now handled by Westend Sound GmbH, Westendstrasse 46, 6 Frankfurt AM. The company are also agents for Amcron products and Macinnes 16/4 pa mixers.



The musical computer.

MXR have been working on a new type of audio delay line. The result is the MXR Digital Delay.

It works on memory banks. Just like an analog computer. The system is called "Digital Random Access Memory". And it's a great improvement on the old type of 'shift register' delay.

It's small. Completely self contained and has ordinary jack plug sockets so it can be used on stage. Or rack mounted for the studio.

The basic unit delays a sound by between 0.08 m.sec and 320 m.secs. But you can add plug-in memory boards to increase this to 1.28 secs.

You have precise control over the volume mix between the original and delayed sound. And over the amount of delay.

So you can produce a large range of effects. From the slightest hint of echo to hard reverb and A.D.T.

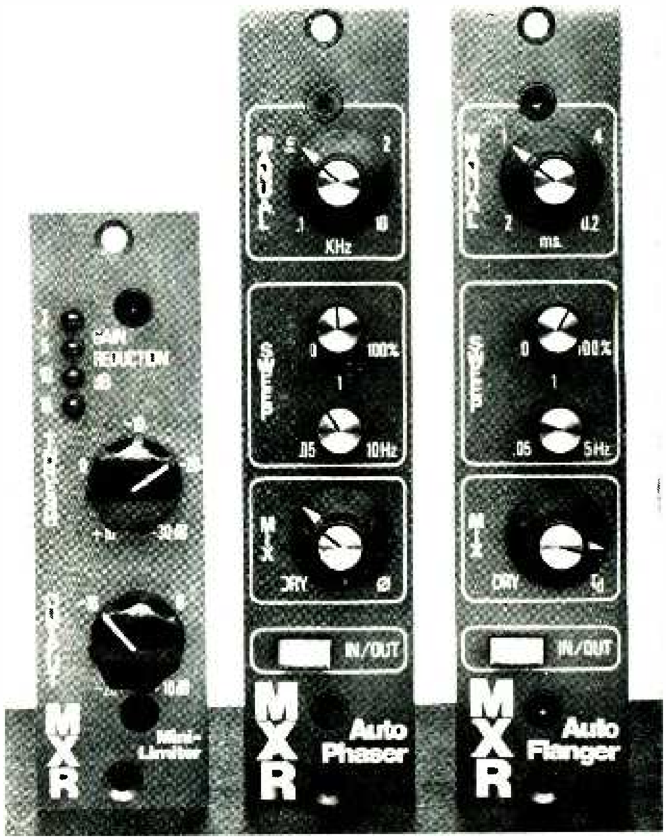
There are special circuits built in to give you flanging, frequency modulation and true vibrato. Pitch alteration, non deteriorating repeat hold and overdubbing effects.

And there's nothing on the market that can produce anything like the same results. Unless you want to pay at least £1,000 on top of the price of the MXR.

The Digital Delay is just part of the MXR Innovations range. Which also includes the Auto Phaser, the Auto Flanger and the Mini Limiter. Everything MXR makes is designed to keep noise and distortion levels down to a minimum. And to sell at a very reasonable price. All the equipment is thoroughly tested before it leaves the workshop. And is backed up by the service professionals need.

MXR is distributed in the UK by Rose-Morris.

Find out more. Fill in the coupon.



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The noise jungle

Hugh Ford

Audio engineers are interested in two types of noise: that generated by electronic devices in the broad sense; and acoustic noise picked up by microphones as unwanted, extraneous noise. Normally noise generated by electronic devices is random but that which we hear . . . ?

BECAUSE OF basic differences, the methods of measuring electronic and acoustic noise frequently vary fundamentally—I do not propose to deal with the many complex methods of measuring 'acoustic noise', since this is a specialised field in its own right. Audio engineers are more often concerned with noise generated within the electronics of a studio, and the many measurement methods used for this are quite complex enough to create widespread confusion.

Sources of noise

Noise in the electronics system of a studio is generated by a number of sources, each of which has its own particular characteristic, and it may be useful to consider each of the following noise sources:

All resistors generate noise.

Semiconductors (including integrated circuits) generate noise when current is passed through them.

Microphones generate noise.

Magnetic tape generates noise which depends upon the tape used, its speed, equalisation and other factors.

Discs generate noise.

Of these five basic noise sources, the resistor is a fundamental noise generator, and it is useful to consider this type of noise before looking at other noise sources. 'Johnson Noise' is not peculiar to resistors as such, but is generated by the resistive (as opposed to reactive) component of any device as a result of the Brownian (random) movement of electrons. This movement of electrons is present in the absence or presence of an applied voltage; it is unaffected by the applied voltage but *is* affected by temperature.

In 1928, Johnson showed that the root-mean-square noise voltage generated by a resistance may be calculated from the following formula:

$$V_{rms} = \sqrt{4kTR \times \text{bandwidth}}$$

Where k = Boltzmann's constant.
T = absolute temperature in °K.
R = resistance in ohms.

A little experimenting with this formula will show that for normal purposes the temperature is not too critical, but that both the resistance and the bandwidth make a very large difference. For instance, changing the temperature from 20 to 40 °C will alter the noise by about 0.3 dB, but changing the resistance from 1 kohm to 10 kohm, or the measuring bandwidth from 20 kHz to 200 kHz, will alter the noise by 10 dB.

If we are concerned with ready-made equipment, there is little we can do about the 'effective noise resistance' other than making sure that the interface between pieces of equipment is properly matched. However, it is fundamental that any statement of noise performance should quote the bandwidth used for measurement. For instance, many modern amplifiers have bandwidths of at least 200 kHz; but measurements made with a wideband meter and then with a meter having 20 kHz bandwidth will differ in the apparent noise performance by 10 dB!

Unfortunately, no filters have infinite attenuation and it is normal to specify a filter's bandwidth in terms of the points where the response has fallen to −3 dB, and necessary (but unfortunately uncommon) to specify the rate of attenuation outside the passband. It is not difficult to imagine that if wideband random noise is applied to a practical filter with, for instance, −3 dB points at 20 Hz and 20 kHz, the output from the filter will contain an amount of energy which is outside the 20 Hz to 20 kHz spectrum. Thus the measured noise at the filter output will be greater than that at the output of an ideal 20 Hz to 20 kHz bandpass filter.

This introduces the concept of 'effective noise bandwidth', which is the bandwidth of a perfect filter with which a practical filter can be replaced with the same effective bandwidth. For instance, a practical filter that has a −3 dB point at 15.7 kHz with 3 dB/octave attenuation has an effective noise bandwidth of 20 kHz.

Another important way in which noise is sometimes specified is in terms of $V/\sqrt{\text{bandwidth}}$. From the formula for Johnson Noise it can be seen that this type of expression is really very simple to use, since by re-arrangement:

$$V_{rms}/\sqrt{\text{bandwidth}} = \sqrt{4kTR}$$

Thus, given a figure for $V/\sqrt{\text{bandwidth}}$ and the bandwidth, the equivalent noise resistance (the equivalent resistor which would generate the same noise voltage) and the noise voltage for any bandwidth can be calculated. This type of expression is frequently used to specify the noise performance of semiconductors, where data sheets will include a plot of noise, in terms of $V/\sqrt{\text{bandwidth}}$, in relation to collector current. Such expressions are necessary because semiconductor noise results from a number of factors, such as recombination of free electron-hole pairs, surface effects at the junctions and the passage of accelerated charge carriers through the junctions, all of which change with the collector current. These different noise sources within a semiconductor have different characteristics; careful listening to a semiconductor amplifier may demonstrate that the noise consists of the expected 'hissing' noise, in addition to which there is random impulsive noise.

With regard to noise generation in microphones, there is, of course, the noise due to the resistive component of the microphone's impedance, plus the noise from any semiconductors in the microphone amplifier and its associated resistors. However, there is an additional noise source that is completely beyond our control. This is the noise present at the microphone's diaphragm due to the Brownian motion of air particles—some modern microphones are so good that this particular noise source is becoming a limitation.

While it is not a particularly commonly used parameter when specifying microphone amplifier performance (but common when specifying radio receivers), mention must be made of the 'noise figure' of an amplifier, and the 'equivalent input noise'. The equivalent input noise is determined by measuring the noise at an amplifier's output and by dividing this value by the amplifier's gain, such that the equivalent input noise is that noise which would have to be generated by a noise generator at the input of a perfect amplifier of the same gain to obtain the measured output noise. The noise figure can be derived from the equivalent input noise by relating it to the Johnson Noise that is generated by the amplifier's source impedance, and is thus a figure of merit for any amplifier. For instance, we can consider a microphone pre-amplifier that is designed to work with a 200 ohm load, has a bandwidth of 0-20 kHz, 60 dB gain, and a measured noise at the output of −65 dBm over a 20 kHz bandwidth. It can be seen that the equivalent input noise is the output noise minus the gain of 60 dB; ie −125 dBm. The Johnson Noise from a 200 ohm resistor at 20 °C over a 20 kHz bandwidth is −129.7 dBm, which is 4.7 dB lower than the equivalent input noise of the amplifier. The amplifier is thus said to have a noise figure of 4.7 dBm.

There are a whole lot more variables when considering noise in magnetic recording systems. To start with there is a series of different tape speeds which affect noise; there are different replay equalisation standards for any given tape speed, and changing the equalisation affects not only the amount of noise, but also its spectrum; there is also a whole series of different recorded track-widths for different applications, and these affect the amount of noise. And just to add a final complication, not only does the noise depend upon the tape type in use, but also on the design of the replay head and its gap size.

As a final noise source, disc reproduction has its own peculiarities, for not only does the system have the replay frequency response modified by equalisation (like tape), but there is also a fair amount of impulsive noise.

Types of noise

Most of the noise sources mentioned above are sources of random noise, which is a 'hissing' sound. However, other noise sources are to be found in electronic equipment. Apart from a pure hissing sound, there is sometimes impulsive noise in the form of crackling or popping—this can come, for instance, from 'shot noise' in transistors. In addition, there is always the problem of mains hum and its harmonics; while this isn't strictly noise, it's part of what we measure as such.

Random noise is defined as a signal whose amplitude cannot be specified in relation to time; the amplitude, therefore, can only be defined in terms of the probability of a given value for a given percentage of time. I don't propose to go into the mathematics of this, but simply make the point that the peak value and the average or root-mean-square value of random noise bear little relation to each other, and depend upon what is known as the 'probability density' of the random noise.

Of far more importance when measuring noise is the 'spectral density' of the random noise. Noise with a uniform spectral density has equal power per unit bandwidth, irrespective of the centre frequency, and is commonly known as 'white noise'. Thus if a spectrum analysis of white noise is carried out with a constant bandwidth filter, the filter's output will remain constant. If the same thing is done with a constant-percentage bandwidth filter, a $\frac{1}{3}$-octave filter or similar, it will be found that the filter's output will rise with frequency at a rate of 10 dB/decade (equivalent to 3 dB/octave). For some purposes it is useful to arrange for a noise signal to compensate for this characteristic; this type of noise which decreases by 3 dB/octave in spectral density is commonly known as 'pink noise'.

Fig. 1 is an oscillogram of white and pink noise. In the upper trace (white noise) it can be seen that there is more high-frequency energy. The pink noise in the lower trace looks more 'lumpy' as a result of the 3 dB/octave cut in high-frequency energy. The same features are shown in **figs. 2** and **3** in terms of spectrum analyses. Fig. 2 shows that the $\frac{1}{3}$-octave analysis of pink noise produces equal energy in each band, while in fig. 3 it can be seen that the $\frac{1}{3}$-octave analysis of white noise gives a plot that increases in amplitude by 3 dB/octave with frequency, while a constant bandwidth analysis of the same noise gives a straight line plot.

So much for random noise: it is a steady noise that can be

FIG. 1 Oscillogram of white (upper trace) and pink noise (lower trace). 10 mv/division.

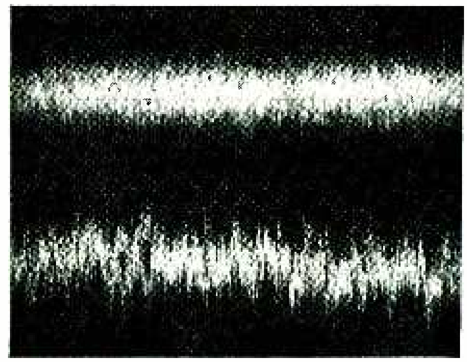


FIG. 2 PINK NOISE THIRD OCTAVE ANALYSIS

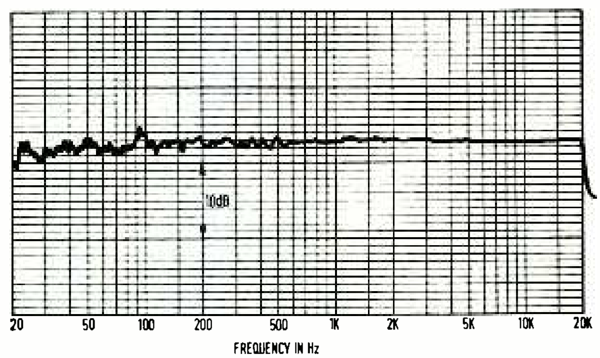
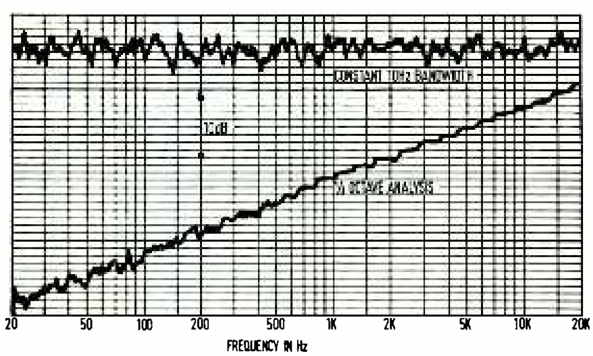


FIG. 3 WHITE NOISE



measured with a conventional meter, and within certain limits it doesn't matter how long or short the meter's reaction time is—as is the case when sinewaves are measured. However, if impulsive types of noise are considered, the situation is very different; it is easy to imagine how differently meters behave when a single impulse is applied to them, or for that matter a series of impulses. It is well known that vu meters and ppms behave differently to audio signals, and just the same problem occurs with impulsive noise. It follows that impulsive noise can only be measured meaningfully with standard meters that have well defined ballistics, and that for the 28 ▶

THE NOISE JUNGLE

measurement of any type of noise the meter's type of rectifier must be defined.

Meters

There are two meter characteristics that have a substantial effect upon the apparent measured noise: the rectifier characteristic of the meter; and its ballistics, including rise and fall time. While the former depends entirely upon the electronics of the meter, the ballistics are a combination of the movement's physical construction, and the time constants in the electronic drive circuits. Although there are a multitude of types of programme-level meter, and also a large number of other types of meter that are used for noise measurements, only a few of these types are of concern to us for the measurement of noise in audio equipment.

Probably the most common type of meter to be found in audio installations has 'vu' written on its scale plate. But beware—many of these are nothing like the genuine vu meter, as defined in the American Standard C16.5-1954. If one is lucky enough to have a standard instrument, it will be a full-wave rectifier, average-reading instrument with reasonably well defined mechanical ballistics. Consequently, the meter can be used as a standard noise-measuring instrument if it is driven by a suitable audio amplifier and attenuator. It needs to be remembered that the movement is designed to be driven through a series resistor such that the combined impedance is 7.5 kohms; the omission of this series resistance could affect the ballistics.

Most general-purpose millivoltmeters are also average-reading instruments with scales calibrated for the root-mean-square voltage of sine waveforms. The relation between root-mean-square and average voltage of any waveform is known as the 'form factor':

$$\text{Form factor} = \frac{V_{rms}}{V_{avg}} = 0.906 \text{ dB for a sinewave.}$$

Thus the true average voltage of a pure sinewave is 0.906 dB less than that indicated by an average-reading calibrated rms meter. Generally true root-mean-square rectifier instruments are to be preferred for noise measurements, since it is considered that the human ear responds to power rather than average noise. However, these true rms instruments tend to be expensive. The reason for their expense is that the rectifier circuit must respond to the square of the input voltage over a large range if the effects of waveform peaks are to be correctly measured—this property introduces the concept of 'crest factor'. The crest factor of any waveform is the relation between its true root-mean-square (power) value and its peak value:

$$\text{Crest factor} = \frac{V_{peak}}{V_{rms}} = 3.01 \text{ dB for a pure sinewave.}$$

In noise measurement this property is very much an unknown, but generally meters that can handle a crest factor of between 5 and 10 are sufficiently accurate.

The third type of meter commonly used for noise measurement is a quasi-peak reading instrument. These instruments do not read instantaneous peaks, but are designed with slugged electronics in their drive circuits, such that they read something below the true peak value of noise—hence their name. Such instruments include the ppm specified in British Standard 4297 (1967), and which is used by broadcasting authorities for both programme level and noise measurement because of its convenience in the latter application.

More important is the German DIN quasi-peak meter as specified by the German Standard DIN 45 405, and also CCIR Recommendation 468-1. It should be noted, however, that the weighting networks specified by these standards are substantially different, about which more will be said later. Unfortunately, there are very few manufacturers of this standard meter, apart from the very expensive unit made by Bruel & Kjaer, and less expensive but antiquated meters from Sennheiser and Grundig, together with a meter manufactured by Radford.

Weighting networks

It is unfortunate that the human ear does not respond with equal sensitivity to all frequencies. Thus when measuring noise it is essential to introduce some form of weighting in relation to frequency, if the measured result is to correlate with listening tests. Such networks are known as 'weighting networks', and without even trying hard I can think of eight completely different weighting networks. It's not surprising, therefore, that confusion exists when this selection is combined with different types of meter.

Fig. 4 shows the characteristics of the A, B and C—weighting networks, which are clearly very different from each other. However, by far the commonest of these is the Standard A-weighting that is used for the measurement of both electrical and acoustic noise. The type of meter associated with this weighting is always a true rms meter for acoustic noise measurement, but may be either a true rms or average reading instrument, such as a standard vu meter, for measuring electrical noise.

Noise measured with A-weighting must always be specified as dB(A), and naturally the type of meter used must be stated if the figure is to have any meaning. While the A-weighting is generally satisfactory for measuring acoustic noise, it has two snags when measuring electrical noise. First, the results do not give particularly good correlation with listening tests; and second, the specified tolerances on the high-frequency cut part of the curve are rather wide, with the effect that different weighting networks, that comply with the A-weighted standard, can give significantly different results in the presence of much high-frequency noise.

The three weighting networks shown in **fig. 5** are aimed at overcoming these snags, and it will be readily appreciated that all three are different from the A, B and C networks in that they have a boost which peaks in the 5 kHz region. Of these the 'D' network was originated for the measurement of aircraft noise, and has been little used for electrical noise. However, the remaining DIN Standard 45 405 and the CCIR Recommendation 468 networks are of great

30 ▶

FIG. 4 NOISE WEIGHTING NETWORKS A,B&C

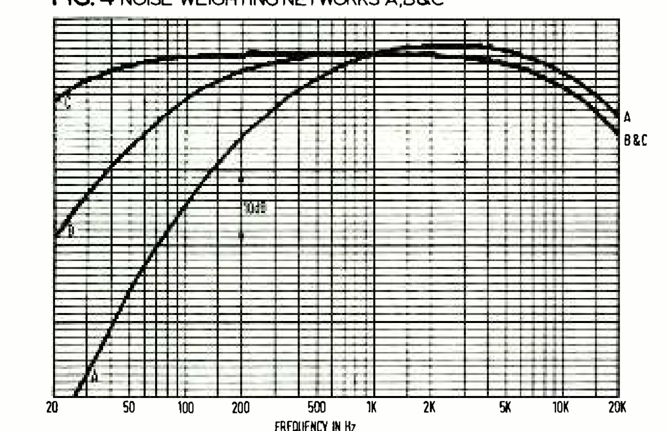
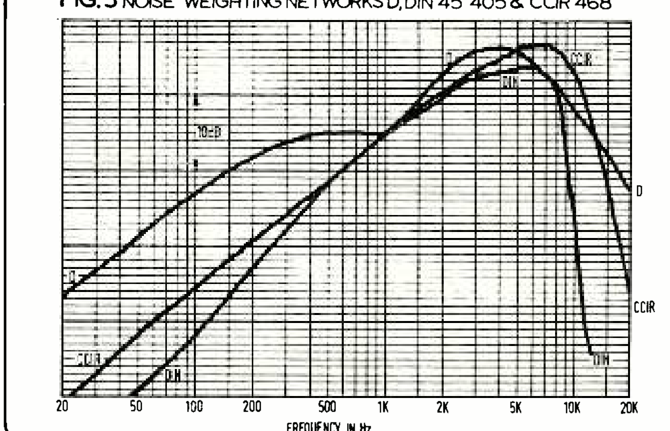


FIG. 5 NOISE WEIGHTING NETWORKS D, DIN 45 405 & CCIR 468



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interest. The DIN 45 405 specifies that this weighting should be used in conjunction with a quasi-peak meter also complying with the standard; a noise-measuring method that is, and has been, widely used in Europe.

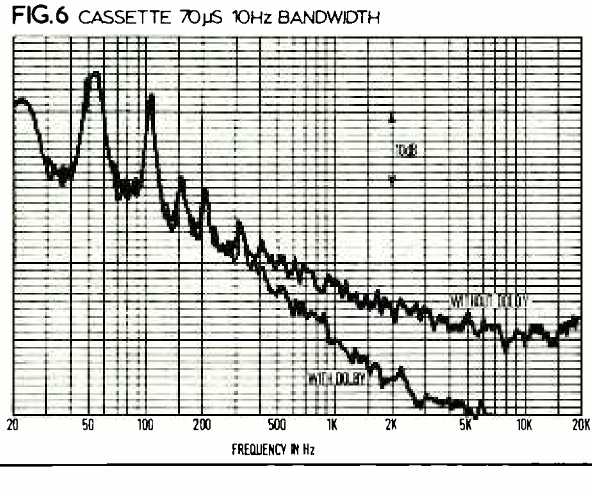
With the improvement in the high-frequency performance of audio equipment over the years, it was found that the high-frequency roll-off of the DIN curve was at too low a frequency to give good subjective correlation with noise measurements—hence the arrival of the CCIR Recommendation 468 curve. While there is no doubt that this curve provides better correlation with subjective effects than the other curves mentioned, there is an important area of confusion about its practical use. In fact, the CCIR Recommendation 468 is quite clear in specifying that the weighting curve should have unity gain at 1 kHz like the other weighting curves, and that a quasi-peak instrument similar to the DIN meter should be used. However, there are two objections to this that have recently been much publicised by Dolby Laboratories. The first objection is that the quasi-peak meter is uncommon in laboratories—and also expensive—while the vu meter is average reading, relatively inexpensive (that is, even a genuine vu meter) and a common instrument. Thus it is recommended by Dolby that an average-reading meter should be used. The second objection relates to the use of 1 kHz as the unity gain point of the weighting filter; Dolby is recommending that the unity gain point should be at 2 kHz, on the grounds that the noise performance looks 5.6 dB better and is more in line with the A-weighted figures.

While I have no personal objection to the use of an average-reading meter as an alternative for routine servicing purposes, I feel that manufacturers' specifications must include figures derived from both a quasi-peak meter and an average-reading meter of the vu type. On the other hand, the use of 2 kHz as the unity gain point is a different matter; since all other weighting networks are based on a 1 kHz unity gain point, this is bound to cause confusion and inconvenience in laboratories. The sole reason for suggesting the 2 kHz point is to 'improve' the published noise performance, but the European DIN 45 405 figures are comparable with the CCIR 1 kHz reference figures:

Reference level (250 nWb/m) to noise performance of a cassette recorder

Measurement method	Dolby B in	Dolby B out
A-weighted rms	—66.0 dB(A)	—59.5 dB(A)
B-weighted rms	—60.0 dB(B)	—57.5 dB(B)
C-weighted rms	—54.0 dB(C)	—53.5 dB(C)
D-weighted rms	—59.0 dB(D)	—53.0 dB(D)
DIN 45 405 quasi-peak weighted	—59.0 dB DIN	—51.0 dB DIN
CCIR 468 weighted average, ref 1 kHz	—64.0 dB	—55.5 dB

FIG.6 CASSETTE 70µS 10Hz BANDWIDTH



From the table it is clear that the DIN 45 405 figure looks far worse than either the A-weighted figures or the CCIR average figure, and it is of significance to note that the apparent noise reduction due to the Dolby *B* system used is larger with the CCIR weighting. This correlates with the subjective effect.

The reason for the difference in the effects of the various weighting networks can be seen from **fig. 6**, which is a spectrum analysis of the noise with and without Dolby. It is clear that the noise improvement is greatest above 1 kHz, and that there is significant noise up to 20 kHz and above. The old A-weighting curve attenuates this high-frequency noise, which is subjectively very important, whilst the CCIR curve boosts the noise around the 6.3 kHz point where it is most subjectively objectionable. Fig. 6 also demonstrates one of the common traps in noise measurements, as relatively large amounts of 50 Hz mains hum and its harmonics are present. While these will be attenuated by noise weighting, it is very important to realise that no weighting networks are intended to deal with the subjective effects of constant tones. Noise weighting is based on the subjective effect of random noise; thus it is always essential to provide details of any constant tones such as mains hum or tape machine servo-tone breakthrough.

Practical statements of noise performance

Any statement about noise performance is completely meaningless if it is not accompanied by three important details:

What filter was used.
What meter was used.
What reference level was used.

For weighted measurements it is simple to state which standard weighting network was used for the measurement, but with unweighted measurements the turnover points and the rate of attenuation of the measurement equipment must be stated—or at least the effective noise bandwidth.

If one of the standard types of meter—genuine rms, vu or standard ppm—is used, it is a simple matter to quote the appropriate standard. Should a non-standard meter be used, however, it is imperative to quote the rectifier characteristic and the type of calibration; for example, 'average rectifier calibrated rms sinewave'.

The third requirement, a reference level, is not always so simple since the type of reference level depends upon the type of equipment that is being measured. In the case of microphone pre-amplifiers, it is good practice to specify the noise referred to the input, in which circumstances the noise is simply a noise voltage or a noise factor. Strictly, it is incorrect to specify the noise voltage in terms of dBm when we are not using a 600 ohm termination, but this malpractice has become common practice. Maybe it can be excused?

The idea of noise voltage can be applied, of course, to other types of amplifier, including power amplifiers. However, in the case of power amplifiers noise is normally referred to some rated power output, which can be output clipping or a certain percentage distortion at some frequency. Such statements do not tell us what we really want to know—surely this is the noise power output?

In the recorded sound field the reference level problem becomes confused, since one is no longer dealing with purely electrical units; other types of reference must be used. For instance, in disc recording the reference level must be in terms of the movement of the replay stylus, while magnetic recording must be in terms of tape magnetisation. The situation in both instances is confused by the fact that the replay signal is equalised, with the result that different frequencies of the same recorded amplitude will replay at different levels. Reference level discs are normally recorded at either 400 or 1k Hz, while 315, 333, 400 and 1k Hz are common reference level frequencies on tape.

The magnetic reference level situation has been explored in a recent article (Studio Sound January '77, p42) and I do not propose to reiterate what has already been said, except to implore people to standardise on a reference level of 320 nWb/m at 1 kHz for tape speeds of 19 cm/s and above, or a reference level of 250 nWb/m at 315 Hz for lower tape speeds.

The disc situation is one that frequently leads to confusion, since the available standard level discs not only use either 400 or 1k Hz, but the recorded level may be also specified in terms of recorded velocity or peak amplitude. In addition, there is the problem of lateral, vertical or 45° modulation. The lateral/vertical transformation is simple to unravel because the formula is quite 34 ▶

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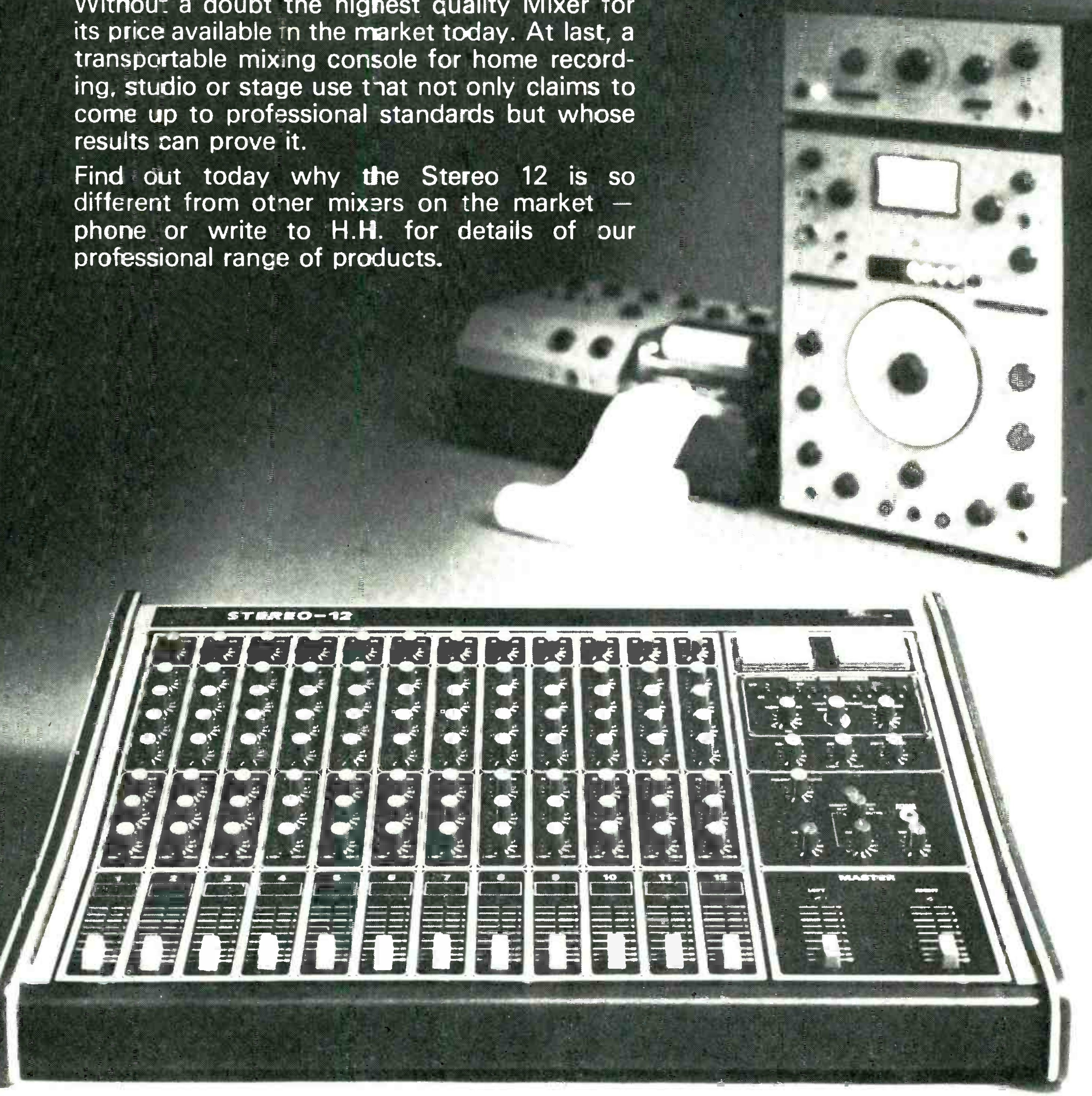

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Survey: disc cutting equipment

Forthcoming surveys include limiters and compressors (October), microphones and ancillary equipment (November) and tape machines (December). Information for inclusion should reach the editorial office (address p3) not later than eight weeks before the issue publication date.

CAPPS

Capps and Co Inc, 20 Addison Place, Valley Stream, NY 11580, USA.
Phone: (516) 825 4413.

VARI-DEPTH COMPUTER

Features 30 dB dynamic range of vertical gain and 15 dB lateral, 150 ms attack time and 400 ms decay time. Modes: manual deepen; auto deepen on lateral, vertical or both; and auto deepen on lead-in, band, expand and/or finish. Requires input from left and right preview and left and right program (all inputs bridging, 30 kohm min). Outputs for Westrex solid-state or tube drive, HAECO solid-state drive, Neumann suspension drive, or high-current suspension drive. Prices vary between $1.6k to $1.9k, depending on cutter to be driven.

VARI-PITCH COMPUTER

For 50-1000 grooves-per-inch (variable or fixed pitch) at 78, 45, 33⅓ and 16 rpm. Lead-in pitch adjustable by internal control between 8 and 32 gpi. Expand pitch variable 30-300 gpi; band pitch 16-64 gpi; expand time 0-5s; and band time 0-5s. Price $7.3k. Remote banding control accessory costs $425.

COUNTY RECORDING

County Recording Service, London Road, Bracknell, Berks.
Phone: Bracknell (0344) 54935.

The company make a complete system less lathe, incorporating their *ME76UK* cutter head. Frequency response is claimed to be within 3 dB from 40 Hz to 18.5 kHz. Driver amp is a 200W model from Acoustical Mnfg. Control desk features slider controls, vu metering, a/b comparison, bass and treble adjustment, stylus heater control and meter, mono stereo button, monitor preamp and psu, and measures only 60 x 90 x 30 cm (w x d x h). The system costs £8k, including installation, and can be tailor-made to fit any lathe.

NEUMANN

George Neumann GmbH, 1 Berlin, 61 Charlottenstrasse 3, West Germany.
Phone: 251 4091. Telex: 184595.
UK: FWO Bauch Ltd, 49 Theobald Street, Borehamwood, Herts WD6 4RZ.
Phone: (01) 953 0091. Telex: 27502.

VMS70 LATHE SYSTEM

Incorporates *AM66* lathe, *VA66* leadscrew drive unit, *AS66* drive control, *SV66* pitch/depth control amp, *NG70* psu and *ZT70* lathe console. Supplied without cutter and amps, transfer control and monitoring equipment, tape playback and preview console, or automatic banding unit. Price: about £28k.

SX74 STEREO CUTTERHEAD

Upgraded version of *SX68*, featuring 7-25k Hz frequency range (±0.5 dB 15-16k Hz) and ≥35f dB channel separation, 4-16k Hz. Price: £4.7k.

SAL74 CUTTER DRIVE LOGIC

Comprises monitor amp, cutting amps, limiter, tracing simulator and psu. Price: £14k.

SP77 CONTROL CONSOLE

Processes both the signal modulation for transferring from tape to disc, as well as the preview signals for the automatic pitch groove spacing control. Price: £23.6k.

MT77 TAPE PLAYBACK CONSOLE

For 6.35 mm masters (IEC and NAB standards) running at 19 or 38 cm/s. Transport is Telefunken *M-15* with two special 2-track heads or normal stereo heads. Four preview time intervals available. Price: £6.8k.

NEVE/MSR

Rupert Neve and Co Ltd, Cambridge House, Melbourn, Royston, Herts SG8 6AW.
Phone: Royston (0763) 60776. Telex: 81381.
Canada: Rupert Neve of Canada Ltd, 2721 Rena Road, Malton, Ontario. Phone (416) 677 6611.
US: Rupert Neve Inc, Berkshire Industrial Park, Bethnel, Conn 06801.
Phone: (203) 774 6230. Telex: 969638.
West Germany: Rupert Neve GmbH, 6100 Darmstadt, Bismarckstrasse 114. Phone: 06151 81764.

SYSTEM 2000

Comprises MSR *series 2000* lathe and programme control rack containing two ppms, varigroove offset attenuator, programme level setting attenuators, phase meter, two Ortofon cutting amps with psu and two monitor amps.

SYSTEM 2001

As *2000*, plus four Neve *1085* equalisers, four Neve *2254E* limiter-compressors, with provision for external Dolby or quadraphonic encoders.

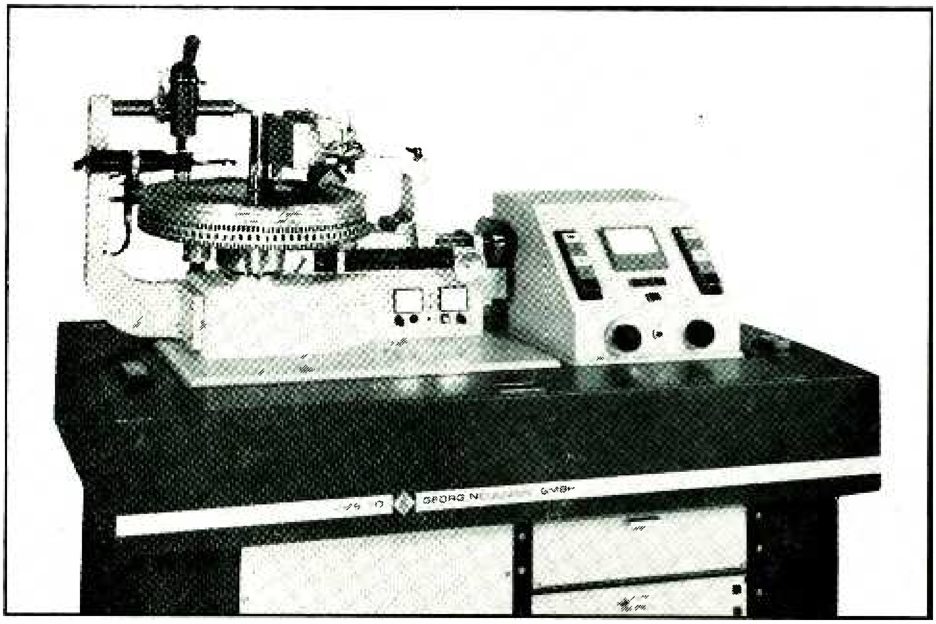
SYSTEM 2002

Comprises MSR *series 2000* lathe and control rack containing two Ortofon cutting amps with psu and two monitor amps, together with Neve *9002* mastering console.

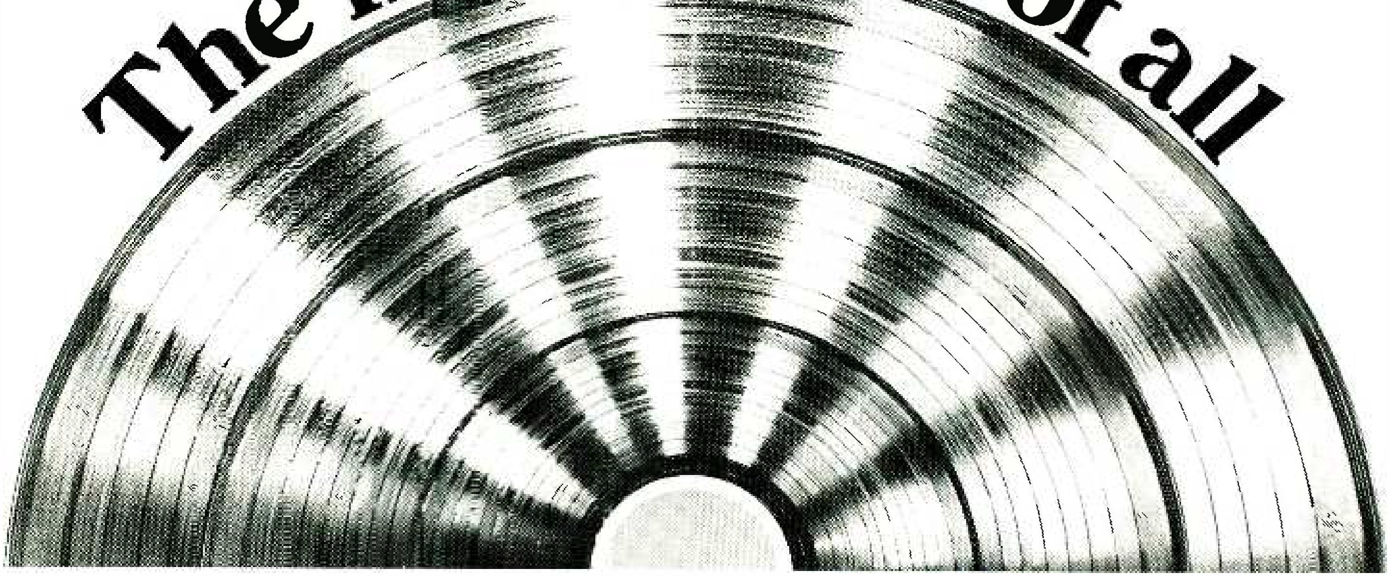
SYSTEM 2003

Comprises MSR *series 2000* lathe and control rack containing two Ortofon cutting amps with psu and two monitor amps, together with a comprehensive Neve *9012* mastering console. 34 ▶

Neumann VMS70 lathe system, a snip at £28k.



The kindest cut of all



The Neve/MSR 2000 series mastering lathe is simply the most advanced disc cutting system yet developed. The culmination of years of laboratory design and practical cutting experience, the Neve/MSR system combines sophisticated electronics with the best of British engineering to set a new standard for the recording industry.

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Rupert Neve of Canada Ltd., Malton, Ontario.
Rupert Neve GmbH, 6100 Darmstadt, W. Germany.

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Ortofon, 11B Mosedalvej, DK-2500 Copenhagen-Valby, Denmark.
Phone: (01) 462422. Telex: 27587.
UK: Feldon Audio Ltd, 128 Great Portland Street, London W1N 5PH.
Phone: (01) 580 4314. Telex: 28668.

TYPE DSS 732 CUTTERHEAD
Features 10-20k Hz frequency range, 15° (or 20° to special order) vertical cutting angle, 10-13 dB ratio of motional feedback at 5 kHz, and a maximum stylus excursion in 40° direction of 100 μm.

TYPE DSS 731 CUTTERHEAD
Four-channel discrete version of *DSS 732*, for use with systems utilising ultrasonic carrier frequencies (half-speed cutting). Frequency range claimed to be 5-25k Hz.

TYPE GO 741 CUTTING AMPLIFIER
Rack-mounting unit, supplied in system comprising two *GO 741* amps plus *GE 741* psu. Front-panel meters display cutter current and temperature. A monitor amp is included for de-emphasising the input signal for a/b checking during cutting. Adjustment controls are mounted behind a front hinged panel.

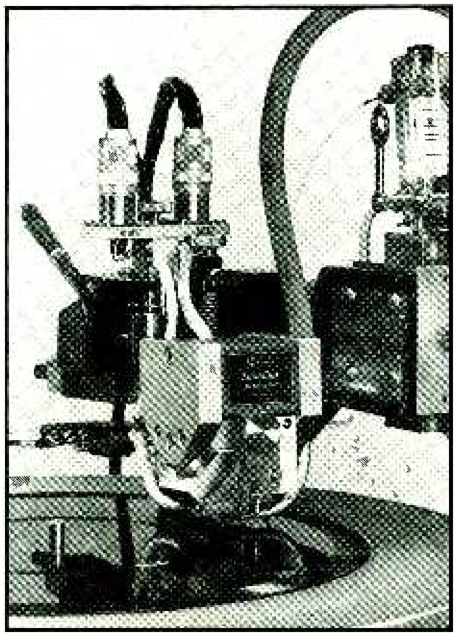
TYPE STL 732 REGULATED FILTER
A two-channel unit to prevent the cutting of non-permittable treble levels. Accepts line levels up to +12 dBm. Attack time is adjustable between 0.3 and 100 ms, release time between 3 ms and 1s.

RANSTELLE

Ranstelle Audio Inc, 167 Broadway, Suite 1407, New York, NY 10019, USA.
Phone: (212) 265 5563.

RDP-500A PREAMPLIFIER
Two-channel disc driver preamp providing all signal processing for moving coil cutterheads, such as Westrex and HAECO types. Also provides all input line and RIAA eq, cutter head and feedback monitor eq, and level adjustment to drive two *RDPA-250* power amps. Accepts input levels between —20 and +8 dBm. Frequency response is within ±1 dB of RIAA curve.

RDPA-250 POWER AMPLIFIER
Requires 2V ac input (impedance 5 kohm) to deliver full output of 250W across 4 ohm or 200W across 8-10 ohm drive coils. Distortion is said to be less than 0.2% thd, noise at least 85 dB below 7-cm cutting level, and frequency response within 1 dB, dc to 50 kHz.



Westrex 3D11A recorder.

SCULLY

L J Scully Manufacturing Co, 138 Hurd Avenue, Bridgeport, Conn 06604, USA.
Phone: (203) 368 2332.
UK: MCI Ltd, MCI House, 54-56 Stanhope Street, London NW1 3EX.
Phone: (01) 388 7867/8. Telex: 261116.

THE LATHE
Available as a separate unit or in three configurations: *System 1000* comprises *The Lathe* mastering unit, either Westrex or Ortofon cutting system, tandem channel amps/equalisers, limiters, and meter/monitoring facilities; *System 2000*, similar to *1000*, plus multiple source input selection, tape and lathe remote controls, safety tape copy provisions, a vertical/lateral crossover, and optional Dolby light-beam ppms and phase scope; *System 3000*, described as a 'you-name-it', custom-built system. *System 2000* is said to be recommended where final, last minute changes are made to the mix, or where each band is to be mastered at different eq settings. A pair of dual, tandem amps/equalisers with automatic cross feed is provided to satisfy this requirement. Basic price of *The Lathe* is $42k.

WAL

Weigand Audio Laboratories, RD 3, Middleburg Penn 17843, USA.
Phone: (717) 837 1444.

Weigand sell complete mono or stereo systems made from rebuilt Scully, Neumann and other brands of lathes equipped with Westrex, HAECO or Grampian new or used cutter heads and amps. Prices range from $2k for a basic mono system, to $25k for a complete semi-automatic, stereo system installed as a turn-key operation.

WESTREX

Westrex Company, 390 North Alpine Drive, Beverly Hills, Ca 90210, USA.
Phone: (213) 274 9303.
Hong Kong: Westrex Company Asia, Room 1302 Luk Hoi Tong Bldg, 31 Queen's Road Central.
Phone: 238 259. Telex: 76329.
Italy: Westrex Company Italy, 65 Via Constantino Maes, 00162 Rome.
Phone: (06) 83 92990.
Japan: Westrex Company Orient, CPO Box 760, Tokyo.
Phone: 211 6791. Telex: 22612.
UK: Westrex Co Ltd, 152 Coles Green Road, Cricklewood, London NW2 7HE.
Phone: (01) 452 5401. Telex: 923003.

RA1700 SYSTEM
Comprises: *RA17101A* equipment shelf and panel; two *RA1703* input amps; two *98609* recording equaliser units (matched to *3D11AH* recorder); two *RA1704* feedback/monitor amps; two *98610* monitor equaliser units (matched to *3D11AH* recorder); *RA1701B* equipment shelf and panel, two *RA1702* power amps and *RA1705* psu. Price: $5.5k.

3D11AH RECORDER
Stereo head equipped with aluminium formless coils, phase and impedance correction networks, advance ball holder with advance ball, suction tube, stylus with heating coil, and helium cooling. Price $5.8k.

RA1706 HF REDUCTION AMPLIFIER
Reduces high-frequency gain in the cutting system whenever the program energy towards upper end of audio spectrum exceeds preset level, to avoid damage to cut groove and ensure tracking of playback cartridges. Price: $414.

THE NOISE JUNGLE

straightforward, being the solution to a right-angled triangle:

Lateral modulation = 45° modulation x 1.414

The difference is 3 dB, with the lateral modulation being the higher when compared with the 45° (left or right channel) modulation. Vertical modulation can similarly be transformed to 45° modulation, and vice versa.

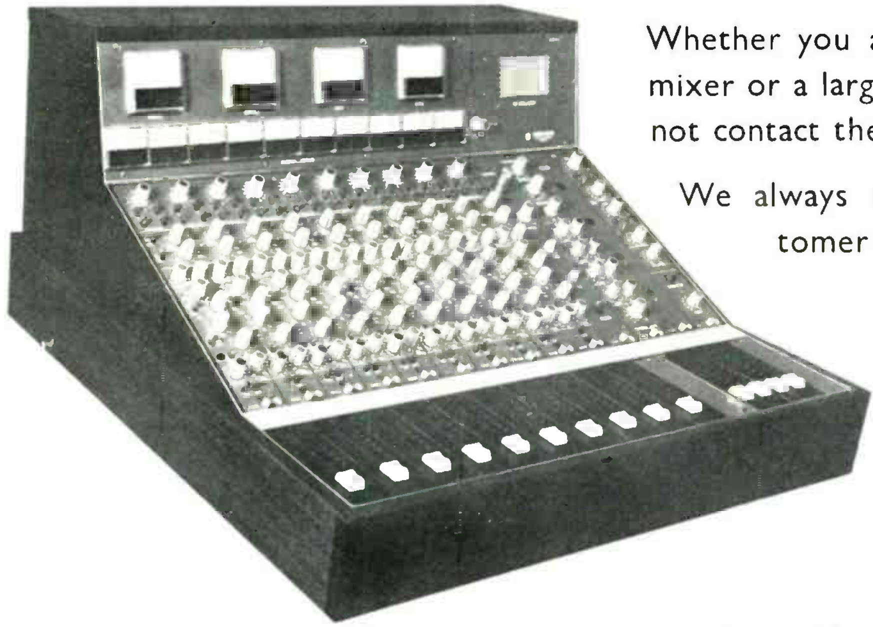
As is to be expected the relation between recorded velocity and recorded amplitude depends on frequency (for the time being ignoring equalisation), and it can be shown that the peak recorded velocity is related to peak recorded amplitude as follows:

$V_{max} = 2\pi$ x frequency x peak amplitude

Armed with the above information and details of equalisation, it is easy to transform one type of reference level to another—but the optimum type to use is certainly open to discussion.

Noise in digital systems
As a final note it is only fair to point out that the measurement of noise in digital systems invokes a whole new series of problems. Conventional noise measurements can be applied to the parts of the system that use analog techniques, but once past the analogue-digital converter a completely new type of noise problem emerges. Briefly, in a digital system the amplitude of the audio signal is converted into a digitally-coded number, and changes in amplitude can only be described by whole numbers. For example, if the numbers 0 to 4096 are available (12 conventional digital bits), the audio signal can only be 'quantised' into one of the numbers 0, 1, 2, 3 . . . up to 4096.

Part of the digital problem is known as 'quantising error', which occurs as a result of the audio signal differing between two or more numbers when it should be constant. This type of noise has a completely different character to normal random noise, and thus requires completely new measuring techniques. The problem applies to a certain extent at high signal levels, but at low levels the quantising noise becomes extremely objectionable if conventional analogue/digital coding is used. However, this leads to a field of various coding techniques and their effects on noise, which is another story. ■



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letters

Dear Sir, In his articles on the history of sound recording in your June issue, Melvin Harris is guilty of a number of errors of fact and misconception. These are some of them:

1) The lateral method of recording and replay was not, as Mr Harris presumes, superior to the 'hill-and-dale' method of indenting signal in depth as employed by Edison and others—the reverse is the case as confirmed by modern research. Contrary to what Mr Harris says—certainly in the acoustic era—the disadvantages lay with the lateral method. Chief among these was the fact that on loud passages the signal was apt to, and often did, break into adjoining grooves causing blast, distortion and actual breakdown of the groove walls. In the hill-and-dale system on the other hand, a loud signal merely indented deeper in depth without encroaching into grooves alongside. Also, when the 'in-depth' method was used with a cylinder system or similar using a feed-screw mechanism, the reproducer was merely positioned in the groove and propelled lightly across it by the feed-screw. In the lateral acoustic method, however, the grooves had to perform the double function of supplying both the signal, and the means of pulling a heavy soundbox across the record. Other advantages of the hill-and-dale system on cylinder are a constant linear speed under the stylus, and no end-of-side distortion. Mr Harris should not accept Cros' condemnation of Edison's in-depth method of recording and replay without evaluating that condemnation, and enquiring as to Cros' partiality in the matter. He would do well to remember the 'Edison tone tests' when audiences were unable to tell certain recorded performances from live ones—when coming off 'Edison diamond discs' and from a signal recorded in-depth by the hill-and-dale method.

2) Other people seem to have had rather more success with a tin-foil recorder than Mr Harris. I have a transfer of Edison's voice, speaking his 'Mary had a little lamb' test words, coming off tin-foil that is remarkably good. If Edison thought it 'imperfect', then it is a tribute to the high standards he always sought to achieve.

3) The highest speed attained by Pathé discs was 130 rpm—not 100 as stated.

4) Edison's two sizes of long playing records of 1926—providing 40 and 24 minutes playing time respectively—were cut at 450 grooves-to-the-inch and not 420 as stated. These long-playing records, of course, invalidate his claim that the first lps were not produced until 1932, although the American Victor Company did produce 33⅓ long-play discs in 1931.

5) To say that after 1905, up until the introduction of electric recording, there was only 'tinkering' with recording techniques, as Mr Harris claims, is surely wrong. What about Edison's Blue Amberol *cylinders, his Diamond Disc Recreations mentioned above, and Pemberton-Billing's constant linear speed 'World Records'.*

6) He states that in the acoustic era, engineers could not record much above 2.2 kHz, and that there is hardly anything below 100 Hz. This is not so—signals up to at least 5 kHz and down to 50 Hz can be retrieved, certainly from Edison's Blue Amberols.

7) He is incorrect in claiming that 'cylinders made recordings inflexible'. The reverse is the case: because cylinder machines were capable of both a record and replay function—like a modern tape machine—many of the earliest recordings come to us only because of this flexible facility.

8) Celluloid cylinders that solved the wear problem of wax cylinders were available from 1900-onwards, and not 1912 as claimed.

9) The details of music cylinders produced by Edison on May 24, 1889, as quoted are incorrect.

Yours faithfully, Joe Pengelly, 36 Thorn Park, Mannamead, Plymouth.

Melvin Harris replies:

1) I wrote, '. . . the *inherent* advantages of the lateral trace . . .', and no more. I didn't state that these advantages had been fully exploited, for they weren't. For example, the use of the groove to drive a heavy soundbox is not necessitated by lateral methods. Cros' idea, in fact, was to use a feed-screw to drive the record under the replay head. Again the interference between adjacent grooves is not inherent in the lateral technique; it arises when the grooves are packed too close together. But commercial considerations being what they are, many faulty practices were certainly associated with the early gramophones. The whole question of lateral versus hill-and-dale recording, however, is too complex to discuss adequately in a short space, and since I shall be writing at length on these topics, that's all I have to say now. But it's worth noting that even Edison came to state that the lateral method was superior, and he invented and patented a lateral recording head for his wax cylinders. It's shown in detail on Sheet 8 of Edison's Patent No 15206 of 1891 (accepted July 9, 1892). And on p11 Edison says this about it: 'The recorders hitherto used are moved by the diaphragm toward and away from the surface of the blank. An improved form of recorder, in which the recording point moves laterally in a succession of minute arcs, has, however, been devised . . . vibrations are more truly recorded in this manner . . . the reproduced sounds being accordingly improved.'

As for the Edison Tone-Tests, they will also be dealt with in the articles I've mentioned. If Mr Pengelly would like to do some research for himself though, here are some tips for him. Similar tests with live artists and standard gramophone discs were carried out years before Edison's tests and with similar results. If he reads p315 of 'Audio Biographies' (Wharfedale, 1961) he will find an account of one featuring Melba, staged in 1910. Let me make it clear though, I *don't* say that the Edison discs weren't fine, but the whole subject of comparison tests is much more involved than most people imagine.

2) I've made many effective tin-foil recordings and used them on the air, but that doesn't alter the fact that it is a tricky hit-and-miss business. And it always was. To *repeat* Edison's words: 'No one but an expert could get anything intelligible back from it'. This verdict is confirmed by many of the experts who worked with the recorders in the early days; these include J E Greenhill, Sir Alfred Ewing, Fleeming Jenkins and Augustus Stroh. And in 1901 the science lecturer T C Hepworth summed up his and Stroh's experience of the method and wrote: 'One had to shout into the mouthpiece of the *Phonograph* to obtain a good record . . . and it was considered quite a triumph if a sentence or two, or a few bars of a popular song, were reproduced in sufficiently accurate fashion to be recognisable'. (Cassell's Popular Science, volume 1, p136.)

3) Yes, there were Pathé discs that went faster than the 100 rpm of the standard discs: they were special discs almost 20 inches in diameter, meant to revolve at speeds ranging from 120 to 130 rpm—very useful for garden parties, though the only one I've ever heard was rather quieter than I'd expected.

4) My information on the Victor lps is that demonstration records were given a hearing on September 17, 1931, but the records did not reach the shops until 1932. But in referring to these I certainly *didn't* claim that they were the first long-playing records; I term them the original lps because as lateral-cut 33⅓ discs they are the direct ancestors of our present-day lps.

Mr Pengelly *is* right though, in saying that Edison's grooving was 450 to-the-inch, and not 420—I must use a stronger magnifying glass when I next count them!

5) I did *not* write that there was 'only 'tinkering': I wrote: '. . . most of the inventive energy was devoted to mere tinkering'. And that has a very different meaning; it's based on my examination of the files of the Patent Office, where I found many trivial inventions, and few fruitful ones.

My brief in writing the articles was to concentrate on recording and ignore replay. That was helpful, but even so the material I had would have more than filled a whole issue, so *many* things had to be left out. These included the constant-speed recording systems of Dr Max Hausdorff and Pemberton-Billing, which were interesting but dead-ends.

6) I don't doubt that signals outside the limits I mentioned, 'can be retrieved'. And I'm certain that with the use of computers, and

38 ▶

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perhaps laser beams, we have even more excitement in store. But those engineers of yesteryear recorded for the equipment around at the time, not for 1977—and that's what I was concerned with.

7) and 8) The 'inflexibility' to which Mr Pengelly referred applies to the problem of increasing playing time. He should read the section again. Then, if he still doesn't get the point, here's how the Edison people put it: 'It would have been easy to lengthen the time of playing by lengthening the records, but that would mean a larger and more expensive *Phonograph* to play them, and it was Mr Edison's idea to make a longer-playing record that present *Phonograph* owners could enjoy, and also keep the prices of his instruments down to a point where every home could afford one. To keep the record the same size as those you have and double the number of threads required, a new kind of composition of sufficient hardness to resist wear between the threads [would be needed].'

Now that's part of a statement issued in 1908 announcing the *Amberol* 4-minute cylinders. But the 'new kind of composition' didn't live up to its promises, and the wear problem remained until Edison used celluloid to take *his finer grooves*—there were, of course, celluloid cylinders around prior to 1912 (I own 15 of them), but they have no bearing on the point I was making.

9) For some odd reason Mr Pengelly doesn't say how or why the details I gave were incorrect. But *if* they are wrong the fault is not mine, since the details come from three separate sources. First of all from the man who made the recordings, Eugene Rose, the flautist. I knew people who worked with him and he often spoke of the event. And H W Schwartz in his 'Bands of America' mentions the event (Doubleday, 1957 ed, page 210). Then in a letter to the *Hillandale News* dated April 14, 1971, Walter L Welch wrote: ' "The First Book of Phonograph Records" prepared at the Edison Laboratory by Theodore E Wangemann begins with entries of May 24, 1889, with a list of 14 flute solos'. Now Walter Welch signs himself as curator and director of the T A Edison Foundation Re-recording Laboratory, Syracuse, NY, and as such must have access to documents, etc completely outside my reach. So if the entries he quoted were wrong, he would have said so; but he didn't and in that way he endorsed them. And I think that even Mr Pengelly will agree that that was enough testimony to allow me to make my statement in good faith.

To sum up, Mr Pengelly has spotted two genuine errors in my articles. Now two very minor slips in over 10 000 words is a very trivial crime; nevertheless I shall do penance by listening to both sides of a Clara Butt record! The 'error' mentioned in his last point certainly needs clarification. Were Welch, Wangemann and Rose *all* wrong? I think that Mr Pengelly has some explaining to do, and I look forward to that. But one thing I must *insist* on: I am not prepared to take up any more time in discussing anything else. Most of the points Mr Pengelly makes would never have been raised had he taken the trouble to read my articles carefully. And the answers I have given are complete and need no expansion.

Finally Mr Pengelly should reread from column two on p57 to the end of column one on p58. This might help to save him from future embarrassment, for he persistently refers to the hill-and-dale recordings as *indented*. But only the tinfoil machine employed the indenting process; the wax cylinders and the diamond discs, etc were made by the incising method—indenting was replaced by incising in 1886. In Bell and Tainter's patent No 6027 of that year the new method is fully described, this method then being adopted by Edison. Such a distinction is a crucial one, and not a quibble over words—a failure to make the distinction can lead to a good deal of misunderstanding.

Dear Sir, On pages 58-60 of the April issue of STUDIO SOUND *there was a review of an echo machine manufactured by the Denon Instrument Company of Japan. The review is entitled 'DENON EM-2000', from which a reader might receive the impression that this product is sold under the brand name 'DENON'. In fact 'DENON' as a trade mark (not used as a word in a company's name) is registered in Japan, Britain and other major countries by Nippon Columbia Co Ltd. Denon Instrument Company has neither any right to use 'DENON' as their trade mark or as a brand name to be carried on their products, nor have they any connection at all with us. Actually, the products of Denon Instrument Company are sold under the 'DIC' brand name.*

The 'DENON' trade name has been owned by Nippon Columbia for many years, and has been applied to broadcasting and high-end audio equipment. As a result of extensive advertising, we have succeeded in establishing the 'DENON' brand name as being of excellent quality both in Japan and abroad. To protect our right as the possessor of the 'DENON' trade mark, we registered it in Japan as Japanese Trade Mark Registration No 489823, and in Britain as British Trade Mark Registration No 860504 (Public Notice 1015058). We have also registered the 'DENON' trade mark in almost every other major country throughout the world.

We are afraid that the review might give readers the misunderstanding that the EM-2000 is sold under the 'DENON' brand name or that it is a product of Nippon Columbia.

I hope that this clarifies the 'DENON' situation.

Yours faithfully, K. Yahagi, Nippon Columbia Company Ltd, 5-1 Minato-cho, Kawasaki-ku, Kawasaki, 210, Japan.

Dear Sir, In summarising the specification of our new Delta-T model 92 *delay unit in the May issue, you mentioned our 'noise and distortion less than 0.1% (whatever that means)'. Since we introduced this form of specification three years ago, there has been little question or comment about it, although clearly this is now in order. When the 'total harmonic distortion' of a digitised audio waveform is measured with a traditional distortion meter (of the notch filter type, such as Radford, HP 331A, Sound Technology, etc), the measured residual is a wideband averaged signal containing everything emerging from the unit under test* except *the input fundamental. If the added harmonics are far enough above the system's noise, the measurement will be the total harmonic distortion. However, in a properly engineered digital system, operating with a signal large enough to excite more than 3 or 4 bits of the code, the output will be almost entirely quantising noise, and not harmonics of the input signal. Thus, when describing the 'distortion' performance of a digitised system, it is more significant for the user to know the 'total noise and distortion'—plus it's easy to measure. The number, then, represents the percentage of all the additional garbage added to the input signal, and will consist almost entirely of broadband noise in a* Delta-T.

By the way, production units have indicated that we can tighten our specification to 0.08% maximum, with typical systems being around 0.06%. This is a little over 64 dB down from the signal, a performance level of which we are proud.

Yours faithfully, Christopher Moore, Lexicon Incorporated, 60 Turner Street, Waltham, Mass 02154, USA.

Hugh Ford replies:

While I realise that specifying 'noise and distortion less than x%' has the best of intentions, particularly with digital systems, we are back in the confusing area of measured effects versus subjective effects.

Unfortunately, the use of total harmonic distortion measurements is all too common. It should firstly be understood that any instrument that measures total harmonic distortion by rejecting the fundamental (as is normal), is measuring, in fact, total harmonic distortion *plus* noise and any other signals which appear within the measurement bandwidth.

Depending upon the bandwidth, such measured signals may, for instance, be at 100 kHz—they will drive bats and dolphins quite nuts, but humans are not likely to be affected! Similarly, us humans don't like odd harmonics; but the instrument does not give any 'weighting' to this factor.

The use of digital systems further complicates this situation as we are faced with other forms of noise that are subjectively objectionable, such as quantising noise. The subjective effect of quantising noise depends to a very large extent upon the digital coding system used, and this is an extremely complex subject.

However, the specification of 'noise and distortion less than x%' goes little way towards enlightening the equipment user about the subjective noise to be expected, as does the specification of 'total harmonic distortion' about distortion.

For further clarification, readers are referred to Hugh's article 'The Noise Jungle' on page 26, and in particular the section entitled 'Practical statements of noise performance'—**Ed.**

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Tower of power

J Fred Riley

*This article was provoked by a comment from Arun Chakraverty (*STUDIO SOUND*, November '76, p36) that the single 'Don't go breakin' my heart' was an example of how one could get: 'the maximum possible level on the disc without any limiting or altering the overall equalisation'. Now try putting it to air.*

THE TERMS 'split-band limiting' and 'asymmetrical' limiting do not usually find their way into the vocabulary of studio engineers, but they are extremely important concepts to a broadcast engineer trying to get the maximum loudness, coverage, and audience out of his transmitter. Unless the average broadcast engineer can get the studio engineer's product through the complex system known as am radio, a record's progress up the charts may be hindered. It is essential that the studio engineer have some type of feel for what is going to happen to their product on its way to the listener's ears.

Consider the am car radio. It sells a lot of records, but it is also a device with horrible performance. Typically, one can find the frequency response at 5 kHz down by 6-15 dB referenced to 100 Hz at the radio's output terminals. This restricted response is coupled with a small speaker and a decided windshield resonance at about 100 Hz. Consider also that the final peak limiter used to protect the transmitter always looks at the highest peak content on the record, and adjusts the entire gain to that level. Now you can understand why *If you leave me now* from the *Chicago X* lp seemed to cause the loudness level of small radios to drop considerably. The heavy bass line through the song was all that the broadcast limiters were seeing, thus keeping the key loudness and perception frequencies below their normal levels. The alternative to this phenomenon is to re-equalise the record at the radio station for most efficient transmission. The ideal is to have equal energy density across the spectrum on all material transmitted, a technique now being achieved by the more progressive broadcast engineer using three processes.

The first process is to split the audio signal into octave or 3-octave bands, gain control each band, and then recombine the bands before final limiting. This system is coming into wide use and the results are quite dramatic. The unfortunate part is that the use of these devices often alters a musical effect.

The second system is to examine in octave bands the spectral density of the disc, digitally store the information, and then display the results on a read-out device—a procedure similar to that used in monitor equalisation. Shelf-equalisers then smooth out the total spectral density of the disc, and the re-equalised signal is recorded on a tape cartridge. When played back, the audio signal is split into high and low-frequency bands, each band being carefully controlled to achieve a continuous balance without losing musical effects. The recombined signal is then processed by the final peak limiter. The big advantage in this system is a less-controlled sound. Unfortunately every disc must be treated individually before being broadcast, and a significant amount of time is required to properly analyse and equalise each record.

The third and last system is to simply roll off the low and boost the high frequencies on all the material to be transmitted, the amount of cut and boost being determined by the characteristics of an 'average' receiver—whatever that means. More often than not, this method backfires for one reason: the high frequencies are usually boosted quite a bit, and whenever a lot of hf information (such as an 's' sound) comes along, the final limiter will cause the whole signal to 'duck' in order to prevent over-modulation.

Wouldn't it be nice not to disturb the recording engineer's idea of what is correct? Wouldn't it be nice standing in the unemployment line because the other stations sound louder, brighter, and better on the station owner's radio? We can conclude that the availability, at very reasonable cost, of digital spectrum analysers that can assist the recording engineer, makes the use of such devices in examining the final mixdown a realistic approach.

Asymmetrical modulation means simply that the transmitter is modulated with higher positive modulation than negative. In am radio, more than 100% negative modulation is impossible, since, by definition, it means no power output. If the signal is continuously modulated down to 100% negative, the transmitter generates spurious responses known as 'splatter'. Conversely, 100% positive modulation means that a peak power of four times the carrier power is being transmitted. Limiters are used to prevent negative 'over-modulation' and 'splatter'. Signals can be modulated in the positive direction as far as required (or as far as the broadcast laws or equipment allows) and the only effect is to make the sound louder.

Consider the nature of the human voice and most musical instruments—they produce fundamental frequencies plus harmonic overtones. A signal comprised of fundamentals plus harmonics implies that we might expect waveform asymmetry; and this is the case. A good visual demonstration of this is to connect an oscilloscope across the output of a microphone, have someone say 'hello' into the mic and sustain the 'o' sound. The resultant trace will deflect much further in one direction than the other, indicating asymmetry. (Incidentally, a male voice is best for this test since, as a rule, they have much more asymmetry than female voices). Thus there exists asymmetry in voice and music, and negative modulation must be limited to 100%—but positive modulation is open to higher values. It would be useful if the incoming waveforms to the final limiter could be continuously monitored, and the proper phasing selected. This would allow the transmitter to always 'see' the higher value peaks as positive peaks, and the lower value peaks as negative.

This is what asymmetrical modulation is all about. No standard has ever been established for every component in every studio to be phased so that every voice recorded in every studio will always come out in the proper phase. The true asymmetrical limiter will continuously monitor the incoming line to determine whether normal or reverse phasing is necessary for max positive modulation.

Asymmetrical limiters are in wide use throughout the world. Problems arise where more than one microphone is used, and there is more than one strongly asymmetrical signal (such as two male voices) and the microphones are out of phase. As the first vocalist sings, the phase is switched to optimum. Then, the second vocalist sings and the phasing circuit must reverse the phase, and so on. *Don't Go Breaking My Heart*, by Elton John and Kiki Dee is an unusual record in many respects: firstly, Kiki Dee has an unusually asymmetrical voice for a female; and secondly, the microphones were reverse phased on the record. This caused the phase switching circuits in the limiters to be continuously searching for the proper phasing as the vocal bounced back and forth.

However, nothing is free and phase switchers are no exception—the price tag here is that of interrupting the signal as the phase is switched. Although the phase is switched in milliseconds, there is obviously a discontinuity in the waveform that can cause an audible 'click'. A properly designed limiter waits for a low passage or dead spot to switch in. On this record, however, Elton John's voice would start out phased properly; Kiki Dee would pick up and the limiter would recognise the reverse phase condition of her voice and would wait for a good place to switch. This occurred at the end of a verse, and the limiter would switch; but, then there would be Elton John's voice now reverse phased—back and forth throughout most of the song the peak limiter would be looking at the wrong phasing, and undermodulating the transmitter in the positive direction.

The only real answer to this problem was to either ignore it or to artificially make the vocal waveforms symmetrical so that the positive peaks could modulate near normal values. There are devices available that do this without excessive audio coloration, and that was my approach. The problem, however, is that advantage could never be taken of the naturally occurring asymmetry in the music.

It is obviously a great help to the broadcast engineer to have the recording studio check to ensure that all microphones are phased identically. This can be verified by an oscilloscope check of a male voice on each microphone. Obviously, this is not always possible, but it is good practice when recording in the studio, and should be done unless a desired effect requires otherwise. An example of how important asymmetrical modulation is to the broadcaster goes as follows: a 10 kW station puts out 40 kW peak power at 100% positive modulation; over 50 kW peak power at 125% positive modulation, and 62.5 kW at 150% positive modulation. Asymmetries where positive peaks are 1.5 times the amplitude of negative peaks are not uncommon in music. If advantage is taken of these asymmetries, the coverage and loudness can be increased in the same way as increasing the transmitter's power.

Asymmetry checks and spectral balance evaluation are two positive ways that can ensure the studio engineer is doing all he can to maximise the effective impact of his product on the listening audience. ■

agony

Hourly news bulletins, like time and tide, wait for no man. So it became a way of life at an Independent Radio Station for journalists to be seen flying in every direction as the dreaded top of the hour approached. Such frequent states of panic became a way of life for the engineers, who thought they had seen everything, until one journalist came up with what must be the piece de resistance. After bursting into the master control room, and pausing only to check that he had the engineer's attention, he started to wave his arms in every direction and explain what he couldn't do. In mid flow, he turned on his heels and vanished to whence he came. Realising that the journalist may have finally flipped, and wishing to maybe protect the station's valuable equipment from the mindless thrashings of a man near the end of his tether, the engineer was off in hot pursuit. Catching up with the journalist, who was now doing his arm-waving act in front of his mixing desk, the engineer was at last able—after more garbled conversation—to see the problem. It transpired that the journalist had been talking on the telephone to a prospective interviewee, but when he tried to talk to him through the console, the journalist could hear the caller but not vice-versa. The cure was easy: with a long-suffering look on his face the engineer simply turned on the journalist's microphone.

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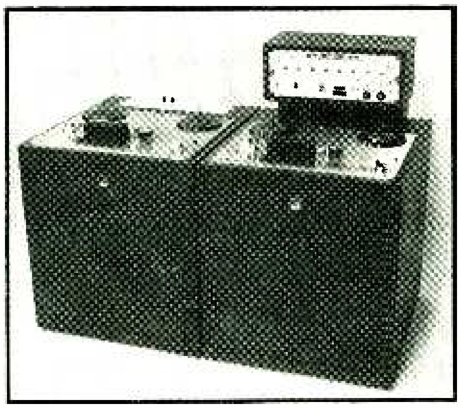
Frequency response: 30-18k Hz +1, —3 dB.
Signal-to-noise: better than 3 dB below blank biased tape. (*Scotch 176*, 1-10k Hz real time.)
Speed error: < 0.5% (overall).
Flutter contribution: 0.15 rms, NAB-weighted (overall).
Stereo phase error: < 45° at 18 kHz.
Dimensions (h x w x d): slave 77.5 x 67.9 x 74.3 cm; master 109.8 x 67.9 x 74.3 cm.
Weight: slave 69 kg; master 86.3 kg.
Power: 117V 60 Hz; 50 Hz available on special order.
Price: 2-channel master $4300; slave $3200.



Accurate Sound model 2400 duplicating system.

AMPEX

Ampex Corporation, Audio-Video Systems Division, 401 Broadway, Redwood City, Ca 94063 USA.
Phone: (415) 367 2011.
France: Ampex, 21 Rue du Dome, 92100 Boulogne. Phone: 609 9155. Telex: 250025.
South Africa: Ampex South Africa (Pty) Ltd, Standard House, 67 Simmonds Street, Johannesburg 2001.
Phone: 838 7640. Telex: 86279.
UK: Ampex Great Britain Ltd, Acre Road, Reading RG2 0QR.
Phone: Reading (0734) 85200. Telex: 848345.
West Germany: Ampex Europa GmbH, Walter-Kolb-Str 9-11, 6 Frankfurt/Main.
Phone: 60581. Telex: 413774.

BLM-200A/3400 SYSTEM

Comprises the *BLM-200A* loop-bin master for 25 mm tape, and up to 10 slave units of the *3400* series.
Track format: 2 or 4-track on 3.8 mm cassette pancakes; 8-track on 6.35 mm cartridge tape.
Duplicating ratio: up to 32:1.
Duplicating speeds: master loop 610/304 or 152 cm/s; slaves 304/152 or 76 cm/s.
Frequency response: cassette 50-8k Hz ±2 dB; cartridge 50-10k Hz ±2 dB.
Signal to noise: better than 8 dB below biased low-noise tape.

Ampex BLM-200A loop-bin and 3400 series slaves.

Wow and flutter: 0.1% NAB-weighted.
Crosstalk: >50 dB 200-100k Hz.
Dimensions (h x w x d): master 154.9 x 106.7 x 68.6 cm; slave 78.7 x 66 x 71.1 cm.
Weight: master 227 kg; slave 68.1 kg.

RR-200/3400 SYSTEM

Comprises the *RR-200* reel-to-reel master and up to 10 slave units of the *3400* series.
Track format: master handles 6.35 or 12.5 mm tape; slaves 3.8 mm cassette pancakes or 6.35 mm tape on 1, 2 or 4-track formats.
Duplicating ratio: up to 16:1.
Duplicating speeds: master 304/152 cm/s; slaves 152/76 cm/s.
Frequency response: cassette 50-8k ±2 dB; cartridge 50-10k ±2 dB; open reel (19 cm/s) 50-15k Hz ±2 dB.
Signal-to-noise: better than 10 dB below biased low-noise tape.
Wow and flutter: <0.15% ASA A-weighted in copy.
Crosstalk: >50 dB 200-200k Hz.
Dimensions (h x w x d): master 154.9 x 66 x 76.2 cm; slave 78.7 x 66 x 71.1 cm.
Weight: master 136.2 cm; slave 68.1 cm.

AUDIO/TEK

Audio/Tek Inc, PO Box 5012, San Jose, Ca 95150, USA.
Phone: (408) 378 5586.

MODEL 1100B SYSTEM

Reel-to-reel (6.35 mm tape) or loop-bin (12.5 or 25 mm tape) masters and up to 10 slaves for 2 and 4-track open reel, 8-track cartridge, 8-track quad, or cassette pancakes. Slave transports are equipped with quick-change heads; record and bias level adjustments, plus monitor test jacks are built-in. Throughput of a 10-slave system is claimed to be 10k 8-track or 6k cassette copies per 8-hour shift.
Track format: 4 and 8-track cart, 2 or 4-track open reel and 4-track cassette. Slave heads can be changed in 15 minutes.
Duplicating ratio: 16 or 32:1.
Duplicating speed: master 304 or 610 cm/s; slaves 152 cm/s (4.75 cm/s copies) and 304 cm/s (9.5 cm/s copies).
Reel size: slaves, either 26.7 or 35.6 cm.
Frequency response: 'copies deviate from master by not more than +2, —3 dB 50-12k Hz; down no more than 3 dB at 12 kHz'.
Signal-to-noise: system contributes <3 dB weighted noise to that of bulk-erased tape.
Bias frequency: 2 MHz, agc amplitude stabilised.
Wow and flutter: ≦0.25% rms NAB-weighted.
Speed error: ≦0.5% overall.

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SURVEY: TAPE DUPLICATING EQUIPMENT

Equalisation: 4 or 8-track 25 mm masters recorded at 19 cm/s to NAB curve; 19 cm/s copies conform to NAB curve; 9.5 cm/s copies to 120 µs curve; cassettes to the Philips curve.
Power: 117V 60 Hz.

MODEL 1200 SYSTEM

Loop-bin master and up to 12 pancake or pancake-to-cassette slaves. Throughput of 12-slave system per 8-hour shift is claimed to be approx 7k cassettes with pancake slaves, or approx 3.5k with pancake-to-cassette slaves.
Track format: 6.35 mm 2 or 4-track master recorded at 9.5 or 19 cm/s to NAB 120 µs curve; 4-track (stereo) or 2-track (mono) cassette.
Duplicating ratio: 16 or 32:1.
Duplicating speed: master 304 cm/s; slaves 152 cm/s (32:1 dup ratio).
Frequency response: 'copies deviate from master by not more than +2, —3 dB 50-10k Hz.'
Signal-to-noise: system contributes <3 dB weighted noise to that of bulk erased tape.
Bias frequency: 2 MHz.
Wow and flutter: 0.2% rms NAB-weighted.
Speed error: 0.5% max overall.
Power: 117V 60 Hz; 50 Hz optional.

DENON

Nippon Columbia Co Ltd, Audio Products Division II, 14-14 Akasaka 4-chome, Minato-ku, Japan.
Phone: (03) 584 8111. Telex: 22591.

DN-020-R-E SYSTEM

Comprises *DN-022-P-E* loop-bin master reproducer and *DN-322-R-E* pancake slave. Duplicating ratio is 32:1, the master running at 304 cm/s with 19 cm/s master tape, and slaves at 152 cm/s. No other details available.

GAUSS

Cetec Audio, 13035 Saticoy Street, North Hollywood, Ca 91605, USA.
Phone: (213) 875 1900.
Europe: Cetec UK, Sapphire House, 16 Uxbridge Road, Ealing, London W5 2BP.
Phone: (01) 579 9145. Telex: 935847.

1200 SERIES SYSTEM

Basic system comprises: *model 1210* master reproducer, *model 1260* tape loop-bin and *model 1220* reel-to-reel or pancake slave. Up to 20 slaves can be used with one master.
Track format: master, 2 or full-track on 6.35 mm, 4-track on 12.5 mm, or 8-track on 25 mm tape; slave, all standard formats on 6.35 mm or 3.8 mm tape, convertible.
Duplicating ratio: 32 or 64:1 with 19 or 9.5 cm/s master tape.
Duplicating speed: master 610, 304 or 152 cm/s; slave 304, 152 or 76 cm/s.
Reel size: 17.8 to 35.6 cm EIA or NAB.
Bin capacity: 3 to 548m, 12.5 or 25 mm tape.
Frequency response: maximum deviation on duplicated copies from master tapes recorded at 19 cm/s (NAB eq) is ±3 dB 30-14k Hz for both 9.5 cm/s and 4.75 cm/s copies.
Signal-to-noise: biased tape noise on copies does not exceed bulk erased tape by more than 2 dB.
Distortion: <0.25% thd electronics only; <1% thd total system distortion due to electronics at 15 dB above standard operating level.
Bias frequency: 10 MHz.
Wow and flutter: <0.05% rms 1-300 Hz.
Crosstalk rejection: 65 dB at 100 Hz, 70 dB at 1 kHz and 60 dB at 10 kHz, cassette programme-to-programme.
Speed accuracy: ±0.1%.
Other: built-in cue-tone generator, range 2-20 Hz, switchable between 32 and 64:1 dup ratio.
Dimensions (h x w x d): master or slave 106.7 x 95.3 x 71.2 cm; loop-bin 107 x 100 x 79 cm.
Weight: master or slave 153 kg; loop-bin 143 kg.
Price: 32:1 system: 8-track 25 mm master $15.3k; 4-track 12.5 mm master $14.8k; 12.5 or 25 mm loop-bin $14.6k; 8-track 6.35 mm slave $13.5k; 4-track cassette slave $12.1k; 4/8-track cassette or 6.35 mm (convertible) slave $15.7k. 64:1 system: 8-track 25 mm master $17k; 4-track 12.5 mm master $16.4k; 12.5 or 25 mm loop-bin $14.6k; 4-track cassette slave $12.8k; 4/8-track cassette or 6.35 mm (convertible) slave $16.4k (all prices USA ex-works).

MODEL 1250B QUALITY CONTROL REPRODUCER

Features convertible tape transport and head assemblies for quick changes between cassette and cart formats. Both formats operate bidirectionally at 4.75 or 9.5 cm/s.
Dimensions: (w x d x h) 72 x 71 x 112 cm.
Weight: 93 kg.

LYREC

Lyrec Manufacturing A/S, Hollandsvej 12, DK 2800 Lyngby, Denmark.
Phone: 287 6322.

14PLM LOOP-BIN MASTER

The unit is operable in a loop-bin or a reel-to-reel mode, and can be connected to 'at least' 20 twin-

transport slaves. Throughput per master/twin-transport slave system is a claimed 700 cassettes per 8-hour shift.
Track format: 4-track on 12.5 mm tape (standard), or on 6.35 or 25 mm to order.
Duplicating ratio: 16:1.
Duplicating speed: 304 cm/s for 19 cm/s master tape.
Bin capacity: up to 548m.
Start time: loop bin mode<0.5s; reel-to-reel 10s.
Dimensions (w x h x d): 99 x 141 x 30 cm.
Weight: 90 kg.
Price: about £9.5k.

49P2S SLAVE
Twin-transport unit.
Format: 4-track on 3.81 mm pancakes; two ½-track 2-channel heads, plus a reproduce head for off-tape monitoring or lineup.
Duplicating speed: 76 cm/s.
Frequency response: 31-14k Hz ±3 dB.
Wow and flutter: <0.1% (DIN 45 507).
Crosstalk: >65 dB programme separation at 1 kHz; >35 dB stereo separation at 1 kHz.
Distortion: <2% thd at standard recording level at 1 kHz. (Electronics only: <0.15%, same conditions.)
Dimensions (w x h x d): 71 x 141 x 30 cm.
Weight: approx 45 kg.
Price: about £4.5k.

OTARI
Otari Electric Co Ltd, Otari Building, 4-29-18 Minami Ogikubo, Suginami-ku, Tokyo 167, Japan.
Phone: (03) 333 9631. Telex: 26604.
France: Reditec, Zone Industrielle des Chanoux, 62-66 rue Louis Ampere, 9330 Neuilly-s/Marne.
Phone: 935 9786.
UK: Industrial Tape Applications, 1-7 Harewood Avenue, Marylebone Road, London NW1.
Phone: (01) 724 2497/2498. Telex: 21879.
US: Otari Corporation, 981 Industrial Road, San Carlos, Ca 94070.
Phone: (415) 593 1648.

DP-1010 SYSTEM
A 'low-cost' duplicating system comprising: *DP-1310* master for 2 or 4-track on 6.35 mm or 4-track on 12.5 mm tape; *DP-1510* slave for 2 or 4-track cassette pancakes, or 2 or 4-track on open reel; and *DP-1610* bidirectional playback monitoring unit. The master is available as a reel-to-reel machine, or modular 6.35 mm loop-bin for larger runs. Standard package consists of three slaves (expandable to five), with either reel or bin-loop master.

DP-1310 MASTER
Track format: 2 or 4-track on 6.35, or 4-track on 12.5 mm tape (convertible).
Duplicating ratio: 16:1.
Duplicating speed: 304 and 152 cm/s.
Reel size: 26.7 cm NAB.
Bin capacity: 366m (1.5 mil) or 549m (1.0 mil) 6.35 mm tape.
Frequency response: 50-10k Hz ±2 dB at 9.5 cm/s; 50-15k Hz at 19 cm/s.
Signal-to-noise: >55 dB (NAB-SRL).
Flutter: <0.1 wrms at 9.5 and 19 cm/s (NAB).
Speed deviation: <±0.2% at 9.5 and 19 cm/s (NAB).
Crosstalk: >55 dB (NAB-SRL 1 kHz between adjacent channels).

DP-1510 SLAVE
Track format: 2-track mono or 4-track stereo on 3.8 mm cassette or 6.35 mm open reel tape.
Duplicating ratio: 152 and 76 cm/s.
Reel size: 26.7 cm NAB.
Frequency response: 30-12k Hz ±2 dB.
Signal-to-noise: >55 dB (DIN-SRL).
Flutter: <0.1% wrms at 4.76 cm/s (DIN).
Speed deviation: <±0.2% at 4.76 cm/s (DIN).
Crosstalk: >55 dB (DIN-SRL between channels 2 and 3).

DP-1610 MONITORING REPRODUCER
Bidirectional reproducer for 6.35 mm open reel or 3.8 mm cassette tape.
Frequency response: open reel 50-7.5k Hz ±2 dB at 9.5 cm/s, 50-15k Hz ±2 dB at 19 cm/s; cassette 30-10k Hz ±2 dB at 4.76 cm/s.
Signal-to-noise: >55 dB.
Equalisation: NAB for open reel; DIN for cassette.
Flutter: open reel 0.15%; cassette 0.2% (wrms-NAB).
Speed deviation: ±0.2%.

DP-4050-OC SYSTEM
A self-contained unit comprising one reel-to-reel master and six cassette slave transports.
Track format: master, two head stacks switchable as 4-track stereo or 2-track mono on 6.35 mm tape; slaves, 4-track in-line heads.
Duplicating ratio: 8:1.
Duplicating speed: master 152 and 76 cm/s (19 or 9.5 cm/s original); slave 38 cm/s.
Reel size: master 12.7, 17.8 or 26.7 cm; slave *C-30*, *C-60* or *C-90*.
Frequency response: 50-10k Hz ±3 dB.
Signal-to-noise: >50 dB.
Crosstalk: >45 dB between channels 2 and 3; 30 dB between 1 and 2.
Bias frequency: 400 kHz (adjustable).
Dimensions (w x d x h): 53.3 x 79.4 x 76.8 cm.

DP-4050-CC SYSTEM
Cassette-to-cassette version of *DP-4050-OC*, using same slave transports.
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SURVEY: TAPE DUPLICATING EQUIPMENT

Track format: 4-track in-line heads.
Duplicating ratio: 8:1.
Duplicating speed: master and slave 38 cm/s (4.76 cm/s original).
Frequency response: 50-8k Hz ±3 dB.
Signal-to-noise: >50 dB.
Crosstalk: >45 dB between channels 2 and 3; >30 dB between 1 and 2.
Bias frequency: 400 kHz (adjustable).
Dimensions (w x d x h): 53.3 x 79.4 x 36.8 cm.

DP-6000 SYSTEM

Comprising: *DP-6300E-240* bin master for 12.5 mm tape or *DP-6300C-240* bin master for cassette tape, and up to 10 *DP-6500C-32* cassette pancake slaves or *DP-6500E-32* 6.35 mm 8-track cart tape slaves. System throughout is claimed to be at least 600 *C-60* or 1500 600m 8-track carts per hour with 10 slaves.

DP-6300E-240/C-240 MASTER

Dual capstan loop-bin unit.
Track format: *E-240* 8-track (two staggered heads) on 25 mm tape; *C-240* 4-track (two staggered heads) on 12.5 mm tape.
Duplicating speed: 610 cm/s.
Reel size: 25.4 cm.
Frequency response: *E-240* 100-7.5 kHz ±1.5 dB; 50-10k Hz +1.5, —6 dB (NAB); *C-240* 100-7.5k Hz ±1.5 dB, 30-10k Hz +1.5, —6 dB (DIN).
Signal-to-noise: *E240* <45 dB (NAB-SRL); *C-240* <45 dB (DIN-SRL).
Distortion: *E-240* <2% (NAB-SRL 1 kHz); *C-240* <3% (DIN-SRL 1 kHz).
Crosstalk: *E-240* <45 dB (NAB-SRL 1 kHz); *C-240* <45 dB (DIN-SRL I kHz).
Wow and flutter: <0.25 rms.
Speed deviation: <±0.25%.
Dimensions (w x d x h): 86.7 x 77 x 173 cm.

DP-6500E-32/C-32 SLAVE

Track format: *C-32* 4-track (two staggered heads) on 3.8 mm tape; *E-32* track (two or four staggered heads) on 6.35 mm tape.
Duplicating speed: *E32*, 152 cm/s; *C-32*, 304 cm/s.
Reel size: up to 35.6 cm.
Dimensions (w x d x h): 80 x 66 x 85 cm.

DP-6750 TAILORING MACHINE

Designed specifically to wind cassette pancake tape into empty cassette cases fitted with leaders. The machine automatically cuts the leader and splices the tape on to it, then proceeds to wind the cassette at high speed and cuts at the appropriate point. Any length up to *C-120* can be wound. An audio sensing head enables the exact length to be cut for prerecorded tapes. A throughput in excess of 100 *C-60* cassettes/hour is claimed.
Dimensions (w x d x h): 55 x 40 x 65.5 cm.
Weight: approx 55 kg.
Power: 100-240V 50/60 Hz, plus vacuum supply.

PENTAGON

Pentagon Industries Inc, 4751 North Olcotte, Chicago, Ill 60656, USA.
Phone: (312) 867 9200. Telex: 253058.

1100 SERIES

Reel-to-reel, reel-to-cassette, cassette-to-cassette versions available. Modular systems accommodating up to 11 slaves. Features include: end of tape sensing, track select, automatic rewind of masters, automatic cue on reel, motion indicators and individual channel controls (preset or manual).
Track format: half-track 2-channel or quarter-track 4-channel on 6.35 mm tape.
Duplicating ratio: 16:1.
Duplicating speed: reel master and slaves 152 and 304 cm/s; cassette master and slaves 76 cm/s.
Reel size: master 17.8 cm max; slave 26.7 cm max.
Frequency response: reel-to-reel 40-12k Hz ±3 dB; reel-to-cassette 40-10k Hz ±3 dB; cassette-to-cassette 40-10k Hz ±3 dB.
Signal-to-noise: adds no more than 3 dB to inherent noise level of bulk-erased tape.
Distortion: <0.5% thd at normal operating level.
Bias frequency: 500k Hz.
Wow and flutter: r-to-r <0.15%; r-to-c and c-to-c <0.2%. (All values of rms contributions to copy.)
Crosstalk rejection: (at 1 kHz) r-to-r 2 or 4-channel —50 dB or better; r-to-c and c-to-c 2-channel —46 dB or better; c-to-c 4-channel —50 dB or better.
Equalisation: 6.35 mm master NAB; cassette masters Philips *120-1590* 'micro-inch curve'.
Rewind time: reel master and slave 366m in 50s; *C-60* cassette in 27s.
Dimensions (h x w x d): reel master and slave 23.5 x 54 x 37.1 cm; cassette master 28.6 x 34.6 x 37.1 cm; cassette slave 20.3 x 34.6 x 37.1 cm.
Weight: reel master and slave 26.3 kg; cassette master 16.8 kg; cassette slave 12.2 kg.
Power: 117V 60 Hz. (117V 50 Hz and 220V 50/60 Hz available at extra cost.)

PRO-SERIES

Reel-to-reel, reel-to-cassette, cassette-to-cassette systems available. Modular system with variety of master/slave configurations. Table-top or console versions of reel-to-reel masters and slaves. Features include: 'failsafe audio/bias monitoring'; automatic rewind, cue and restart; and individual cassette audio/bias adjustment.
Track format: 2-track mono, 4 or 8-track stereo, on 6.35, 12.5 and 25 mm reel-to-reel or 3.8 mm cassettes or pancakes.
Duplicating ratio: 8 or 12:1.
Duplicating speed: reel master and slaves 76 and 152 cm/s and 114 and 228 cm/s; pancake slaves 38 and 76 cm/s and 57 and 114 cm/s; cassette master and slaves 38 and 56 cm/s.
Reel size: master and slaves 26.7 cm max.
Frequency response: reel-to-reel (6.35 mm) 40-12.5k Hz ±3 dB (9.5 cm/s copy from 9.5 or 19 cm/s master), 40-15k Hz ±3 dB (19 cm/s copy and master) and 40-15k Hz ±2 dB (38 cm/s copy and master); reel-to-cassette 40-12.5k Hz ±3 dB; cassette-to-cassette 40-10k Hz ±3 dB; reel-to-pancake 40-12.5k Hz ±3 dB.
Signal-to-noise: adds no more than 3 dB to inherent noise level of bulk-erased tape.
Distortion: <0.2% thd at normal operating level; record amp overload margin 35 dB.
Bias frequency: 500 kHz.
Wow and flutter: r-to-r 0.12%; r-to-c 0.2%, c-to-c 0.25%.
Crosstalk rejection: (at 1 kHz) 2-track cassette 55 dB min 'between stereo programs'; 4-track cassette 50 dB min between adjacent stereo tracks.
Equalisation: 6.35 mm masters NAB; cassette masters Philips *120-1590* 'micro-inch curve'.
Rewind time: reel master from 50s for 366m on 17.8 cm reel, to 100s for 1.1 km on 26.7 cm reel.
Dimensions (w x h x d): reel master, reel slave, and 4-position cassette slave 63.5 x 21.6 x 36.8 cm; electronics 63.5 x 44.4 x 31.7 cm. (Table top versions; consoles measure 51.4 x 76.2 x 63.5 cm.)
Weight: reel master and reel slave 23 kg; electronics 16 kg; 4-position cassette 19 kg. (Table top versions; console weights vary.)
Power: 117V 60 Hz, or 117V 50 Hz and 220V 50/60 Hz option.

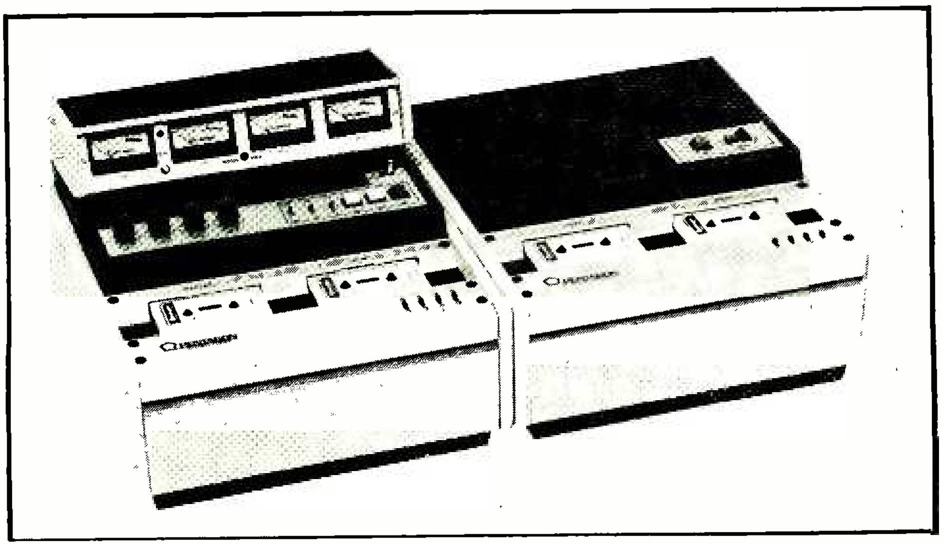
SUPER C-32

Desktop, self-contained cassette-to-cassette duplicator producing three *C-30*s in 60s or three *C-60*s in 135s. Features include automatic level control, track select and auto rewind of master.
Track format: 2-track mono.
Duplicating ratio: 16:1.
Duplicating speed: 76 cm/s.
Frequency response: 40-10k Hz ±3 dB.
Signal-to-noise: equals bulk-erased tape by 3 dB or better.
Wow and flutter: contributes <0.25% (weighted) to copy.
Crosstalk rejection: >46 dB at 1k.
Rewind time: 23s for *C-60*.
Dimensions: 69 x 27 x 16 cm.
Weight: 20.4 kg.
Power: 117V 60 Hz 150W. 220V 50 Hz at extra cost.

SUPER C-1 and C-4

Desktop, self-contained cassette-to-cassette duplicator producing one *C-30* in under 60s. Track select allows any combination of programmes to be copied in one pass.
Track format: *C-1*, 2-track mono; *C-4*, 2-track mono or 4-track stereo.
Duplicating ratio: 16:1.
Duplicating speed: 76 cm/s.
Frequency response: 40-10k Hz ±3 dB.
Signal-to-noise: equals bulk-erased tape by 3 dB or better.
Wow and flutter: *C-1* contributes <0.25%, *C-4* <0.2% weighted to copy.
Crosstalk rejection: (at 1 kHz) *C-1* <46 dB, *C-4* <50 dB.
Rewind time: 27s for *C-60* cassette.
Dimensions: 35 x 27 x 16 cm.
Weight: *C-1*, 8.6 kg; *C-4*, 9 kg.
Power: 117V 60 Hz 150W. 220V 50 Hz at extra cost.

Cassette-to-cassette copying system from the Pentagon 1100 Series—master/slave and add-on slave unit.



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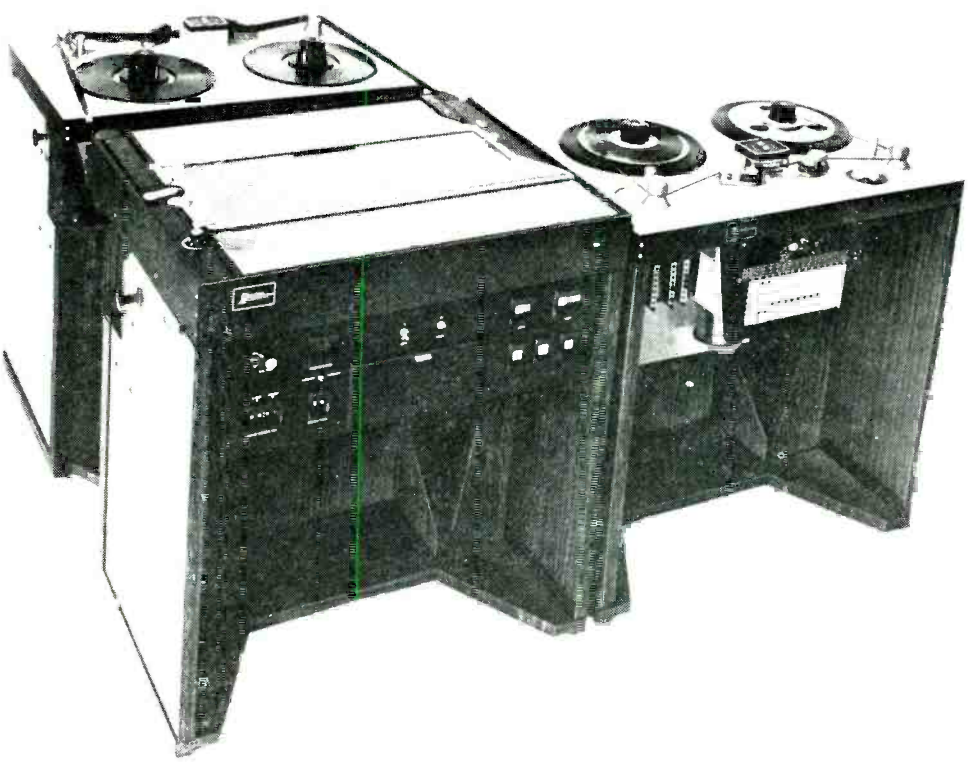
Gauss The Number 1

Now 64:1

Over recent years GAUSS technology has reshaped the cassette duplication industry. The most sophisticated product of GAUSS research and development, the Series 1200 unit (with attendant slaves), is recognised as the world's standard for optimum duplication quality, giving maximum return on investment.
Now our newly introduced 64:1 capability lets you double your production rate. Your 3¾ master is reproduced on slaves running at 120 IPS, maintaining the unmatched quality that you've come to expect from GAUSS. To update existing units in the field we offer conversion kits that interface simply with our existing 32:1 system.
GAUSS set the standard for quality tape duplication Now GAUSS sets the pace.



CETEC INTERNATIONAL LTD.

CETEC AUDIO · GAUSS · SPARTA · JAMPRO

SAPPHIRE HOUSE, 16 UXBRIDGE ROAD, EALING, LONDON W5 2BP Telephone: 01-579 9145 Telex 935847

SURVEY: TAPE DUPLICATING EQUIPMENT

RECORTEC

Recortec International, 777 Palomar Avenue, Sunnyvale, Ca 94086, USA.
Phone: (408) 735 8821.

AUTOMATED DUPLICATOR SYSTEM
Combines open-reel bidirectional master and high speed duplication and cassette loading in a single operation—the blank tape from a pancake reel is recorded while it is being loaded onto a cassette at an accurately controlled and constant speed. Slave/loaders can be equipped with an automatic cassette feeder that allows more units to be controlled by a single operator. A simple cassette loader is also available.
Track formats: 4-track on 6.35 mm; 4 or 8-track on 12.5 mm; 4, 8, 12 and 16-track on 25 mm tape.
Duplicating ratio: 32 and 64:1.
Duplicating speed: master 610 cm/s; slave/loader 304 or 152 cm/s (for 19 or 9.5 cm/s master tapes).
Reel size: master 26.7 cm max; slave/loader 30.5 cm, NAB or EIA-J hubs.
Frequency response: 30-15k Hz for 32:1; 30-12k Hz for 64:1.
Wow and flutter: <0.1%.
Signal-to-noise: adds less than 3 dB.
Dimensions (w x d x h): master 89 x 43 x 61 cm slave/loader 56 x 38 x 71 cm; slave/loader with acf 53 x 38 x 94 cm.
Weight: master 59 kg; slave/loader 38 kg; slave/loader with act 48 kg.
Power: 120/240V 50/60 Hz.
Price: $25 000 for one master and one slave/loader; additional units approx $12 500.

SUPERSCOPE

Superscope Tape Duplicating Products Inc, 455 Fox Street, San Fernando, Ca 91340, USA.
Phone: (213) 365 1191.
Europe: Audiomatic Corporation, 4 Rue Ficatier, 92400 Courbevoie, Paris, France.
Phone: 333 3090. Telex: 62282.

AUTOMATIC CASSETTE LOADER
The *Series 1300* loaders fill empty cassettes from 26.7 cm pancakes or reels at a winding speed of 610 cm/s. Length of tape is controlled by a cue tone, 1s in duration 5-20 Hz (at 4.76 cm/s real time), giving a splicing accuracy of ±5 cm. Price is around $7k.
An 'automatic cassette feed mechanism' (*ACFM*) is also available as an add-on. Price: about $3k.

TELEFUNKEN

AEG-Telefunken, 20092 Cinisello Balsamo, Viale Brianza 20, Italy.
Phone: 92 798. Telex: 31473.
UK: Hayden Laboratories Ltd, Hayden House, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW.
Phone: Gerrards Cross 88447. Telex: 849469.

Telefunken manufactures a variety of masters and slaves for operation with 6.35 and 12.5 mm master tapes to pancake or *Stereo-8* cartridge tape slaves. Accessories are available for making master tape recordings on all 6.35 mm master consoles.
Complete systems are available: *BK12* comprising *BKM12* master and *M123A* slave; *BK5* comprising *BKM5* master and *M123A* or *BKT3* slave; *BK15* comprising *BKM15* master and *M123A* or *BKT3* slave; and *BK16* comprising *BKM16* master and *M123A* or *BKT3* slave.

BKM12 MASTER
Master console containing two *M12* tape reproducers running at 152 or 304 cm/s on 6.35 mm tape. Four-track master tapes for pancake slaves recorded at 19 cm/s (16:1 duplicating ratio). Up to four slaves can be accommodated, but others can be added with an extra amplifier set per slave.

BKM5 MASTER
Master console containing two *M15* tape reproducers running at 152 or 304 cm/s on 6.35 mm tape. Four-track master tapes for pancake slaves recorded at 9.5 cm/s (32:1 duplicating ratio), or for *Stereo 8* slaves recorded at 9.5 or 19 cm/s (16 or 32:1 dup ratios). Up to four slaves can be accommodated, plus others (see *BKM12*).

BKM15 MASTER
Master console containing two *M15* tape reproducers running at 304 or 610 cm/s on 6.35 mm tape. Four-track master tapes for pancake or *Stereo-8* cart slaves recorded at 19 cm/s (16 and 32:1 duplicating ratios). Up to four slaves can be accommodated, plus extras (see *BKM12*).

BKM16 MASTER
Master console containing two *M15* tape reproducers running at 304/610 cm/s on 6.35 or 12.5 mm tape. Four-track master tapes (for both widths) for pancake slaves recorded at 19 cm/s (32:1 duplicating

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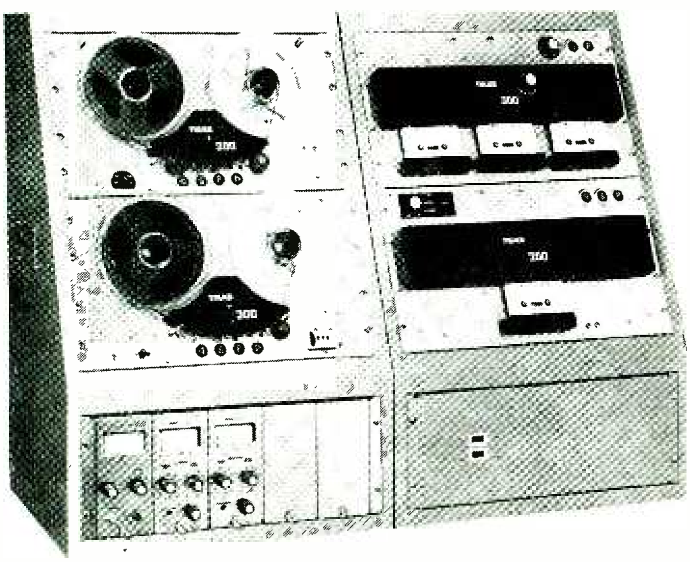


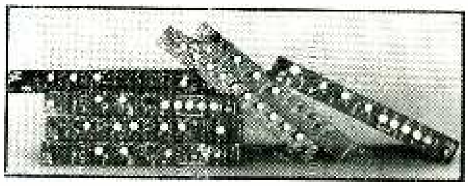
The modular model 300 system from Telex can accommodate reel-to-reel master or slave transports, and cassette masters or slaves in a variety of configurations.

The Scamp. All the signal processing you need, plugged into one box.

For example:
A compressor-limiter with push button ratio and automatic threshold selection; 30dB control range; and LED gain reduction indicator.
A sweep equaliser with three sweep sections: 20Hz to 1kHz (Q=3), 75Hz to 7.5kHz (Q=1.5), and 400Hz to 20kHz (Q=3), each with an amplitude control range of 40dB; overall LED overload indicator and output attenuator.
A parametric equaliser with the same three frequency sections as above plus variable bandwidth from half an octave to five octaves; and LED optimum modulation indicator.
A high pass dynamic noise filter with programme controlled variable slope filter (0 to 18dB/octave) with turnover frequencies at 100, 200 and 400Hz, to progressively attenuate low level, low frequency noise below the threshold; and a 20 or 40dB full frequency gating option.
A low pass dynamic noise filter similar to the high pass except it has turnover frequencies of 2, 4 and 6kHz to dynamically attenuate low level high frequency noise.
An octave equaliser providing 12dB lift or cut at the ten standard centre frequencies between 31.25Hz and 16kHz.
An LED display column with 20 LEDs per column; range of +16dBm to −40dBm; and switchable to display PPM or VU characteristics.
An expander gate with a range control to vary the maximum low level attenuation and automatically adjust the slope; a remarkably fast attack time (>5μS/10dB); a 20:1 slope gating mode, and selectable peak or rms level sensing.

The basic box is 19" by 8¾" by 13½", and is therefore standard rack mounting. It has an external power supply feeding common internal power rails. All connections are via Molex multi-way connectors.

You can build up a whole library of modules and quickly and easily transfer them from one installation to another (studio to mobile, for instance).



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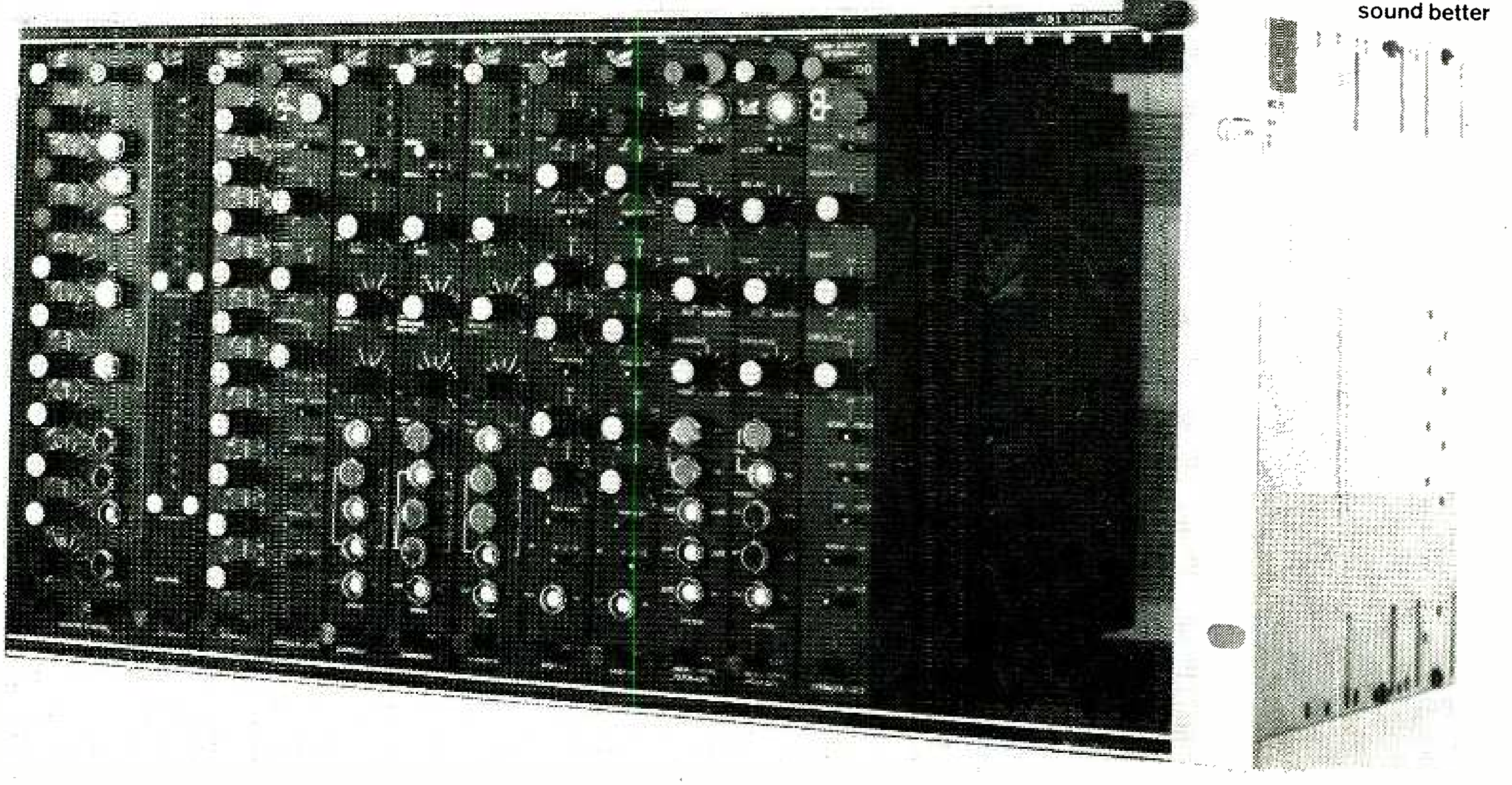


REPRESENTED IN: USA – CANADA – AUSTRALIA – NEW ZEALAND – JAPAN – SOUTH AFRICA – BRAZIL – SINGAPORE – MALAYSIA – BRUNEI – INDONESIA
EASTERN EUROPE – BELGIUM – DENMARK – FINLAND – FRANCE – WEST GERMANY – GREECE – HOLLAND – ITALY – NORWAY – SWEDEN – SWITZERLAND

SURVEY: TAPE DUPLICATING EQUIPMENT

ratio), and 8-track master tapes (12.5 mm only) for *Stereo-8* slaves recorded at 19 cm/s (16 and 32:1 dup ratios). Up to four slaves can be accommodated, plus extras (see *BKM12*).

M123A SLAVE
Slave console containing three *M12* recorders for continuous pancake or continuous/intermittent *Stereo-8* cart tape running at 76 or 152 cm/s (16 or 32:1 duplicating ratios). Pancake version is capable of producing 135 *C-40* cassettes/hour; *Stereo-8* version 135 *T-40* carts/hour.

BKT3 SLAVE
Slave console containing two *M12* recorders for continuous pancake or continuous/intermittent *Stereo-8* tape running at 152 or 304 cm/s (32:1 duplicating ratio). Pancake versions capable of producing 270 *C-40* cassettes/hour; *Stereo-8* version 240 *T-40* carts/hour.

TACHOS 12 TAPEWINDER
An automatic tape winder for filling cassettes already loaded with leader tape. The unit can accommodate a maximum of 50 cassettes via a reloadable hopper, and winds tape at approx 1200 cm/s. Minimum length of 60 cm of tape can be handled; stop time approx 40 ms, accuracy ±5 cm. Production rate: 3-4 cassettes/minute according to tape length.

TELEX

Telex Communications Inc, 9600 Aldrich Avenue South, Minneapolis, Mn 55420, USA.
Phone: (612) 884 4051. Telex: 297053.
UK: Avcom Systems Limited, Newton Works, Stanlake Mews, Stanlake Villas, London W12 7HA. Phone: (01) 749 2201. Telex: 897749.

MODEL 300 SYSTEM
A modular console-mounted system available in reel-to-reel, reel-to-cassette, and cassette-to-cassette configurations, or in any combination. Basic units comprise: open-reel master transport; open-reel slave transport; cassette master transport; slave module containing three cassette transports; plus record amp and bias oscillator modules. Each console will accept two transports and up to five modules.
Track format: half-track 2-channel, or quarter-track 2 and 4-channel.
Duplicating speed: reel master 38 and 76 cm/s; reel slave 19 and 38 cm/s; cassette master and slave 19 and 38 cm/s.
Frequency response: c-to-c and r-to-c 30-10k Hz ±3 dB at 4.75 cm/s; r-to-r 80-40k Hz ±3 dB (sic) at 38 cm/s and 40-20k Hz ±3 dB at 19 cm/s.
Signal-to-noise: c-to-c 45 dB; r-to-c and r-to-r <3 dB degradation from master tape, 55 dB peak at 19 or 38 cm/s.
Distortion: <1% thd at 1 kHz at '0' vu and 19 cm/s.
Bias frequency: 300 kHz.
Wow and flutter: c-to-c and r-to-c 0.25% rms; r-to-r 0.17% rms at 38 cm/s and 0.2% rms at 19 cm/s.
Crosstalk rejection: c-to-c and r-to-c ½-track 2-ch 45 dB at 1 kHz, ¼-track, 2-ch 30 dB stereo channel separation at 1kHz, ¼-track 4-ch 50 dB stereo channel separation at 1 kHz and 50 dB adjacent stereo programme at 1 kHz; r to-r > 50 dB at all frequencies.
Equalisation: c-to-c front-panel switching, Philips (unspecified) standard; r-to-c and r-to-r front-panel switching NAB and EIA.
Rewind times: *C-30* in 24s, *C-90* in 62s; 366m of tape in 60s.
Speed regulation: c-to-c 0.8%; r-to-c master 0.5% and slave 0.8%; r-to-r 0.5% long term.
Dimensions: console 80.3 cm high, 52.7 cm wide, 47 cm deep at base, and 21.9 cm deep at top. Front panel accepts two transports mounted at 67° angle.
Weight: transports 16 kg; consoles 8.2 kg; electronics 13.6 kg.
Power: 115-220V 50/60 Hz.

Avcom can supply the *300* system fitted with a **Leevers-Rich/Bias** transport handling 26.7 cm reels.

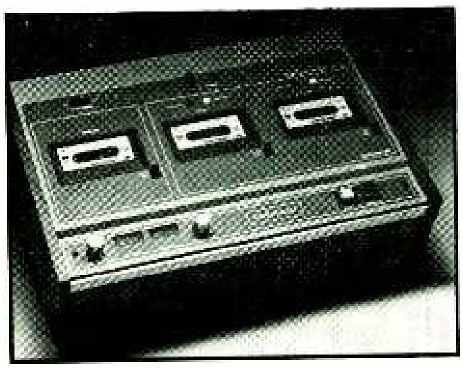
COPIER I, II, IV and V
Desktop, self-contained cassette copying system. *Copier I* and *IV* are master/slave units; *Copier II* and *V* add-on slaves containing two transports. Two slaves can be added to one master, the slaves depending on the master for power and operating control. *Copiers IV* and *V* feature additional track-select facilities, and a bias select switch for ferric oxide or chromium dioxide tape.
Track format: *I* and *II* half-track 2-channel; *IV* and *V* quarter-track 4-channel.
Duplicating speed: *I* and *II* 76 cm/s; *IV* and *V* 'greater than 31 cm/s'.
Frequency response: 40-10k Hz.
Signal-to-noise: 45 dB below reference level.
Distortion: typically <1% thd at 7 dB below 'zero' level.
Bias frequency: *I* and *II* 600 kHz; *IV* and *V* 500 kHz.
Wow and flutter: less than 0.25% contribution to cassette copy (ANSI Standard S4.3-1972).
Crosstalk rejection: >45 dB at 1 kHz.
Equalisation: RIAA and DIN.
Rewind time: automatic at 178 cm/s.
Dimensions (w x d x h): 39.4 x 45.1 x 19.1 cm.
Weight: 14.5 kg.
Power: 120-220V 50/60 Hz 90W.

WOLLENSAK

Mincom Division, 3M Company, 3M Centre, St Paul, Mn 55101, USA.
Phone: (612) 733 1110. Telex: 297434.
UK: Recording Materials Division, 3M United Kingdom Limited, 3M House, Wigmore Street, London W1A 1ET.
Phone: (01) 486 5522.

2770 AV SYSTEM
Desktop cassette copying system comprising one master and two slaves. One or both tracks can be duplicated in a single pass; *C-30* copy and rewind in 100s, *C-60* in 200s. Manual or automatic recording level, plus adjustable bias.
Track format: half-track 2-channel mono.
Duplicating ratio: 13.3:1.
Duplicating speed: 63.5 cm/s.
Frequency response: 40-10k Hz ±3 dB.
Signal-to-noise: within 3 dB of master.
Distortion: <1%, typically 0.5%.
Wow and flutter: within 0.15% (DIN-weighted) of master.
Crosstalk: better than 50 dB at 1 kHz.
Dimensions: 46.9 x 31.7 x 16.5 cm.
Weight: 15 kg.
Power: 240V 50 Hz 200W.

1780 AV SYSTEM
Add-on unit for *2770 AV* comprising three slaves. Dimensions, weight and mechanical and recording specifications similar to *2770 AV*.



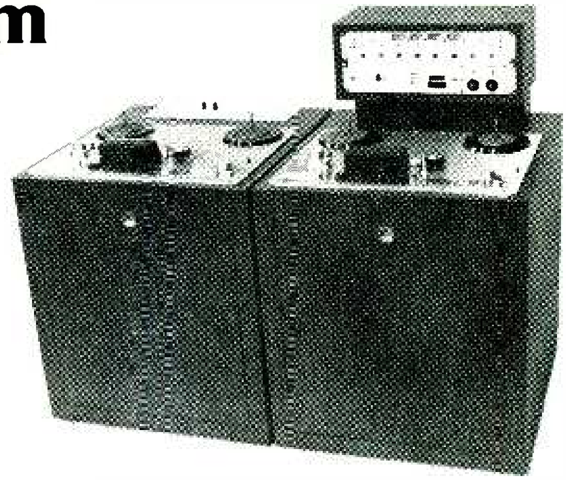
Desk-top 2772 AV system from Wollensak.

2772 AV SYSTEM
Desktop cassette copying system comprising one master and two slaves.
Track format: quarter-track- 2-channel stereo.
Duplicating ratio: 13.3:1.
Duplicating speed: 63.5 cm/s.
Signal-to-noise: within 3 dB of master.
Wow and flutter: 0.15% rms max.
Crosstalk: 40 dB min at 1 kHz.
Dimensions: 46.9 x 31.7 x 16.5 cm.
Weight: 15 kg.

6030/2760 SYSTEM
A modular system comprising *6030AV* reel-to-reel master and *2760AV* cassette slave(s).
Track format: half-track 2 channel.
Duplicating ratio: 13.3:1.
Duplicating speed: 'master can be copied at either 19, 9.5 or 4.75 cm/s.'
Frequency response: 40-10k Hz ±3 dB.
Signal-to-noise: >46 dB.
Wow and flutter: <0.25%.
Dimensions: master 16.5 x 43.2 x 35.6 cm; slave 12.7 x 35.6 x 49.5 cm.
Weight: master 7.7 kg; slave 5 kg.

Accurate Sound Corporation

2400 Tape Duplicating System



FEATURING :

- 30 Hz to 18KHz, 16:1 DUPLICATION
- .150 INCH, .250 INCH and .500 INCH FORMATS
- PRECISION MOUNTED FERRITE HEADS
- AUTOMATIC RE-CUEING
- RAPID TAPE FORMAT CONVERSIONS
- ADVANCED TAPE MOTION CONTROL:
  - ○ MOTION SENSING
  - ○ CONSTANT TENSION HOLDBACK
  - ○ DYNAMIC AND MECHANICAL BRAKING
- UP TO 10 SLAVES

THE AUTOMATIC CUE OPTION may be used for single runs or preset for a given number of copies. A digital readout displays the number of cycles remaining. The slaves stop during the master recue cycle and may be reloaded for the next run.

HEAD ASSEMBLIES :

Long lasting **FERRITE** heads are available in all formats of ASCO 2400 Duplicators. These narrow gap heads are precision mounted and tested at the factory to insure **LOW STEREO PHASE ERROR** out to 18KHz. The **EXTENDED FREQUENCY RESPONSE** of the 2400 is achieved by integrating plug-in master playback amplifiers (with special gap loss equalizers) into the head assembly. **RAPID FORMAT CONVERSION** is made possible by incorporating bias and record level calibrations in each slave head assembly and two sets of remotely selected equalization and playback level calibration on plug-in preamp cards in each master head assembly. Mono/stereo slave head assemblies are also equipped with track selection switches.

CONSTANT TENSION HOLDBACK reduces operating costs and improves the quality of duplicated copies. Head life is extended and tape stretch is avoided by selecting the proper uniform tension for the tape used. Speed and timing accuracy with all reel sizes is insured by eliminating capstan slippage. Also, consistent head to tape pressure guarantees excellence in high frequency performance, reduced tracking error, and smaller azimuth variations.

PRICE:	Master	Slave
2 CH	4,300	3,200
4 CH	5,175	3,525

Automatic Rewind & Cue with Digital Counter— $400

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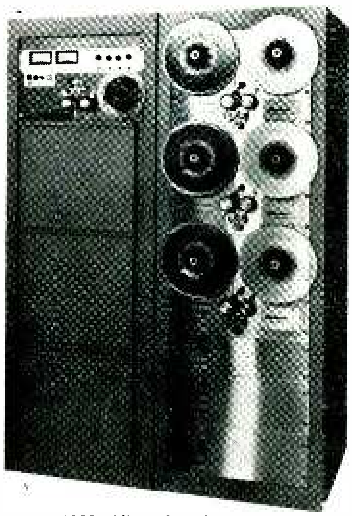

Model 1200 High Speed Audio Cassette Duplicating System

The Audio/Tek Model 1200 High Speed Cassette Duplicating System shown here can produce 2,500 30-minute stereo cassettes per 8-hour shift with one operator.

FEATURES . . .

- Quarter-inch loop-bin master
- 32:1 duplicating ratio
- Ferrite record heads
- Master can drive up to 12 slaves
- Automatic bin loading features

Prices start as low as $10,245 for a master and one slave. Write or call today for complete technical information.

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503-B VANDELL WAY, CAMPBELL, CA 95008
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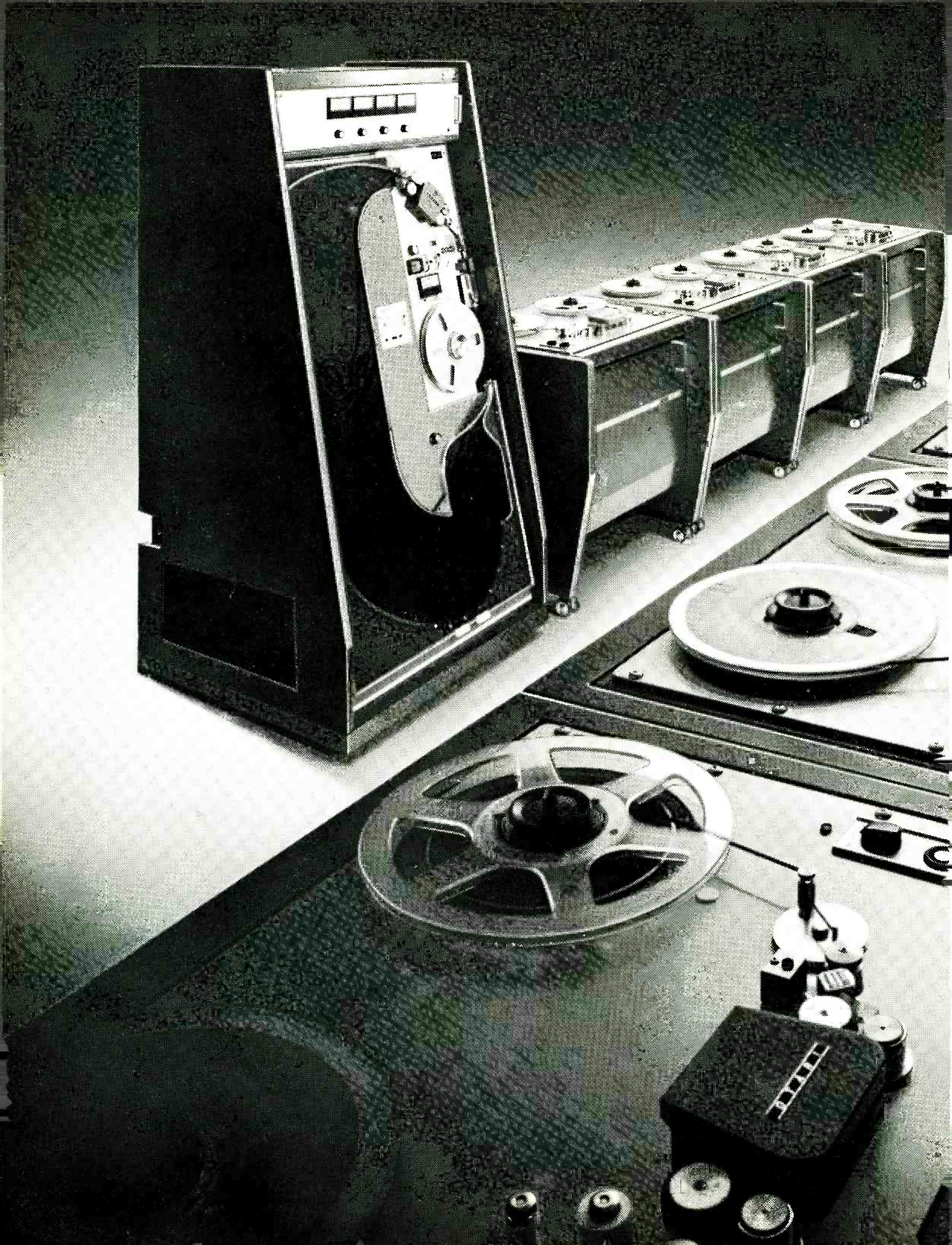
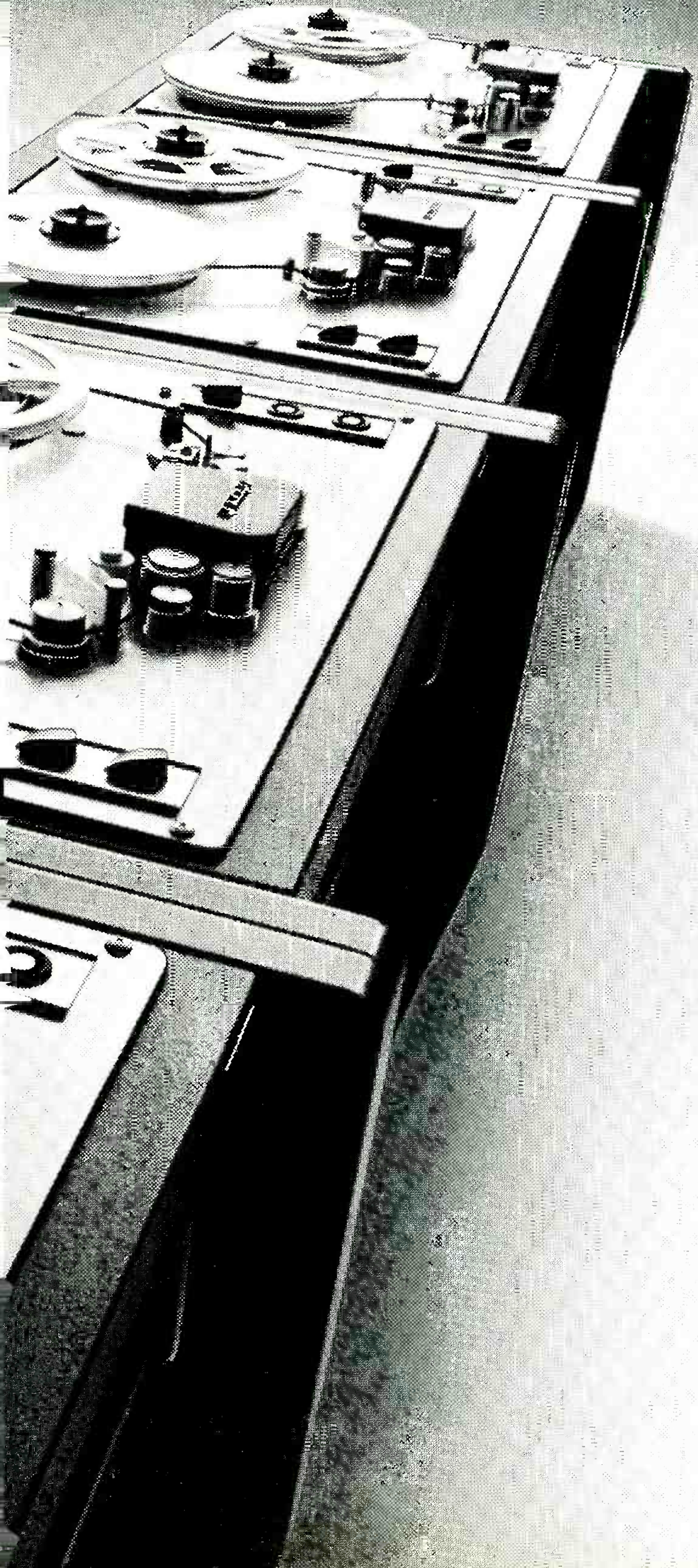


OTARI's DP-6000 gives you duplications at 64:1!



OTARI's DP-6000 duplicator is designed for quality sound duplications at the super high speed of 64:1! Its uniquely slanted loop bin insures smoothest 240ips transport of your 3¾ips master. Up to 10 slave units are centrally and automatically controlled. A quartz-crystal bias generator is employed, and crystal-coated ferrite heads assure clean, clear duplications for years on end.

Behind this sophisticated system stands the proven reliability of Otari technology. Otari studio master recorders, duplicators, QC monitors and tape loaders are meeting rugged every-day production schedules with the highest performance standard in every sector of audio recording and duplicating industries.

OTARI

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work

Come to sunny Switzerland

A recent conversation overheard between some gentlemen actively engaged in the British recording industry: 'Yes, Switzerland is fairly expensive, though not all that much. But the atmosphere's so nice, no rush or bustle, and the people are friendly—not like certain other places, etc, etc.' It would seem that Switzerland is starting to be known for something more than cuckoo clocks and cowbells. Because of its central position in Europe and easy access by motorway, it offers the opportunity for touring groups, etc to stop over (or come over) to lay down some tracks in a relaxed environment—and, what's more, be away from the telephone and local hangers-on. Two such studios catering for this are Powerplay, near Zurich, and, at the other end of the country, Aquarius in Geneva. **Powerplay Recording Studios** is situated at Horgen, about 24 km from Zurich by motorway, overlooking the lake and the mountains. Jim Duncombe, the studio's co-owner and engineer, was formerly a balance and cutting engineer with a small, but highly respected, classical music studio in Zurich. He had wanted to open his own studio, and also branch out into rock and pop music. (The former is no stranger to him, having originally been lead guitarist with one of Germany's top rock groups in the 'dim and distant', with no small success in the charts.)

The studio takes up most of the top floor of a modern industrial building, with a picture-postcard view of the Alps from the control room. As Jim puts it: 'If the producer gets bored with the session, there's always the view'! The layout at the moment consists of an office, maintenance room, control room, studio and large general-purpose room.

The studio measures 10 x 5m, with the original height of 4m having been lowered to 3m by means of a false ceiling made with acoustic tiles. The rest of the studio is principally covered with carpet and moquette. As one would expect, the studio is fairly dry-sounding but keeps a good balance with the mid-range frequencies. The original intention was to keep the studio open plan, but it was found necessary to build a drum booth in one of the corners to give the 'drier' sound preferred by many customers. While I was there the 'resident' metalshell Rogers drum kit was being set up for a session, and gave a tight, punchy sound. Mic arrangement was fet *U47* on bass drum, *KM84* on snare, with AKG *451*s and *D202*s competing for the toms and cymbals. In the rest of the studio Neumanns were well in evidence, and Jim told me that he finds a *U87* set on figure-of-eight very good for vocals, giving a nice clear, transparent sound. For confirmed rock n' rollers, however, there is also an old Shure *55SW*: 'a good Elvis Presley mic, that!'

Other available gear includes: Fender *Twin Reverb* with various effects pedals; Peavey bass amp (a more modern sound, according to Jim); grand piano, which was due to be replaced by a Steinway; Rhodes *73* with a *D6* Clavinet perched on top; and a Hammond *Model T* spinet organ with Leslie *900*.

The studio is air-conditioned, but due to rather noisy operation has to be turned off during takes (which is no real hardship). From the studio side of the control room window the outside windows are in direct line of sight, and Jim was obviously proud to say that Powerplay 'is one of the only studios in Europe where you can sit and see real daylight'.

As well as a splendid view, the 5 x 5m control room features a Midas 16/8 desk, JBL *4333A* monitors, ancillary equipment and tape machines. The latter are a trio of Studers that have been completely factory reconditioned: an *A62* (now to *B62* spec); a *C37* for mastering; and a 16-track *A80*. A few facts about the *A80* may be of help to secondhand shoppers: the machine was bought from a well known s/h equipment supplier, and Jim sent it to Studer to be checked over and adjusted to standard. Taking him at his word, Studer sent the machine back in A1 condition (all new amplifiers, etc, etc), plus a bill for over 11 000 Swiss francs (nearly £3000 at the time!). So, when budgeting for that secondhand machine, keep a possible overhaul in mind—to spare heart (and bank) failure!

The Midas desk features parametric eq on each input channel—which was found to be a very useful facility—and stereo foldback via two H/H *TPA 100*s to the studio. A third H/H amp is used for talkback and workhorse jobs.

Jim Duncombe at work

Though a 16/8, the desk has been modified with a large patch bay, so that 16-track recording is easily achieved using the 8 subgroups, and patching 8 inputs direct to the Studer. The Midas is also fully quadraphonic—no call as yet—with two auxiliary sends for echo, etc, in addition to the two for cue. Metering is by vus, though Jim prefers working with ppms on the desk and vus on the tape machine.

Ancillary equipment consists of a new Dolby *M16* rack plus four *A361*s, a *Scamp* rack of expanders, two A&D *F760* compressor-limiters, two each of MXR *Auto Phaser* and *Auto Flanger* modules, and EMT plate echo. An Eventide *Harmonizer* is on order. For cassette copies there is a Nakamichi professional model, and the inevitable Revox *A77*—the broadcast version made for Austrian radio—which serves as 'odd-job boy' for copying, repeat echo, and the like.

Although the 16 tracks are fully dolbied, Jim's personal preference for keeping noise down is to work with the *Scamp* expanders, because, to date, tape hiss hasn't been a problem. The main need for noise reduction has been to eliminate the clunks and bangs in the studio, as well as the sounds usually associated with bottles containing liquid refreshment; here the *Scamp* rack comes into its own. However, for Dolby-conscious customers . . . it's there!

Much of the studio's layout and acoustics are based on the advice of a certain Mr Hidley, and the sound in the control room certainly gave a clear, steady image when extracts from a Superlove album they were just finishing were played back. Worthy of note are the MXR phasers, which give a good effect at an interesting price—for the budget-conscious they are well worth consideration.

The studio has been in operation since May 1976, and is now fully booked through to September/October. Being in the same building as Phonogram records, Powerplay has developed quite close ties with them, doing a lot of their sessions.

As well as the studio, Jim also has his own group (which doubles as sessionmen) entitled 'Jimmy and the Rackets'—'we keep the "and the" because it's rock n' roll'—that he describes as good old rock in the Shawaddywaddy-style, but more sophisticated. The group does well around Zurich, and will soon be on disc in the first of Powerplay Productions!

Last but not least is the 10 x 10m auxiliary room. This is fitted out with a fridge and full cooking

56 ▶

facilities, divans, chairs and tables, etc and piano. Its uses are obvious and handy to have: it serves as rest/waiting room, restaurant and guest house, music and rehearsal room—or even a good 'live' recording room.

In short, Powerplay offers all the facilities for basic track laying for the established group, as well as the up and coming groups who do not have a large budget behind them—a chance to do a good first album without breaking the bank. For groups on tour, roadies will be pleased to know that access is by loading ramp and large industrial lift.

Erroll, Aquarius SM, playing the Soundcraft desk.

Aquarius Studio SA is situated at the other end of the country, virtually in the centre of Geneva. The studio's main claim to international fame is Patrick Moraz's last lp, *The Story of i*; at the moment Patrick is engaged in recording his next album.

The studio is situated in the basement of a large building in the old city where parking is not too much of a problem—and neither is isolation, thanks to the 1.5m-thick, solid rock walls. One enters down a single curved flight of stairs, arriving directly in the studio that is about the size of a small hall (approx 25 x 8m, and 3m high). Access to the control room is via twin doors to the left at the far end, and this again is fair sized (approx 12 x 8m). A small maintenance room completes the setup.

Arriving in the studio it was evident that the ex-Yes keyboards' man was 'in session'—one third of the studio being taken up with road cases and sundry equipment, another third by a tiered circle of keyboards, amps and Leslies, with the remainder taken up by a drum kit and more amps. Mr Moraz himself was in one of the two isolation booths laying down some tasty Rhodes piano.

Decorwise, the studio is fairly rough and ready—carpets, hessian, painted glass-fibre wadding, and bare rock walls. The sound, however, is another proposition. Personally, I find a good test of studio acoustics is to see whether it is 'agreeable' to conversation—the t's and s's being clear and sharp—and at Aquarius this is the case. (Not that there is much that could resonate!) The acoustics allow drums to be recorded 'open' in the studio, using only low-separation screens to avoid possible spillover from nearby instruments. As would be expected, a battery of close mics are used, mainly Neumann and Electro-Voice, with overhead ambience mics conspicuous by their absence. The resultant sound is very 'live' and full of presence—no compression is used—and a welcome change from the highly equalised sound so often heard today. Aquarius say they have spent a lot of time experimenting to get this stage-sound on tape, and indeed hope to make it a studio hallmark. The same research has gone into acoustic guitar and rhythm instruments in general, as an answer to the much-vaunted American 'rhythm section sound'. (Those interested should check out *The Story of i*.)

Eat your hearts out, keyboardists . . .

Foldback to the studio is by the usual cans or by ceiling-mounted monitor speakers, the latter also being useful for rehearsal purposes. Instruments available in the studio include the standard Fender *Twin Reverbs*, small Ampex bass amp, a Steinway *B* grand, customised Hammond *C3* with two Leslies, *Minimoog* and various other keyboards, and a drum kit. Hiring additional instruments locally is also no problem. The studio has 40 mics, including four Neumann *U47*s, four *U87*s, four Schoeps *CM64*s, one AKG *C24*, the complement being made up by AKG and Electro-Voice units.

Passing through the two spaced doors, one enters the 90° control room. The 'window' is provided by those in the doors, and the main visual contact is with the two isolation booths—the general philosophy being to let the musicians in the studio get on with making music, rather than worry about the control room.

The general decor is the same as the studio, though tidier. Centre-piece is the large and much-customised 40-in/24-out Soundcraft desk, which features 24-track monitor mix and eight auxiliary sends, the latter offering very flexible foldback and echo facilities, etc. Each input channel features a compressor-limiter, 3-band eq with selectable centre frequencies, monitor and routing. Metering is selected from 40 large vertical led displays with vu or ppm characteristics. The desk also has a very extensive patchbay—enough to meet more than a few tricky situations. Ancillary equipment consists of two Dolby *A361*s for mastering, eight dbx *157*s, two parametric equalisers, Audio & Design stereo *F760 Compex Limiter*, two each Eventide *Instant Phasers* and *Flangers*, and two AKG *BX20* reverbs, with tape echo by, yes, you've guessed it, an *A77*, aided and abetted by several Roland *Space Echos*.

Recording is done on a modified MCI 24-track machine (scheduled for replacement), which also has 16 and 8-track headblocks, with mixdown to one of three Ampex machines (2, 4 or 8-track). There is also a Telefunken 2-track mastering machine for use as 'odd-job boy'. The monitors are custom-built (or homemade if you prefer) using Altec and Electro-Voice components. And whereas they wouldn't win the Design Centre award for presentation, they sound good and that's what counts in the end.

Much of the studio's custom work has been done by Colin Broad of CB Electronics (also a leading light with A&D, which has connections with both studios, Jim Duncombe being their Swiss distributor) in conjunction with Chris Peneycate, formerly chief engineer with Aquarius, and who still maintains close ties.

Erroll, the studio manager, has been with the studio for about three years (previously he was with the SSR—Swiss radio and television) and is determined to put Aquarius on the map now that the initial founding problems have been resolved. Due to friends and customers such as Moraz, the studio is starting to gain a reputation by word of mouth, and several well-known personalities and groups are likely to be booking up. The studio is also another one of those where the game of 'hunt the studio clock' is in vigour. It also has interesting block-booking arrangements whereby artists can come in to rehearse, or just doodle, waking the engineer when they finally feel like recording something. The staff are dedicated to getting good music down, and bemoan the lack of imaginative local producers.

The big question at the moment is whether or not to invest in redecorating the place to come into line with the more luxurious competitors. The general view, however, appears to be one of wait and see. As Erroll said: 'We have invested in good equipment and time to get a good sound—doing the place up will only increase the customer's bill, not improve the sound'! Maybe he's got a point there.

Terry Nelson

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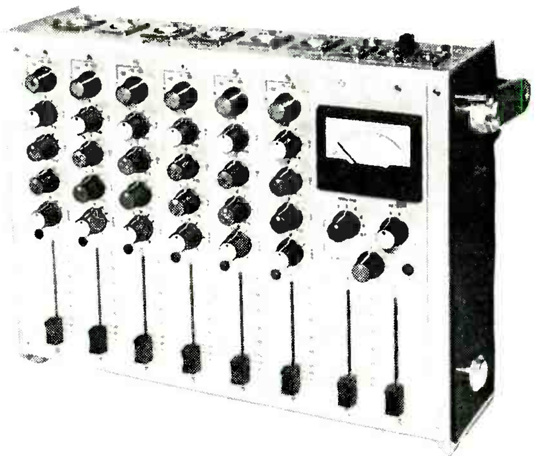

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Manchester's big three—minus one

Recently there have been dissatisfied rumblings from the North of England to the effect that London is not necessarily to be regarded as the centre of the recording and music universe. Bands have started to rebel against the concept of bookings made only through London agencies, and a tacit feeling that a group must move to London if it is finally to break through in a big way. Northern recording studios have also found themselves similarly handicapped by London prejudice. Ad agencies, northern recording engineers will tell you, are the worst. Although their offices may be in the North, and the final product scheduled for use in the North, there is no doubt in their minds that the recording must be made way down south. Likewise, aspiring groups dream of a week in a real London studio . . . but the cost is horrendous. It will cost everyone involved at least £20 or £25 return on British Rail, as much again per night for a decent hotel, and prestige London studio rates are around £40 an hour. Small wonder that some re-thinking about where it's at has started at grass roots. In the vernacular, it's 'at' where you make it. One wonders how long it will be before some of the record companies start thinking twice about the rent and rates they are paying on plush, West End front office accommodation.

Without doubt it was Strawberry Studios, on the outskirts of Manchester, and the group 10cc that made possible the current reverse trend of thought. Of course 10cc have now halved, and a Strawberry South is under construction. (Not without problems, it seems, but that's another story.) Strawberry North is now so well established that it is booked solid into the future, and the home-grown 'west coast sound' has inspired London musicians to venture north. Indeed, when I planned this look at northern studios and phoned Strawberry, I was left with the distinct impression that goodwill visits from journalists were no longer needed. Even more, indeed, let's hope that success doesn't turn to complacency; there's a once-famous studio in North London currently running at half capacity for just that reason.

Although there is no shortage of cellar studios with Teacs and Tascams serving the upper bracket demo and low-budget market for the Manchester area, there are two major studios that with Strawberry at Stockport make up what one might regard as the Manchester Big Three : Indigo and Arrow.

Wouldn't you smile if you had a new Spectra Sonics desk and 24-track Ampex 1200? No—well Indigo seem to be happy with theirs.

INDIGO. There stands in the Deansgate area of Manchester a large building bearing the sign 'Granada'. Now Granada tv is justifiably famous for its exports to the South, especially its documentary films. It also has a reputation for music programmes, and in some respects this is somewhat surprising. For instance, it's perhaps not generally known that although now all very 16-track, up until a couple of years ago the Granada sound system was very firmly mono. The 'mime' backing tracks for artists were recorded and replayed in mono and, to be euphemistic, this did not leave the engineers too much scope for producing a reasonable balance between live artist, backing track and audience reaction at the time of transmission or vtr. Just around the corner from the Granada building, like an oasis in modern concrete, stands a row of old, Georgian houses and a hospital. David Kent-Watson, a sound engineer who had come to Granada via GEC and BBC tv, left his job as sound balancer and took over one of these houses in 1972. There, with Bob Auger, he put in an 8-track machine, and thus was Indigo born. Hardly surprising, a considerable amount of 8-track backing work came out of Granada and around the corner to Indigo. It was hardly surprising because groups did not, on the whole, take kindly to Granada's suggestion that they should record their backing tracks by mixing straight down into mono.

To set the record straight, once Granada went sound conscious they did so with a vengeance, rapidly moving up to the current 16-track situation. Probably the slow move to audio sophistication was a direct result of their pioneering work in video. They were, for instance, one of the first companies to use electronic editing.

It's here opportune to clear up the Bob Auger confusion. There are in fact two Bob Augers: one senior and one junior. They both worked at Granada at one time, which produced protests of nepotism. In fact the two Augers are totally unrelated—although they enjoy a cordial relationship—and are unconnected businesswise. It was Bob Auger junior (who sometimes refers to himself as Robert Auger to avoid confusion) who left Granada and formed Indigo with David Kent-Watson. In 1974, Auger and Kent-Watson went their own cordial, but again unconnected, ways. We shall meet Bob Auger again because it was he who started Arrow Sound. Meanwhile, back at Indigo, Kent-Watson went 16-track.

'We really like your sound', groups coming into record 8-track backings for Granada shows would say, 'and we'd love to come back and record an album, if only you were 16-track'. It was a gamble, as Kent-Watson well knew, because there was every chance that the groups would then 'love to come back and record an album if only you were 24-track'. In fact, Indigo is now 24-track, having installed an Ampex and Spectra Sonics quadraphonic desk (reputedly the only one of its kind in the country) earlier this year. (See news item in last month's Studio Sound, p34.)

Kent-Watson has very definite feelings about what matters in the sound and feel of a studio. I was interested to hear these echoed closely, and quite independently, by Auger the next day. Essentially, it's something of a backlash against the Westlake/Eastlake philosophy, and doubtless not entirely unconnected with the 'Laking' of Strawberry. Essentially, the philosophy, questions the need to have every studio acoustically similar to the rest, with the kind of flat response that full-scale Laking can guarantee. As Kent-Watson points out, the kind of eq facilities on a modern desk and monitor system enable an engineer to correct an inadequate sound (or destroy an equalised sound) at the quarter-turn of a couple of knobs. A good engineer can produce fine results from a less-than-perfect environment, and a rotten engineer can produce terrible sounds from a room that is graphically as flat as a pancake. It is, of course, all down to the engineer's ears and abilities. What matters most is that the engineer should have a grip on the situation, know what the group and public want as a final sound, and *en route* make whatever mental or control adjustments are needed to get it. A musician told me recently of how an engineer (working, incidentally, in an equalised room) was recording a large swing band along with a vocal group. By the time the vocal group had arrived, the engineer had used up 23 of the available 24 tracks by close-miking every instrument and item of the drum kit—so there was one track left to record a 4-piece vocal group! They sang into one mic (no problem for them, because they were professionals with internal balance), but were left after each take with an unenviable decision to make—either settle for what they'd just got or lose it by trying for another. Laking won't cure that kind of lunacy.

Kent-Watson also has firm views on the perennial problem of what 'sound' to choose for monitoring. He feels there's a gap between the high-level, 'impressive'

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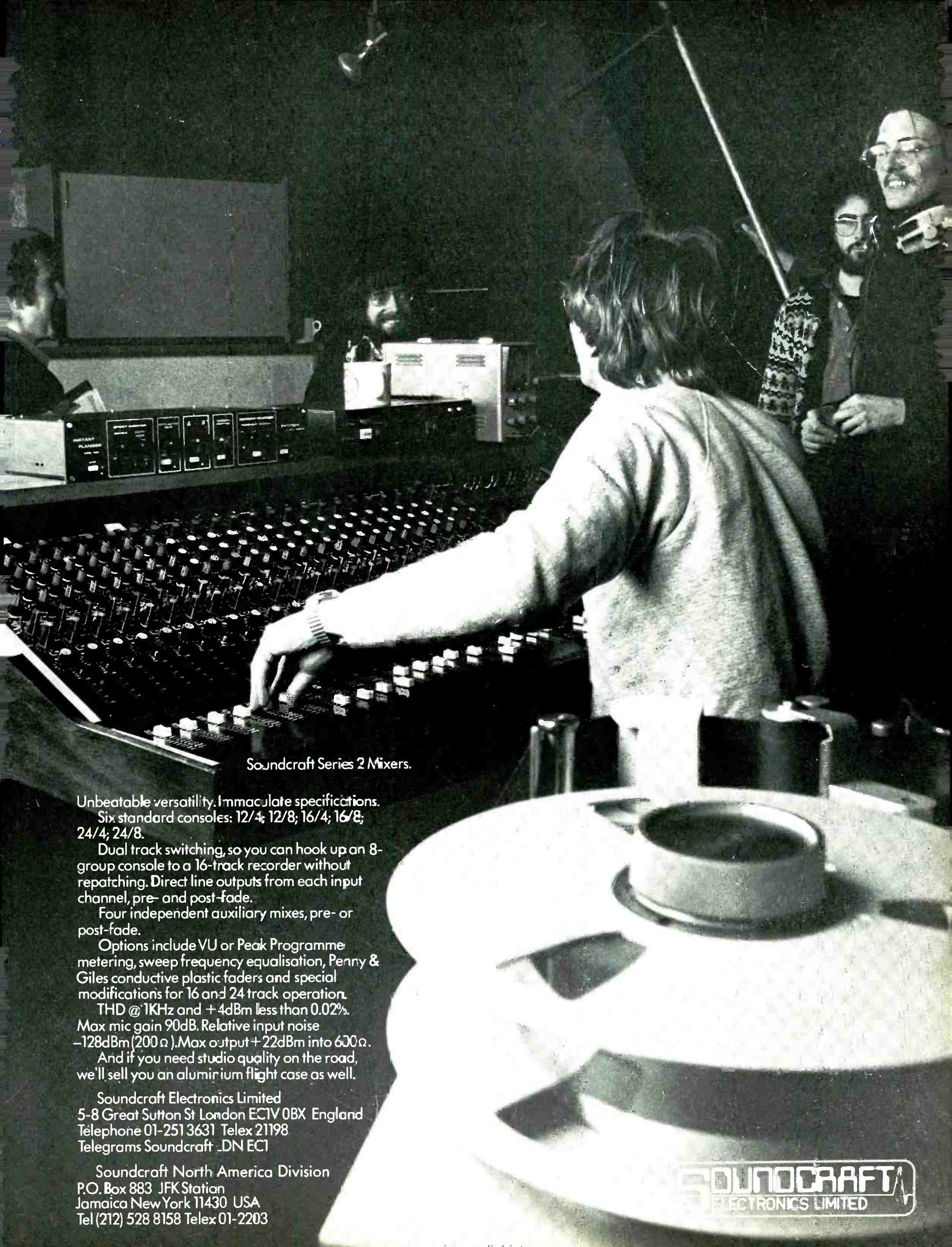
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sound available from JBLs, and the less impressive, but more accurate, sound available from Tannoys — but Tannoys can't produce JBL levels. Indigo's answer was to dispose of its JBLs and build pairs of Tannoy 38-cm units into brick infinite baffles in the basement walls of the studio control room. By doubling up, with two units in parallel, power handling is increased, and the next step is to upgrade the *DC 150* to a *DC 300*. At first this ib mounting of the Tannoy units seemed to produce less bass; actually it was producing lower, but flatter bass. Now everyone at Indigo is used to the sound, and it has become the reference point: and that, of course, is the crux. Experienced engineers have their own reference points, and that is their yardstick—without it they are lost. At The Manor recently, I noticed a visiting engineer monitoring a session not on the Eastlake units built into the walls, but on a pair of JBLs standing out in front. Heaven knows what that did to the equalisation, but if the final product was what was wanted, then was it a mistake? In this context, though, and before the anti-flat backlash gets out of hand, it's important to remember the undeniable advantage of a 'perfect' studio world, in which every control room sounds the same. A tape with tracks recorded in one studio can be overdubbed and sweetened in another, quite unfamiliar, studio without the engineer needing to make any mental or desk adjustments.

At present, Indigo spreads through two of the Georgian houses, and purchase of a third is under negotiation. Motorway blight has recently been lifted, and there's now a 10-year guarantee on the premises. So there's a plan to restore the buildings to what must have been a splendid condition. Indigo rates are £24 an hour, with £4 an hour overtime surcharge after 8 o'clock. Taking these rates and rail fares and hotel bills in London into account, it's obviously a substantial saving for groups to record at home. In fact, a fair amount of work now comes from touring groups appearing at the Golden Garter club in Manchester, or the Batley Centre outside the city. Although the music business has now started to recognise the ability of northern engineers to capture sounds on tape, it's interesting to note that when Kent-Watson and Auger were looking for financial backing for Indigo they couldn't get it locally, and had to go to London. In the North, muck and brass still go together—business men are only just waking up to the possibility that where there's *tape* there may also be brass.

At Indigo there are currently two studios: a large area for orchestral work in the basement, which can be curtained off halfway for smaller group work; and upstairs a smaller studio for voice-overs and the like—Piccadilly Radio is, of course, a flourishing IBA local radio station. Although the basement studio has a 24-track Ampex, the stereo machine is a twin-capstan Klark Teknik *SM-2*. These machines are now extinct, the design having been sold to Leevers-Rich and now appearing as the *Proline 2000TC* (see news item, p24). Same meat, different gravy. Although first-time observers worry about the twin-capstan, Indigo have nothing but praise for the machine, especially the varispeed with remote control facility that can alter tape speed from a few cm/s to around 71 cm/s, or even up to 152 cm/s, with an external oscillator. So in this way the machine can be used for adt at around 102 cm/s.

The Spectra Sonics desk has 24-in plus four echo returns and 24-out, via 8 programme subs. There is parametric eq at five frequencies, with three separate bandwidths and shelving. Interestingly, all the wiring connections are by flat strip harnesses, as are now used in aircraft.

Although there are two channels of Dolby for stereo mastering, Indigo has deliberately avoided the use of full-scale noise reduction. The philosophy is to save line-up time by using Ampex *Grand Master* tape and a full 24-track facility of Audio & Design *Scamp* expanders. Some of the *Scamp* units are straightforward, single-ended expanders for gain riding; others are 'frequency-conscious' to pass anything at lf but control low-level hf. Kent-Watson believes that intelligent use of either of these units can offer real advantage. For instance, by gating lower level hf, the frequency conscious units will cut hf splash and reduce hiss due to masking effects. The linear expanders can tighten a drum-sound, kill leakage from cans and help close-mic separation. As an example, take the case of singers who tend to 'tune up' by humming their first note as they come to the microphone. The odd little noises that come over from the mics in this way can be kept off tape by judicious gating. But can't you hear gates like these working? 'Yes, you can,' says Kent-Watson, 'if you listen to the track on its own; but if you use the facility sensibly, by the time the 24-track master is mixed the sound of the gates working can be totally lost.' Kent-Watson has also found that with care the *Scamps*, which first interested him at the APRS a year or so ago, can be used to handle Dolby-encoded tracks from tapes brought in from elsewhere. 'Of course we make clear in advance that we aren't Dolby-equipped,' he says, 'but in some cases the tight compression effect that you get from mastering Dolby-encoded tapes through *Scamps* may be just the punchy sound that the producer wants.' It's the first time I've seen a full 24 tracks of *Scamp* facility. At around half the cost of Dolby, however, and with facilities other than noise reduction—such as improving sloppy snare drum sound and separation—it's an area that others might like to investigate. Of course, as Kent-Watson readily agrees, you can hardly treat a live classical recording in this way. But as he points out, with *Grand Master* tape noise isn't too much of a problem. And for a while Indigo had a stereo pair of Burwen noise gates that they used for outside classical recordings — for instance, to cut down ambient noise. In general, despite the cost of the Burwens (around £450 per channel) they were impressed but found that reliability was a problem. The units were encapsulated, and it was in practice necessary to have two stereo pairs so that there was always one available, while the other was in for service. Hardly surprisingly under the circumstances, the Burwens went.

Plans for the future centre round expansion into the third Georgian house of the row, and the construction of a sauna and hi-fi listening room. This latter ties in with increasing recognition on the part of the studio world at large that Mr Average who buys the records doesn't necessarily listen either on JBLs or Tannoys powered by the likes of an Amcron—or on a grott-box used to check for radio intelligibility. No, Mr Average now listens on hi-fi that is halfway between the two extremes, and Indigo has plans to install a Revox plus upper-bracket domestic hi-fi set up in a room separate from the studio's control room. This will give groups and their engineers and producers a chance to hear on the spot how the final product will sound to those who actually buy it—and go back into the studio and remix if it doesn't sound right.

ARROW. When Bob Auger left Indigo he moved physically only a few yards round the corner, but into a completely different recording world. Although Arrow, like Indigo, also handles groups and music recordings, it is heavily film-oriented.

Housed on the top floor of what was once a garage, Arrow shares the building with various movie and photo companies specialising in advertising and films for the tv industry. One highly valuable legacy of the garage origins of the building is a still-deserted ground floor, in which Arrow clients can park their cars for free—and without the meter warden hassles normal for the centre of Manchester. Another useful legacy is the goods lift, which can bodily lift a fully-laden van up from street level into the back hall of the top floor studio, for unloading instruments direct into a corridor leading (past a busy billiards table) onto the studio floor.

Arrow rates are currently £25 an hour for 16-track facility; plans are afoot to go 24-track fairly soon. The music studio desk is a Raindirk 26 mic or line-in plus eight echo returns with eq, and eight stereo output groups patchable to any of

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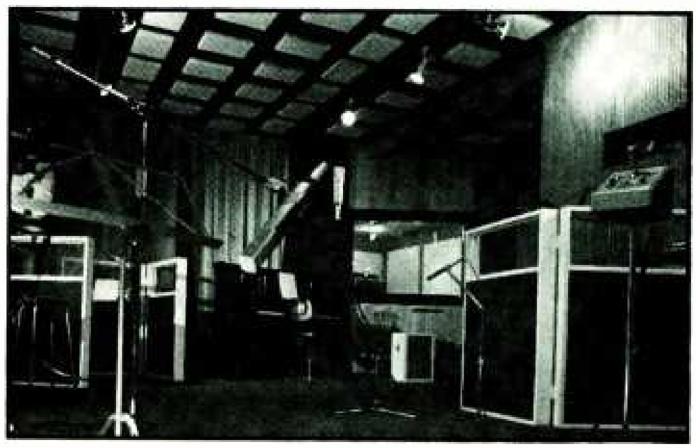
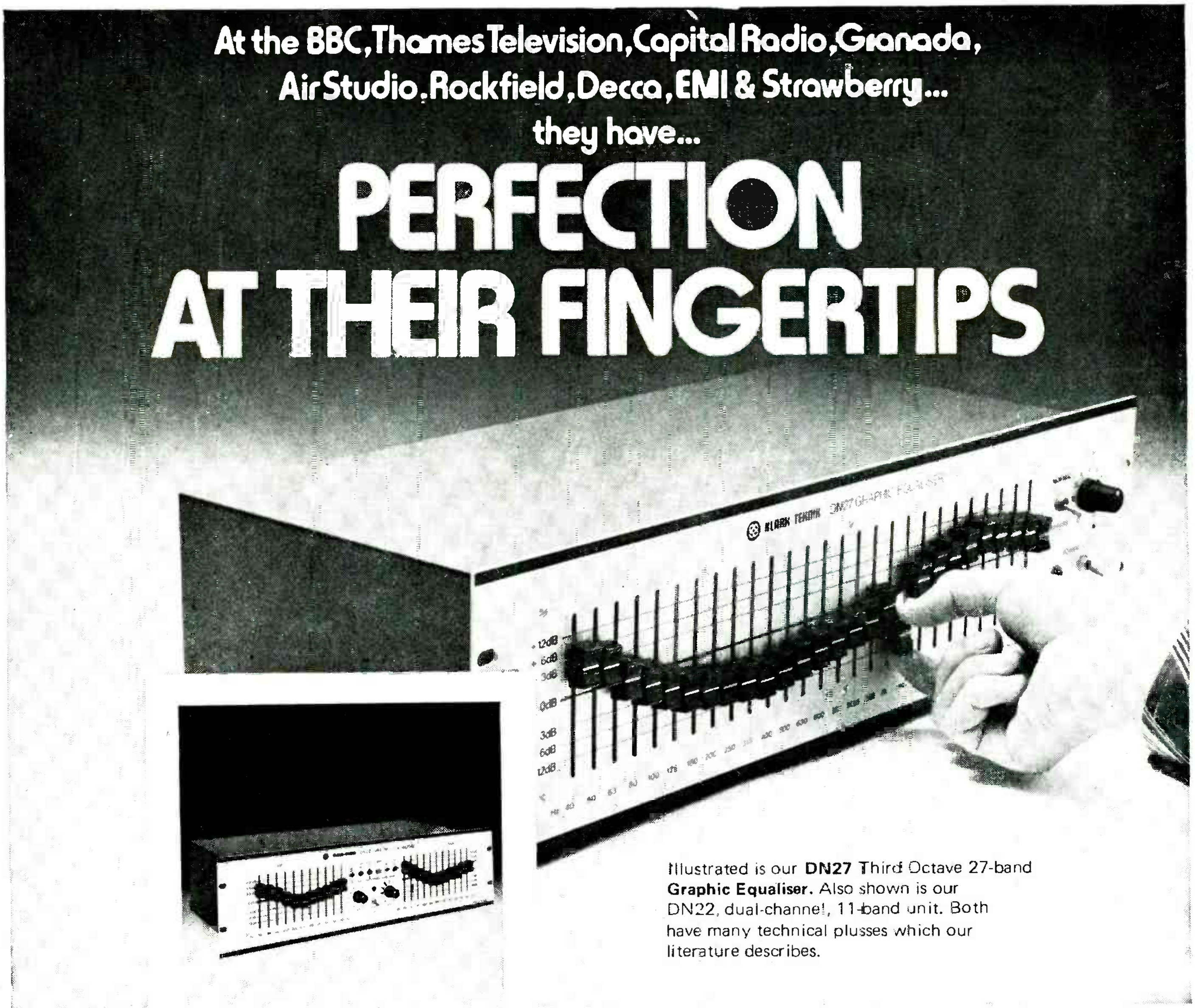
View from the string area towards the control room at Arrow. Nice decor.





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Another Notton special is the remote tape and film-time clock with display read-outs around the studio and control rooms. In the film-dubbing business, the remote facility is particularly important. Think of the main music studio as having two separate functions; for taping music there's the main studio floor for the md and musicians, and at one side the main recording control room with Raindirk desk, 16-track machine and stereo mastering. Apart from the talkback, there's a direct visual link through a conventional glass window—all quite straightforward.

Bob Auger (see text for which one) at the Raindirk 26/8 desk, obviously engrossed in something happening in the studio.

But additionally there's a projection box with 35 and 16 mm projection equipment, sync-linked to German Keller fully-coated magnetic film recording equipment. When someone once said that Keller equipment 'looked as if it was made by a mad fighter pilot in Hamburg', he wasn't far wrong. The incredibly complex mechanical drive relies on belts, but it's warhorse gear that never gives problems. For dubbing there are six Keller replay channels plus one record and one telecine display, so that the film picture can be viewed on tv monitors round the studio. The Keller units all have interchangeable 16 and 35 mm headblocks, and are standardised on 25 frames per second (for tv projection, rather then cinema). Dubbing control is handled through another Raindirk desk (this time 10 into 4) out on the studio floor, and is thus quite separate from that in the main control room. Monitoring at this desk is, of course, on cans, and there is remote control of all the film and sound equipment in the projection box and dubbing suite. Eventually there are plans to move the dubbing desk and remote control into another, separate box, but the current on-floor situation seems to work well.

The sound transfer facility, using a Pye 8/2 mixer is from tape and library discs (using Nagras and Sparta turntables) onto full-coated magnetic film or cassette or cartridge. This again uses Kellers with interchangeable headblocks to provide for either a 16 or 35 mm final product.

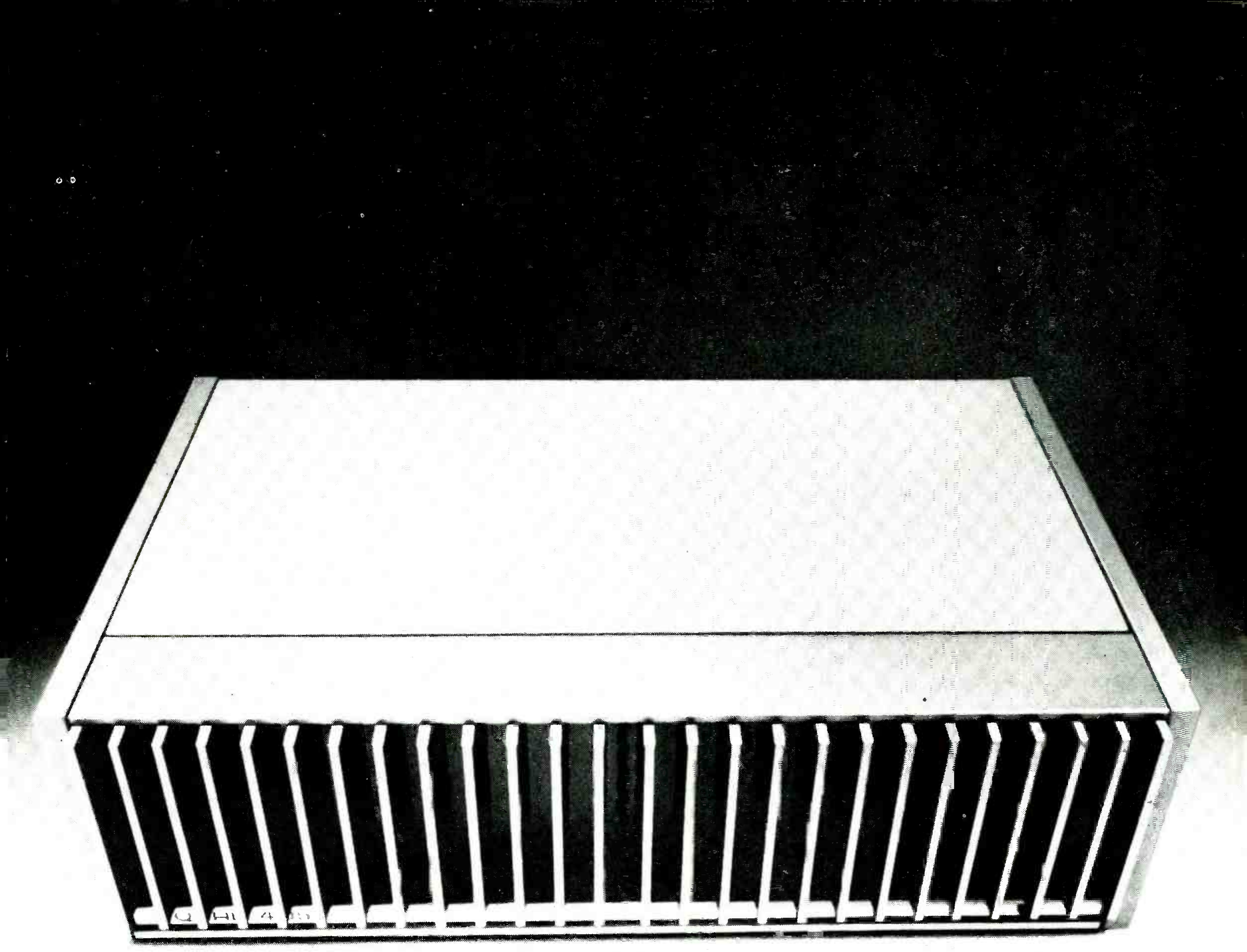
The investment needed for any studio to handle film as well as audio is mildly horrifying. Round the corner from the massive bank of dubbing Kellers (which incidentally levitate themselves on hydraulic jacks for servicing in the most impressive manner, at the turn of just two keys) is an Oxberry multiplane animation rostrum, which alone would set you back £40 000. And all this to sell us more cornflakes and cat food.

Hardly surprising with this kind of investment in film, and with video standards still in flux, Arrow has not yet "gone video". All its visual productions are straight onto film with sound dubbing onto fully-coated magnetic film. Auger, in fact, has doubts whether video will ever take over from film as a creative medium. Of course, there's already often transfer from film to video for convenience at the time of transmission—but at the stage of origin editing, dubbing and so on, film wins every time. For a start, you can hold film up to the light and see what's on the strip. And in dubbing sound effects, with picture on one strip and effects on the other, you can step one strip past the next until the effect coincides. 'With video it's all down to the man with the effects, pushing the right button at the right time. Until digital correction techniques come along you'll never be able to juggle the relationship of the sound and picture on a video format,' Auger points out.

With such heavy involvement in the audio-visual area (Arrow can also cope with tape/slide presentations), one might expect a somewhat half-hearted approach to the multitrack side. But of course, quite apart from the use of the multitrack facility for normal radio sound or album recording, in-house film music recordings are initially taped on 16-track, mixed down onto coated film, and from there dubbed with effects and whatever, using the Kellers. So every link in the chain is as important as the rest. Doubtless with this in mind, Arrow recently hired £35 000 worth of B & K test gear to check out the control room acoustics. Using a real-time digital frequency analyser, with ⅓-octave bands and memory facility, they were able to compare left and right speaker performance, check out room performance at centre and off-centre listening positions from 30 kHz right down to 6 Hz, and at one stage isolate a 63 Hz resonance in the Lockwood cabinets. At the same time they've checked out maximum clean-listening levels, and for personal interest and hearing-preservation the whole Arrow staff is now having an annual audiogram for the ears, read by the Manchester Audiology Clinic round the corner. All this ties in with the attitude that I noted as common between Auger and Kent-Watson: namely that the engineer who produces a good sound is he who knows his ears, equipment, and what sounds right to the public. As Auger says: 'It's a myth that multitrack produces a better sound. Only engineers who can get a decent stereo mix out of a simple situation are going to get better sound from multitrack. We hear of ad agencies insisting on a 24-track studio to record a jingle, which turns out to be just two vocalists.'

When there are more 24-track studios up North, it will be interesting to see whether those same ad agencies who currently insist on using a London 24-track studio are happy to stay at home. Or will there be another excuse, like 'we'd like to use you, but you haven't got a London sound'? Bob Auger has very definite views about the London sound: 'Any interest in the Northern recording business interests me', he says, 'I don't care whether it's Strawberry, Indigo, Arrow or what, that benefits. I've heard plenty of tapes come back from London that cost a fortune, and are far worse than anything that any of us could have ever done.'

Adrian Hope



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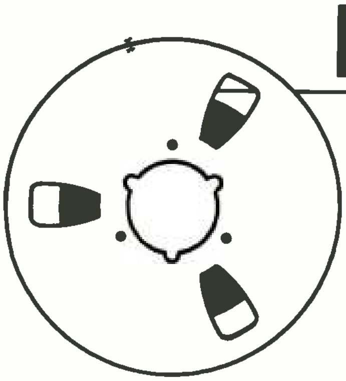
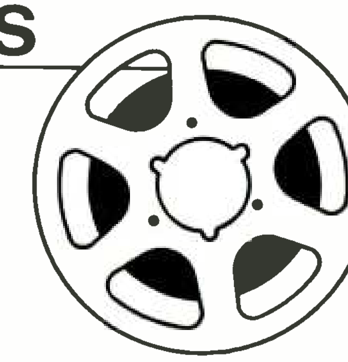


Magnetic tapes

Reviewed by Hugh Ford



ALL THE major manufacturers and importers of professional recording tape were invited to supply two samples on NAB reels of each type of recording tape they wished to include in this survey. Standard-play and long-play material were both requested in view of the use of long-play on portable machines, but it is interesting to note that the importers of Japanese tape do not supply standard play tape for professional use.

It will be obvious that some manufacturers have included a limited sample of their range of products which presumably presents their best materials, and it is also known that some manufacturers will be releasing new materials that have not been supplied—this apparently accounts for the absence of Memorex from the survey.

Before use all tape samples were inspected for quality of winding as received, and as will be seen many imported samples suffered from 'blocking', ie sections of tape had slipped in steps across the reel. This defect was probably caused in transit, due to the combined effects of temperature changes and of vibration and shock in handling.

All samples were subsequently inspected for winding properties at low fixed speed and tension (300 cm/s and 80g) on an Ampex *ATR-100* recorder, which is renowned for good tape handling. High-speed winding was then assessed again on the Ampex or on a Teac *3340*. Vast differences in winding performance were noted, with back-coated tapes generally performing better than shiny-backed tapes.

Unfortunately, the design of many modern recorders is such that they can only fast wind at a very high and fixed speed, with the inevitable result that many tapes end up with 'leafy' winds (ie individual turns stand proud) that are prone to accidental damage. It appears that many tape machine manufacturers have forgotten that the tape spool is intended as a protective device and not as a tape guide; indeed many machines are completely incapable of winding tape on to European-type open hubs, as also are some tapes on any machine.

Having said that the tape spool is intended as a protective device to stop the tape's edges being accidentally damaged, it is pleasing to note that most tape manufacturers are using spools with the minimum hole area in the flanges. These spools have far more strength than the old open types, and thus offer better protection to the tape whatever the winding characteristics; furthermore, they are not so easily bent.

Measurements of electroacoustic properties

All measurements were undertaken on an Ampex *ATR-100* tape machine, which has a very substantially better noise performance than any available tape—at least 13 dB margin with CCIR-weighted rms noise in comparison with the best tape in this survey. Furthermore, the drive capability and bias range, in addition to the drive capability of the replay amplifier, were far better than any tape used.

Assessment was only carried out at a tape speed of 38 cm/s using the NAB replay equalisation of 50 µs and 3180 µs, since it was considered too lengthy a task to include tape speeds of 19 and 76 cm/s, together with the various replay equalisations applying to all three speeds.

The track width used was the NAB 2-track format of 1.91 mm because Ampex still haven't managed to supply the European CCIR stereo headblock I ordered with the machine. But, having regard for the little use of full-track recording nowadays, and also to the track widths used on multitrack machines, the 1.91 mm width really isn't a bad compromise.

Not only does the track width affect the apparent tape performance, but also the record and replay head gaps affect the measured results—in the case of the Ampex *ATR-100*, the record gap is 12.5 µm and the replay gap 2.5 µm, both fairly typical gaps for modern professional machines.

For all measurements the bias was set to the '4 dB over' bias point at 10 kHz, it being felt that this condition would be fair to all tapes, and in general agreement with the '1 dB over' bias point at 1 kHz that is still used by some organisations. In practice the '1 dB over' bias point at 1 kHz is impossible to determine accurately, due to the flatness of the bias/sensitivity curve at long wavelengths. Consequently, I thoroughly recommend the practice of biasing at 10 kHz where the bias/sensitivity curve is much sharper.

The tabulation of test results shows the bias current for the '4 dB over' bias point for each tape sample, in relation to the same point for the standard unrecorded section of the DIN reference tape *38* according to DIN 45 512 sheet 2. Similarly, the sensitivity is related to the DIN reference tape at the individual bias of '4 dB over' bias at 10 kHz; it is possible, therefore, to relate these parameters to a standard tape, provided that similar head configurations are used.

In practical terms the sensitivity variations are relatively small, such that most machines can have their record amplifiers readily equalised for the tapes examined. It should be noted, however, that Agfa *PEM 469* and *Scotch 250* tapes require considerably more bias current than others, and could therefore prove to be a problem on older machines.

Similarly, problems can be encountered with the maximum output level that several modern tapes can deliver. Not only is the maximum recorded level capable of saturating replay amplifiers in some machines, but many older machines are not capable of recording such high fluxivities, as a result of limitations in their record amplifiers and heads.

It is perhaps unfortunate that it is current practice to align record level metering in accordance with the maximum output level capability of a tape for 3% third harmonic distortion at 1 kHz, since examination of the harmonic distortion at lower levels, and of intermodulation distortion, reveals that the maximum output level is only part of the distortion story. If you are offered an amplifier with 1% intermodulation distortion, 3% harmonic distortion, a frequency response of ±1 dB from 20-15k Hz and a dynamic range of 70 dB, what do you do? Simply stand back in horror? Yes, of course you do, but such are the characteristics, in addition to other horrors, of even the best modern tapes—in short, tape is the really weak link in the recording chain.

Purely as a matter of interest the third harmonic distortion at 360 nWb/m fluxivity is included, this particular fluxivity being a convenient measuring point; but the variation in distortion at this level is quite alarming.

While in the past harmonic distortion has been considered as the distortion criterion, it is now generally felt that intermodulation products are subjectively more objectionable—partly on the premise that all musical instruments generate harmonics, but not intermodulation products.

Consequently, I have included four tabulations of intermodulation distortion representing the 10% and 1% intermodulation distortion points at both high and low frequencies, with respect to the reference level of 320 nWb/m

66 ▶

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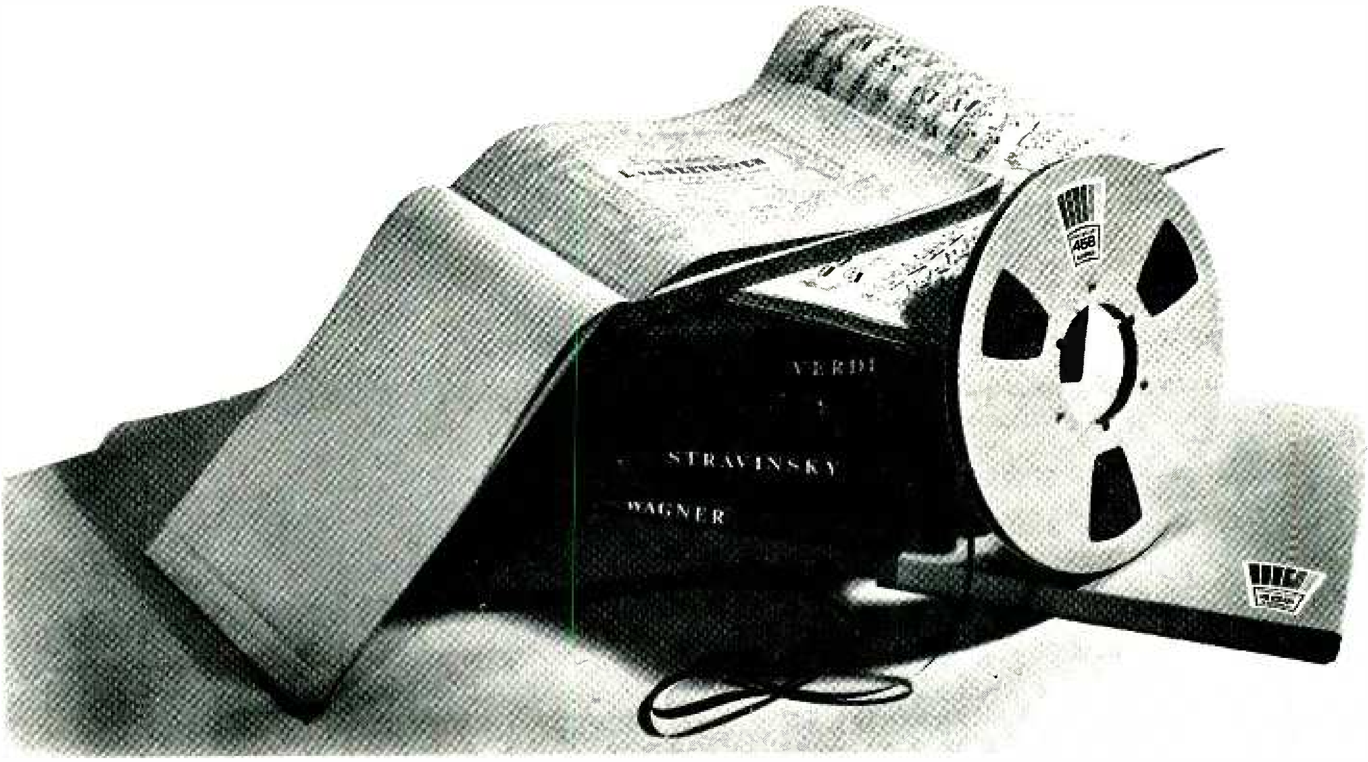

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Magnetic Tape ; Audio and Video Recording Equipment ; Video Cameras ; Instrumentation Recorders ; Computer Tape Drives ; Core Memories ; Disk Drives (which is also the reference level for the maximum output level). Intermodulation distortion was measured by applying two simultaneous tones of either 1000 Hz and 1100 Hz, or 10 kHz and 10.1 kHz, and relating the third-order intermodulation product at 1.2 kHz or 12 kHz to the amplitude of one of the original tones that were of equal amplitude. As a result, the choice of NAB replay equalisation for evaluating the tape, as opposed to the IEC standard of 35 μs, will have little effect upon the low-frequency figure, but will affect the high-frequency figure to the extent that the IEC performance would be approximately 2.5 dB worse.

Noise performance of the tapes has been expressed in terms of CCIR (recommendation 468) weighted noise, using either a true rms meter or a quasipeak meter to the DIN standard; in both cases the weighting filter was set for unity gain at 1 kHz. The choice of the CCIR weighting as opposed to the IEC A-weighting is based on the fact that the CCIR curve has been shown to give far better correlation with the subjective effects of tape noise. The quoted noise performance is related to the reference level of 320 nWb/m at 1 kHz, with corrections allowed for the fringing effects of the narrow-track replay heads, as is the case with other measurements. The use of the European Standard stereo-format heads would give a noise performance 3.3 dB better than the quoted figures.

With regard to modulation noise, which is additional noise and only present when an audio signal is being recorded, I have adopted a special measurement method that is intended, amongst other things, to take into account the effects of modulation noise when using Dolby noise reduction systems. The conventional dc method of measuring modulation noise is, in my opinion, suspect and can give poor correlation with subjective effects; furthermore, being essentially a wideband measurement, it cannot be correlated with the subjective effects when band-splitting noise reduction systems are in use. In these circumstances we are concerned with modulation products that are close in frequency to the audio signal being recorded, and it is always in this area that modulation noise products are to be found.

The practical measurement set-up used is shown in **fig. 1**, in which a 1kHz tone is recorded onto the tape at a reference level of 320 nWb/m. The resulting output from tape is passed through a bandpass filter with −3 dB points at 500 and 1.5k Hz and an attenuation of 24 dB/octave, thus effectively eliminating harmonics and also providing a well controlled measurement bandwidth. The output from this filter is then passed through a very sharp notch filter to eliminate the 1 kHz audio, and the resulting noise output is related to the amplitude of the 1 kHz audio signal with a true rms reading meter.

The resulting performance figures for the tape samples show a range of up to 10 dB in modulation noise performance using this system, and it is my opinion that modulation noise performance is a very important factor when selecting a recording tape.

The uniformity of reproduction of a tape is often closely related to modulation noise, but in terms of dropout and general erratic behaviour is normally shown as a high-speed pen recording. Such pen recordings are shown here for each tape sample at both 1 kHz and 15 kHz, using a Bruel & Kjaer pen recorder with a pen speed of 100 dB/s and a paper speed of 1 mm/s. These plots show substantial differences between tape samples, but as a further aid to uniformity comparison, a figure for 'apparent SMPTE intermodulation distortion' has been included.

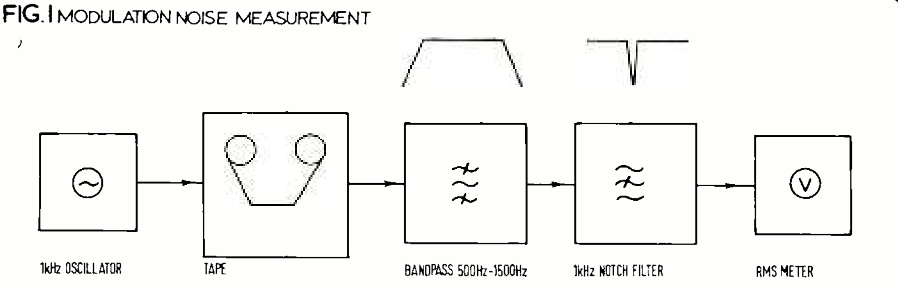
Some explanation of this figure is required, since it was obtained from the unconventional use of an Amcron intermodulation analyser. In simple terms, intermodulation meters of this type normally apply a high and a low-frequency signal to the device under test, and determine the amount of intermodulation distortion by measuring the degree of amplitude modulation that the high frequency suffers from the low-frequency signal. In tape terms the function of the analyser can determine the amount of amplitude modulation a high-frequency tone alone suffers from lack of tape uniformity, and it is this figure that is quoted as a result of recording and replaying a single 7 kHz tone.

The final measurement undertaken was that of print-through, which was done using a 1 kHz signal recorded at the reference level of 320 nWb/m. This was recorded for 5s at a tape position 15 minutes from the leader measured at a tape speed of 38 cm/s. The tape was then rewound and stored at a temperature of 20°C for 72 hours. After storage the tape was replayed and the amplitude of the first 'echo' noted—this is the quoted print-through performance. Because print-through is an exponential function this is nearly the worst-case figure; the fact that the post-echo is less than the pre-echo means that storing tapes 'tail out', and rewinding before replaying will reduce the effective print-through by 3 or 4 dB. It will be noted from the results that the high-output tapes such as Ampex *456* and *Scotch 250* are particularly poor for print-through, which is bound to be subjectively bad in these instances since they are also low-noise tapes.

While noise reduction systems reduce print-through they also reduce the noise, so unfortunately the subjective effect of print is little improved because it is the print-to-noise ratio that is of subjective interest.

The final column in the tabulated results is intended to give an idea of the useful dynamic range in terms of the ratio between noise and the average 10% intermodulation point for high and low-frequencies. This shows little difference between tape types, and given a silent tape machine it casts some doubt upon the real value of high-output tapes. Perhaps more consideration should be given to the distortions at lower signal levels than to the available dynamic range?

FIG. 1 MODULATION NOISE MEASUREMENT



General notes on individual tapes

AGFA: All three types of Agfa tape arrived in very good condition with a first-class wind. Low and high-speed winding properties were the best of any of the tapes tested, and there was little shedding of debris during their use, with the exception of the *PEM 468* samples that shed a little dirt from the edges.

AMPEX: All types of Ampex tape left something to be desired regarding their original condition, with the samples of types *406* and *456* received having a 'blocked' wind. Low-speed winding characteristics were very good on the *ATR-100*, with no sign of oxide shedding or other debris. High-speed winding of types *406* and *407* produced severe 'leafing', with type *456* being somewhat better but still far from perfect.

AUDIOTAPE: The original wind of the sample of *Q19* appeared to be at too low a tension, with resulting blocking. On the other hand, both the low and high-speed winding characteristics were very good. No shedding or debris were noted.

BASF: The samples of *SPR50 LH* both arrived with fairly good winds, one sample being distorted and suffering from 'spoking'; but no such complaints were attributed to the samples of *LPR35*. The *SPR50 LH* winding was good at both high and low speeds, but slight oxide shedding was noted. The *LPR35* winding was to a good standard for a long-play tape. While the *LPR35* was supplied on a modern spool, the *SPR50 LH* was wound onto the open-type spool.

EMI: While the original wind of the backed *816* samples was good, the other samples can be described as having only fairly good wind. The *816* sample wound well at high and low speeds, but with slight 'leafing' at high speed and a little oxide shedding; the *815* sample had similar properties but showed a very leafy wind at high speeds. Type *825* showed a medium-quality wind on the *ATR-100* at low speed, and exhibited a medium degree of leafing at high speed; like the other EMI samples there was mild oxide shedding.

FUJI: Both types of Fuji tape suffered from a blocked wind as received, and one sample of type *FG* showed mild leafing. The performance of type *FB* was not particularly good at low

68 ▶

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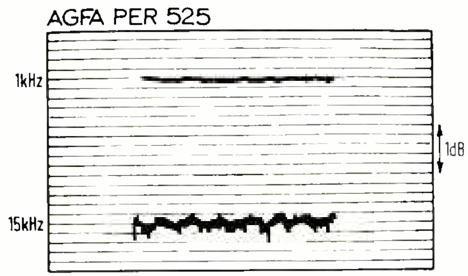
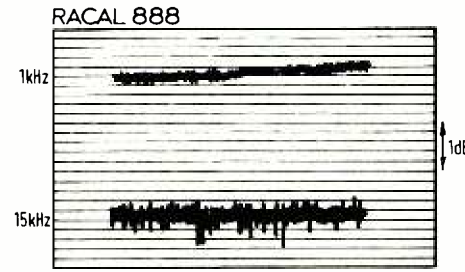
STANDARD PLAY TAPES

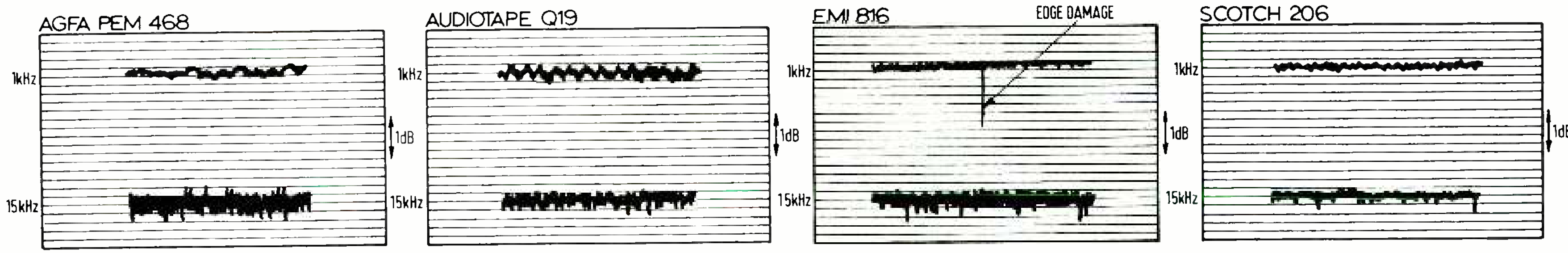
	AGFA PER 525	AGFA PEM 468	AMPEX 406	AMPEX 456	AUDIO TAPE Q19	BASF SPR50 LH	EMI 815	EMI 816	PYRAL CJ87 HR	RACAL 666	RACAL 888	SCOTCH 206	SCOTCH 250	SCOTCH 262
Bias at 10 kHz—dB	+0·7	+4·3	0	+0·3	+0·7	+1·9	+0·2	+0·2	+0·4	+0·3	+0·6	+0·4	+2·9	+0·4
Sensitivity at 1 kHz—dB	+0·9	+0·5	+1·5	+2·7	+0·2	+0·4	+1·3	+1·1	+1·7	+0·5	+1·8	+0·2	+1·6	+0·8
Sensitivity at 10 kHz—dB	+0·5	—0·5	+2·3	+3·8	+1·4	+0·6	+0·4	+0·6	+2·4	+1·6	+1·8	+1·0	+1·8	+1·3
Sensitivity at 15 kHz—dB	—0·2	—1·2	+1·8	+4·3	+1·2	+0·3	—0·2	0	+2·4	+1·6	+1·1	+0·6	+1·2	+0·8
Maximum output level (3% third harmonic at 1 kHz)—dB	+7·3	+10·8	+8·3	+11·9	+7·3	+9·5	+7·9	+7·6	+10·3	+7·1	+10·1	+6·9	+11·5	+7·7
Third harmonic distortion at (360 nWb/m at 1 kHz)—%	0·9	0·5	0·9	0·4	1·2	0·6	0·9	1·0	0·6	1·3	0·6	1·2	0·4	1·0
INTERMODULATION DISTORTION														
1% im (1 kHz+ 1·1 kHz)—dB	—2·7	+0·3	—2·2	+2·3	—3·3	—0·7	—2·1	—2·7	+0·3	—3·1	—0·5	—3·5	+1·5	—2·7
1% im (10 kHz+10·1 kHz)—dB	—6·2	—5·2	—4·2	—2·7	—5·0	—4·2	—6·4	—6·4	—4·3	—5·0	—3·9	—6·4	—5·2	—6·4
10% im (1 kHz+ 1·1 kHz)—dB	+9·1	+11·6	+10·3	+11·8	+9·3	+10·8	+9·5	+10·7	+11·3	+9·0	+11·8	+8·7	+12·3	+9·5
10% im (10 kHz+10·1 kHz)—dB	+5·3	+6·8	+7·3	+8·3	+6·9	+7·3	+5·8	+6·5	+7·8	+7·1	+7·5	+5·9	+6·9	+5·7
CCIR—weighted noise (rms)—dB	—49·7	—53·2	—51·2	—52·2	—54·0	—52·9	—53·2	—52·9	—52·8	—51·0	—52·5	—54·0	—54·7	—51·0
CCIR—weighted noise (peak)—dB	—45·2	—48·2	—46·0	—47·2	—49·2	—47·7	—48·2	—47·9	—47·5	—45·9	—47·4	—49·2	—49·9	—45·9
Modulation noise—dB	—56	—51·5	—59	—60	—52	—57	—55	—55	—55	—55	—54·5	—59	—60	—52
Apparent SMPTE intermod—%	1·0	3·5	0·5	0·5	1·0	1·0	1·5	1·5	2·0	0·8	1·5	0·3	0·3	2·0
Print-through (1 kHz)—dB	—56	—54	—55	—48	—51	—52	—53	—53	—53	—56	—53	—51	—49	—57
Dynamic range (in terms of average of 10% im to rms noise)—dB	56·9	62·4	60·0	62·2	62·1	61·9	60·8	61·0	62·3	59·0	62·1	59·8	63·8	58·6

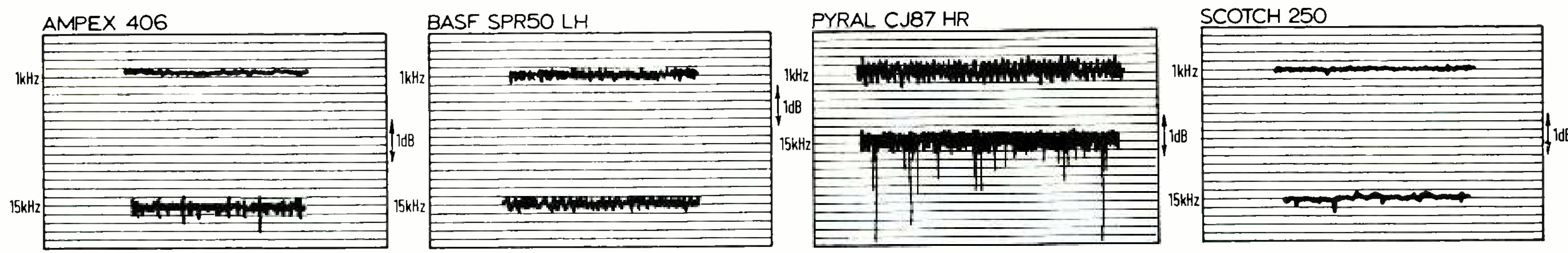
STANDARD PLAY TAPES

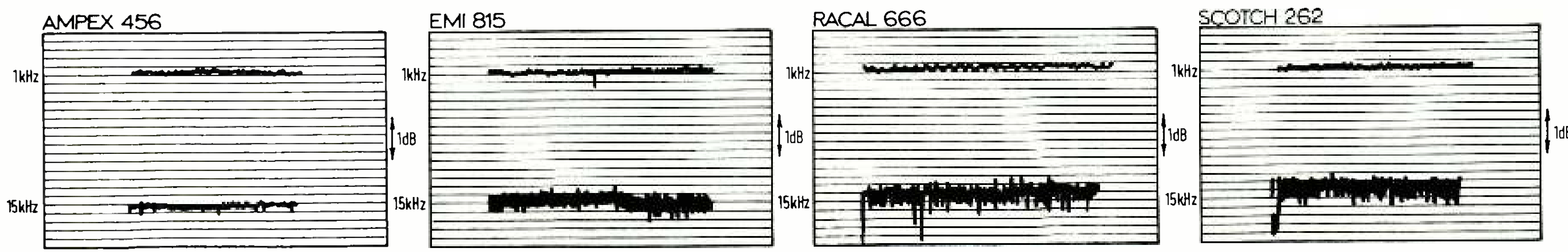
Uniformity of Reproduction (see text)











LONG PLAY TAPES

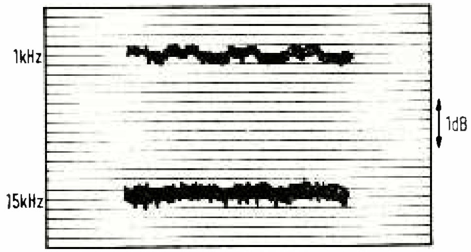
	AGFA PEM 368	AMPEX 407	BASF LPR 35	EMI 825	FUJI FB	FUJI FG	MAXELL UD35	RACAL 333	SONY SLH	TDK AUDUA L	TDK AUDUA LB	SCOTCH 207
Bias at 10 kHz—dB	+1·2	+0·2	+0·4	—0·2	0	+0·2	+0·4	+0·2	+0·9	+1·9	+1·9	+0·4
Sensitivity at 1 kHz—dB	—0·1	+2·3	—1·3	—1·1	+0·5	+0·3	+0·2	—0·1	—1·5	+0·2	+0·1	—0·5
Sensitivity at 10 kHz—dB	+1·4	+2·5	+1·3	+0·8	+2·0	+2·2	+2·5	+2·0	+1·6	+2·0	+2·3	+1·4
Sensitivity at 15 kHz—dB	+1·4	+2·1	+1·8	+0·8	+2·2	+2·3	+2·8	+2·1	+2·1	+2·1	+2·6	+1·3
Maximum output level (3% third harmonic at 1 kHz)—dB	+6·8	+9·5	+6·5	+4·3	+8·0	+7·8	+7·8	+9·4	+6·3	+8·7	+8·7	+6·3
Third harmonic distortion at (360 nWb/m at 1 kHz)—%	1·2	0·6	1·3	2·0	0·9	1·0	0·9	0·8	1·2	2·9	1·0	1·3
INTERMODULATION DISTORTION												
1% im (1 kHz+1.1 kHz)—dB	—4·1	—0·2	—2·7	—2·5*	—2·1	+1·3	—2·2	—1·1	—3·3	—1·7	—2·1	—3·7
1% im (10 kHz+10.1 kHz)—dB	—4·7	—3·7	—2·7	—3·0*	—3·5	—3·7	—3·7	—4·4	—4·3	—4·1	—3·3	—6·0
10% im (1 kHz+1.1 kHz)—dB	+8·3	+11·3	+8·1	+10·4*	+9·3	+11·5	+9·1	+11·7	+8·1	+10·3	+10·1	+8·1
10% im (10 kHz+10.1 kHz)—dB	+7·3	+7·6	+8·3	+6·3	+7·3	+8·3	+7·9	+10·2	+7·3	+8·3	+8·3	+6·3
CCIR—weighted noise (rms)—dB	—53·2	—51·9	—54·0	—53·2	—53·1	—53·7	—53·7	—51·1	—54·5	—53·5	—53·3	—54·9
CCIR—weighted noise (peak)—dB	—48·2	—46·7	—48·9	—48·0	—48·2	—48·4	—48·7	—45·9	—50·5	—48·4	—48·2	—49·7
Modulation noise—dB	—51·5	—59·0	—54·0	—50·0*	—57·0	—57·0	—54·0	—57·5	—51·5	—58·0	—57·0*	—55·0
Apparent SMPTE intermod—%	2·0	0·5	0·8	1·5*	0·6	0·5	0·6	0·8	0·8	0·8	0·8	0·5
Print-through (1 kHz)—dB	—53	—50	—52	—55	—54	—52	—53	—56	—55	—52	—51	—51
Dynamic range (in terms of average of 10% im to rms noise)—dB	61·0	61·3	62·2	63·3	61·4	63·6	62·2	62·0	62·2	62·8	62·4	62·1

*See text (Conclusions)

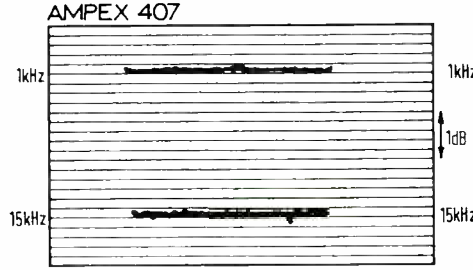
LONG PLAY TAPES

Uniformity of Reproduction
(see text)

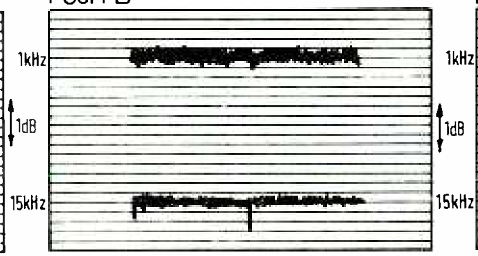
AGFA PEM 368



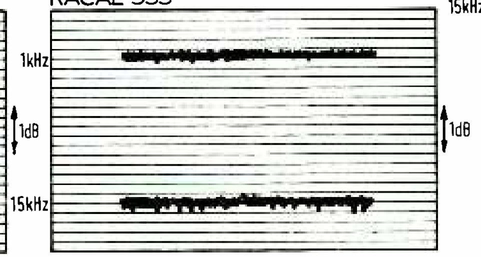
AMPEX 407



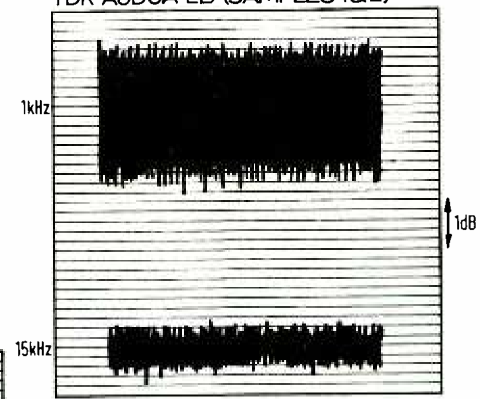
FUJI FB



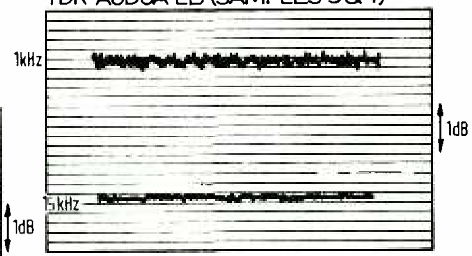
RACAL 333



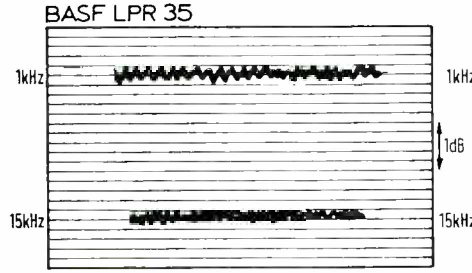
TDK AUDUA LB (SAMPLES 1&2)



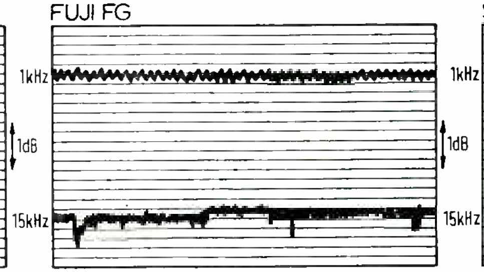
TDK AUDUA LB (SAMPLES 3&4)



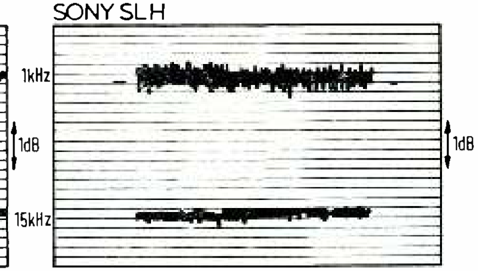
BASF LPR 35



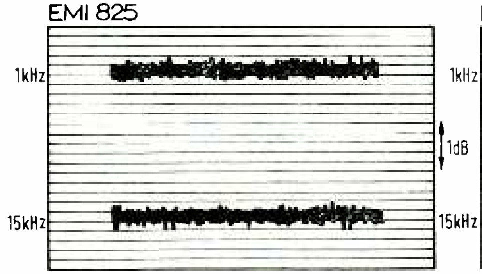
FUJI FG



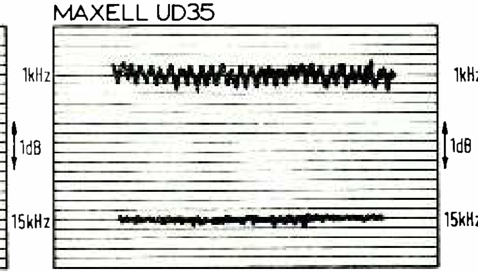
SONY SLH



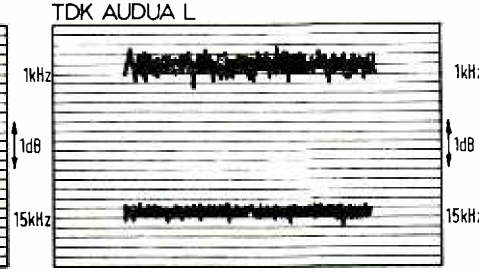
EMI 825



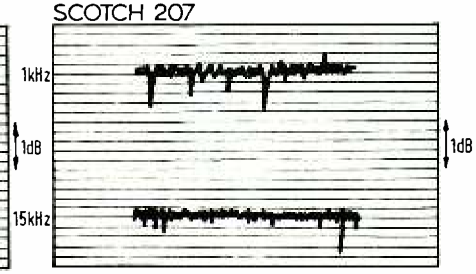
MAXELL UD35



TDK AUDUA L



SCOTCH 207



MAGNETIC TAPES REVIEWED

speed on the *ATR-100*, and exhibited poor leafing and leant to one side of the spool at high speed. The performance of the type *FG* was similar but worse, being really rather poor even on the *ATR-100* at low speed.

MAXELL: The original wind as received was excellent, but the low-speed winding was poor and leafy. The high-speed performance exhibited very poor leafing and lean to one side of the spool. No shedding was observed.

PYRAL: The original condition of both samples of *CJ87 HR* was poor, with one sample being wound onto a reel that had two flanges on one side! Old open-type reels were used, and both samples exhibited damaged tape edges. On the credit side, the tape wound very well at high and low speeds with no signs of shedding.

RACAL-ZONAL: The original winding of types *666* and *888* was very good, but that of type *333* left something to be desired. All types were wound onto old open-type spools. Types *666* and *888* exhibited very good winding at both high and low speeds, but showed slight oxide shedding. Type *333* had a poor and leafy wind at the low speed on the *ATR-100*, and had severe leafing and lean to one side of the spool at high speeds.

SCOTCH: The original winding of all types was very good, as was the low-speed winding of all but type *206*. The performance of type *262* was also very good at high speeds, but types *206*, *207* and *250* all showed some leafing and lean to one side of the spool at high speeds. All types ran clean.

SONY: The original wind was good except for some blocking. Low-speed winding showed severe leafing and a generally poor wind, with high-speed winding being extremely poor.

TDK: The original winding and the low-speed performance of both types was good and running was clean. High-speed winding gave bad leafing of type *Audua L*, with lean to one side of the spool; *Audua LB* was much better at high speeds, but still exhibited some leafing.

Conclusions

This examination of 26 types of tape has been a time consuming exercise in spite of the small number of samples of each type, and in fairness to manufacturers and readers it must be emphasised that the batch sample is very small and the results cannot be guaranteed to be typical of production. It is hoped, however, that the results provide useful data. In general a reasonable correlation was obtained with manufacturers' published data.

In two instances further samples were requested from manufacturers because of the poor performance of the samples supplied, and in both instances there was immediate action taken. The tapes in question were EMI *825* and TDK *Audua LB*; the tabulated results have been marked with an asterisk. The initial EMI samples suffered from very poor intermodulation distortion at low signal levels and poor modulation noise—this appeared to be a result of surface defects associated with the gravure coating process. In the case of the TDK *Audua LB*, the uniformity of reproduction and modulation noise were poor—further samples gave the tabulated results that were substantially better.

It will be noted from the tabulated results that with few exceptions the bias requirements for the tapes fall within a small range. Nevertheless, the use of such tapes as Agfa *PEM 468* and *Scotch 250* could produce compatibility problems between the tape and older machines; the sensitivity variations are unlikely, however, to produce equalisation problems.

High maximum-output level and low noise are another story: there are a number of tape machines incapable of using the full capability of high-output tapes due to either record amplifier limitations or saturation of the replay amplifier in the replay mode. Likewise, at least 10 dB margin is desirable between replay amplifier noise and tape noise, and in this respect many older machines contribute significant noise to the inherent tape noise.

It may be rather a shock to note that the differences in dynamic range of the tapes as determined by the average 10% intermodulation distortion point to noise performance is surprisingly small. It should be noted also that the margin between 10% intermodulation distortion and the maximum output level for 3% third harmonic distortion at 1 kHz varies somewhat.

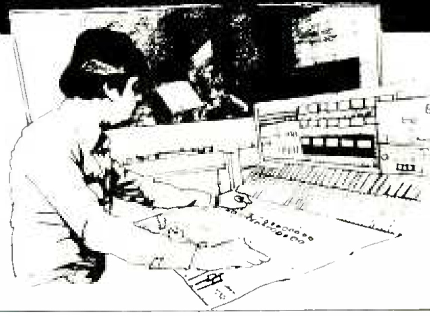
So far as the practical dynamic range is concerned, the differences between tapes are small in comparison with the differences in modulation noise and in print-through; it is in the latter respect that tapes with the largest maximum-output level suffer seriously. Furthermore, the high-output tapes tend to suffer from poor intermodulation distortion at high frequencies, when related to their mid-frequency performance.

The real benefit of high-output tapes lies in their performance at conventional recording fluxivities where distortion is much reduced. Unfortunately, the signal-to-print performance remains constant with recorded fluxivity so there is still a penalty to pay. However, some tape manufacturers are tackling this problem with excellent results, and if they pay equal attention to modulation noise problems we will have a new and better generation of tapes available soon—but analogue tape recording will still remain a weak link in the recording/reproducing chain.

agony

A recent Branch Bulletin from the London Musicians Union contains news of what must be the most important musical legal precedent ever. In Brentford County Court the MU helped a social club trio plead that they had been unjustly dismissed for boozing. Astonishingly, the judge refused to accept the other side's assertion that drink must impair a musician's performance. He maintained that it was well known that many musicians performed extremely well under the influence of drink and drugs, and ordered that the trio be paid for all the gigs that had been cancelled. Cheers.

INTRODUCING PYRAL



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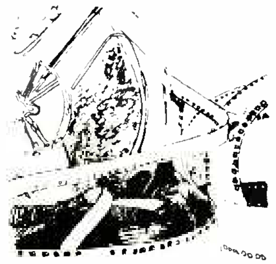

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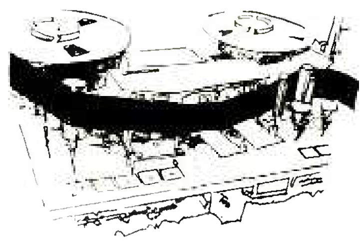

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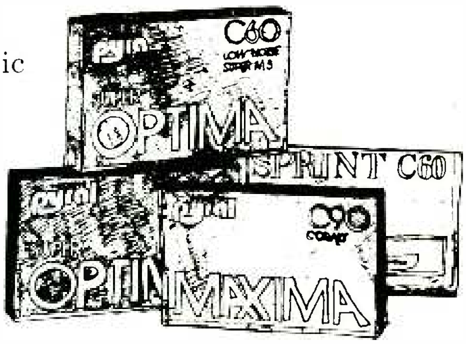

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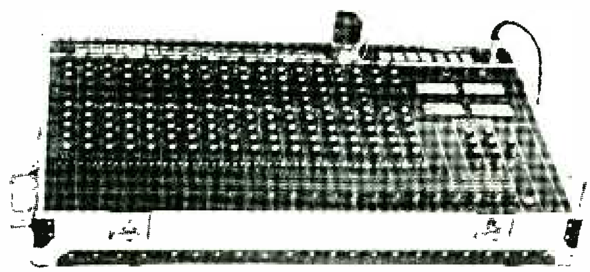

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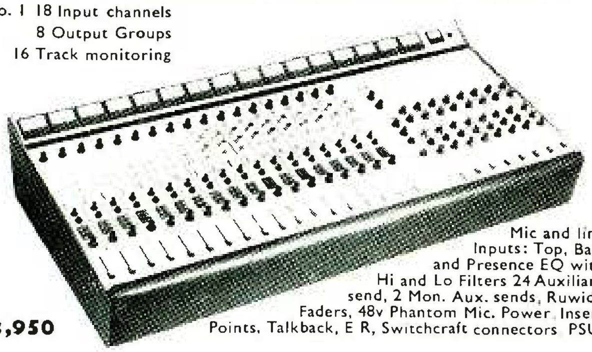

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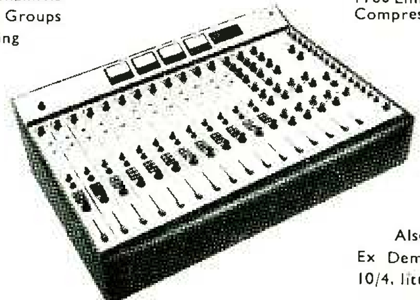

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