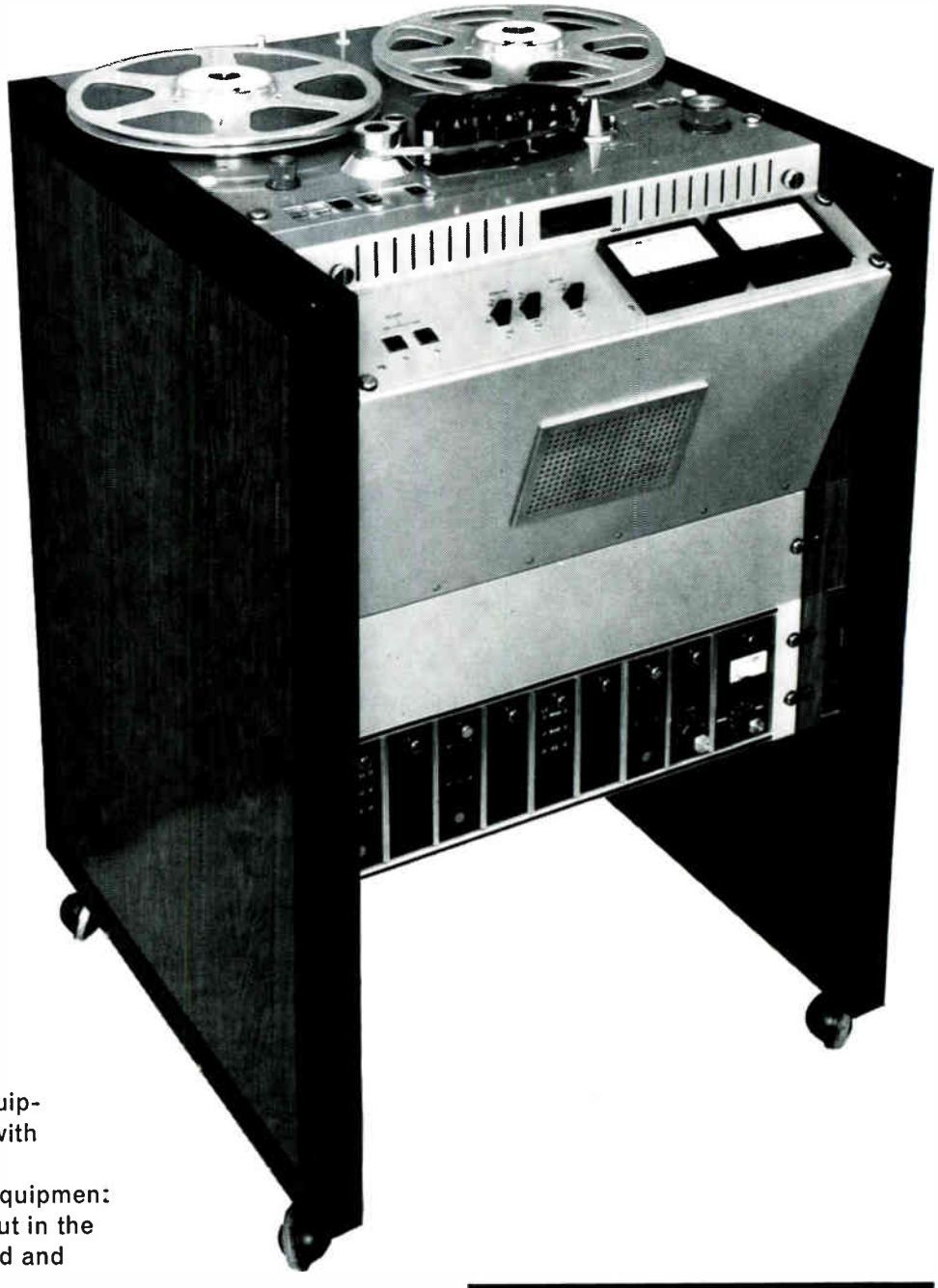
March 1972 25p

studio sound

TAPE TRANSPORT DESIGN CRITERIA

SURVEY: INDUSTRIAL SOUND RECORDERS

Highest attainable technical performance



QUICK AND EASY

No major repair facilities available ?
This professional tape recording equipment needs none and can be used with confidence anywhere in the world.
In the past a fault in sophisticated equipmen: could mean expensive down time, but in the E200 any fault can be quickly isolated and the part or circuit replaced.
All major mechanical components and sub-assemblies are quickly and easily changed. Many circuits simply plug-in.

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EQUIPMENT LIMITED

A Member of the MCP Group

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Full details of these and other quality microphones are available on request.

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STC 4121 Moving Coil headphones and Boom Microphone. These dynamic earphones have a wide frequency range and low distortion at high sound levels. The microphone has an excellent response to most communication or announcement purposes giving good speech quality, free from blasting, overloading or appreciable breath noises.

STC 4104 Broadcast Quality Commentators Noise cancelling lip microphone. A highly damped ribbon unit ensures freedom from non-linearity and low frequency surges.

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Telex tape duplicating systems consist of the open reel series 235-1 and the reel to cassette series 235 CS-1. Both systems are designed for mass production of professional quality tapes by commercial, educational, institutional, or industrial facilities. Heavy duty tape transports matched to solid state modular electronics, provide long term equipment reliability. With a mixture of reel to reel and cassette modules, total flexibility is possible.

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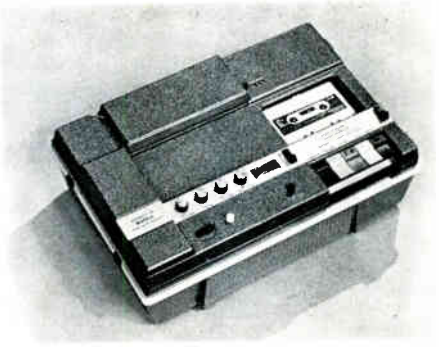

The Telex audio comparator is the ideal unit for the 'listen-respond-compare' learning situation, especially for foreign language, speech, drama, and music studies. Pre-recorded programmes are played via a master track which cannot be erased. Student response is recorded on a second-track which may be played or re-recorded as required. Each channel has separate volume controls with the students' record channel controlled via manual or automatic control of volume.

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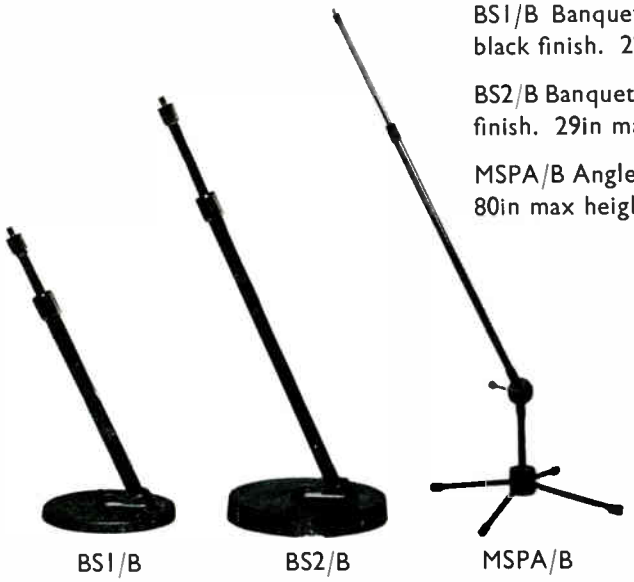
RSC • TELEX COMMUNICATIONS DIVISION

AVCOM SYSTEMS LIMITED

Newton Works, Stanlake Mews, LONDON W12 7HA 01-749 2201

NEW ADDITIONS TO OUR EXTENSIVE RANGE OF MICROPHONE STANDS AND ACCESSORIES



BS1/B BS2/B MSPA/B

BS1/B Banqueting Stand. 4½lb base. Matt black finish. 22in max height.

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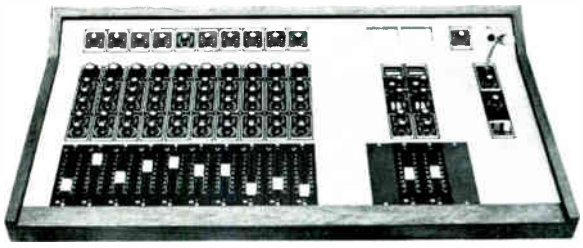
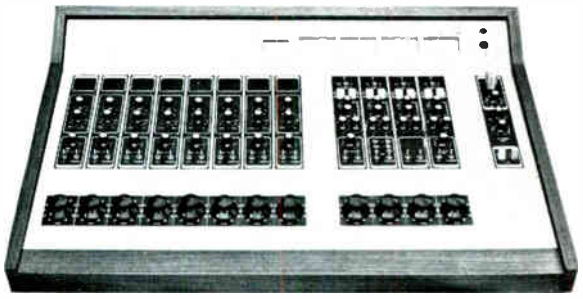
One mixer

Many faces





A successful design breeds many varieties. These are just two that have been dreamt up by discerning engineers. The Alice SM2 mixer, originally conceived as a high quality professional portable desk with essential facilities, has been so well received by enthusiastic users that we are now building them in every possible configuration. Foldback, monitoring, power amplifiers, compressors, filters, jackfields, tone generators, phantom powering—you choose just the facilities you need. And for a thoroughbred of this class the price will be a surprise. Basic six channel stereo mixer as above from £464.

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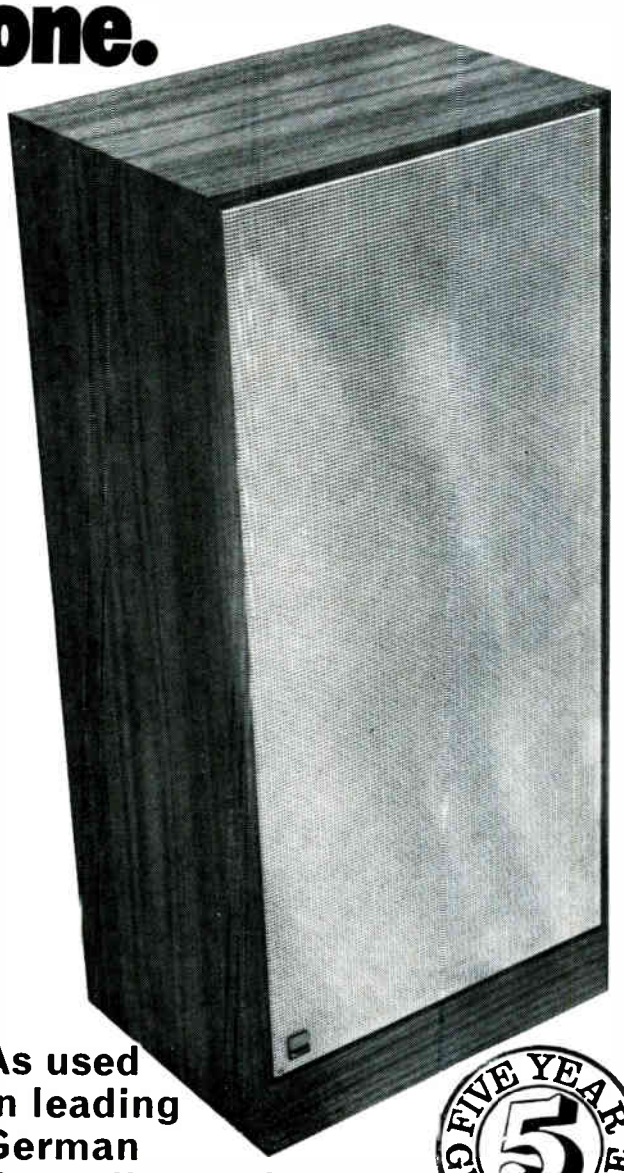
Heco P.6000. the professional one.



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FIVE YEAR 5 GUARANTEE

SPECIFICATION
Frequency Response: 20-25,000 Hz.
Power Handling: 60 watts RMS.
Impedance: 8 ohms.
Cross-over Frequency: 250/800/3,000 Hz.
Speaker Assembly: One 12" woofer.
One 5" mid-range speaker. One upper mid-range hemispheric dome radiator. One ultra-high hemispheric dome radiator.
Recommended Retail Price £110.00

Please send me full colour literature and test reports on Heco Speakers, also name and address of my nearest stockist.

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WOW and FLUTTER METERS

Illustrated is the ME 104, one of the three types of Wow and Flutter Meters distributed by us exclusively in the U.K. It is widely used by all the leading Broadcasting, TV and Recording Studios, manufacturers of tapedeck-tape recorders, turntables, record-changers—in fact by anyone concerned with the accurate measurement of drift and wow and flutter. Fuller details on application.

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CALREC

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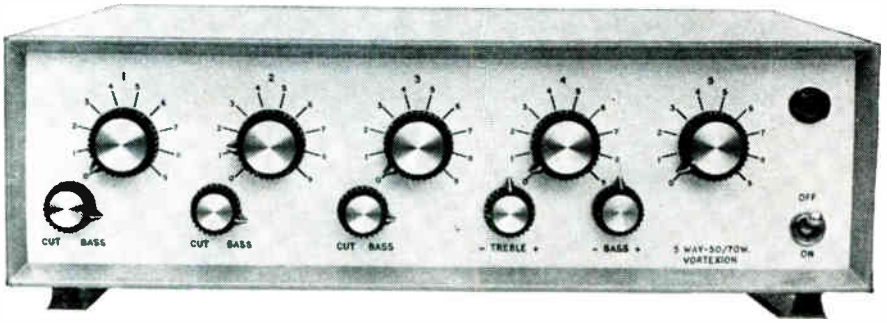
Vortexion

50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 5-WAY MIXER USING F.E.T.'s



This is a high fidelity amplifier with bass cut controls on each of the three low impedance balanced line microphone stages and a high impedance (1.5 meg.) gram stage with bass and treble controls, plus the usual line or tape input. All the input stages are protected against overload by back to back low self capacity diodes and all use F.E.T's for low noise, low intermodulation distortion and freedom from radio breakthrough.

A voltage stabilised supply is used for the pre-amplifiers making it independent of mains supply fluctuations and another stabilised supply for the driver stages is arranged to cut off when the output is overloaded or over temperature. The output is 75% efficient and 100 V balanced line or 8-16 ohms output are selected by means of a rear panel switch which has a locking plate indicating the output impedance selected.

The mixer section has an additional emitter follower output for driving a slave amplifier, phones or tape recorder, output 0.3 V out on 600 ohms upwards.

50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4-WAY MIXER (0.3% intermodulation distortion) using the circuit of our 100% reliable 100 Watt Amplifier with its elaborate protection against short and overload, etc. To this is allied our latest development of F.E.T. Mixer Amplifier, again fully protected against overload and completely free from radio breakthrough. The mixer is arranged for 2-30/60Ω balanced line microphones, 1-HiZ gram input and 1-auxiliary input followed by bass and treble controls. 100 volt balanced line output or 5-15Ω and 100 volt line.

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

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

20/30 WATT MIXER AMPLIFIER. High fidelity all silicon model with F.E.T. input stages to reduce intermodulation distortion to a fraction of normal transistor input circuits. The response is level 20 to 20,000 cps within 2 dB and over 30 times damping factor. At 20 watts output there is less than 0.2% intermodulation even over the microphone stage at full gain with the treble and bass controls set level. Standard model 1-low mic. balanced input and HiZ gram. Outputs available 8/15 ohms OR 100 volt line.

CP50 AMPLIFIER. An all silicon transistor 50 watt amplifier for mains and 12 volt battery operation, charging its own battery and automatically going to battery if mains fail. Protected inputs, and overload and short circuit protected outputs for 8 ohms-15 ohms and 100 volt line. Bass and treble control fitted. Models available with 1 gram and 2 low mic. inputs, 1 gram and 3 low mic. inputs or 4 low mic. inputs.

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

F.E.T. MIXERS and PPM's. Various types of mixers available. 3, 4, 6 and 8 channel with Peak Programme Meter 4, 6, 8 and 10 Way Mixers. Twin 3, 4 and 5 channel Stereo, also twin 4 and 5 channel Stereo with 2 PPM's.

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

RCA (Records) New York choose

Photo by Glenn B. Ward Co., Glendale 5, California

One of two 32-input comprehensive multi-track sound control consoles designed and built for RCA (Records) New York and installed in their Hollywood studios. These consoles incorporate many unique facilities and are another example of Neve ability to satisfy customers' exacting requirements.

The sound of Neve is worldwide

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Telephone: (203) 744 6230 Telex 969638

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studio sound
INCORPORATING TAPE RECORDER

MARCH 1972 VOLUME 14 NUMBER 3

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IT TAKES a survey to emphasise the worthless nature of performance specifications as a means of comparing one magnetic recorder with another. Many manufacturers glibly quote noise figures referred to one level, distortion referred to another level, and frequency response against no level at all. Some refer vaguely to 'nominal peaks' while others employ unspecified 'weighted' values.

One of the most elementary aspects of a tape transport is its speed stability. It should be within human ability to decide upon one method of measuring the maximum drift, wow and flutter produced throughout a maximum size reel of standard play tape. For a variety of reasons (notably end-of-reel wow) manufacturers produce figures under conditions that favour their particular design. They further complicate the issue by presenting these measurements in whatever format suits their mood or their locality. The choice is between rms, rms NAB weighted, peak, peak DIN weighted, and peak to peak. Enough to make Michael Faraday turn in his grave.

A case can be made for quoting both weighted and unweighted speed fluctuation figures, though the value of weighted figures alone is open to dispute. In our view, standards committees (and note that wretched plural) should commit themselves not merely to a uniform standard but to a uniform circuit for measuring speed stability. This would overcome the present situation where it is even necessary to name the fluttermeter.

Overall frequency response is commonly quoted at –20 dBm, giving little indication of system performance at normal working levels. Less impressive, but more realistic, figures are obtained around –6 dBm for the very reason (condemned by some) that tape behaviour becomes closely involved in the resultant data.

A few manufacturers trouble themselves sufficiently to quote fairly detailed performance figures against both IEC and NAB equalised versions of their recorders. It is interesting to compare these figures against, for example, the Philips *Pro 36*. Wow and flutter again. The 38, 19 and 9.5 cm/s peak values (EMT *420*, unweighted) are 0.1 per cent, 0.1 per cent and 0.1 per cent respectively. Measured to NAB standards (Micom, unweighted rms), these equate to 0.05 per cent, 0.06 per cent and 0.01 per cent respectively. The latter figure must surely be a misplaced decimal point, the alternative being to assume that 0.1 per cent peak and 0.1 per cent rms are equivalent.

With so much audio-ironmongery crossing the Atlantic, Europe and America are perhaps more closely integrated than the IEC and NAB committees appreciate. These two bodies should long ago have agreed to total uniformity. Their failure to combine lends credence to the view that the first objective of any committee is to prolong its own existence.

FEATURE ARTICLES

REGULAR COLUMNS

EQUIPMENT REVIEWS

Part Eight of 'Designing a Studio Mixer' will appear next month.

COVER PICTURE

One recorder that will not be found in this month's survey of industrial machines, a Blattner-Stille unit employed by the BBC at Maida Vale in 1935. Some 2 km of steel tape travelling at 152 cm/s . . . and run for your life if it breaks.

CORRESPONDENCE AND ARTICLES

All STUDIO SOUND *correspondence should be sent to the address printed on this page. Technical queries should be concise and must include a stamped addressed envelope. Matters relating to more than one department should occupy separate sheets of paper or delay will occur in replying.*

Articles or suggestions for features on all aspects of communications engineering and music will be received sympathetically. Manuscripts should be typed or clearly handwritten and submitted with rough drawings when appropriate. We are happy to advise potential authors on matters of style. Payment is negotiated on acceptance.

SUBSCRIPTION RATES

Annual UK subscription rate for STUDIO SOUND *is £3 (overseas £3.80, $8 or equivalent)*
Our associate publication Hi-Fi News *costs £3.12 (overseas £3.66, $8.64 or equivalent). Six monthly home subscriptions are £1.50* (STUDIO SOUND) *and £1.56* (Hi-Fi News).

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

PAST ISSUES

A small number of certain past issues may still be purchased from Link House, price 31p each including postage.

Photostat copies of any STUDIO SOUND article are available at 25p including postage.

BINDERS

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

Precis

Metric/Imperial Equivalents

Tape Speed

centimetres/second	inches/second
38	15
19	7.5
9.5	3.75
4.75	1.875

Tape length

metres	feet
270	900
360	1,200
540	1,800
720	2,400
1,080	3,600
1,440	4,800

Tape width

millimetres	inches
50	2
25	1
12.5	0.5
6.25	0.25

Distance

1 metre (m) = 39.370113 inches
1 centimetre (cm) = 0.393701 inches
1 millimetre (mm) = 0.039370 inches
1 kilometre = 0.6214 miles

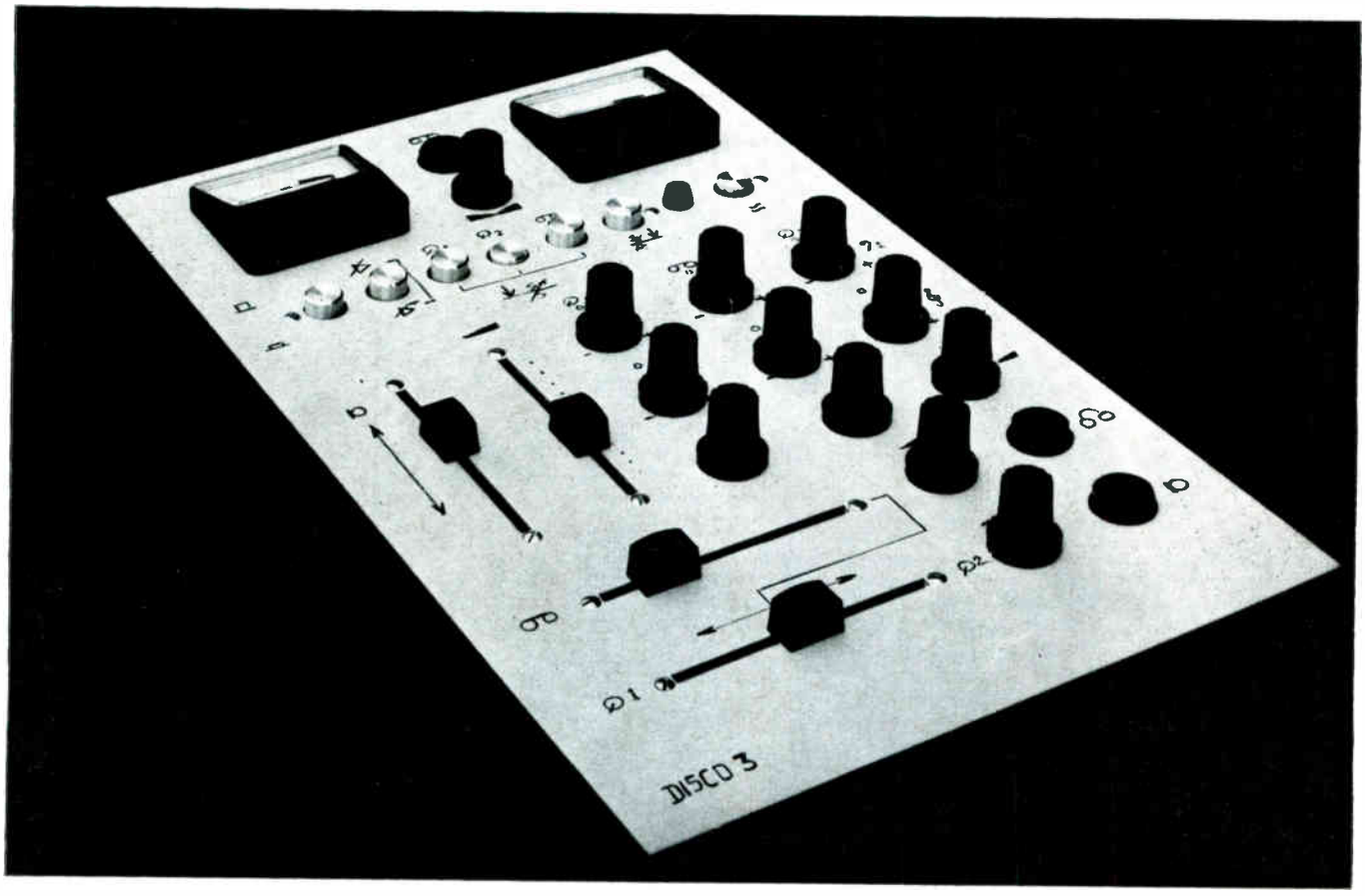
Weight

1 kilogram (kg) = 2 pounds 3.37 ounces
1 gram (g) = 15.432 grains or 0.564383 drams
1 Tonne (metric ton, 1,000 kilogrammes) = 2204.6 pounds

Temperature

n° Celsius = $(\frac{9}{5}n + 32)°$ Fahrenheit

Audio Engineering for Professionals



Four years ago, only a handful of people had heard of the Millbank Electronics Group. Today, our equipment is operating in 25 countries and is specified by most major professional users of audio and communications equipment in the United Kingdom.

Why?

We think the simple answer is that we give our customers exactly what they want. And we're just as anxious to satisfy the small firm round the corner as we are to help the big company.

When Millbank Electronics was formed, but before it started to make anything, we took the trouble to talk to professional sound and recording engineers, and DJ's and listen to their problems. They told us exactly what they wanted; we went away and made it. And that's precisely what we've been doing ever since.

Everything we make is carefully engineered to give a specific performance—and meet a definite need. Take, for example, our new Disco 3 professional sound mixer. It is based on our very successful Disco 2 model, but incorporates several major new refinements. For instance, it offers stereo reproduction, as well as mono, and has full audio/visual monitoring, pre-fade and post-fade, of all inputs and outputs, except microphone. That's something many sound engineers and DJ's have wanted for years.

These are some of Disco 3's other important new features:

*Switched audio limiters *Twin peak reading VU meters *Brand new styling—vapour blasted stainless steel fascia with matt black knobs and fittings ***Automatic*** or manual music/microphone fade to **any** selected level *Compact, **rugged** printed circuit construction *Low distortion, high signal-to-noise ratio, wide frequency range and full bass and treble tone correction *Fully floating outputs, free of earth, to avoid hum loops *Front panel microphone input mutes rear connected socket *"Jingle" tape input on front panel mutes rear connected socket *DIN standard construction and terminations *Twin AC switched outlets for turntables, amplifiers, etc. *Stabilised power supply.

Disco 3 has been designed and manufactured specifically for professional sound engineers—the people we're in business to help. For a full technical specification of this new development in sound mixers, please telephone or write to our General Sales Manager, Bernard Skinner.

ME Millbank Electronics Group,
Bellbrook Estate, Uckfield, England.
Tel: Uckfield 4166 (0825-4166)

News

Compatible stereo at the BKSTS

UNDER THE title 'Techniques for Compatible Stereo Today', the BKSTS lecture of December 8 covered the generation of stereo signals and their suitability in combination for mono listeners. It was given by Eric Dougharty of the BBC who is responsible, in the Programmes Operation Department, for the origination of stereo material and its optimum balance. Before the last war he became a professional musician, later joining the BBC as a music balancer. He commenced experiments in stereo operational techniques in 1958 (three years after vhf/fm broadcasts began on a regular basis) and has worked in this field since.

Mr Dougharty began his lecture by looking back to the earliest stereo recording work and played one of some spaced microphone experiments produced by Bell Telephone Laboratories in 1931. Although excellent as regards separation, it suffered from a severe 'hole in the middle'. In contrast, this was followed by a modern recording of orchestral music in Liverpool Anglican Cathedral, made with a pair of *C12A* in Blumlein crossed form, which was very effective. Incidentally, for this lecture two Quad Electrostatic Speakers per channel were employed, one above the other.

The lecturer then dealt with the features of various microphone arrangements, with particular attention to the monophonic result, since even today the majority of radio programmes are heard in this mode. The points covered included the effect of multiple microphones on apparent stereo stage width, the use of inverse pairs of rear-facing cardioids for reverberation pickup, and the influence of microphone polar diagram on apparent reverberation in stereo and mono. The evening was rounded off by excerpts from a diverse range of musical performances, with illustrations of how practical problems of placement and balance were overcome, mostly under studio conditions.

New name for Philips

WITH EFFECT from January 1, Philips Records Ltd became Phonogram Ltd. The change in marketing name will not affect the label names under which the product is released. The Phonogram address remains Stanhope House, Stanhope Place, W2 2HH.

Keith Prowse buy Neve desk

A 20 INPUT, eight group sound control desk was recently delivered to the Denmark Street studios of Keith Prowse Music Ltd. The console was delivered within a day of the order being received.

Continuing expansion of the music recording industry in Spain resulted in orders for over £17,000 of Neve consoles. These include a 16 channel desk for a new studio and a transportable console for the Madrid Escuela Superior De Canto.

Dolby agreement signed with Sony

THE LONG-AWAITED addition of the Sony Corporation to the Dolby B fold was accomplished during a recent visit to Japan by licensing manager Adrian Horne, chief engineer David Robinson, and Ray Dolby. The team visited more than a dozen B-Type licensees in Tokyo, Nagoya and Osaka, to discuss technical and marketing aspects of noise reduction.

Magnetic Tapes produce a mixer

A COMPACT ten channel two group mixing unit has been announced by Magnetic Tapes Ltd, Chilton Works, Garden Road, Richmond, Surrey. The Chilton *M10/2* (illustrated) features independently variable lf and hf equalisation on each input channel, stereo monitoring, pre and post fade, ppm output level meters (dB scaled), break jacks on all channels, and a 40,100 Hz, 1, 10 and 15 kHz line-up oscillator accurate within 0.5 dB. Equivalent input noise is specified as better than −121 dBm referred to a 600Ω source and 20 kHz bandwidth. Frequency response is

30 Hz to 18 kHz ±1 dB and distortion better than 0.1 per cent at 0 dBm output. The *M10/2* incorporates illuminated tape pause and cue light switches and in its basic form costs £200.

Complete with 30/60Ω floating balanced microphone inputs and power supply, the price is £262. This and the basic model also includes balanced or unbalanced line and RIAA equalised gram inputs.

Sound transmission at the AES

THE BRITISH Section of the Audio Engineering Society lecture on December 14 covered sound transmission in structures and was given by Dr C. L. S. Gilford of the University of Aston in Birmingham. He formerly worked for a long period on acoustics with the BBC Research Dept.

Dr Gilford first emphasised the variety of vibrational waves that can exist, from earthquake waves to those in the ultrasonic range, together with their modes of propagation. After discussing basic formulae of transmission, reflection and attenuation, the lecturer centred on sound transmission and losses in building structures and the special conditions existing at joints and media interfaces. Concerning the achievement of high attenuation, the relative importance of mass, stiffness and spacing of various types of panels and walls was covered, although it was emphasised that a purely theoretical treatment was still inadequate, partly because of the variability of the materials themselves, together with their assembly and the overall damping incorporated.

During the question period, such topics as whether bricks were more effective 'frog up' or 'frog down', the value of triple glazing in relation to spacing and the better isolation of traditional materials such as stone and lead as against prestressed concrete were raised, and led to considerable discussion.

Power cable reels

A RANGE OF 12 power cable reels is now being produced by Lexor Dis-Boards Ltd, 25/31 Allesley Old Road, Coventry. Features include smash-proof plugs, PVC cable impervious to oil, water and grease, and on most models live warning indicators. Prices are from £4.48 (10m light-duty units) to £50.70 (heavy-duty 100m).

Colour games

AMPEX HAVE announced a £17,000 contract to lease two *VR-1200B* video tape recorders and two *MM1000* multichannel audio machines, together with synchronising equipment, to the International Radio and Television Organisation. The equipment is being supplied for the colour broadcasting of the Winter Olympic Games to be held in February at Sapporo, Japan. The Eastern contract is notable in that the OIRT have not previously leased equipment from an American company. A similar deal has been made by Ampex with the European Broadcasting Union, the European equivalent of the OIRT.

Mixing in Moscow

AT THE invitation of the Moscow All-Union Chamber of Commerce, 11 British firms cooperated to install a complete multi-track recording studio and control room equipped with £50,000 worth of equipment. The exhibition of British electronic expertise resulted in orders worth more than £35,000, and among those participating were Neve, Dolby, Ampex, (GB), EMI, STC and Kudelski SA.

The exhibition, which was held at Melodia Studios, the head of the State record producing organisation of the USSR, was attended by visitors from all parts of the Soviet Union—it is reported that there was even a visitor from Tashkent, who would have had to travel a total distance of four thousand miles to be present.

Genuine 4-Channel Status: Sansui gives you more ways to get there.

Get there with one of the four 4-channel receivers Sansui offers in its great QR series. Or, if you already have a 2-channel system, get there with one of Sansui's QS series 4-channel rear amplifiers.

No matter which way you go, you get Sansui's own synthesizer/decoder matrix system, complete with phase shifting and exclusive phase modulation circuitry for more genuine 2- to 4-channel sound conversion. You also get complete control for 2-channel, concert hall or surround sound effects. Plus provisions for connecting discrete 4-channel stereo components.

Sansui QR series receivers include the 280 watt QR-6500, the 240 watt QR-4500, the 100 watt QR-1500 and the 60 watt QR-500. The only choice you have to make is one of power and features desired, and budget.

In the QS series of 4-channel rear amplifiers Sansui gives you a choice between the 120 watt QS-500 and the 50 watt QS-100. Add either of these components and another pair of speaker systems to your present 2-channel system and you have yourself a genuine Sansui 4-channel system.

Your nearest Sansui dealer will be happy to demonstrate just how easy it is to acquire genuine 4-channel stereo status. Stop in and see him soon.

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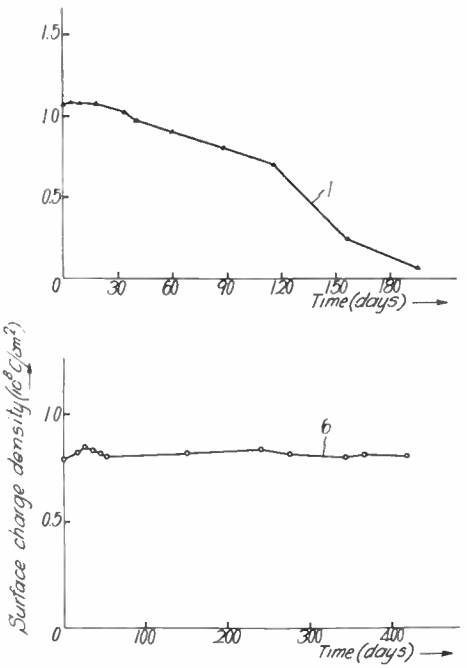
Patents Review

SONY have patented an improved electret (BP 1,258,638). An electret is a permanently polarised dielectric often used for providing the polarising voltage in capacitor microphones and other such items. The usual method of manufacturing an electret is to heat a dielectric material such as carnauba wax, polymethyl methacrylate or nylon, to a temperature beyond its melting point. A high intensity electric field is then applied to the melted material and maintained for as long as it takes for the material to regain room temperature. The field strength will be between 500 kV/m and 5 MV/m. At the end of this process, the dielectric should be permanently polarised. In practice there are two factors which militate against the retention of the charge for very long periods; these are the low volume resistivity of carnauba wax, which is as undesirable in this case as it is in the core of a transformer, and the high hygroscopicity (property of absorbing moisture) of the other two materials.

The basis of the Sony patent is the invention of a high molecular weight polypropylene film having a high volume resistivity. The method of manufacture involves keeping the polypropylene film at a temperature between 65 and 120°C and applying a voltage of 50 to 600V across the electrodes, the separation of which the patent does not indicate. Film thickness is later stated as 2 to 50 μm.



The polypropylene film (trade name *Torayfan*) is prepared; initially it is 15 μm thick. An aluminium layer is then deposited on the top surface of the film and the resultant assembly is polarised after it has been sandwiched between two metal plates. The whole is then immersed in a thermostatically controlled temperature bath maintained at 90°C. A dc voltage is then applied for two hours, after which the film is cooled to room temperature within 30 minutes, still under the influence of the electric field.

The difference in charge retention between the old and new types of electret is indicated in the two diagrams on the left, upper and lower respectively.

Multicore have developed a new approach to cassette tape editing (BP 1,258,280) which is surprisingly simple and needs no tools beyond a 3 mm editing block and pin.

After the point at which the edit is to be made has been located, and the cassette removed from the machine, a piece of cardboard is inserted between the tape and the pressure pad at the centre of the cassette's aperture. A pinhole is then made at the centre of that area where the pressure pad normally presses against the tape. The unwanted section of tape is run through until the next point is arrived at; the point which is to be spliced to the preceding point of edition. Another hole is made in the same way, pressing a pin into the coated side of the tape. The tape is then cut about 20 mm on the waste side of the edit point and the two holes lined up over the diagonal cut on the editing block.

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

December 8, 1971

1260175
RCA Corporation
Electron beam deflection circuit

1260387
Pioneer Electronic Corporation
Transducers

1260413
Western Electric Co Inc
Sealed electrolytic cells

1260417
Agfa-Gevaert AG
Moving-coil assemblies for use in electric meter movements

1260426
Marconi Co Ltd
Memory cells

1260444
Canadian General Electric Co Ltd
Rectifier frequency converter

1260454
Compagnie Generale D'Electricite
Means for forming sound holograms

1260468
National Research Development Corporation
Formation of connections on microelectronic circuits

1260471
Marconi Instruments Ltd
Power amplifiers

1260490
Davy Plastics Machinery Ltd
Capstans and pulleys

1260499
Pirelli General Cable Works Ltd
Outdoor electric cables termination units

1260501/2
Stewart-Warner Corporation
Travelling message display

1260506
Matsushita Electrical Industrial Co Ltd
Acoustic delay line glass

1260522
Fuji Shashin Film KK
Magnetic recording media

1260524
Honeywell Inc
Positioning assemblies for magnetic heads

1260525
Zenith Radio Corporation
Acoustic electric filter system

1260568
Central Dynamics Ltd
Mix/effects system for television video signals

1260570
New Zealand Inventions Development Authority
Recorders for recording numerous inputs of data

1260576
Textron Inc
Signal transmission system

1260646
Philips Electronic & Associated Industries Ltd
Magnetic powder

1260660
Agfa-Gevaert AG
Method and apparatus for the production of a directly viewable stereoscopic image

1260712
Branson Instruments Inc
Ultrasonic pulse-echo apparatus

1260728
Mitsubishi Denki KK
System for controlling DC power

1260735
Ferrieu, G and Person
J-M Vocoder speech transmission system

1260736
Retention Communication Systems Inc
Combined endless loop film and endless loop magnetic tape cartridge

1260747
Compagnie Electro-Mecanique
Magnetic circuit for dc and synchronous rotary electrical machines

1260751
Bosch GmbH, Robert
Recording apparatus

1260752
Philips Electronic & Associated Industries Ltd
Device for shifting a belt in a recording and/or playback apparatus

1260756
International Business Machines Corporation
Adaptive pattern recognition system

1260779
Fernseh GmbH
Arrangement and method for delaying an electrical signal

(*continued over*)

J. J. Francis

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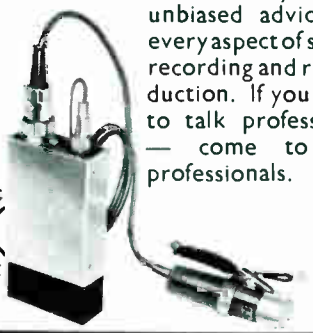

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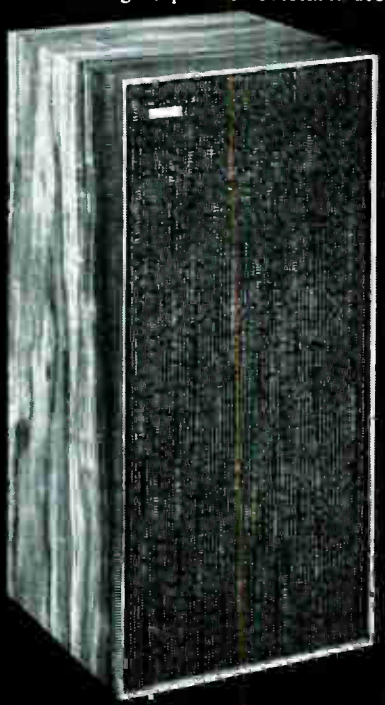

Brief Specification: Overall Frequency Response: 40Hz-25kHz. ±3dB 50Hz-14kHz. Power Handling Capacity: 25 watts, speech and music. Impedance: Standard 15 ohms, to order 8 and 25 ohms. Drive Units: Three. Overall Dimensions: Enclosure 12" × 12" × 25". Height including stand 37". Finish: Teak.

Recommended U.K. Retail Price (including stand) £83·50 + £16·28 P.T.

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

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

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SS/3

PATENTS REVIEW

continued

1260783
Philips Electronic & Associated Industries Ltd
Television camera tubes
1260873
Fuji Photo Film Co Ltd
Magnetic recording media
1260885
Fernseh GmbH
Colour television camera arrangements
1260891
Picciotto, E V
Separator of synthetic fibre for lead-acid secondary batteries
1261070
Akustishce U Kinogerate GmbH
Amplifier circuits
1261098
Krupp GmbH, Fried
Apparatus for determining the direction of incident sound
1261128
Philips Electronic & Associated Industries Ltd
Oscillator frequency-control arrangement
1261145
Deutsche Grammophon GmbH
Gramophone record manufacture

December 15, 1971
1261201
Shandon Southern Instruments Ltd
Recording apparatus
1261229
Eastman Kodak Co
Take-up reel for strip material
1261233
Philips Electronic & Associated Industries Ltd
Holographic image systems
1261234
Philips Electronic & Associated Industries Ltd
Electronically operated indexing mechanism
1261240
Hazeltine Corporation
Current controlled oscillator circuit
1261265
RCA Corporation
Frequency modulation of a solid state oscillator
1261305
Ampex Corporation
Mount for concave tape guide
1261317
Compagnie Generale D'Electricite
Fuel cells and fuel cell batteries operating at high temperature
1261325
Square D Co
Field weakening circuit for a series field motor
1261326
North American Rockwell Corporation
Ratioless and noninverting logic circuit using field effect boosting devices
1261340
Matsushita Electronic Corporation
Pressure-sensitive solid-state device
1261385
Matsushita Electric Industrial Co Ltd
Speech analyzing apparatus
1261391
Sony Corporation
Displacement measuring instrument
1261409
Telefunken Patent-Verwertungs GmbH
Transistorised amplifiers
1261425
Franz, F
Damage-resistant mechanical metronome
1261430
Tesla Narodni Podnik
Modulator circuit arrangement
1261447
Philips Electronic & Associated Industries Ltd
Multiplex transmission system
1261468
Pioneer Electronic Corporation
Method for remotely controlling an automatic telephone answering device for use by said method
1261498
Ampex Corporation
Delay circuits
1261534
Aviation Supply, Minister Of
Sweep frequency oscillators
1261552
Philco-Ford Corporation
Formant vocoder utilizing resonator damping
1261578
Licentia Patent-Ver-Waltungs GmbH
Method of producing a circuit board having conductor patterns and metallised holes through the board
1261598
International Standard Electric Corporation
Synchronisation circuit in a PCM central exchange
1261618
Marconi Co Ltd
Triggerable pulse generators
1261634
Philips Electronic & Associated Industries Ltd
Magazine for recording tape and film
1261671
International Nickel Co of Canada Ltd
Detection of electromagnetic field anomolies
1261735
Ikb-Produckter AB
Feed-back amplifier arrangements
1261738
Kombinat Robotron VEB
Electro-optical arrangement for light modulation
1261783
Staalmeubel NV
Device for storing reels of tape
1261915
Diamond Stylus Co Ltd
Replay recorders and the like
1261917
Ford, H D (trading as HF Eng)
Systems for synchronising a film transport and a magnetic tape replay machine or other signal reference source

December 22, 1971
1261951
Philips Electronic & Associated Industries Ltd
Pulse code modulation transmission device
1261982
Starkstrom—Anlagenbau Karl—Marx Stadt, Veb
Circuit arrangement for a pulse counter
1261988
Kistler Instrumente AG
Transducer units
1262001
International Business Machines Corporation
Differential amplifier circuit
1262025
Fuji Photo Film Co Ltd
Method of duplicating recorded magnetic tapes
1262029
Akai Electric Co Ltd
Tape reeling mechanism for a video tape recorder
1262036
Fernseh GmbH
Recording apparatus
1262038
Philips Electronic & Associated Industries Ltd
Apparatus for magnetic recording
1262080
International Computers Ltd
Character recognition apparatus
1262094
Bailey, B
Apparatus for facilitating viewing a series of illustrations
1262143
Philips Electronic & Associated Industries Ltd
Logic circuits
1262153
Matsushita Electric Industrial Co Ltd
Television-facsimile apparatus
1262190
Western Electric Co
Acousto-optic devices
1262215
Wulf, T E
Harmonograph
126284
Agfa-Gevaert
Reproduction of multicolour scenes and prints in multicolour television
1262360
Western Electric Co Inc
Band-pass filters
1262362
Rank Organisation Ltd
Audio Frequency power amplifiers
1262370
Marconi Co Ltd
Radio frequency transmitters
1262416
Standard Telephones & Cables Ltd
Range-gated vision system
1262485
Plessey Co Ltd
Logic circuit arrangements
1262493
Pye Unicam Ltd
Thin layer chromatography
1262505/6
Bobb L J and Pond C C
Speaker system and electrostatic speaker
1262507
Electronic Research Corporation
Method and system of sequential colour television pickup and transmission
1262534
Branson Instruments Inc
Conic or ultrasonic horns for use in piezoelectric and other transducers
1262550
International Standard Electric Corporation
Frequency discriminator
1262551
Nilsson, R R E
Reproducing device and a record unit therefor
1262558
International Business Machines Corporation
Tape reel motor control apparatus
1262562
Hopt Electronic GmbH
Tuning device for high-frequency communication apparatus
1262594
Philips Electronic & Associated Industries Ltd
Method of reducing the coercive force of permanent-magnetic material
1262596
Ampex Corporation
Automatically loadable tape transport
1262612
Chu Associates Inc
Elastic wave delay line
1262664
Alich, G
Method and apparatus for measuring a length with the aid of a magnetic field
1262671
Iwasaki Tsushinki KK
Sweep oscillator
1262694
Krupp GmbH, Fried
Apparatus for the directional transmission and/or reception of sound waves in water
1262717
Olympus Kogaku Rogyo KK
Tape cassette for use in tape recorders
1262721
Defence, Secretary of State for
Apparatus and method for synchronising time-division multiple-access transmissions

December 30, 1971
1262770
International Business Machines Corporation
Stabilized reference voltage source
1262833
Philips Electronic & Associated Industries Ltd
Camera tube including a photoconductive target
1262841
Standard Telephones & Cables Ltd
Character generation system
1262908
Thomas Electronics Inc and Loral Corporation
Storage tube in combination with television camera means and a cathode ray tube
1262919
Tektronix Inc
Image storage cathode ray tube and visual monitor tube system
1263046
Westinghouse Electric Corporation
Electromagnetic radiation activated semiconductor device
1263130
International Business Machines Corporation
Magnetic recording and reproducing head
1263378
Honeywell Inc
Voltage Limiting circuits
1263523
RCA Corporation
Audio information synthesizer
1263524
Elecktronische Rechen-Maschinen—Wissenschaft-Licher Industriebetrieb—Karl Marx—Stadt VEB
Method and devices for indicating groups of characters on the screen of a cathoderay tube
1263598
Lo Sound Developments Ltd
Sound deadening materials

Around the Studios

BY KEITH WICKS

Jackson Recording Company

THE Jackson Recording Company is located in that green and pleasant land known as Rickmansworth, Hertfordshire. On arrival you see an impressive modern building, but Jackson's place is the compact structure alongside, dwarfed by its companion and looking rather like an old stable. Before anyone thinks I am being unkind I should point out that it *is*, in fact, an old stable. According to studio engineer Malcolm Jackson, the building used to be a coach house and stables on an estate belonging to the monks of St Albans, and it is mentioned in the Domesday Book. What that book says about the building I don't know, but a slightly more up-to-date publication, known as *Kemp's Music & Recording Industry Year Book*, lists it as a four track studio measuring about 9 x 6m.

The studio is run by Malcolm and his brother John, both of whom studied accountancy for five years. After that John armed himself with a trombone and joined the Coldstream Guards, while Malcolm went into television and ran the recording side of a programme for their father, Jack Jackson. 'That's where I picked up most of what I know about recording—from people like Peter Lodge, now with Sound Associates, Mark White, who did Jazz Club presentations for the BBC back in the '50s, and John Fielder, the fastest thing with a razor blade except for my mother in law.' Malcolm continued, 'I suppose I was just lucky to have had a chance to record with all the greats—people like Vera Lung, Alf Wiedersehen, and Marlena Horne'. (Rickmansworth had a bumper corn harvest this year.)

Working with Malcolm proved too much of a strain for Jack, who retreated to Tenerife, where he continued making his programmes in relative peace. As a reminder that he would not return to this country until Malcolm had left, he would utter at the end of each show what many thought was a mere catch phrase, 'I'll be here if you'll be there'.

Jack's absence meant that the studio was vacant, and at this stage John and Malcolm both decided that making records was what they wanted to do. John is now aged 35, two years older than his brother, and looks after the financial aspects of running the studio. 'Like deciding whether or not to pay Malcolm's Easter bonus', hinted Jackson the younger.

I expect he will receive it, as he works very hard at a number of jobs. Besides working in the studio he also supplies personnel and second hand equipment to other studios. In the little leisure time he has available Malcolm organises Studiopoly contests. I understand that most studios now have their own boards for playing this lively adult studio game in which anything can and does happen. For example, 'Mobile at Kennel Club. Dogged by howl-round', or 'Wipe Julie Ege tape on purpose. Rebook session'.

You may well wonder how it is that this studio, some way out of town, has been so successful during the seven years it has been in operation. MJ had the answer. 'It's adaptability. We have to give a personal service which will attract clients over the years. Secondly, we have creative ability. There is a big demand for recorded music around the world, and people go to the studios where the staff have the know-how and the contacts. Big successful London studios, like Lansdowne, have superb recording facilities, and people go there because they are so convenient and reliable. I'm not saying that we are unreliable but we are out of town. In the case of a studio like ours the studio work, publishing, production and management are so closely allied that it's almost impossible to separate them. What we have to do is to provide the right atmosphere for the work and we create that with a business-like approach which provides a framework in which creators and artists can relax. And *relax* is the important word in studio work. Our approach allows people to become more involved in their recordings. For example, we encourage people to do their own reductions and never object to clients getting on to the board as long as we can keep them on the rails. In this way, they help to decide their own destiny. We have found that many of our clients have a definite flair for balancing, although that is not really their job. They're not so good at keeping overall levels accurate, but I do that.

Malcolm, son of Jack, Jackson

'To get the right studio atmosphere there are several things to be considered. If the session is going to run smoothly, the staff must be ready for action at all times, and they must be happy, and encourage the artists. The engineers must learn to communicate with the people in the studio, especially when the clients are in for the first time and don't know what to expect. If the clients are told exactly what is going to happen and asked what they are going to do they will be much happier, and the results will usually be good.'

In an effort to ensure that everything goes according to plan, a list of points to remember is on the wall. Included are the following:

Less than 1% of studio clients make the right noises. If they did, they would be making hit records every day.

Why not rehearse before *you start the session?*

What sounds bad in the studio often sounds good in the box.

If you are not producing a record, please keep your wild suggestions to yourself.

100% of engineers are docile until roused. Want to try your luck?

During the first two years in operation, the control room equipment consisted essentially of a pair of EMI *TR90* mono recorders and five Vortexion mixers mounted in a desk. Like other studios that had used similar equipment, the Jackson Recording Company made many successful recordings, including a hit by the Second City Sounds. The original desk was eventually replaced by a 16 channel, four track design by Martin Brown. This has facilities for providing variable speed effects and phasing and has special modules for cassette duplication and tape-slide pulsing. Another feature is a separate reduction section paralleled in with the main mixer, and giving a mono or stereo output. When recording a budget album a four track master and a stereo reduction are made simultaneously and, very often, the reduction is good enough to be issued. In this way the cost of a separate reduction session is avoided, although the four track tape is always available should the original reduction not be perfect.

John Bales of Studio Republic, Pinner, services the mixer and is currently updating it. He has recently added attenuators which allow the signal to be controlled before it gets to the modules, thus allowing distortion to be minimised.

(continued on page 21)

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A Versatile Recording Amplifier

Part Three **By L. Hayward**

THIS amplifier was developed to meet a requirement for a high quality playback system, particularly for use with the modern high output tapes. Such a system needs a good dynamic range and low background noise. These parameters are well met by the amplifier to be described.

The circuit is a derivation of the well-known 'feedback pair' (fig. 1) and this particular arrangement featured in a *Wireless World* article*. The use of the third transistor Tr3 (in fig. 2) allows the feedback circuit to remain isolated from the output, and the emitter-follower Tr4 reduces the output impedance sufficiently to provide a maximum output level of 0 dBm (1 mW into 600Ω). Silicon low-noise transistors are used. These are currently available types and have the added advantage of being cheap. As will be seen from the test figures, noise and dynamic range are quite satisfactory and there is a voltage overload margin of some 8 dB above the peak level produced by fully modulated EMI *815*. Due to the large degree of feedback, the distortion remains very low up to the clipping point, typically below .02 per cent at 1V rms output.

The capacitors C3 and C8 are added to improve hf stability and also to remove the possibility of rf signals being picked up and amplified by the circuit. The input coupling capacitor C2 is made much larger than is necessary for audio frequencies. This is to damp the input circuit of the amplifier when the head is connected, removing sub-audio noise.

The equalisation controls provide for adjustment at the ends and at the C/R turnover points in the characteristic curve. The values shown are for the CCIR 35 μS curve (38 cm/s). When correctly adjusted, it will be found that the combination of R18, VR19 and C11 does not exactly equal 35 μS. This is because the impedances associated with Tr1 and Tr3 are effective in the total time constant. The L/C adjustment L1. C10, was calculated to obtain an extended response from the head used for testing, a Bogen type *UK200*. It is resonant at a frequency of 20 kHz. For professional use this would normally be tuned to a lower frequency, and the amplitude control VR17 used to allow for gradual head wear. Since the range of adjustment for operation at lower frequencies, C11 is shunted by R20/VR21. This adjustment is effective in the region 35 to 50 Hz. If this were omitted a resistor across C11 would still be required to limit the gain at sub-audio frequency and preserve a good noise figure.

The adjustment of the equalisation controls is carried out as follows: Set the controls to a central position. Replay a test tape at 1 kHz. Adjust the output amplitude control to the level required, note this, and adjust VR19 for the same level at 10 kHz. Then VR21 at 40 Hz. L1/VR17 is set at the top end—the amount and frequency required will depend on the particular type of head used. A check should now be made of the complete range, adjusting slightly as required to obtain an optimally flat response.

The prototype was tested, and the results were as follows:

A range of frequencies was recorded on EMI *815* tape, using a Bogen *UK200* head. No recording pre-emphasis was used, and the head was fed from a constant-current source. The bias frequency was 100 kHz, set for 1 dB overdrop at 1 kHz. The tape was replayed from the same head to the amplifier on test. After setting up, the range from 35 Hz to 20 kHz was found to be within −1 and −2 dB, relative to 1 kHz. It should be emphasised that, since a compromise was made by using the same head for recording and replay, much greater accuracy can be expected when using a proper replay head and an accurate test tape.

The noise was measured with a mean sensing rms reading valve voltmeter having a response from 10 Hz to 10 MHz, and was found to be 72 dB below peak signal level with the input short circuited. With the head connected, this rose to −68 dB, mainly due to induced noise and hum in the long test lead and head.

Construction is not critical, provided that the amplifier is enclosed in a fully screened box, and is fed with a very well smoothed 20 to 27V supply. The most expensive component is L1, costing around £1. Many other types of pot core are suitable and, if heads other than the *UK200* are used, L1, C10 and R22 will require

(continued on page 21)

FIG. 1 BASIC FEEDBACK PAIR

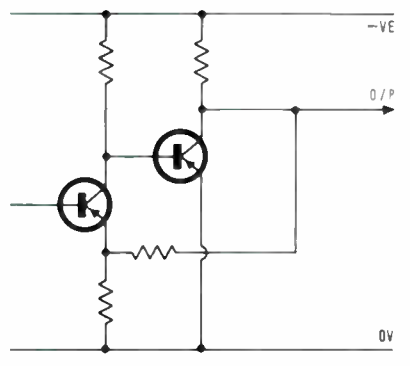


FIG. 2 PLAYBACK AMPLIFIER

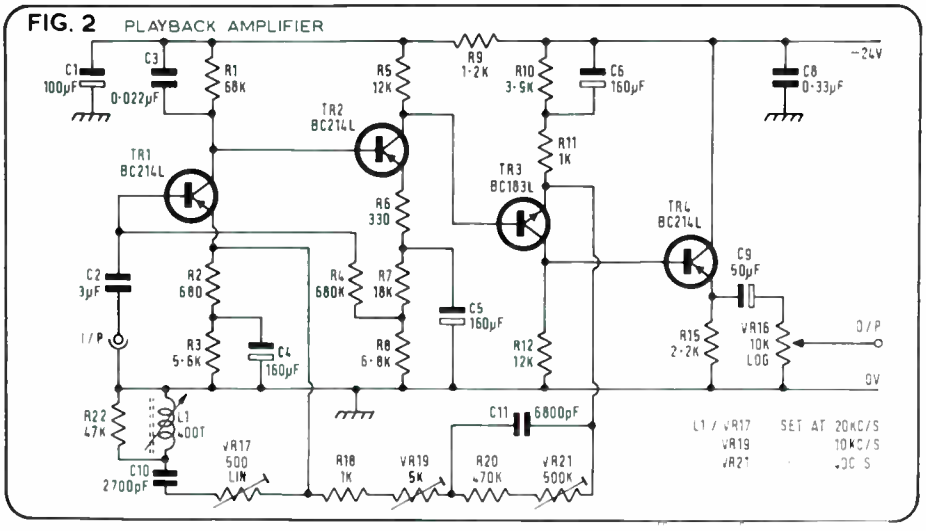
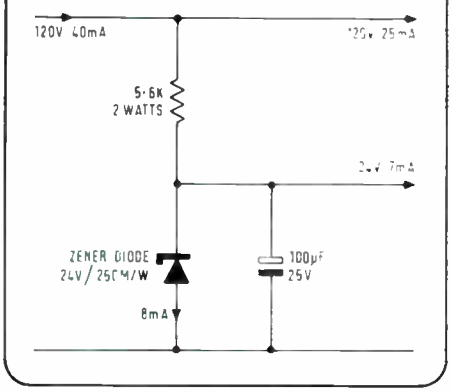
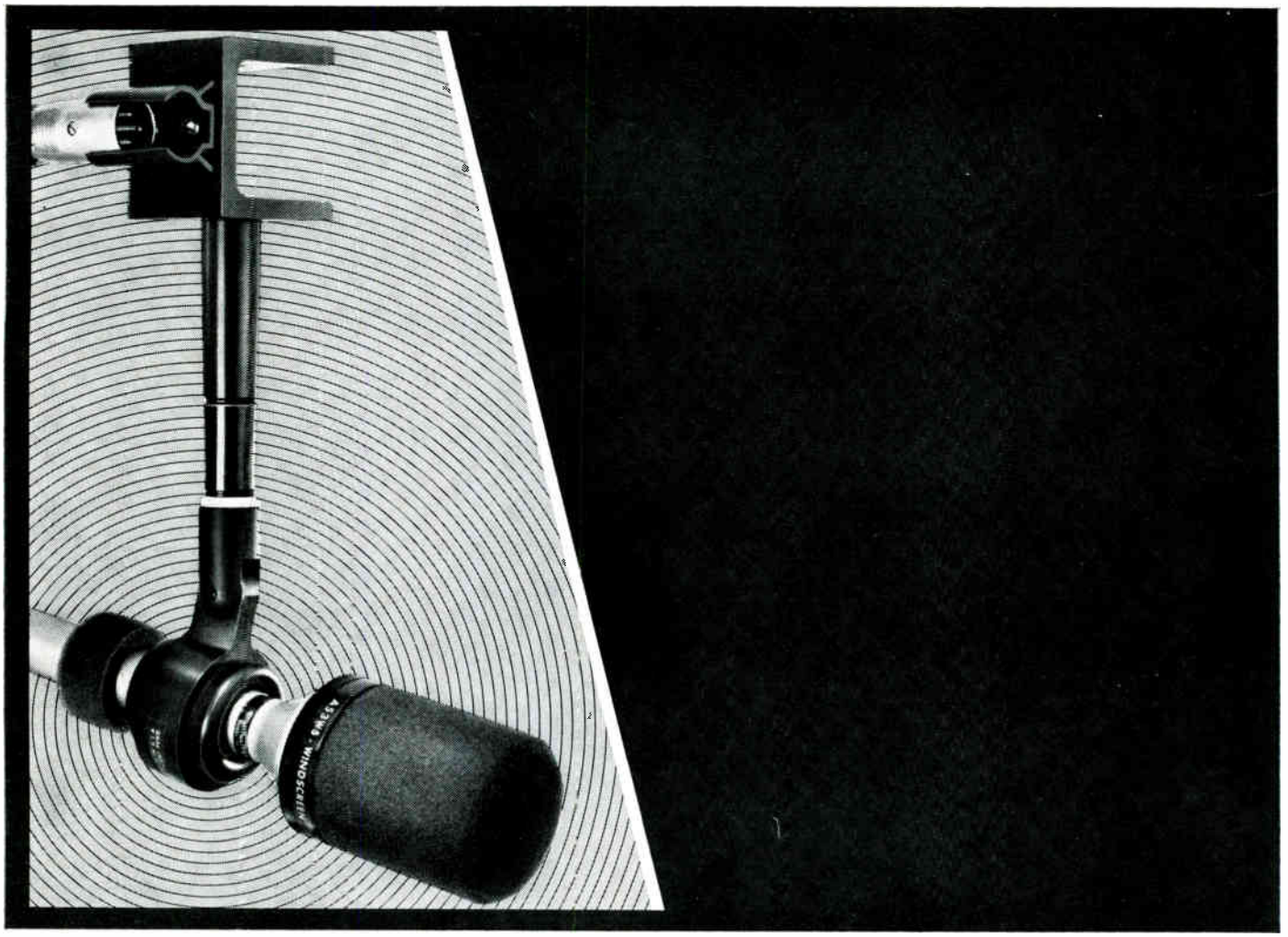


FIG. 3





The ubiquitous SM53.

The *Shure SM53* professional unidirectional microphone is seen with increasing frequency in the best of company because it affords eight distinct performance advantages: (1) a wider front working angle with uniform tonal quality; (2) effective noise rejection through a true cardioid pickup characteristic; (3) a built-in shock mount for effective mechanical noise isolation; (4) extraordinary ruggedness for performance consistency after severe shocks; (5) a superior hum rejection system; (6) an integral breath "pop" filter; (7) a minimized proximity effect for constant tonal quality; and (8) full field serviceability. Interested?

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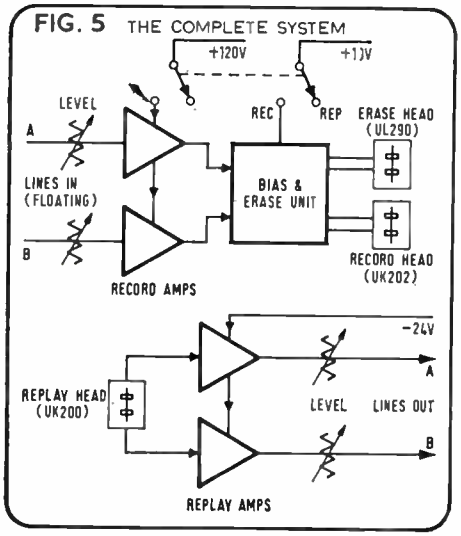
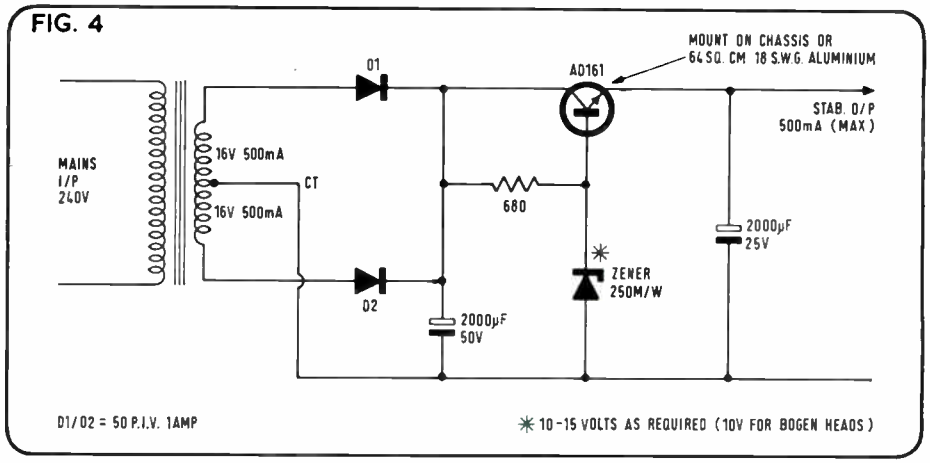
continued





adjustment in any case. **Table 1** shows the component requirements.

It should be stressed that C2 should not be electrolytic unless the expensive tantalum type is used.

The amplifier is suitable for any equalisation standard or tape speed, if the necessary time-constants in the equalisation circuits are altered.

Power Supply

Regarding the design of a suitable power supply for the complete record/replay system, the requirements are:

Record amplifier 100 to 150V at 25 mA
Replay amplifier 20 to 27V at 7 mA
Bias Oscillator 10 to 15V (depending on power required) at 400 mA maximum.

The record amplifier supply need not be stabilised and the 120V nominal supply is most easily obtained from the usual R/C smoothing arrangement. The replay amplifier supply can be obtained from the 120V supply, via a resistor and zener diode, as in **fig. 3.** Note that the total current from the 120V rail is now 40 mA. It must also be remembered that the replay amplifier has a negative rail and some care must be taken with respect to the earthing arrangement used.

Having decided upon the power required from the bias oscillator, this must be stabilised against variations in mains voltage; a suitable and simple circuit for this is shown in **fig. 4.**

A connection diagram for the complete system is shown in **fig. 5.**

*D. Leblebici, High gain audio voltage amplifier, April 1971.

Table 1

All capacitors 25V wkg. 20% unless stated.
C1 160 μF electrolytic
C2 3 μF paper or polyester
C3 0.022 μF
C4 160 μF electrolytic
C5 160 μF electrolytic
C6 160 μF electrolytic
C7 0.33 μF polyester
C8 0.33 μF polyester
C9 50 μF electrolytic
C10 0.0027 silver/mica 2%
C11 0.0068 μF polyester

All resistors ½ Watt, 5% low noise, unless stated.

R1 68kΩ	R11 1 kΩ
R2 680Ω	R12 12 kΩ
R3 5.6kΩ	R13 100 kΩ
R4 680kΩ	R14 120 kΩ
R5 12kΩ	R15 2.2 kΩ 500 mW
R6 330Ω	VR16 10 kΩ log pot
R7 18kΩ	VR17 500Ω lin pot
R8 6.8kΩ	VR19 5 kΩ lin pot
R9 1.2kΩ	VR21 500 kΩ lin pot
R10 3.9kΩ	R18 1 kΩ
	R20 470 kΩ
	R22 47 kΩ

L1 consists of 400 turns of 38 SWG Enam copper wire, wound on Mullard ferrite pot core, type *LA2208.* When ordering this component ask for bobbin and mounting assembly.

Tr1, 2, and 4, are Texas *BC214L.*
Tr3 is Texas *BC183L.*

AROUND THE STUDIOS

continued

'We've got one of the quietest collections of equipment in the country', claimed Malcolm Jackson. 'John Bales has worked hard on the mixer, to give us a very clean sound, and Ted Fletcher of Alice has combatted noise from guitar amplifiers and other sources with his noise reduction unit. We also use Ted's compressors and limiters which are very very good.

'Our recording equipment consists of an Ampex *AG440*, which makes a nice pot of tea, Ampex *351* and *375* stereo machines, a Revox stereo *G36*, an EMI *BTR/2* mono monster, and an EMI *L4* for mobile work. All our mobiles are done by John Bales or by John Taylor (of Hollick and Taylor).

'For monitoring we use a Quad *303* stereo amplifier and a pair of Lockwood Major units containing Tannoy Monitor *Golds.*'

Malcolm is the only person I know who is equally happy and at home with vu meters and ppms. Most people love one and hate the other, but he has vus on the desk and a ppm on the *BTR/2* which he uses for mastering mono recordings.

When Malcolm is not operating the desk it may be Guy Fletcher (for Egg Productions), Michael Lehr (for Reflection), Ken Freeman (for Freeway Productions), or John Dunsterville (for Mitey Mo). Among the musical arrangers and producers who operate at the studio are John and Malcolm Jackson, Bruce Baxter, Ken Freeman, John Dunsterville and Guy Fletcher. For technical advice on electronic music and organs, experts like David K. Burrows, John Gummer and Ken Synthesiser Freeman are available.

Clients of the Jackson studio can be provided with a suitable producer or arranger who will represent them as a personal and recording manager. The company's involvement with Ad-Rhythm Records has given them valuable experience in every aspect of record production, so clients can (and do) ring the studio for advice and are almost sure to get the right answer. Clients can also take advantage of the company's negotiating experience.

The work at the studio includes a variety of pop material, a lot of organ music for Ad-Rhythm and tape - slide presentations for conferences. Most clients are regulars, a fact which Malcolm attributes to the fact that he gets a good vocal sound using a Neumann *M49.* He also gets a good rhythm sound.

'I think that Tony Pike of Putney and myself run the only two studios outside central London which get a tight rhythm sound. It's because we have been at it a long time, and we work our musicians very close together—so close there is hardly room to breathe. Although there *could* be room, we make them play very close together to get a good overall rhythm, and a very good feel. The separation is superb, but we've been working on that a long time as well. We use screens a lot as well as lots of blankets, cushions, and jackets. They are better because they are more adaptable, and they fit round a guitar amplifier so well. I've got a special blanket that I keep for the bass drum, and I would never change it.'

If you want to make a record, and enjoy yourself at the same time, give Malcolm a ring on Rickmansworth 72351. Four track recording costs £10.50 per hour, and the same charge is made for all other studio work.

Film Production on Videotape

By Adrian Hope

EARLY in 1971 American musician and composer Frank Zappa, plus an entourage of pop musicians, groupies and just about everyone else you can think of in the pop world, descended on Pinewood studios to make the two hour pop colour film 'Two Hundred Motels'. The film, about the experiences of pop musicians and camp followers on tour, was shot in only ten working days, and as reported in the September 1971 STUDIO SOUND, the Rolling Stones' mobile studio was used for recording the soundtrack and associated lp albums. The greatest significance of those ten days at Pinewood, however, was the fact that the filming involved no film at all. Instead it was shot entirely on video tape by Lion Television Services of Shepperton.

The use of video tape in the film industry is nothing new and for a while now directors have been shooting scenes both on film and on video tape. But this system is designed to provide 'instant rushes' so that after a scene has been shot the tape can be played back to give the director an immediate idea of whether or not anything usable is likely to be on the film, and thus whether or not the scene should be re-shot. Incidentally, American director Blake Edwards (who made the Peter Sellers 'Pink Panther' film among many others) is not only married to Julie Andrews but also has a big stake in the video instant rush business.

But what Lion Television Services were doing at Shepperton was to use video cameras only (four in all) and to produce the film in video form for subsequent transfer on to film for showing either in cinemas or over broadcast television.

In theory the tape-to-film technique divides itself neatly into two halves. Lion Television produce a finished video tape, all edited and in final form, and hand it over to the Vidtronics Division of Technicolor Limited. But in practice there is no such neat division. Vidtronics and Lion work pretty much hand in hand all along the line and such co-operation is essential for an acceptable end product.

For a long time the Editor and I have been curious as to the quality of which the tape-to-film technique is capable, and I think it is safe to say that both of us had pretty definite reservations about how a 625-line TV picture would look on the screen of the Odeon, Leicester Square. Various tales had filtered down the grapevines about the quality involved. Among them was the fact that 'Two Hundred Motels' (and another film made earlier about the pop group Juicy Lucy) were so heavily 'freaky', i.e. full of television type colour explosions and exotic effects, that at no time was there any real chance of getting an idea of what the actual video quality was like. One considered opinion was that a taped-to-film product would be acceptable on the large screen provided that it was not inter-cut with standard 35 mm original film (i.e. pictures shot on 35 mm rather than on video tape), the theory being that the human eye (just as the human ear) adapts pretty readily to whatever quality is presented to it—provided that there is no yardstick for comparison. This is borne out by the fact that many 35 mm cinema prints started off life as 16 mm negative but their relatively poorer quality is only noticeable when the film-maker has inter-cut with scenes that began as 35 mm negative.

Another story that went round was that equipment is already available which will produce two- or three-thousand line standard pictures. Remember that there is no transmission involved and so some bandwidth problems are reduced. But, so these stories went on, problems arose in practice and 'Two Hundred Motels' was eventually shot on 625 lines. One lab technician who asked to remain anonymous described the final quality as 'diabolical', but this opinion is hotly contested by plenty of other people who should know. At the time of writing, no one with an unbiased opinion has seen the film, but by the time this appears in print the situation should have changed. So the question of final quality is simply a matter of pudding proof.

One point that is worth remembering, though. There are occasions when the audio or visual content of something canned transcends the medium. For instance the films of the McCarthy-Army hearings which were taken from the original USA telecasts are poor in quality but so fascinating in content as to make the question of quality completely irrelevant. Likewise the recordings available today of the original Orson Welles 'War of the Worlds' broadcast that sent America into a panic in the mid-30's are poor in quality, but who cares? Likewise plenty of documentary films are of poor technical quality if judged by studio standards. But in the case of a film—like 'Two Hundred Motels'—which is made in the studio with the express intention of entertaining, good quality becomes essential, and although the industry may regard the new tape-to-film system as solving a lot of financial problems, in the long run nothing will be achieved if the final result looks terrible on the screen.

Conversely, if the tape-to-film system is a workable system and can eventually produce quality sufficiently good to justify its use for the production of straightforward entertainment films, its effects on film budgets will be nothing short of revolutionary.

In an effort to get some sense out of the situation I talked to Chris Pooley, one of the technical staff of Vidtronics.

AH We have been very interested in the Zappa film from two viewpoints—sound and vision. In a previous issue we covered the use of The Rolling Stones' mobile for recording the sound, but we're also interested in the video quality. We would really like to know what the Vidtronics process is all about—so far as you can tell me without giving away any secrets.

CP *Well, there are two ways of going about it all. We can either get a finished tape product for straight transfer or—as here—we are presented with a rough cut video tape. In this case, incidentally, we had to cut something like four or five hours of video tape down to a hundred minutes of running time. The technique itself is based on the fact that the television system incorporates in its signals three separate sets of information—red, green and blue. These are normally displayed simultaneously on a colour screen. But what we do is decode the colour television signal into separate signals and record on three separate runs; first the signal corresponding to the red information, then the one corresponding to the green, then the one corresponding to the blue. This means that we end up with three separate negatives which correspond to the different colour informations, and in fact the negs we end up with are silver negs, exactly as in the old Technicolor process. From then of course it's the same as catching white elephants. White elephants have a great yearning for cornflakes so you put the cornflakes at the top of the tallest tree you can find, and they stretch and stretch and stretch to reach them until they go grey and then the procedure is exactly the same as for catching grey elephants.*

AH In other words it's the ordinary dye transfer method which is being done now, is it?

CP *Although you say 'ordinary', it's the old method as opposed to the current one which is used. In fact we've resurrected a lot of the original techniques used with the three strip Technicolor studio cameras that they used to use. In the current method for ordinary film work it is Eastmancolor film that goes through the camera and we take an Eastmancolor negative and print through filters on to three matrices—a yellow, a magenta and a cyan. The only difference when we are presented with an electronic neg (i.e. video tape) is that we just print without the filters. The image on our yellow separation neg is the yellow image, and so on—you don't need filters—we just print straight on to the matrix stock, which doesn't even need to be colour sensitive.*

AH When you're doing this transfer from tape on to the three separate lengths of film in monochrome, each containing its own colour information, is that a purely electronic process

(*continued on page 25*

or is there any display—on a cathode ray tube for instance?

CP *It's a film recording process using a crt display.*

AH Someone was suggesting that there might be some direct electronic wizardry whereby you cut out the need to display on a cathode ray tube.

CP *It's only the results that are magical—not the process.*

AH Am I right in thinking that Rank uses a similar thing for going on to EVR?

CP *No—Rank use an electron beam recorder which, if you like, incorporates the film as part of the cathode ray tube. In fact the film is directly bombarded by electrons and therefore the picture is recorded by electrons on film.*

AH That's what put me on that red herring—thinking that you might be cutting out that display step to improve quality. Bombarding film stock with an electron beam, for instance, to record directly on to film.

CP *We could use an electron beam recorder, but we don't.*

AH Well now, on 'Motels'. There was one other before that, I believe. The Juicy Lucy film, which I'm hoping to see later this month. What line standard was used on that?

CP *625. And also on 'Motels'.*

AH Now I understand that there is equipment available for 1000, 2000 or 3000 lines and that it was intended to be used for 'Motels' but something went wrong. Is that a fair statement?

CP *There has been a lot of talk about such cameras becoming available, but it was never on the cards that they would be available at that time.*

AH That's in direct conflict with what somebody else told me but obviously you would be the one to know.

CP *There was never any question in our minds about not using 625 lines. There has been a lot of work done and a lot of consideration given to higher line standards, which obviously would improve definition provided that everything else in the television system was improved to keep pace with it.*

AH Well, what I got was obviously from someone who'd got the wrong end of the stick.

CP *It would have been easy to get that impression from the various stories that were going around.*

AH There have been so many conflicting stories also about what is happening to 'Motels'. One suggestion is that it's held up because of technical problems and another because they swore too much.

CP *Well, as I said, 'Motels' was given to us rough cut. What we did was produce our separation negatives as I've described, and from one of those we produced a black and white cutting copy which was sent to the States for editing in the normal film manner. And also, of course, the music was recorded separately, as you know. So the time lapse (I wouldn't call it delay) has been in the editing in the States.*

AH So you sent them an ordinary—just monochrome—cutting copy which they then worked on and sent back to you in its final cut state.

CP *Yes. Then we cut the separation negatives to match and print it in colour.*

AH You explained that there are two alternative systems, one where you do some cutting and the other where what you are given is a finally cut tape.

CP *The procedure one adopts depends very much on the sort of effect one is trying to create and many other production requirements, as well as aesthetic requirements, rather than any technical ones. You can edit the thing completely on video tape, which if it is a television-style sort of production you can probably do quite quickly and efficiently. But if on the other hand it's a film production, then of course it will take you a long time and therefore cost more to edit on tape. So it is easier to transfer on to a cutting film print for all the rough cut editing and then do the final version on film. It all depends on a lot of factors.*

AH I gather that *Juicy Lucy* was very much television stuff.

CP *Oh yes. It was shot exactly as television. Hardly any editing was done to it—just a question of joining it together on video tape and when it was finalised we just put it straight on to film in final form. The whole thing took about a fortnight.*

AH I see—whereas obviously the 'Motels' thing has much more of a story line and has to be handled more as a film. But the perennial question is quality, as that's what started this whole thing off for us—on the face of things the idea of something coming out of the system you described and ending up on the screen at The Odeon, Leicester Square, is pretty horrifying. On the other hand, if someone had told me about the Technicolor process 30 years ago I would have said 'Oh, it'll never work'—so I'm open to be proved wrong. Have you seen any of the final transfers on the large screen?

CP *Yes, I've seen the whole thing and it was even better than we expected.*

AH And it will stand up to wide screen presentation?

CP *Oh yes.*

AH Do you see the lines? They must be very large spread over the height of the average screen.

CP *The only time you see lines is on certain types of movement when a strobing effect can be apparent. Normally the lines structure is destroyed in the process and you don't see them. It is destroyed by spot wobbling.*

AH You can do that because you're not relying on display with the phosphor triads I suppose. Is the definition comparable to 16 mm original—or 35 mm, or is it worse?

CP *It's better than 16 blown up to 35. When we produce 16 mm prints our average results on 16 mm are better than the average result on direct shot 16 mm strip. But we 'shoot' on 35 whether we're going to 16 or 35 and we then produce a 35 matrix if we want 35 or a 16 matrix if we want 16.*

AH I see. So all the transfer from tape to film is initially done on 35. Then you go downhill rather than going uphill.

CP *The vast improvement over ordinary 16 mm is that our results are relatively grain-free because the neg that we use is very slow and fine grained and the only graining is in the matrix. Our final transfer has no grain either. The only thing you're left with is the television noise, which looks like grain. If you get a quiet picture, your results are remarkable.*

AH I'd guess this is where the future problems and improvements will be. Because you've been doing Technicolor work for 30 years now—I mean Technicolor Ltd have ironed out the bugs over 30 years and therefore the bugs are now presumably in the tape noise.

CP *Not just tape noise. The main problem is television noise generally, which isn't necessarily tape noise. The most offensive kind of noise is the noise you get out of the camera when it's under-exposed. Obviously a reduction in tape noise would help but it is only one of the factors. There are more serious factors, but I think we can overcome them.*

AH What about the future of films. I know that there are a lot of instant rushes done, aren't there—a sort of side by side process where at the same time as filming on film they film on tape for the Director just to get an idea of what he's shot on film.

CP *Well with our process it's done automatically due to the fact that you're recording only on 12.5 mm tape. But of course you can record as well on a smaller gauge helical scan recorder so that people can go away and think about it and make a lot of their editing decisions on cheap apparatus in a quiet room rather than with 12.5 mm tape and VTR machines, which cost a lot of money.*

AH Finally, back to the question of actually filming on video tape only—are there any plans for doing any feature stuff on it that you can talk about?

CP *There are a lot of projects in the offing which will obviously await the results of '200 Motels'.*

AH So really it's something of a turning point.

CP *We think it will justify our belief in the system.*

To round things off I went to the National Film Theatre in late September for a showing of the Juicy Lucy film. To be more accurate the film is called 'Juicy Lucy/Colosseum' and not too surprisingly it is a simple filmed—or rather videofilmed—record of a stage performance by these two British groups. For the record it was made in 1970 by the Oakhurst production company and was directed by Tony Palmer (who also directed the 'Motels' film). The TV technical side was handled by Lion and the tape-to-film printing by Vidtronics (again as per 'Motels'). So it should certainly be reasonably indicative of what the Zappa film has in store for us—technically at least. Also very convenient was the fact that the NFT were showing JL/C in the same programme as the 1968 film 'Monterey Pop', which is a film of the Monterey Pop Festival shot on 16 mm and blown up to 35 mm for cinema distribution. In other words in the same programme we had a direct comparison between the two techniques referred to by Chris Pooley (tape-to-35 and 16 film-to-35) and used for very similar subjects.

In short, and on the strength of the nearest we can get so far to an A/B test, I reckon the tape-to-film system wins hands down!

Not only 'Monterey Pop', but also the Rolling Stones' film 'Gimme Shelter' and parts of the feature 'Woodstock', have been blown up from 16 mm camera stock to 35 mm distribution prints and they are all distinctly 'rough' in

(continued on page 27)

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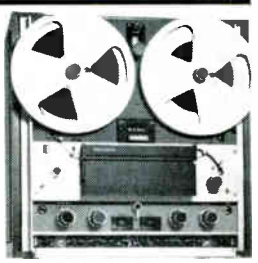

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picture quality by everyday cinema standards. The grain is very obvious indeed, especially in the low light shots, such as the evening and night concert shots, and definition is poor (to use pretty neutral terminology). But usually it is a case of material and subject matter transcending the technical inadequacies, and in 'Gimme Shelter' there is the reduction from Glyn Johns' 16 track recording to wallow in as compensation. However, the JL/C film was presumably made under comparable inadequate lighting conditions and it proves that Pooley is certainly right in drawing a favourable comparison with finished products that started off life in the camera as 16 mm colour stock.

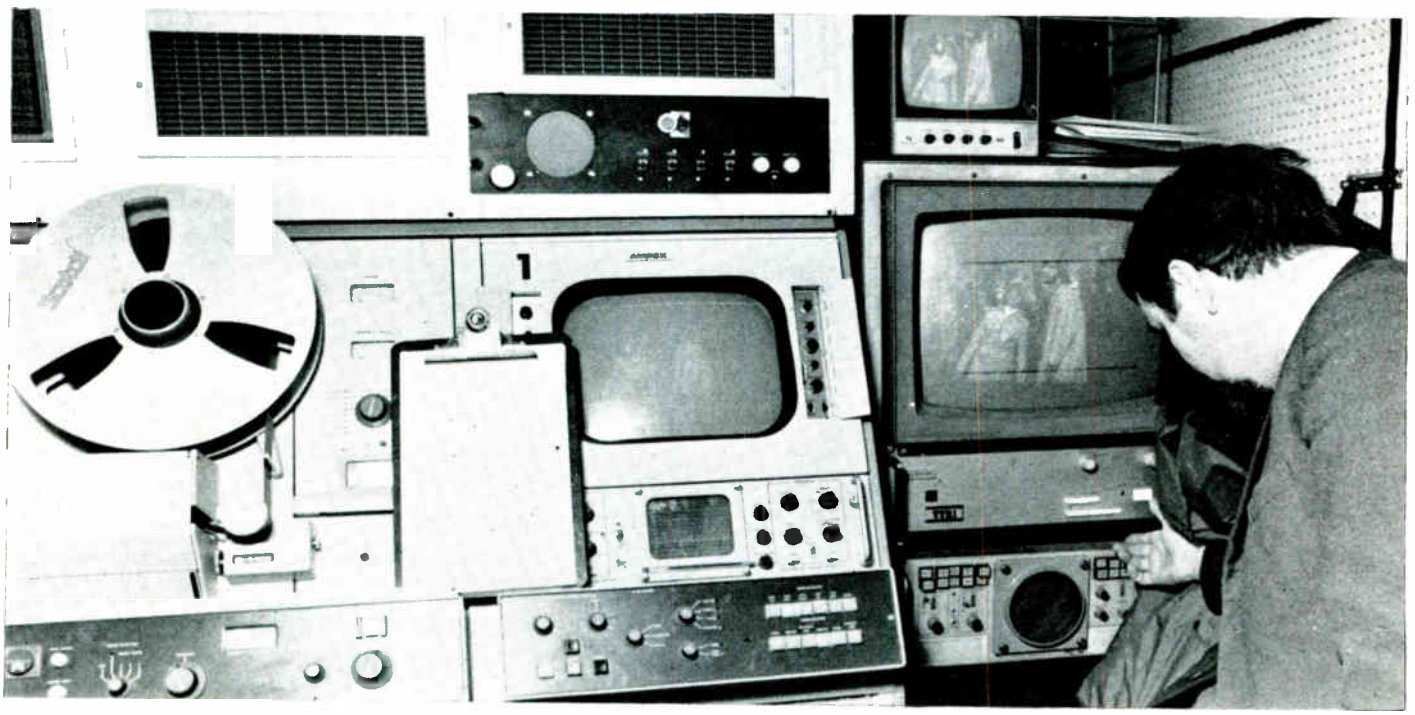
I was sitting halfway back in the NFT from the screen but for a while stood close to the screen side. At no time could I see any grain at all. What I could see was a very sharp image (far sharper than on Monterey Pop which was shown on a smaller masked screen) and detail right down to skin texture in close shots of hands and faces etc. The film is, as everyone has said, fairly heavily spiced with video effects

Equipment cost and portability are probably the main snag in the tape-to-film process. Are there any others? Probably there are all kinds of problems with which Lion and Vidtronics are faced and a few are hinted at in the transcription of my talk with Chris Pooley. But clearly none are so serious as to throw doubt on the system as a whole and equally clearly most of any existing bugs will sooner or later be ironed out. The only one I noticed was the curious tendency of the line structure (destroyed by spot wobbling for 99.9 per cent of the time) to recreate itself in fast moving parts of the image. Thus, as an object like a drumstick or hand moves at a certain speed up or down, the object momentarily shows up as being defined by conventional TV lines. The effect also seems to become evident sometimes on fast cut passages. Pooley mentioned this in passing but gave no explanation of the cause and made no comment on whether or not it will ever be eradicated. I would guess it follows from image movements which phase briefly with the wobble velocity of the spot—vaguely comparable to the stroboscopic freezing of wagon wheels on film—but as I say that is only a guess. In any case the effect is only noticeable if you are looking for it.

Incidentally, colour rendition is, I would say, most nearly comparable to Sony Trinitron colour. With the prints being made by the Techni-

Since I wrote the foregoing, a fair amount of water has flowed under the bridge. Frank Zappa and Tony Palmer have fallen out publicly in a way that seems to have involved Palmer adversely criticising the final cut of the film and demanding that his name be removed from the credits. The compromise reached was that visual direction be credited to Palmer and characterisation direction to Zappa. The film opened in London on December 16, at about which time Zappa was publicly punched off the stage at The Rainbow Theatre, where he was giving a live performance. All of which incidents are presumably unrelated—but somehow seem not too surprising when you have seen the film.

One thing is certain—it is certainly not family entertainment or a film to take your auntie to at Easter. But at least some of it is entertainment and, although quite different in content, it is similar in spirit to the Beatles' *Magical Mystery Tour*. Thus although *200 Motels* is a surrealistic impression of life on the road with a touring rock band, and the Beatles' film a surrealist impression of life on the road with no one in particular, both films have in common the feel of a brave experiment that in places comes off and in other places doesn't. Each is rather like an adventurous home movie that suffers from over-indulgence, inadequate editing and an overdose of pretension. One can



—colour bursts, colour saturation, colour draining etc. But there are enough straightforward documentary style shots, of the audience and drummer Jon Hiseman, for instance, to suggest that this particular medium may already be technically adequate for most requirements and a good bet for any work where the presence of the so far cumbersome colour TV cameras is no problem. Whether colour cameras as portable as 16 mm Bolex and Arriflex equipment will become available at reasonable price is a moot point.

color dye transfer process there is presumably no limit to the scope of controlled colour variations which can be introduced by dye control at the printing stage.

Remarkable as it may sound I cannot imagine Mr Average Cinema Goer in the stalls of his local Odeon—or for that matter Mr Keen Cinema Goer in his seat at the NFT—noticing any difference whatsoever between a conventional film print and a Vidtronics print. And that must surely be the object of the whole exercise.

imagine *200 Motels* being shown in years to come at the National Film Theatre as an example of a courageous attempt at doing something different. With the benefit of hindsight, perhaps even Zappa will acknowledge that more ruthless editing might have improved the film.

The video tape to film conversion technique really does work and, although the screen I saw the film on is small (The Classic, Piccadilly Circus) definition is good enough for the technique to be considered a success.

richardson

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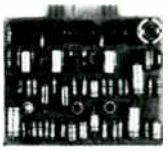
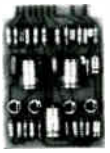


This rationalised system allows numerous applications for mixing and amplification—the modules have been developed over the past four years and successfully used in discotheque mixers, studio mixing/recording equipment and custom-built installations. The system now features a universal Mother Board which is designed to accommodate these modules, enabling the manufacture of a wide range of equipment from standardised units.
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TAPE TRANSPORT DESIGN CRITERIA

By Tom Reps*

IN mid December, I received a telephone call from D.K. inquiring if I could supply information on any industrial recorder we manufacture for a forthcoming survey. With a certain reluctance, I replied that we had a machine in the making which had been under development for some time but would not be available until later in 1972. In any case, the company did not wish to give detailed specifications until the product was available. Oh, says D.K. and with subtle cunning asks why not write about the design of industrial tape transports to back up the survey—knowing full well that more than specifications would then be divulged. Before I could refuse, a letter arrived confirming the conversation and please could he have the manuscript by January 4 latest. Merry Christmas.

What is the dividing line between domestic and industrial tape transports? The question is often asked but is difficult to define as some borderline designs have features applicable to both categories.

Magnetic tape is virtually weightless and easily stretches. It is therefore difficult to maintain at constant speed whereas a disc, as soon as this is placed on a turntable, effectively gains the turntable mass and becomes a flywheel with natural resistance to speed change. If no provision is made to control tape tension, this is proportional to reel diameter—the amount of tape on a spool. To take an example, say this tension is approximately 40 gm (in practice this figure is lower on domestic and higher—as much as 100 gm—on industrial transports. This depends on tape compliance and head contour). A tension of 40 gm on a full 27 cm NAB spool increases to 80 gm when empty, and to 180 gm on an empty 18 cm spool. This progressive tension increase produces flutter, wow, and long term speed change. It also increases the capstan power requirement.

A back tension switch is often fitted for use with small spools but is only a compromise. A near approach to constant back tension can be achieved by means of a pressure pad against the erase head or against a stainless steel plate. This is unsatisfactory for large industrial machines using high tension.

Smooth passage of the tape past the head assembly is basically achieved with a capstan shaft rotating at a constant speed, the tape being pressed against the shaft by a jockey or pinch wheel. This action is not quite as simple as would at first appear. Ideally the jockey wheel should be the same width as the tape, the tape traction coming direct from the capstan. Unfortunately, considerable pressure is necessary because the coefficient of friction between tape and capstan is low, especially on 6.25 mm tape. The pinch wheel is therefore made wider by about 50 per cent, overlapping the tape equally on both sides and thus imparting pinch wheel drive. Here the tape is driven (a) by the capstan shaft direct and (b) by the effective diameter of shaft and tape. This results in surface flexing of the pinch wheel material as the wheel now has a contributory effect on tape drive. Any short term variation in hardness or long term deformation of shape will have an over-riding influence on wow and flutter.

In my opinion rubber, either natural latex or synthetic Nitril, is unsatisfactory in the long term. Natural rubber is affected by oil and both have variations in hardness from point to point, giving rise to wow irrespective of grinding concentricity. Nitril exhibits cold set properties. Flaws directly below the surface cannot be checked (i.e. hard spots and air bubbles) as the material is opaque. Also, both materials tend to glaze with use, imparing their traction. Finally, poor resistance to abrasion causes the material to shed which is more noticeable when rubber is used for a drive idler.

Realising the limitations of rubber, some manufacturers have turned to polyurethane. This is not one material but a group available for injection or compression moulding, or casting. The former is most economic, having fillers and plasticisers, similar to rubber in appearance, highly resistant to abrasion, unaffected by oil, subject to only slight variation in density, due possibly to fillers. Cast material is mechanically similar to compression types but subject to air bubbles, making it unsuitable.

The compression type is moulded on a heated platten at very high pressure for about 15 minutes, then cured slowly in an oven. It is characterised by its pale brown translucent appearance, being excellent for both pinch and idler wheels. We have used it in both roles for a number of years. The density is constant due to slow curing. Traction is high if ground correctly and abrasion resistance is so high that scraping with a sharp razor makes no impression.

FIG. 1

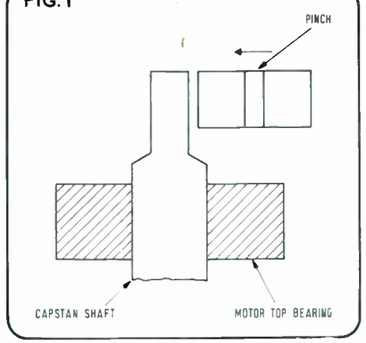


FIG. 2

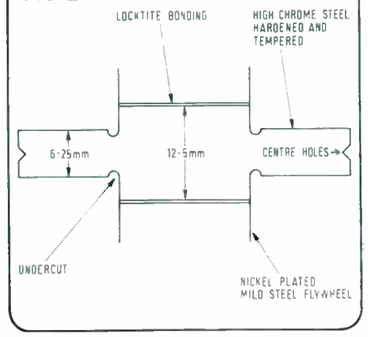
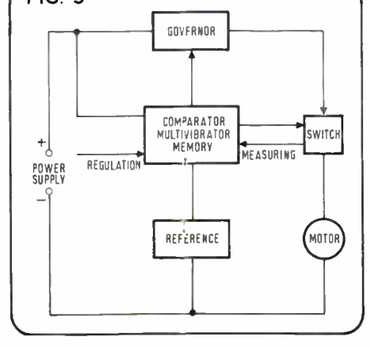


FIG. 3



The capstan now deserves some attention. Not only does it have to be very round with a high degree of surface finish but completely free of stress and highly abrasion resistant *not necessarily very hard*. When a direct drive capstan motor is used, the shaft is part of the motor and is normally, unless otherwise specified, a case hardened steel (mild steel cyanide treated to increase surface carbon content up to 1 per cent, then surface hardened). Stresses are partly released in the grinding process but, due to the varying depth of carbon and bowing occurring during hardening, this hard case varies considerably in depth. It is generally thinner at the ends—including the driving end. Unless chrome plated, this type of finish is not abrasion resistant, hence the wear on some shafts when in continuous use.

Pressure applied to a shaft in relation to its support bearing is more important than is realised. This distance is fixed on direct drive and, in order to reduce the thrust, a soft pinch wheel requiring less pressure for a given traction is used (**fig. 1**). The high impact from a solenoid operated pinch should also be considered.

The kinetic energy stored in a direct drive motor is governed by physical diameter and weight and can be insufficient to maintain low wow at slow speeds although the torque is relatively high.

A high torque motor is unnecessary, in my opinion, in a transport with servo tape tension. We therefore resort to a driven flywheel which can be direct or belt driven from a small servo controlled motor of preferably the brushless type, not necessarily the Hall effect type used in the Braun *TG1000* and Philips *N4450* domestic models. This motor, although very satisfactory for low speeds, is not suitable for industrial use. It may be of interest in passing to mention that some tape decks rely on a sand blasted capstan shaft to obtain sufficient traction at low pinch pressure, generally where the mechanism is non-solenoid, to obtain light start button pressure. This capstan surface is soon smoothed by tap abrasion and the technique is not recommended.

The ideal capstan shaft material is brass or mild steel with thick hard chrome plating, ground between centres, lapped and polished. This has hard wearing properties with very low remanence. Unfortunately, it is expensive to produce, with a tendency to peel when corners are ground. There is also a build up of chrome in both centre holes, making accurate grinding difficult. Having described in some detail this humble shaft, I hope it will be of interest to describe the production of one such shaft and flywheel used in the Chilton *100 S* tape recorder.

The material chosen (**fig. 2**) has a high chrome content, and a very low distortion characteristic when hardened. It is supplied in 12.5 mm (0.5 inch) ground stock. Both ends are turned down to within 125 μm (.005 inch) of the finished size and are undercut at the junction of both diameters to facilitate grinding up to the shoulder, also preventing stress cracks in the hardening process. The centre holes are for grinding and mounting purposes. The 12.5 mm diameter centre section strengthens this shaft, eliminating flexing during grinding and the natural tendency to bow while bonding the flywheel on to this shaft. There is also a larger contact area giving a stronger bond. The component is now hardened by Mar-Quench process (quenching vertically in high temperature liquid salts which greatly reduces internal stress). These complex stresses would disturb the component when partly relieved by grinding. After tempering to 60° Rockwell (scale C) hardness, it is checked by noting the amount a diamond penetrates the surface for a standard impact pressure. Each centre is now cleaned and lapped to ensure absolute roundness prior to grinding.

The precision centre grinder used on the next operation is situated on a surface completely free from the slightest vibration. The grinding fluid must be absolutely clean and free from the smallest foreign particles otherwise a high degree of surface finish and accuracy is impossible. This fluid goes through three

(*continued over*)

*Managing Director, Magnetic Tapes Ltd

settlement tanks and a magnetic filter, and finally an automatically controlled paper filter.

After grinding to size, the roundness runout is checked on an electronic probe, giving accurate readings down to a few millionths of an inch. The runout is normally less than 0.25 μm (10 μ inches). Both bearing surfaces are then honed to a very high degree of surface finish which not only reduces bearing noise but, more important, increases bearing life. The elimination of microscopic troughs in the surface prevents the bearing material occluding to the surface which accelerates wear. A well designed sintered bearing is quieter than a ball race which, unless specially selected, is subject to low frequency rumble. Finally the flywheel (which has been turned, bored and reamed, then accurately re-turned in relation to its centre) is nickel plated. Both components are now bonded together, the clearance being determined for maximum strength and concentricity. The latter is achieved by rotating the shaft in its housing as the Loctite cures. This process gives a stronger joint with far less stress than a force fit. I have described it to emphasise the attention to detail necessary to achieve reliability and maintain performance during production. I would add that centreless grinding cannot achieve the same consistent accuracy as grinding between centres (see Terence Long's letter, April 1970 STUDIO SOUND).

Mention should be made of printed circuit motors which are being used increasingly in the larger industrial machines, especially for instrumentation and digital recording. These motors have low rotating mass and constant torque, even at very slow speeds, making them ideal as spooling motors where rapid start and reverse are necessary. The latter features in tape drives where speeds from 300 cm/s to fractions of a centimetre are required. I would stick my neck out, however, and question the suitability of the cheaper pressed steel constructed types having a poorly finished shaft and short bearing surface. The mechanical noise from the brushes proved sufficiently high to be (at least psychologically) detrimental in a high quality audio recorder.

While developing the industrial recorder which I mentioned in the introduction, a number of suitable tape drive systems were considered for use with a servo take-up and feed tension. The requirements were:

1. Electronic speed change.
2. Vernier adjustment of speed.
3. Speed independence of mains frequency (allowing both 50 and 60 Hz powering).
4. Speed stability of better than ±0.1%.
5. Speed ratio of 4-1 (38 down to 4.75 cm/s).
6. Item 4 to hold at 38 cm/s.
7. Minimal maintenance over long periods of use.

Conditions 1, 2, 3 and 5 are satisfied by a dc brush motor controlled by a dynamic regulator. In other words, the regulator monitors the dc motor current which varies according to speed and compensates accordingly. Conditions 4 and 5 can be approached by fitting operational amplifiers having a high degree of feedback at very low output impedance, the latter being a very desirable feature as a short circuited brush motor is highly damped. Brushes, however, do require replacing and can damage the commutator beyond repair if not examined regularly. They also generate interference.

I should add that a Swiss firm called Portescap manufacture motors with gold alloy brushes which are a definite improvement, an alternative brushless dc motor is available from Siemens which depends on the Hall effect of semiconductor materials to switch the four poles. This is silent in operation but, although the makers specify a speed stability of only 3 per cent, this is at extremes of temperature not normally encountered in factory or home. I had the opportunity to measure the speed consistency from beginning to end of an 18 cm spool on a Braun *TG1000* and found it within 0.5 per cent which could doubtless be improved. This motor has a low-torque/high-speed (approximately 4,000 rpm) performance and does not comply with item 6.

One of the most successful servo systems is that used on the Revox *77*. This has very good speed stability and can be vernier controlled but is limited to a 2:1 speed ratio. The motor acts as a large rotating mass (flywheel) in the servo loop and thus presents certain design problems, effectively acting here as a large capacitor causing over-compensation or hunting when shock excited. This effect has been greatly reduced by introducing compensating phase shift in the control amplifier but is always present to a varying degree. An ideal system has low mass as the servo acts as its own flywheel. Unfortunately this is difficult to achieve in practice although the Nagra comes very close.

A system which has very favourable possibilities consists of feeding a brushless dc motor with pulses, the duration of which vary according to the load (pulse width modulation, **fig. 3**). The speed is measured during intervals between pulses, while the motor is working as a generator, the induced voltage is compared with a reference voltage and the difference determines the length of the power pulses. This system, in conjunction with constant tape tension, achieves speed stability in the order of 0.1 per cent. Automatic tape tension is increasingly used on both domestic and industrial transports and is an essential requirement when standards have to be maintained from start to finish on any spool size.

Servo tension systems

Before discussing what I consider an ideal form of servo tension control, it would be interesting briefly to discuss the various types now in use. The most basic comprises a sensing arm controlling the braking on a feed or take-up spool. The effectiveness of this system depends on the ratio between the spool brake, the pivot, and the distance between the pivot and the tension arm on the tape. The tension is governed by a spring pulling the brake on to the spool and in effect varies the load on the spool which compensates for the varying tension as the spool empties or fills.

With this system, motor power is wasted as maximum power is only required in the condition where the take-up spool is full and the feed spool empty. Also the tension arms have a limited movement which does not always eliminate looping when starting on the higher speeds.

The second type is the electronic servo where the arm movement controls light on to a photoresist or phototransistor. This controls the voltage to the take-up and feed spools and can result in smaller spooling motors than would be needed were servo arms not incorporated. These sensing arms also have a larger movement and can be designed to eliminate looping completely. It should be emphasised that where the motor voltage is controlled from the sensing arm, isolation from the mains is necessary. The motors are powered from the secondary of the mains transformer which results in a greater hum field. In order to reduce spool power requirements, it is for two reasons very desirable to terminate the sensing arm with large diameter rollers. Firstly, friction is considerably reduced, especially if a small bearing diameter is fitted. Secondly, the tape is not deformed or bent to the same degree. The roller also reduces flutter compared with the pin. One problem which arises with the closed loop servo is oscillation of the tension arm. If the arms are damped to prevent this, as in the Braun, the take-up efficiency on start is impaired. The correct solution is to arrange damping in one direction only—i.e. on return. There are many ways of achieving this, the simplest being by means of a pad riding up a cam giving high resistance in one direction, and assistance in the other.

The use of a torroidal transformer to reduce the humfield when using the latter type of servo appears the most satisfactory solution.

It is highly desirable to fit a scrape filter which reduces the flutter content, this being an accurate rotating wheel pressed against the tape between the play and record head. It effectively gives mass to the tape.

The most satisfactory form of braking is the wrap round type; steel bands applying cork or cotton fabric to the spool motors. The main criteria for braking are that it should be snatch free and have a high front-to-back ratio, braking by at least 10:1 ratio when turned in either direction. This ensures that spillage is prevented when dissimilar spools are used. Cork has proved particularly satisfactory in this respect. Self cleaning of the brake material can be achieved by machining a helix on the braking surface. This serves two purposes. Firstly a helix when rotating has a moving surface at right angles to the rotation direction. Secondly, the fine troughs prevent the buildup of undesirable deposits between the two surfaces.

The combination of solenoid operated brakes, pinch wheel and servo arms permit very rapid stop/start without undue tape stress.

Touch button deck control via relays with logic circuits to prevent tape spillage is also very desirable, as is illumination of the relevant control.

I am not going to pretend that this article more than outlines the problems faced in designing a tape transport [*Perhaps the detail will come later*—**Ed**]. Nevertheless, I hope it emphasises that close attention to production methods, as well as to machining tolerances, is essential to consistently good performance.

A Low-Distortion Oscillator

By Arthur Garratt

I RECENTLY bought a Sugden *Si 452* distortion measuring unit, an instrument reviewed in *Hi-Fi News* (August 1971). This has no oscillator or millivoltmeter—suitable ones are sold separately—and consequently I needed a low distortion oscillator as a source. If the readings from the distortion measuring unit are to be meaningful, one needs an oscillator with much less distortion than one is measuring after the signal has passed through the equipment under test. To measure distortions accurately down to 0.1 per cent demands a source oscillator with no more than 0.01 per cent inherent distortion. Such oscillators exist, of course, but they are usually expensive and not very cost-effective for other uses, where distortion less than one per cent is usually not important. I already owned two audio oscillators, one a commercial instrument with sine and square wave output and with a measured distortion of about 0.5 per cent (well within specification) and the other a transistorised instrument I had built myself—distortion about 0.1 per cent.

So I decided for simplicity that I would make myself a simple, low distortion, battery-operated oscillator with four switched frequencies. Most audio oscillators nowadays are of the Wien type, using a minimum of two stages of amplification with a frequency selective feedback loop. This consists of two RC combinations, the first in series and the second in parallel. The voltage produced across the parallel combination has zero phase shift at only one frequency, given by

$$f = \frac{1}{2\pi RC} \qquad (1)$$

To work properly, the amplifier has to have negligible phase shift over the operating range of frequencies—this is easy to accomplish when transistors are used as one can employ direct coupling. It is necessary to limit the amplitude of the oscillation, and a thermistor is a simple and effective way of doing this.

Distortion of the waveform is produced if there is distortion in the amplifier itself. An analysis of this is given by P. F. Ridler ('Distortion in Feedback Oscillators', *Electronic Engineering*, September 1965). Ridler gives a design for a low distortion, variable frequency audio oscillator in this article. His circuit uses four transistors, while Ferranti have developed a circuit using three. The latter is the one I chose as the basis for the design. The specification is that harmonic distortion at 1 kHz is less than 0.01 per cent (measured 0.004 per cent) with an output of about 1V.

I chose 100 Hz, 1 kHz, 2 kHz, and 10 kHz as suitable pre-set frequencies and then designed a circuit to give me these approximately, using equation (1). For R=7.5 kΩ the actual and calculated frequencies are:

C	f (calc)	f (measured)
0.22 μF	96.5	95 Hz
0.022 μF	965	920 Hz
10.000 pF	2.122	2.0 kHz
220 pF	9.65	10.4 kHz

The frequencies could easily be trimmed to precise values if needed and obviously any desired frequencies can be selected within the audio range.

The instrument was built on Veroboard and fitted into a die-cast box approximately 11.5 x 9.5 x 5.5 mm. with an external battery. There are no special problems in the construction providing the layout is carefully planned. To ensure stability I connected a small capacitor (10 pF) across the output pot to prevent any chance of rf oscillations and I used a screened lead for the main feedback line. The battery is switched by a combined pot and switch. This was done deliberately as carbon track pots which are not used regularly tend to break down.

Measuring very low distortions is not really possible using a notch filter instrument and Sugden claims as a 'useful limit condition' a minimum figure of 0.05 per cent. One limiting factor is noise. Using an input of 0.3V as advised by Sugden, the distortion meter gives an output of 0.1V. 0.01 per cent of that is ten μV which stretches most millivoltmeters. I use a 40 dB gain transistorised amplifier which I can switch in or out, the output feeding a Heathkit *AV-3U* valve millivoltmeter. The amplifier has a very low noise figure—less than one μV at its input—so one cannot do a great deal better than this. But the distortion meter itself generates about 30 μV (as measured in the *Hi-Fi News* review) which confirms Sugden's 0.05 per cent. My own tests were done with an oscilloscope across the output which verified that, at balance, the residual signal was almost all noise.

All this goes to show that the distortion measurements I made mean little if the readings are less than 0.05 per cent—except of course that the distortion is no greater than this. In fact with care I got about 0.03 per cent, confirming that the distortion is very low indeed, and quite acceptable for its purpose.

In use the oscillator has proved very satisfactory. Its frequency stability is excellent—this is important when it is being used with a notch filter, otherwise one is driven mad with frustration as one constantly tries to readjust the null point while the source frequency drifts. Being battery operated there is no trouble with hum loops and the thermistor controls the amplitude very well, so much so that I use it to calibrate my oscilloscope and to feed tone at a known level into tape recorders. At a total cost of well under five pounds—not counting one's time of course—it is well worth building.

Components

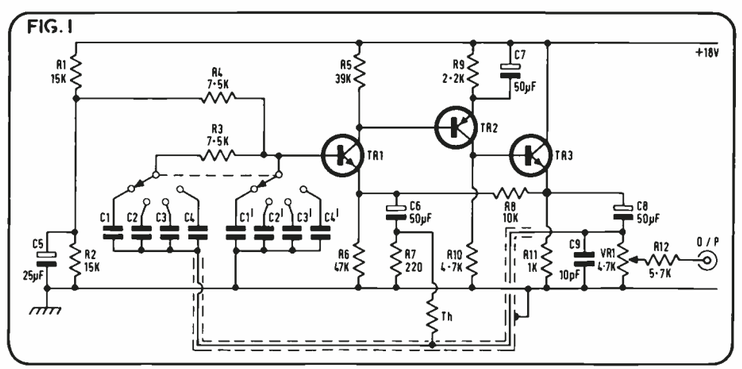
R1 15 kΩ
R2 15 kΩ
R3 7.5 kΩ
R4 7.5 kΩ
R5 39 kΩ
R6 47 kΩ
R7 220 kΩ
R8 10 kΩ
R9 2.2 kΩ
R10 4.7 kΩ
R11 1 kΩ
R12 5.7 kΩ
(all 0.25W)

Tr1 ZTX 300
Tr2 ZTX 500
Tr3 ZTX 300
Th STC R53 Thermistor
V1 4.7K linear switched pot

2-pole 4-way switch
Diecast box, Eddystone 6908P
Jack output socket
2-pin socket for supply input
Veroboard

C1 0.22 μF
C2 0.022 μF
C3 10 000 pF
C4 220 pF
C1[1] 0.22 μF
C2[1] 0.022 μF
C3[1] 10 000 μF
C4[1] 220 μF
C5 25 μF 25V
C6 50 μF 25V
C7 50 μF 25V
C8 50 μF 25V
C9 10 pF

FIG. 1



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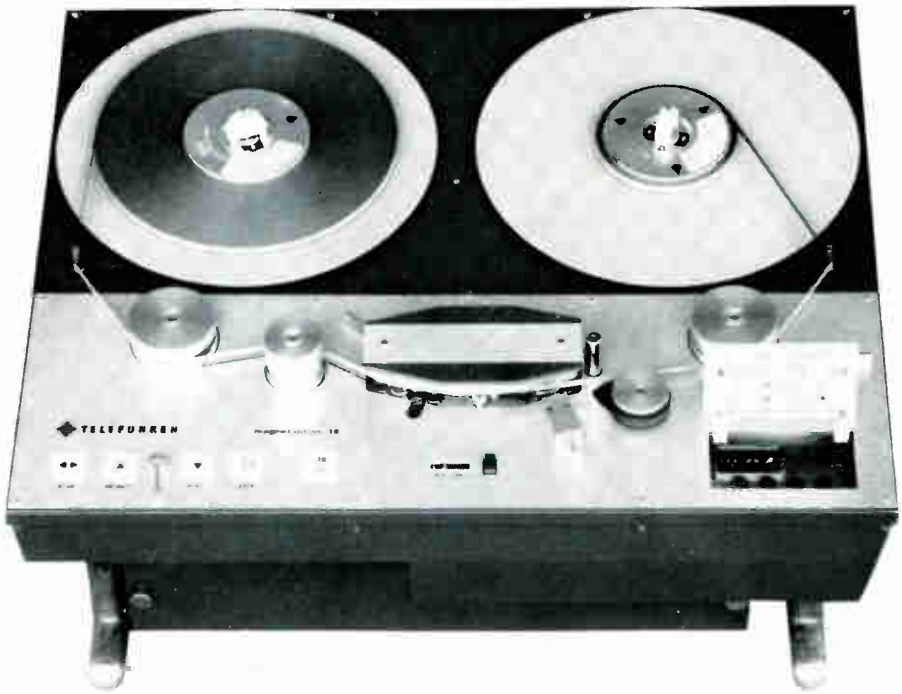

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Slip: 0.2%.
Spooling tension: 100 gm, peaking to 750 gm.
Tape time counter: 0.2% accurate 4s addition after tape end.
Frequency response: 40 Hz to 60 Hz ±1.5 dB, 60 Hz to 15 kHz ±1 dB.
Signal-to-noise ratio: 55 dB (full track).
Distortion: 1%.
Chassis dimensions (hwd): 308 x 645 x 525 mm.
Weight: 53 kg.

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Chancery Lane, London WC2
Tel. 01-242 9944

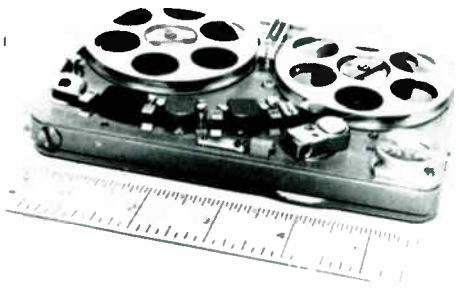
Survey: Industrial Sound Recorders

3.81 mm

NAGRA SN

Miniature two speed pocket battery recorder employing a flat motor originally developed by Kudelski for missile instrumentation. Features include drive and servo capstan control (on the Nagra *3/4* principle). Manual/AG remote start/stop, cine sync.

Recommended tape: BASF TP18, DP12 or XP9.
Dimensions: 147 x 100.5 x 26 mm.
Weight with batteries and tape: 0.574 kg.
Normal Power Supply: Two Ever Ready *E91* manganese cells or similar. Average continuous life is 7½ hours.
External Power Supply: 125 mA at 3V.
Reel Size: 68 x 6.35 mm
Normal Tape Length: 160 m



Recording time: 27 mins (9.5 cm/s); 54 mins (4.75 cm/s); 108 mins (2.4 cm/s). These values can be doubled with 12.5 µm tape.
Record and Playback pass band (with high-pass filter and external playback corrector): 80 Hz to 15 kHz ±2 dB.
Signal-to-noise: 60 dB (ASA 'A' weighted)
Distortion: 2% (400 Hz)
Wow and flutter: ±0.1% (DIN peak weighted).
1 kHz signal erasure: 70 dB.
MANUFACTURER: Kudelski S.A. Ch 1033 Cheseax/Lausanne, Switzerland.
AGENT: Hayden Laboratories Ltd, Hayden House, 17 Chesham Road, Amersham, Bucks.

6.25 mm

AMPEX AG-440 B

Available in full and two track form with rapid conversion between 6.25 mm two-track and 12.5 mm four track. Two speed transport (38–19 and 19–9.5 cm/s).
Signal to noise ratio: 66 dB (full track).
Frequency response: ±2 dB, 30 Hz to 18 kHz.
Wow and flutter: 0.08%.
Playback timing accuracy: ±0.2%.

ABR-10

Bidirectional recorder conceived for automated broadcast applications. Variable speed fast-forward search. Servo-controlled transport available in adjacent speed pairs from 38 to 2.4 cm/s. Unidirectional models available.
Signal-to-noise ratio: 66 dB (full), 63 dB (half), 57 dB (¼-track).
Frequency response: 30 Hz to 18 kHz ±2 dB.
Wow and flutter: 0.1 %.
Start time: 100 ms.

ABR-15

Version of ABR-10, accepting up to 38 cm diameter reels. Unidirectional models available.

AG-600

Smaller solid-state version of earlier *600* series, available in full or ¼-track mono and half or ¼ track stereo. Portable or rack.
Spool capacity: 18 cm.
Speeds: 19–9.5 cm/s.
Frequency response: 40 Hz to 15 kHz +2 −4 dB
Signal-to-noise: 57 dB full track.
Wow and flutter: 0.17%.

AG-500

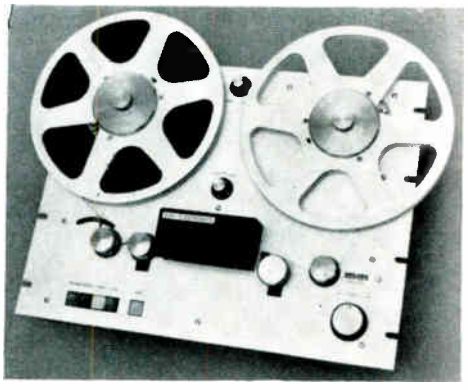
Portable dual speed mains recorder. Two line inputs per channel. Single or two channel available.
Spool Capacity: 18 cm
Speeds: 38-19 or 19–9.5 cm/s
Frequency response: 30 Hz to 18 kHz ±2 dB.
Signal-to-noise: 55 dB (full track).
Wow and flutter: 0.15%.
MANUFACTURER: Ampex Corporation, 401 Broadway, Redwood City, California 94063, USA.
AGENT: Ampex UK Ltd, 72 Berkeley Avenue, Reading, Berkshire.

AVCOM 235

Cassette programme loader, with cue-tone automatic tape cutter, electronic counter, splicer and vacuum pump. **Price:** £1,323.
Cassette blank loader with automatic cutter, electronic counter, splicer and vacuum pump. **Price:** £1,295.
Cartridge (eight track) programme loader, with electronic counter and auto-cut tone tape cutter. **Price:** £1,100.
Cartridge (eight-track) blank loader with electronic counter. **Price:** £1,055.
235 Series. Liberty/UA eight-track cartridge run-in machine. **Price:** £545.
AGENT: Avcom Systems Ltd, Newton Works, Stanlake Mews, Stanlake Villas, London W12 7HA.

BIAS ELECTRONICS BE 1000

Dual speed two channel recorder operating at 78–38, 38–19 or 19–9.5 cm/s.
Specification relates to 38 cm/s.
Speed stability: ±0.2%.
Wow and flutter: 0.06%.
Spool Capacity: 29 cm.
Frequency Response: ±2 dB 40 Hz and 18 kHz.
Start time: (To rated speed) 200 ms. To rated flutter: 1s.
Signal-to-noise: 62 dB (full track).



Tension counter: Servo back tension controlled by sensing arm and damped by fluid dashpot.
Tape counter: Reads in minutes, driven by 38 cm/s tape.
Heads: Ferrites available to order.
Additional features: All machines wired for stereo. Fibreglass plug in modules. Console available. Full remote facilities are standard. Plug in interchangeable headblock. Electronic clock available.
Prices: Mono from £448. Stereo from £498.
MANUFACTURER: Bias Electronics Ltd, 162 Randall Avenue, London NW2.

BRENELL TYPE 19

Deck only. Two-speed Papst capstan motor (38–19 or 19–9.5 cm/s) Solenoid made selection.
Wow and flutter: 0.05%.
Spool capacity: 29 cm.
Dimensions: 483 x 356 x 155 mm.
Weight: 12.019 kg.
MANUFACTURER: Brenell Engineering Co Ltd, 231/235 Liverpool Road, London N1.

EMT LOOPMATIC

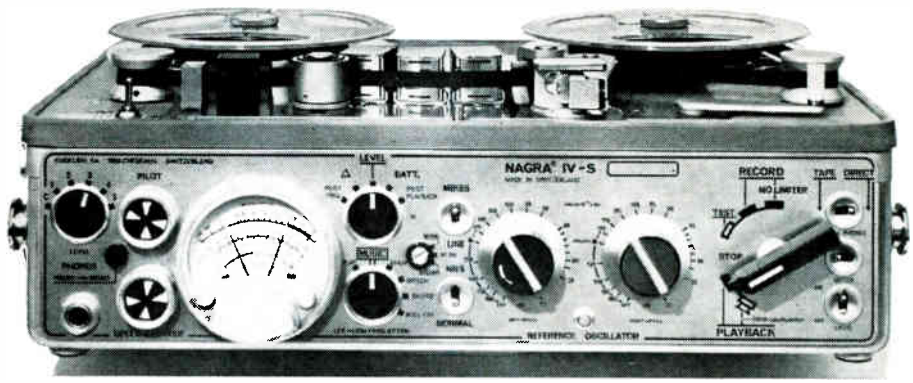
Automatic tape recorder with rapidly interchangeable endless loop steel cartridges. Programme duration: 3 seconds to 15 minutes.
Tape speed: 19 cm/s.
Maximum number of times a tape loop may be played: 5,000.
Run-up time (until permissible wow and flutter figures are reached): 0.5 s.
Stopping time: 0.2 s.
Tape run on: 4 cm.
Wow and flutter: ±15% (Din 45 507 weighed).
Frequency response: +1, −2 dB, 40 Hz to 15 kHz (CC1R equalisation).
Price: From £1,097.
MANUFACTURER: Elektromesstechnik Wilhelm Franz KG, D-7630 Lahr/Schwarzwald, Postfach 1520, West Germany.
AGENT: F.W.O. Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts.

(continued on page 37)

HAYDEN

Suppliers of professional audio equipment by the world's leading manufacturers, including:

NAGRA Portable, Professional Tape Recorders.



Nagra Model IV-S

AVAILABLE EX STOCK–

New Stereo Models IV-S and IV-SL (Pilotton)
New Mono Models 4.2 series
Miniature Model SN with crystal oscillator

SENNHEISER Microphones and Headphones

New dynamic microphone MD 441.
Especially suitable for sound and recording studios.

Suppliers also of the following equipment in the audio field:
Plessy cartridge record and replay machines, Series C.T.80
Sondor 16 & 35mm record and replay sprocketed tape machines.

Please contact us for full details of Sennheiser, Nagra, Plessey and Sondor Products.

Hayden Laboratories Limited,
Hayden House, 17, Chesham Road, Amersham, Buckinghamshire, England. Telephone: (02403) 5511.
Telex 83251. Cables: Haylab Amersham.
Audio equipment showroom, despatch and service department: 12-13 Poland Street, London W1V 3DE.
Tel: 01-734 3748-9

INDUSTRIAL SOUND RECORDERS

continued

FERROGRAPH SERIES 7

Three-speed (38–19 –9.5 at 19 –9.5 4.75 cm/s) single or dual channel records available in full, ½ or ¼-track format. Internal monitor loudspeakers and amplifiers. Variable speed search.
Equalisation: IEC.
Spool capacity: 21 cm.
Frequency response: 40 Hz to 20 kHz ±2 dB.
Signal-to-noise: 9.5 cm/s, 55 dB at 2% distortion level.
Stereo crosstalk: 50 dB.
Wow and flutter: 0.08%.
Stability: ±0.5%.

Series P

Essentially as *Series 7*. Developed for use in broadcasting, specifically local radio.
MANUFACTURER: The Ferrograph Company Ltd, The Hyde, Edgware Road, London NW9.

GATES CRITERION 80 CARTRIDGE

19 cm/s system designed for broadcasting applications
Wow and flutter: 0.2%.
Stability: 0.1%.
Tape start time: 100 ms.
Frequency response: 50 Hz to 15 kHz ±2 dB.
Signal-to-noise: 55 dB (mono), ref 400 Hz 3% distortion.
Manufacturer: Harris-Intertype Corporation 123 Hampshire Street, Quincy, Illinois, 62301, USA.
AGENT: Lee Engineering, 16 Grove Road, Shepperton, Middlesex.

KUDELSKI NAGRA 4

Lightweight (6.4 kg) battery portable three-speed (38–19–9.5 cm/s) recorder available in single and dual channel forms. Specification relates to single channel model *4D*.
Erase track width: 6.25 mm (8 mm head).
Record track width: 6.25 mm (6.4 mm head).
Play track width: 6 mm.
Record head gap: 7 μm.
Play head gap: 3 μm.
Bias frequency: 120 kHz.
Signal-to-noise ratio: –73 dB (ASA A weighted).
Total harmonic distortion: 0.8%.
Frequency response: 30 Hz to 20 kHz ±1.5 dB (30 Hz to 35 kHz ±1.5 dB to special order).
Tape flux at peak recording level: 510 pWb/mm.
Spool capacity: 18 cm (cine) 27 cm NAB with outriders.
Level meter: PPM characteristic, dB calibrated.
Price: £560.
Measured on BASF *SP52*.
MANUFACTURER: Kudelski S. A. Ch 1033 Cheseaux/Lausanne, Switzerland
AGENT: Hayden Laboratories Ltd, Hayden House, 17 Chesham Road, Amersham, Buckinghamshire.

LEEVERS-RICH E200

Heavy duty two-speed recorder available in full track and stereo forms, rack or console mounted. Track format to BS 1568: 1970.
Tape speeds: 73–38, 38–19 or 19–9.5 cm/s. (Specification relates to 38 cm/s).
Wow and flutter: 0.06%.
Stability: ±0.2% end to end.
Start time: 90 ms to rated flutter.
Spool capacity: 29 cm European, 27 cm NAB, 21 cm cine.
Frequency response: 40 Hz to 18 kHz ±2 dB.
Signal to noise: (full track): 62 dB.
Metering: Vu Standard. Ppm to order.
Price: £770 (full track), £950 (stereo), excluding mounts.
MANUFACTURER: Leevers-Rich Equipment Ltd, 319 Trinity Road, Wandsworth, London SW18 IYQ.

METROTECH 500

Slow speed logger for long term unattended recording of broadcast and industrial voice information. Bi-directional ¼-track transport available as single channel with triple reverse, two channel with single reverse or simultaneous four channel.
Tape speeds: 4.75, 2.4, 1.2 and 0.8 cm/s.
Wow and flutter: 0.5%.
Signal-to-noise: 43 dB (3m 290).
Frequency response: 30 Hz to 10 kHz ±3 dB.
Distortion: 0.25% at +8 dBm.
Timing Accuracy: 0.2%.
Start-stop times: 100 ms.
MANUFACTURER: Metrotech Dictaphone, 670 Nation Avenue, Mountain View, California 94040, USA.
DISTRIBUTOR: Feldon Recording Ltd, 126 Great Portland Street, London W.1.

ROLA PLESSEY

77 MARK 3

Two-speed (38–19, 19–9.5 or to order) recorder with 18 cm spool capacity. Direct capstan drive. Variable wind speed. Full or half track mono, or stereo.
Wow and flutter: 0.12%.
Stability: –0, +2% of nominal speed.
Distortion: 2% at 400 Hz.
Frequency response: 30 Hz to 15 kHz ±2 dB.
Bias frequency response: 90 kHz.
Signal-to-noise: 58 dB (30 Hz to 15 kHz, full track)
Available in portable and console form, both with sloping deck.

CT80 CARTRIDGE

Two-speed (19–9.5 cm/s) endless cartridge system. Separate record and play heads.
Maximum playing time: 31 minutes at 19 cm/s.
Tape drive: Capstan direct driven by a high torque synchronous motor with integral flywheel.
Starting and stopping time: 200 ms.
Stability: –0 +0.25% of nominal speed.
Flutter: Less than 0.2%.
Bias frequency: 100 kHz nominal.
Cue signals: NAB standard cue tones.

Distortion: 3%.
Frequency response: 50 Hz to 12 kHz ±2 dB.
Signal to noise: 52 dB (3% distortion level).
Circuit metering: Vu switchable to read record level, replay level, cue, and bias.
Remote control: Press button control of all functions—available via multipin connector at rear (complementary connector plug supplied).
Cartridges: Standard NAB types, A. B, C.
Tape: Graphite lubricated. Recommended types Scotch 151, 153.
Ambient temperature range: –20° to +60° C.
MANUFACTURER: Plessey Electronics Pty Ltd, 91 Murphy Street, Richmond, Victoria, Aus 3121.
AGENT: Hayden Laboratories Ltd, Hayden House, 17 Chesham Road, Amersham, Bucks.

REVOX H77

Transportable stereo recorder with direct drive 38–19 cm/s servo controlled capstan system.
Bias frequency: 120 kHz.
Signal-to-noise ratio: 60 dB.
Total harmonic distortion: 2%.
Frequency response: 30 Hz to 20 kHz ±1.5 dB.
Crosstalk: 45 dB.
Wow and flutter: 0.04% peak-to-peak.
MANUFACTURER: Willi Studer, CH 8105 Regensdurf, Zurich, Switzerland.
AGENT: C. E. Hammond & Co Ltd, Lamb House, Church Street, London W.4.

SCULLY 270

Dual speed (38–19 or 19–9.5 cm/s) reproducer designed for automated broadcast applications. Reverse drive facility available for ½-track mono and ¼-track stereo versions.
Spool capacity: 36 cm.
Start time: 100 ms.
Frequency response: 35 Hz to 15 kHz ±2 dB.
Signal-to-noise: 65 dB full track.
Wow and flutter: 0.08%.
Distortion: 0.5% (total harmonic) at +18 dBm.

280

Dual speed (38—19, 19—9.5 cm/s or to order) recorder available in portable or console cases or for rack mounting, full track or two track.
Spool capacity: 29 cm (SP 14 up to 35.5 cm).
Wow and flutter: 0.08%.
Start time: 100 ms.
Frequency response: 30 Hz to 15 kHz ±2 dB.
Signal-to-noise (3M 202): 65 dB (full track, 30 Hz to 18 kHz band).
Bias frequency: 180 kHz.
Erase frequency: 60 kHz.
MANUFACTURER: Scully-Dictaphone, 280 Bunnel Street, Bridgeport, Conn. 06607, USA.
AGENT: Feldon Recording Ltd, 126 Great Portland Street, London W1.

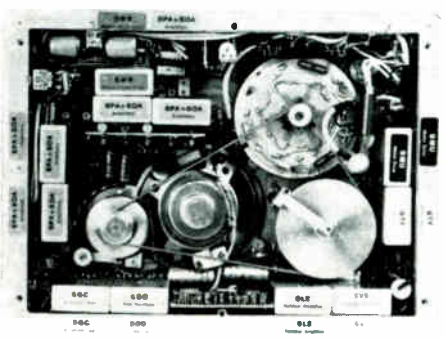
STELLAVOX SP7

Stereo battery recorder taking 13 cm spools, extending to 27 cm capacity with accessory outriders. Tachometer capstan servo system. Mono and pilot versions available.
Tape speeds: 76, 38, 19 and 9.5 cm/s.
Wow and Flutter: ±0.12%.
Tape slip: 0.1%.
Frequency response: 30 Hz to 15 kHz ±2 dB.
Signal-to-noise: 65 dB (ASA 'A' weighted, full track).

(continued on page 39)

INDUSTRIAL SOUND RECORDERS

continued



Distortion: 2%.
Weight: 3.5 kg.
Dimensions: 80 x 215 x 300 mm.
Price: £525.
MANUFACTURER: Georges Quellet, 2068 Hauterive/Ne, Switzerland.
AGENT: Beaulieu Cinema Ltd, 234 Baker St., London NW1 5RT.

STUDER B62

Improved version of A62 transportable/studio recorder. Available in full track, 0.75 mm stereo, or low-crosstalk two-track.
Tape speeds: 38—19 cm/s ±0.2% (adjustable).
Tape slip: 0.1%
Wow and flutter: (Agfa PER 525) 0.1% peak.
Starting time: 500 ms to reach 0.2% flutter, peak value, weighted.
Tape timer: ±0.5% repeated timing accuracy, indicating minutes and seconds.
Frequency response: 30 Hz—18 kHz ±2 dB.
Signal-to-noise ratio (stereo 0.75 mm, 510 nWb/m): 61 dB (CCIR equalisation).
Distortion: 1%
Crosstalk rejection, stereo: 40 dB or more, 60 Hz to 12 kHz.
Erasure efficiency: 75 dB.
Bias/erase frequency: 150 kHz.
Price: £660 (full track).

A80

Two speed console (38—19 cm/s, ±0.2% adjustable with swivelling deck. Tachometer capstan stabilisation. Available in full track, stereo and low crosstalk.
Spool capacity: 30 cm.
Wow and flutter: 0.08% peak.
Tape slip: 0.1%.
Tape timer: 0.2% repeated accuracy, stops instantly at end of tape.
Fast wind stop: 3s.
Frequency response: 30 Hz to 18 kHz ±2 dB.
Signal-to-noise (Agfa PER 525): 61 dB (full track).
Distortion: 1%
Bias frequency: 240 kHz.
Erase frequency: 80 kHz.
Price: £1,420 (single channel).
MANUFACTURER: Willi Studer, CH 8105 Regensdorf, Zurich, Switzerland.
AGENT: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts.

TANDBERG 11-1P

Three speed (19—9.5—4.75 cm/s) battery tape recorder with film sync facility. Single audio channel. Mechanical mode selection. Tachometer speed control. Limiter may be switched into all inputs.
Spool capacity: 18 cm.
Wow and flutter: 0.1%.
Frequency reponse: 40 Hz to 16 kHz ±2 dB.
Signal-to-noise: 59 dB (DIN 45511 weighted).
Distortion: 3%.
Erase/bias frequency: 85.5 kHz.

TANDBERG 1300

Endless cartridge unit available in ¼-track mono, ½-track mono, or ½-track with automatic track change. Internal loudspeaker.
Tape speed: 9.5 cm/s.
Cartridge format: EIA standard RS —332, Type 1.
Speed tolerance: 2%.
Wow and flutter: 0.2% (DIN 45507 peak weighted).
Frequency response: 50 Hz to 10 kHz ±3 dB.

Signal-to-noise: 50 dB at 5% distortion.
MANUFACTURER: Tandbergs Radiofabrikk A/S Oslo 8, Norway.
AGENT: Farnell-Tandberg Ltd, Farnell House, 81 Kirkstall Road, Leeds LS31 HR.

TELEFUNKEN

M15

Dual speed (38—19 cm/s) recorder with electronically commutated DC capstan motor. Available in A or B wind forms with full track, stereo or two-track head format.
Speed deviation: ±0.1%.
Wow and flutter: ±0.05% (DIN 45 507 peak weighted).
Slip: 0.2%.
Spooling tension: 100 gm, peaking to 750 gm.
Tape time counter: 0.2% accurate 4s addition after tape end.
Frequency response: 40 Hz to 60 Hz ±1.5 dB, 60 Hz to 15 kHz ±1 dB.
Signal-to-noise ratio: 55 dB (full track).
Distortion: 1%.
Chassis dimensions (hwd): 308 x 645 x 525 mm.
Weight: 53 kg.

M28

Two speed (38—19 cm/s) unit available with or without meters and signal level controls. Specification relates to basic stereo M28C.
Tape speed deviation: 0.7%.
Wow and flutter: ±0.08% (DIN 45 515 weighted).
Tape tension: 80 gm.
Starting time: 200 ms.
Frequency response: 40 to 100 Hz ±1.5 dB, 100 Hz to 16 kHz ±1 dB.
Signal-to-noise: 58 dB.
Erase/bias frequency: 85 kHz.
Dimensions: 160 x 409 x 458 mm.
Weight: 17 kg.
MANUFACTURER: AEG-Telefunken, 775 Konstanz, Bucklestrasse 1-5, West Germany.
AGENT: AEG (GB) Ltd, AEG House, Chichester Rents, Chancery Lane, London WC2A INH.

TELEX SERIES 1000

Endless loop transport deck units with replay, cue and record facilities. The tape transport is designed to handle standard NAB magnetic tape cartridges, types A, B and C. The *R1000* unit is available as a free standing equipment or as a rack mounting system. Input and output connector are cannon type mounted at the rear of the equipment, together with the supply fuses. The standard unit is for 240V 50 Hz operation. Remote control is possible. Tape speed to order (19, 9.5 or 4.75 cm/s).

R1000-R. Replay model having mains on/off switch, transport start and stop switches and vu meter monitoring output level. One low impedance output suitable for driving 600 ohm lines. Remote start and stop switching is available at the rear connector. **Price:** £210.

R1000-RC. As *R1000-R* but having automatic cue facility. A push switch on the front plate enables cue signals to be recorded on the lower track. During playback, the previously recorded cue tone energises a relay, closing a normally open contact. The cue signal is available at the rear connector. Each time a cue signal is recorded or replayed, the cue lamp is illuminated. A panel mounted switch allows for the continuous complete erasure of all previously recorded cue signals if required. **Price:** £248.

R1000-RP. As *R1000-R* but also having a signal record facility. **Price:** £256.

R1000-RCP. As *R1000-RP* but having cue circuits as *R1000-RC*. **Price:** £296.

R1000-AVP. Designed specifically for audio-visual, exhibition and automatic programming with synchronised slide or filmstrip projector operation. Basically, same facilities as **R1000-RP**, the cue signals operating a slide or filmstrip projector. An 8 W output amplifier and loud speaker incorporated; an extension speaker line is provided which, when connected, automatically mutes internal speaker. **Price:** £255.

R1000-AVR. Specification as above but with the additional facility for recording cue pulses of automatically timed duration. **Price:** £295.

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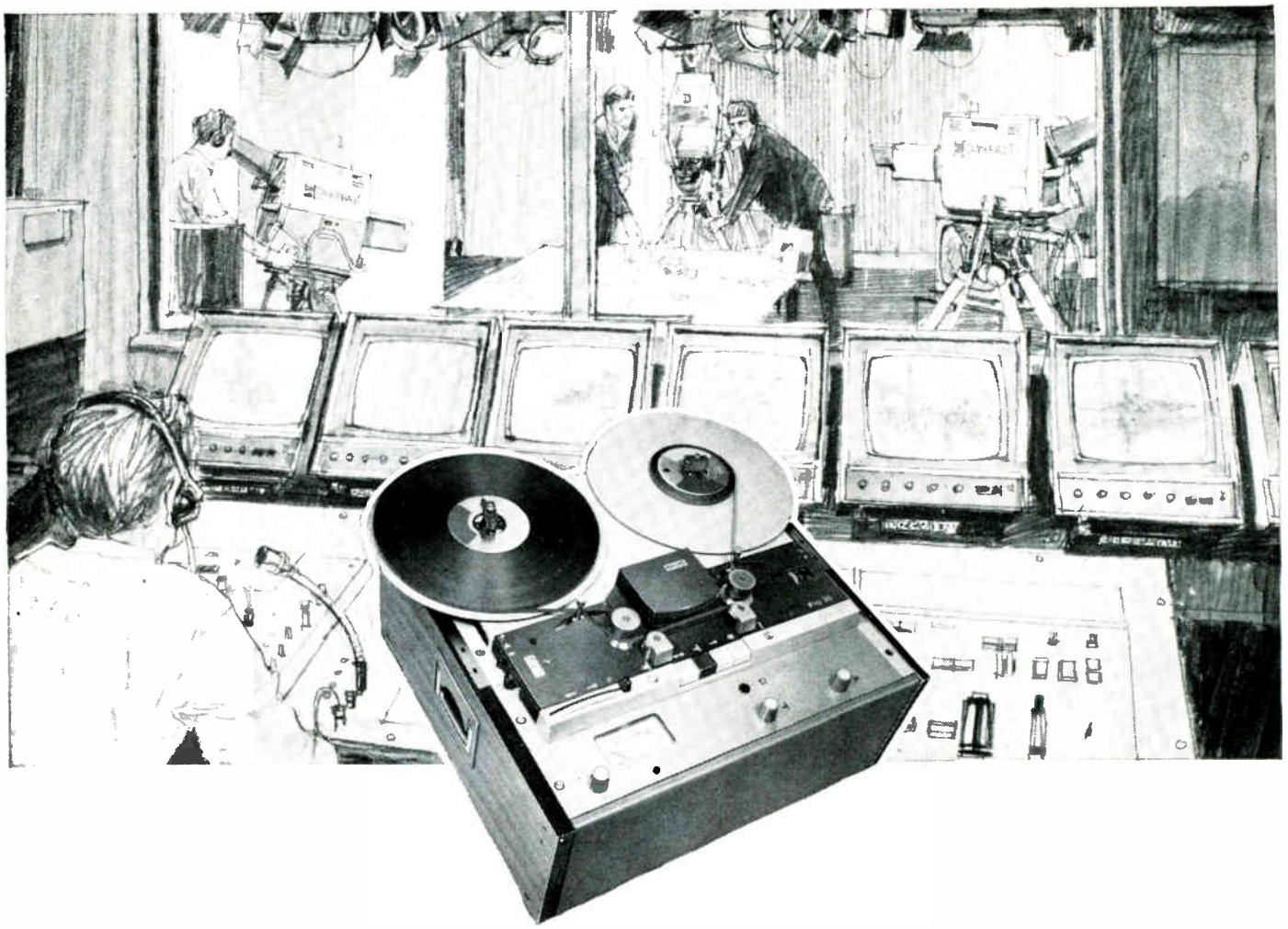

Philips Pro'36 Studio Tape Recorder

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

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

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

rely on Pye for professional studio equipment

PYE TVT

Pye TVT Limited, Cambridge, CB1 3JU, England. Telephone: Cambridge (0223) 45115 Telex: 81103

INDUSTRIAL SOUND RECORDERS

continued

Speed stability: ±0.5%.
Wow and flutter: 0.3%.
Start actuation time: 100 ms.

MANUFACTURER: Telex Communications Division, 9600 Aldrich Avenue, South Minneapolis, Minnesota 55420 USA.
AGENT: Avcom Systems Limited, Newton Works, Stanlake Mews, London W12 7HA.

UHER 1200 REPORT SYNCHRO

Full track single speed (19 cm/s) battery recorder designed for pilot tone film sync. Hanging magnetic heads permit rapid adjustment from above. Mechanical mode selection. Switchable AGC.
Spool capacity: 13 cm.
Wow and flutter: ±0.07%.
Speed deviation: ±0.5%.
Frequency response: 60 Hz to 12.5 kHz ±1 dB.
Signal-to-noise: 56 dB.
Distortion: 2%.
Pilot attenuation: 58 dB.
Price: £271.50.
MANUFACTURER: Uher Werke Munchen, 8 Munchen 71, Postfach 71 10 20, West Germany.
AGENT: Bosch Ltd, P.O. Box 166 | Rhodes Way, Watford, WD2 4LB, Herts.

12.5 mm

LEEVERS-RICH SERIES H

Four track two speed unit (38—19 cm/s) or 79—38 cm/s to special order).
Tape speed stability: ±0.2%.
Rewind speed: 2400 ft. in 90 secs.
Spool capacity: 26.7 cm 10½ inch NAB.
Wow and flutter: 0.06% (38 cm/s).
Frequency response: 40 Hz to 18 kHz ±2 dB.
Bias frequency: 127 kHz.
Noise level: 60 dB below peak.
Crosstalk: 45 dB minimum below adjacent track. —14 dBm for peak recording level with preset sensitivity adjustment. 10 K ohms bridging.
MANUFACTURER: Leevers-Rich Equipment Ltd, 319 Trinity Road, London SW18.

STUDER A80/VU-4-4

Four track version of 6.25 mm *A80*. Exchangeable head assemblies and tape guides permit expansion to 16 track.
MANUFACTURER: Willi Studer, CH 8105 Regensdorf, Zurich, Switzerland.
AGENT: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts.

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25 mm

AMPEX AG-440-8

Eight track version of 6.25 mm *AG-440-B*.
Crosstalk: 65 dB at 500 Hz.

MM-1000/8

Eight track system capable of rapid expansion to 16 or 24 channels. Based on videotape transport handling both 25 and 50 mm tape. Tape motion sensing, 38—19 cm/s speeds.
Frequency response: ±2 dB, 30 Hz to 18 kHz.
Wow and flutter: 0.08%.
Distortion: 1.1% at normal operating level.
Crosstalk: 50 dB, eight and 16 channels at 500 Hz.
Timing Accuracy: ±0.1%.
Start time: 500 ms.
AGENT: Ampex (GB) Ltd, 72 Berkeley Avenue, Reading, Berks.

LEEVERS-RICH SERIES G

Eight track version of 12.5 mm Series H.
MANUFACTURER: Leevers-Rich Equipment Ltd, 319 Trinity Road, London, SW18 17Q.

ORANGE (ADVANCE DATA)

Two speed (76—38 cm/s) multitrack recorder in eight or 16 track 25mm format.
Wow and flutter: 0.08% (38cm/s), 0.04 (76% cm/s).
Frequency response: 30 Hz to 15 kHz ±2 dB.
Distortion: 1% total.
Signal to noise: 57 dB.
MANUFACTURER: Orange Recording Studios, 3 New Compton Street, London WC2

SCULLY 288

Eight or 12 track version of 6.25 mm 280.

SCULLY 100-8, 100-12

Single speed (38 cm/s, or 76 cm/s on special request) recorder available with 8 or 12 tracks. Capable of expansion to 16 track 50 mm.
Wow and flutter: 0.06%.
Frequency response: 35 Hz to 15 kHz ±2 dB.
Bias/erase frequency: 100 kHz.
Price: £5,850.

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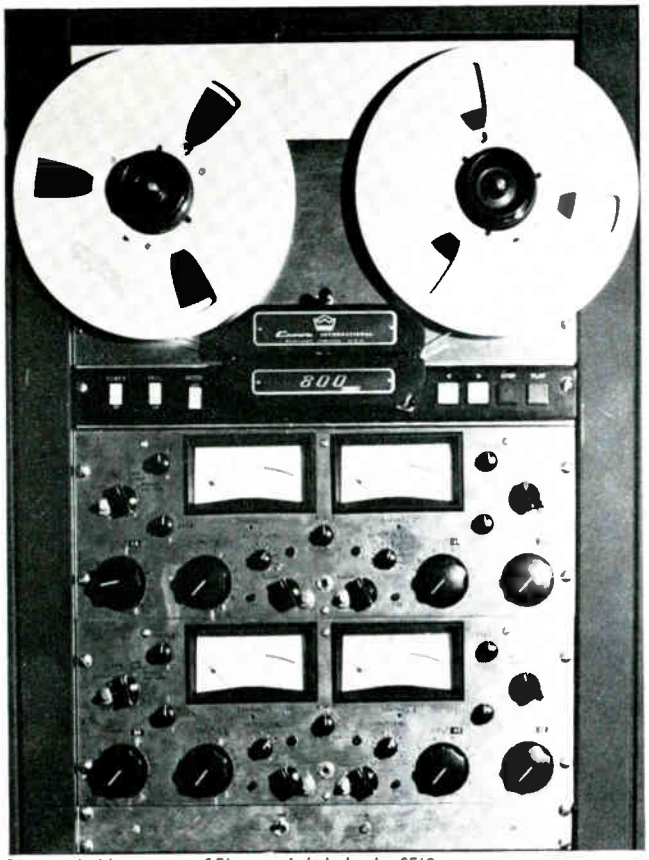

Photographed by courtesy of Electrosonic Ltd., London SE10

CROWN INTERNATIONAL

Only Crown International can offer professional quality performance from four track in-line machines using ¼in tape!

You even have three models to choose from:

SX744 Budget priced model with 8 mike inputs, and two speeds. **£997**

CX744 Modular electronics, remote facilities, three speeds. **£1340**

CX844 Logic circuit tape control, three speeds fabulous performance. **£1670**

Full details from sole agents

MACINNES LABORATORIES LIMITED
71 Oakley Road, Chinnor, Oxon

Tel. Kingston Blount (0844) 52061

CHILTON

We can rightly claim to be one of the leading British Companies in Tape Recorder Technology. We produce most of the specialised components, all sheet metal work, wooden cabinets, etc . . .

David Kirk. Studio Sound, April 1970:
Wow at 19 cm/s, listening to the replay of a 1 kHz tone at various points along the reel, was practically inaudible. This either means the *100S* transport is quite exceptional for its price or simply that I am deaf. I should therefore qualify the comment that three very much dearer recorders currently in my possession can all be heard wowing at 38 cm/s.

F. C. Judd. Hi-Fi Sound, October 1971:
I must also stress the point that it is all British made and that it provides facilities and performance rarely found on even the most expensive foreign-made recorders.

If you have a special requirement and want a competitive price may we quote?

* 2 or 4 channel ½ or ¼ track
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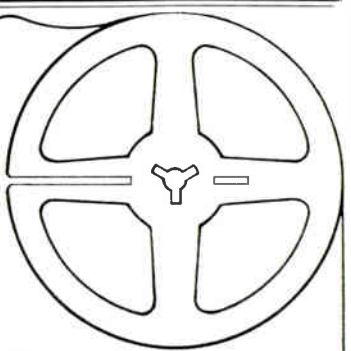

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High-speed Tape Copying Equipment

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sole UK distributors of Infonics

INDUSTRIAL SOUND RECORDERS

continued

MANUFACTURER: Scully Dictaphone, 480 Bunnell Street, Bridgeport, Connecticut 06607, USA.
AGENT: Feldon Audio Ltd, 126 Great Portland Street, London WIN 5PH.

STUDER A80/VU-4-1
Four track version of 6.25 mm *A80*. Exchangeable head assemblies and tape guides permit expansion to 16 track.

A80/VU-8-1
Eight track version of VU-4-1.
MANUFACTURER: Willi Studer, CH 8105 Regensdorf, Zurich, Switzerland.
AGENT: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts.

---

50 mm
AMPEX MM-1000/16
16 track version of 25 mm *MM-1000/8*.
AGENT: Ampex (GB) Ltd, 72 Berkeley Avenue, Reading, Berks.

ORANGE (Advance data)
16, 24 or 32 track version of 25 mm unit.
MANUFACTURER: Orange Recording Studios, 3 New Compton Street, London WC2.

SCULLY 100-16
16 track version of 25 mm *100-8*.
Price: £7,600.

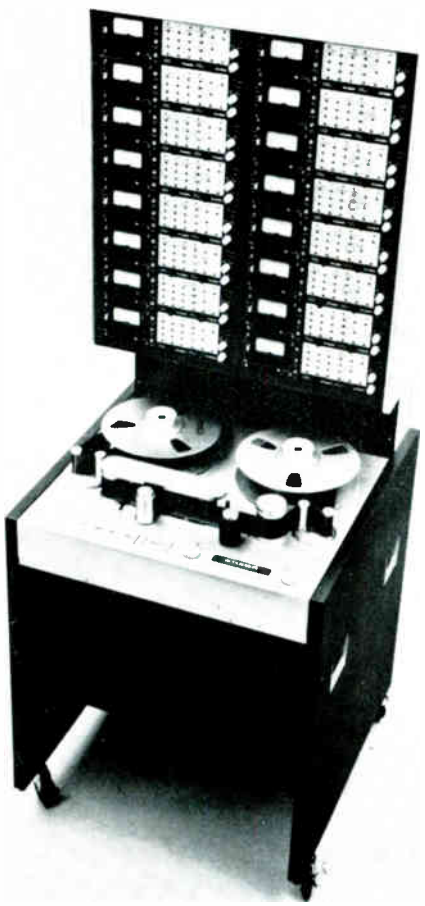
SCULLY 288
16 track version of 6.25 mm 280.
MANUFACTURER: Scully Dictaphone, 480 Bunnell Street, Bridgeport, Connecticut 06607, USA.
AGENT: Feldon Recording Ltd, 126 Great Portland Street, London W1.

STUDER A80/VU-16-2
16 Track version of 6.25 mm A80.
MANUFACTURER: Willi Studer CH8105 Regensdorf, Zurich, Switzerland.
AGENT: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts.

MAGNETIC FILM

ALBRECHT MAGNETIC FILM SYSTEMS

Prices for all machines are for basic model excluding head assembly, printed board carrier, level control unit, connecting cables and amplifiers; 16 mm and 17.5/35 mm models have the same price.



Studer A80/VU-16-2

MR10 portable recorder: £1,694.
MB2/1-W reproducer: £1,476.
MB2/1-A recorder/reproducer: £1,466.
MB21/1-W reproducer: £1,658.
MB21/1-A recorder/reproducer: £1,677
MB41 recorder/reproducer (syntronic): £3,280.
MB41- Duplex (second machine of pair): £2,510.
MB41-16/35 Interchangeable 16/35 mm: £3,550.
BA21-16 Video sync machine: £2,264.
BA41-16 Video sync machine (Syntronic): £3,820.
MANUFACTURER: Wilhelm Albrecht GmbH, 1 Berlin 44, Maybachufer 48-51.
AGENT: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts.

LEEVERS-RICH SERIES F

Range of magnetic recorders suitable for COMMAG duplicating and all SEPMAG applications. Available in 8, Super 8, 16, 17.5 and 35 mm. Specification relates to model *F35*.
Film Gauge: 35 mm edge stripe or fully coated.
Film Speed: 24 or 25 f/s convertible (sprocket change).
Frequency Response: 40 Hz to 15 kHz ±2 dB.
Noise Level: 57 dB.
Wow and flutter: 0.05%.
Dimensions: 700 x 540 x 1560 mm.
Weight: 100 kg.
Price: (single F4R-C-R recorder/reproducer): £1,400.
MANUFACTURER: Leevers-Rich Equipment Ltd, 319 Trinity Road, Wandsworth, London SW18.

SONDOR MINI M3

Operates from 12V car battery (24V on request.) Two tracks (interchangeable plug-in head assemblies available).
Cue Track: Automatic.
Speed: 24 or 25 f/s.
Counter: Built-in footage counter.
Interlock: (a) 1V 50 Hz pilot tone
(b) Rotary pulse generator.
(c) Built-in crystal oscillator.
(d) Signal output for interlocking further 'Minis'.
Starting Time: Less than 5 ms.
Loudspeaker: Built-in, switchable.
Dimensions: 420 x 280 x 250 mm.
Weight: 16 kg.

OMA 3

Rack system operating synchronously from any of the following input signals: (1) AC mains. (2) Pulses from a remote Sondor pulse generator attached to any rotating shaft. (3) 50 or 60 Hz pilot signals from a 6.25 mm magnetic tape replay machine. (4) 250 Hz control track from a video tape recorder, interlock output from any other Sondor machine.
Frequency response: 40 Hz to 12 kHz ±1.5 dB.
Signal to noise: (20 Hz to 20 kHz) 60 dB.
Distortion: 1.2% using BASF Polyester film.
Wow and flutter: 0.1%.
Dimensions: 1890 x 635 x 543 mm.
Weight: 170 kg.
AGENT: Hayden Laboratories Ltd, 17 Chesham Road, Amersham, Bucks.

DUPLICATORS

AMPEX BLM-200

Endless loop bin storage reproducer (304—152 or 608—304 cm/s) playing eight track 25 mm master, equalised for NAB 19 cm/s. Designed to feed *3400 Series* slaves.
Wow and flutter: 1% peak-to-peak (0.5 Hz to 10 kHz). Will not introduce more than 0.1% rms (NAB weighted) in final copy.
Frequency response: Reproduce chain from a 19 cm/s NAB master: ±1 dB 1 kHz to 320 kHz at 608 cm/s (30 Hz to 10 kHz at final copy speed) Duplicated copies ±2 dB 50 Hz to 10 kHz at 19 cm/s (8 track cartridge) ±2 dB 50 Hz to 8 kHz at 4.75 cm/s (cassette).
Tailoring Tone: Switchable 120 Hz or 320 Hz actuated by photocell, applied at saturation level to input of record amplifiers.
Crosstalk Rejection: Between tracks or between adjacent even or odd track pairs; greater than 50 dB from 30 Hz to 10 kHz (at final copy speed).
System Noise: Better than 10 dB below a blank, biased, Ampex 404 low noise tape; 30 Hz to 5 kHz

(continued on page 45)

Sound like the pro you'd be if you were recording for money instead of love.

If you're serious about tape, the TEAC's A-3300 is a tape deck you can take seriously.

It'll accept 10½-inch reels, like a professional deck, for up to 6 hours of recorded material. And it has professional features you won't find on any other tape deck for the price.

Like the new Front Panel Bias Switch for the proper selection of bias current and recording equalization for either conventional tapes or the new low noise/high output tapes.

And expanded scale professional-type VU meters for each channel. The wide excursion scale simplify recording at higher (up to 6dB) signal levels, a must when using the new tapes, assuring better signal-to-noise ratio and an expanded dynamic range.

Another is TEAC's unique Edi-Q, an electronic pause control; it interrupts taping but keeps the recording amplifiers on and ready, eliminating recording clicks and tape bounce during quick-start operation.

Of course the A-3300 has the kind of professional specs you'd expect from TEAC (after all, we make the professional systems too) – S/N: 58dB, wow and flutter: 0.06% and frequency response: 25 – 24,000Hz (± 3dB; 30 – 20,000Hz) at 7½ ips.

Before you spend your money on any tape deck, spend some time with the A-3300. At your dealer's.

Various head configurations and speeds are available to fit every need.

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TEAC EUROPE N.V., Kabelweg 45-47, Amsterdam-W.2 Phone: 020-12 44 04 **U.K.** Lasky Radio Ltd., 42/45, Tottenham Court Road, London, W.1 Phone: 01-580-2573 **Belgium** INELCO S.A., 20-24, Rue de l'Hopital, B-1000 Brussel 1 Phone: 112220 **Denmark** Quali-Fi, Christiansholms Parkvej 26, Klampenborg Phone: ordrup 10600 **Greece** Elina Ltd., 59 & 59A Tritis Septemvriou Street, Athens 103 Phone: 820-037 **Switzerland** Lectronic AG, Weststrasse 117, CH-8036 Zurich Phone: 331022 **W. Germany** TEAC EUROPE N.V. Wiesbaden Office, 6200 Wiesbaden-Dotzheim Wiesbadenerstrasse 68 Phone: 06121-42791 **Italy** Audel s.a.s., 20124 Milano V. le Tunisia 45 Phone: 66-11-68 **Holland** INELCO-Holland N.V., Amstelveenseweg 37-39 Amsterdam Z 2 Phone: 766617, 766618 **Sweden** Martin Person AB, Sveavagen 117, Box 19127 10432 Stockholm 19 Phone: 08-233045 **Ireland** International Trading Group Ltd., 5 Cope St., Dame St., Dublin 2 Phone: 771769 **Portugal** Jorge Goncalves, Avendia 5 de Outubro, 53, Lisboa-1 Phone: 44029

INDUSTRIAL SOUND RECORDERS

continued

at final copy speed. Better than 6 dB up to 10 kHz.
Size: 155 x 107 x 69 cm.
Weight: 225 kg.

CD-200
High speed cassette copier feeding up to five slaves.
Tape speed (throughout length of C60 cassette): 190 cm/s ±0.2%.
Overall cycle time: C60 cassettes, approx 75s plus load time (45 per hour per slave).
Typical copy: ±2 dB, 50 Hz to 8 kHz, using Ampex *361* cassette, biased for maximum long wavelength sensitivity.
Wow and flutter: Less than 0.05% rms, NAB weighted.
Crosstalk rejection: 20 dB at 1 kHz playback between adjacent tracks of stereo pair. 50 dB between programmes.
Track formats: Four track stereo, two track mono.
End of tape sensing: True end of tape sensed independent of leaders, splices, sensing tape, or tones.
Automatic slave loading: 100 cassettes (may be replenished manually while CD-200 is operating). Load Time: approximately 7s.
AGENT: Ampex (GB) Ltd, 72 Berkeley Avenue, Reading, Berks.

BRANCH & APPLEBY MASTER COPIER
Copies 9.5 cm/s originated master at 38 cm/s on to eight cassettes running at 19 cm/s for 4.75 cm/s reproduction. Crystal controlled master oscillator.
Frequency response: 50 Hz to 8 kHz ±3 dB (cassette to cassette).
Wow and flutter: 0.25%.
Dimensions (desk version): 580 x 540 x 570 mm.
Weight: 33 kg.
Master reel to cassette copier, eight station, desk mounted: £1,480.
Master cassette to cassette copier, eight station, desk mounted: £1,490.
Floor mounted: £1,480.
Slave copier, eight station: £1,180.
Auxiliary cassette to cassette replay unit, desk mounted: £390.
Auxiliary reel to cassette replay unit, desk mounted: £390.

Cassette rewind unit, high speed auto ejection, desk mounted: £150.
MANUFACTURER: B. & A. Systems, 42 High Street, Harrow-on-the-Hill, Middlesex.

INFONICS 102
76 cm/s two-off cassette to cassette duplicator.
Frequency response: 40 Hz to 10 kHz ± 3 dB.
Price: £800.
AGENT: Fraser-Peacock Associates Ltd, 94 High Street, Wimbledon Village, London S.W.19.

TELEX 235 -1
Open reel duplication system designed for maximum operational flexibility. Flutter-filter multiple belt drive from two speed hysteresis synchronous motor. Wide range of track and slave configurations.
Speed stability: 0.5%.
Wow and flutter: 0.17% (38 cm/s).
Frequency response: 40 to 10 kHz (9.5 cm/s copies)

235 CS-1
Reel to cassette version of 235 —1.
Price: £1,360 (½ track mono, three slaves)
MANUFACTURER: Telex Communications Division 9600 Aldrich Avenue South, Minneapolis, Minnesota 55420, USA.
AGENT: Avcom Systems Ltd, Newton Works, Stanlake Mews, London W12 7HA.

Late Entries

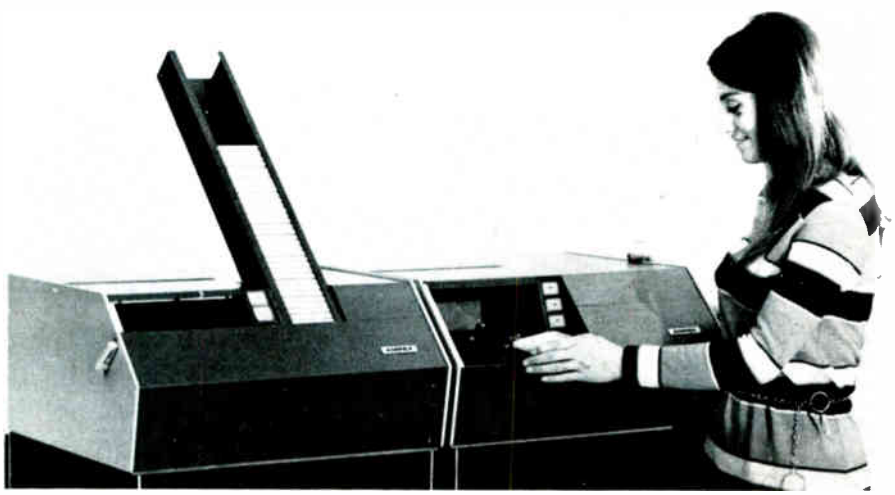
CROWN
Range of two and four channel 6.25 mm recorders manufactured by Crown International, Indiana, USA. Models SX724, SX700, CX711, and CX824.
AGENT: Macinnes Laboratories Ltd, 71 Oakley Road, Chinnor, Oxon.

KLARK
6.25 and 12.5 mm custom-built tape equipment with full remote control facilities.
MANUFACTURER: Klark Equipment, MOS Industrial Site, Summerfield, Kidderminster, Worcestershire.

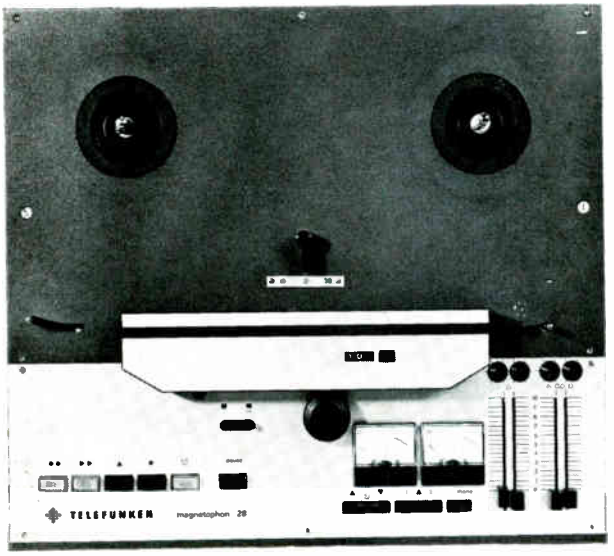
PHILIPS
Range of two, four and eight channel recorders manufactured by Philips Broadcasting Equipment, Eindhoven, Holland. Models Pro36, Pro51, Pro71A and Pro72.
AGENT: Pye TVT Ltd, Cambridge CB1 3JU.

RICHARDSON
Range of 6.25, 12.5 and 25 mm recorders for one two, four and eight channel operation.
MANUFACTURER: Richardson Electronics Ltd. 57 Jamestown Road, London NW1.

Ampex CD-200



TELEFUNKEN M28A £633



MAGNETOPHON M28A professional tape recorder by Telefunken, the company who made the world's *first* tape recorder.

● **Three-motor tape transport** at 3¾ and 7½ ips ensuring maximum speed constancy.

Fully comprehensive mixing facilities.

● **Solid state electronics** are used throughout Modular construction ensures trouble-free maintenance and replacement of parts.

● **Relay operated transport control** operated by illuminated push buttons requiring only fingertip operation.

● **Two-channel monitoring and VU-meter amplifier** can be switched to two modes. In the 'before-tape' mode the amplifier is connected to the output on the mixer, while in the 'after-tape' mode it is connected to the output of the replay amplifier. Two large VU-meters calibrated to international standards are provided.

● **Interchangeable head assembly** comprising half-track, stereo, erase, record and playback heads, is mounted on a single rigid plate fixed to the main chassis. It is normally not necessary to replace or adjust heads during the normal life of the machine.

Broadcast studio versions. Models 28B and 28C are provided with tape speeds of 15 and 7½ ips, but have no mixing or monitoring and VU-meter amplifier. Model 28B is equipped with full-track heads.

Model 28C has two-track heads and track selector switch.

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A.E.G. House
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Letters

Transistor amplifier noise

Dear Sir, I am prompted to write this letter by what appear to be some misconceptions held by a number of authors in the area of transistor amplifier noise.

On a recent occasion ('Designing a Studio Mixer' Part Six in the January issue) the following statement was made: 'We know that we want a virtual earth resistance of somewhere about 1 kΩ for optimum noise performance from the amplifier because this resistance is the source impedance seen by the amplifier'. This implies that the source impedance required by an amplifier for optimum noise performance can in some way be provided by feedback (ie the virtual earth impedance). In fact, the effect of any feedback resistor depends only on its actual value and not on the amount of feedback it provides. A resistor providing shunt feedback at the input appears directly in parallel while a resistor providing series feedback appears directly in series with the input as far as its noise contribution is concerned.

In fig. 4 of the aforementioned article the effective source resistance of Tr1 as far as noise is concerned is the total resistance of the source including Rin, in parallel with the resistance formed by the combination of R1, R2 and R3. Thus with 10 kΩ faders and 47 kΩ mixing resistors (resulting in around 50 kΩ say) the amplifier source resistance will approximate to 50 kΩ divided by the number of channels, since the bias and feedback resistors will be negligible with more than say five inputs.

There also appears to be some confusion as to the optimum emitter current and optimum source impedance for minimum noise contribution by the amplifier. As long ago as 1963 the BBC published an excellent microphone amplifier design in their monograph. If I remember correctly, this was subsequently published in a mixer design by Mr Robinson in this journal. In this design a noise figure of 3 dB was achieved; ie the amplifier only increased the noise by 3 dB above that which the microphone itself generated because of thermal noise in its source resistance. The BBC found that for the germanium transistors used the optimum emitter current and source resistance were about 280 μA and approximately 800Ω respectively. When the Robinson mixer was updated and converted to silicon transistors I seem to recall that similar emitter currents and source resistances were maintained whereas these are not the optimum ones for silicon devices.

If one consults the published data of a low noise silicon transistor such as the Mullard *BC771*, one finds from the noise curves that optimum emitter current and source resistance are around 10 μA and 50 kΩ respectively when a typical noise figure (due to the transistor alone) of less than 1 dB can be obtained. It would thus appear fairly easy to produce amplifiers which add only 1 dB to the thermal noise of the source. One not immediately obvious advantage of operation at emitter currents of about 10 μA is a considerable reduction in low frequency 'flicker' noise over that obtained at 200 μA.

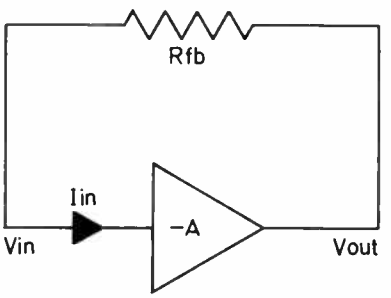
Another area where the source impedances optimum for germanium transistors seems to have been retained when silicon devices took over, is in tape heads. Whereas 100 mH was about right for matching to germanium devices, it would appear that silicon devices operating at around 10μA and feed from replay heads of inductance (or transformed inductance) of between 1 and 10 henrys should produce better results.

Yours faithfully, J. E. Marshall, 59 Tremayne Road, Bilborough, Nottingham NG8 4HS.

I may suffer from some misconception and I am always grateful for someone pointing this out. I do believe, however, that our correspondent is up a gum tree and I shall try to explain why. In order to clarify matters, let us look at the simplest possible form of an operational amplifier as shown in the sketch. Here we have no input resistors or potentiometers to confuse the issue. According to your correspondent, the source resistance seen by the amplifier is Rfb, neglecting the bias network etc. See his third paragraph, I wish to test this assumption by having the amplifier make a current demand on the source and see what the voltage change at the input terminals is.

Let the standing input current be 10 μA and let the standing output voltage be 10V. Since the input currency is derived from the output voltage, there must be a volt drop across the Rfb (=100 kΩ) of 1V (100 kΩ x 10 μA). This gives a standing input voltage of 9V. Now what happens if the amplifier makes a demand for ten more microamps? The volts drop across Rfb will increase to 2V all right but what will the change input voltage be? We know that the amplifier gain is fixed at 100, so we know that more of this voltage drop difference will be established at the output terminals than the input.

Thus $\triangle V out = 1V$



Therefore $\triangle V in = 1/100 = 10 mV$

Then $R_S = \frac{10^{-2}}{10^{-5}} = \triangle \frac{Vm}{Im} = 10^3\ \Omega$

Then the source resistance for the amplifier is $\frac{100\ k\Omega}{A}$ *(or the virtual earth resistance) which is what I said before. Compare this result with what would happen if he was right.*

$\triangle I in = 10\ \mu A$

$R_S = 10^5\ \Omega$

Therefore $\triangle Vin = 10^{-5} \times 10^5 = 1V$

$A = 100\ x$

$\triangle V out = \triangle V in \times A$

$= 1 \times 100 = 100V$

which is impossible.

He must therefore be wrong QED. I think he is neglecting the fact that noise is a dynamic rather than a static condition.

Common sense is against him anyway because, if what he says is true, then the more input channels you have, the quieter is the mixer noise, which is clearly not true. The fact is that, in an extreme case, when the external source is made comparable in value with the Virtual Earth Resistance (as when the source is a microphone), the noise output rises.

Peter Levesley

Mr Marshall is right when he says the contribution of a resistor depends only on its value and not on the feedback—otherwise we could carry on increasing the feedback and get lower and lower noise levels. This old fallacy was opened up in Wireless World not all that long ago.

On the subject of the mic amp itself, yes, the germanium devices required a source impedance of about 2 kΩ (not 800Ω though) for lowest noise. Silicon devices like to see somewhat higher sources, and in any new design this would be taken into account. Practically this will be somewhat lower than the 50 kΩ quoted, with 20 to 30 kΩ being typical. Noise figures of 1 dB can be obtained, but it is a very difficult problem even so as there are many other things to be considered. With these low collector currents, there can even be the paradox that the second stage is more difficult to design than the first in the mic amp!

In the mixer, the most important point was that it was updating of the design. Many people wished to convert as simply as possible retaining as much as they could of the old components—for example the input transformer. Doing the very minimum of changes (and hence no time-consuming design work!) gave a noise figure of in the region of 2 dB, which is pretty good. As a compromise, the new transformer (Sowter) is wound with a much higher ratio to get the source input impedance higher.

Much the same goes for tape heads—one problem here is capacitance in the leads and shunt effects. **David Robinson**

Studio Diary

BY KEITH WICKS

SARM (Sound & Recording Mobile), a small studio born last October, is now doing virtually all the tape copying work for Bell, Page One, Transatlantic, Rediffusion, Sunbury, Carlin and Avenue. Business has been so good that Barry Ainsworth and Garry Lyons are now looking for better premises. Rather than build a new studio, they would prefer to buy an existing small studio somewhere in the Greater London area. Prospective customers or vendors should telephone 01-346 0209.

Among recent visitors to IBC **Studios** were American artist Joyce Everson, Andy Bown, the Bee Gees, Richard Barnes, Magna Carta, Roger Jensen and Atomic Rooster. Doug Flett and Guy Fletcher of Egg Productions were among those recording material for MIDEM.

Bob Kerr (of Whoopee Band fame) and his partner, BBC technician Chris Glass, spent about a year building **Felsham Sound Studios.** The Whoopee Band have been trying out the studio, which measures about 4.5 x 9m and holds up to ten musicians. At the moment, a borrowed 12 channel mixer is in use until their new 24 channel mixer is ready. The microphones are mostly AKG capacitors, and the stereo recorders are Revox.

Although the studio is still in the experimental stage, several well known artists have recorded there. Keef Hartley has been in, Thunderclap Newman made half of an album for Track Records here, and Roger Ruskin Spear recorded an album for Liberty. Bob Kerr is now recording an album featuring his own band.

The charges are very low, stereo recording being £3 or £4 per hour, depending on the material. Additional information can be obtained by telephoning 01-789 5804.

Harry Hall, **West of England Sound Studio's** wine, women and wiring expert, is busy constructing the company's second studio. Business has increased considerably over the last few months, albums having been made for Faraway Folk and Sharon Whitbread & Fred. Reflections, the Kevin Sands Orchestra, Sweet Life and Gandalf Folk are others who have recorded at this studio recently.

At the time of writing, Hallmark's Top of the Pops Number 21, recorded at **Intersound,** was at second place in the *Retailer* album charts, and forecast by an excited Vena Nolan to hit the number one spot. Phoenix, Standard, Rediffusion, Pickwick and Avenue have been using the studio regularly.

This month's varied work at **Theatre Projects Sound** has included a music session for a Thames Television *Witches* programme. This was recorded to picture on 16 mm sep mag, with simultaneous recording on 6.4 mm tape with sync pulses. Mitchell Monkhouse Associates booked several sessions to record music for an *Old Silent Comedy Film* series for BBC Television. Film director Lloyd Fraser saw the Madame Tussaud *Battle of Trafalgar* display, for which Theatre Projects provided visual and aural effects. As a result, he has asked Theatre Projects to supply the sound effects for a film about Nelson which he is making for Anglia Television. Pre-Christmas pantomime work included a Frank Ifield voice-over for *Sinbad the Sailor*, effects for *Cinderella* and *Toad of Toad Hall*, and a voice-over for *Robinson Crusoe on Dolphin Island* by Bob Danvers-Walker. Bong.

Marquee's TBT desk

Since perfecting their 16 track 25 mm machine, the **Orange** engineers have been working on five production models and hope to exhibit a completed machine at the Frankfurt Trade Fair. A batch of 100 amplifiers is being built and two types of deck will be made, one to take up to 25 mm tape, and the other to take up to 50 mm. A great deal of interest has been shown in the Orange *Mini 16* design and there are many potential customers.

The Orange tape amplifier modules will have no mechanical switching, all functions being selected by pressing buttons which illuminate and operate relays. This allows all switching to be performed from a remote location. Another feature of the design is separate aural and visual monitoring switching. This makes the system more versatile and, among other things, allows the engineer to check the presence of the recorded signal on the meter while the signal is monitored on the speakers. BBC readers are reminded that commercial studios, almost without exception, listen to *line in* when recording.

Melody Maker writer Karl Dallas has produced a Teddy Monro single at **Gooseberry Studios.** Georgie Fame has been recording a film soundtrack, and some of the T. Rex musicians are scheduled to come in soon. Around the time this issue of STUDIO SOUND is published, Gooseberry will be going eight track and the charge will be only £10 per hour. Twelve track facilities will also be available as it will be possible to run the eight track machine in sync with the four track.

Wessex studio manager Adrian Ibbetson engineered sessions for Bridge (formerly Putney Bridge), who have been working on an album and a single, the latter entitled *Oh Day, Oh Day*. Will this sound like the Banana Boat Song played backwards? Mike Batt produced more tributes to various artists, Helen Macarthur finished an album, and pop ballad singer Robert Young worked on an album for CBS. The Straight finished an album for Chapter One Records, and newcomer Mike Brady, a Midlands cabaret artist, recorded a single with the help of MD and producer Cy Payne. Also at Wessex this month were Milkwood, the Royal Lifeguards, the Andy Ross Orchestra, and Clodagh Rodgers, who finished an album for RCA.

In December, **Marquee** installed a new 24 channel desk, designed and built by Tim Blackham Technical. In addition, two more 6.25 mm machines were acquired for effects and copying. The studio had a very heavy month, Jonathan King laying down tracks for three

(continued on page 56)

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★ Free Service during Guarantee period
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Revox 1102/4 2 sp. Stereo
Sharp RD 712D 3 sp. 4 Tr. Stereo
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Sony 630D 3 sp. 4 Tr. Stereo
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*Telefunken M207 2 sp. 4 Tr. Stereo
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Telefunken 201 Mono 4 Tr.
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*Uher Royal de Luxe 4 Tr. 4 sp. St.
*Uher Varicord 263 Stereo
*Uher 724 4 Tr. 2 sp. Stereo

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Sony TC 330 Stereo Cass./Spool

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

*Sony TC 127 Deck and Pre-amp
*Sony TC 122 Deck and Pre-amp
*Philips 2503 Deck and Pre-amp

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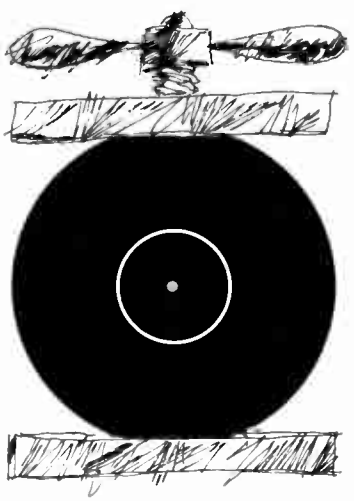

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Improving a Revox A77

Part One **By Angus McKenzie**

IT is well known that Revox model *A77* recorders can make recordings of a very high standard although certain facilities are lacking on the machines, facilities which are normally required in professional use. This article describes how a number of modifications can be incorporated, making the machine suitable for use as a high standard, professional mobile recorder.

The Revox is available with or without loudspeaker amplifiers and, when supplied with amplifiers, can also include built in loudspeakers, if required, in a version known as the suitcase model. The machine is available with two speeds, either 9.5/19 cm/s or 19/38 cm/s. The high speed version is often termed the professional version. The low speed model is usually supplied with NAB equalisation whereas the high speed model is normally supplied as a DIN version, although NAB can be supplied to special order.

Most studios use a nominal peak line level of six on a ppm equivalent to +8 dBm. Alternatively studios using vu meters will frequently be driving levels of up to +14 dBm under normal conditions, and transient peaks of up to +16 dBm are occasionally encountered. When not modified the Revox input circuit clips if the input exceeds approximately +11 dBm, and the output circuit clips at approximately 13 dBm into open circuit and +8 dBm when loaded with 600 ohms. It will be seen therefore that an unmodified Revox *77* will record severe clipping distortion on its input amplifier when used across the output of many professional control desks or systems. Many engineers who have not had the time to look into the reasons for this have blamed the electronics of the record amplifier. Similarly very high output tapes when played back on the Revox may well distort at the output sockets on the machine due to the monitor line out amplifier being overdriven. Many Revox owners have commented to me that the hiss level deteriorates on playback, or indeed when monitoring line input if the replay gain control is used at about 6 dB down from its flat out position. Also some users have noticed that the monitoring circuits load down the input of the record amplifiers by 1 dB when in the line in monitoring position, this position therefore dropping the record level by the same amount. It is worth pointing out here that if the replay volume control is set flat out and the mode switch set such that tracks one and two are combined for mono, should the a/b switching be left inadvertently in the 'line-in' position, the recording made will also be mono, even if all the record amplifier controls are set to stereo.

The Revox can in some cases also produce an earth loop, particularly when both the auxiliary input and output phono sockets connect with external equipment. In some cases readers have also had radio frequency interference problems which can become quite noticeable under certain conditions, particularly on replay. In addition to radio breakthrough, noise from lighting or power circuits may be noticed.

In order to appreciate the reasons for the different modifications proposed it is useful to regard the different circuits in the Revox as a series of operational amplifiers and these will now be described.

The input pre-amplifier in the record section has different gains controlled by changing the amount of feedback, the gain change being achieved by the input selector. The low impedance microphone input has the highest gain and hence the least amount of feedback, whereas the auxiliary input has the least gain—in fact almost unity gain—achieved by nearly 100 per cent feedback.

The input preamplifier has a fixed gain in any one position and its output feeds the record volume control. The outputs from the two channels can be resistively mixed, the output from this point feeding both the input to the record amplifier proper and the a/b monitoring switch. The mixing resistors form a 6 dB pad when the machine is used for stereo and the source impedance of the a/b monitoring amplifier is largely controlled by the value of the replay volume control, which is 25 kΩ. When the a/b switch is in the 'line in' position this affects the output of the 6 dB pad, which follows the record volume control, by 1 dB. This affects the level read by the vu meter and thus the level recorded on to tape.

Record amplifier

The record amplifier contains the recording equalisation circuits, the equalisers simply shifting the point above which a 6 dB per octave boost curve is applied to give the correct overall response. The output of this record amplifier drives the vu meter circuit with both its own preset and the record level preset pot enabling the correct a/b level balance to be achieved. The available amount of record equalisation can be altered if necessary by adjusting the value of the capacitors connected to the sliders of the record equalisation presets.

The record head driver circuit includes two transistors; the head is driven from the junction of the emitter of one with the collector of the other. The emitter circuit of the second transistor includes the extra components giving the treble end of the NAB response curve, and consists of an RC time constant in parallel with the emitter load section, this circuit giving approximately a 3 dB shelf treble lift. In series with this circuit down to ground is a 38 kHz filter to stop any interference which might be produced by harmonics from some stereo tuners beating with the bias supply.

The replay amplifiers have the replay equalisation applied back to the first emitters and are followed both by the replay bias traps and by the replay preset gain controls, the output of which feeds the a/b monitor switch. The a/b monitor amplifier follows the replay gain control and has an unnecessarily high input impedance. The balance control operates by reducing feedback in one channel, thus increasing its gain, at the same time as increasing feedback in the other channel, reducing the latter's gain. The line output is taken from the final emitter of this amplifier which also drives loudspeaker amplifiers if present.

Since the record preamplifier when switched to the auxiliary position has normal unity gain its input clipping point is virtually the same as its output clipping point and this is determined both by the type of circuitry employed and the rather low ht voltage. Since the gain of the amplifier cannot itself be reduced it becomes necessary to apply a resistive pad on the auxiliary input to decrease the level applied to the preamplifier. An 8 dB pad giving an input impedance of approximately 50 kΩ can be achieved by using a series 27 kΩ resistor followed by a 22 kΩ resistor to earth. These are best mounted immediately behind the auxiliary input phono sockets. This modification will give an input clipping level of about +19 dBm which should be sufficient for any requirement.

To obviate the bridging effect of the replay amplifier on the record circuits the entire resistive mixing pad circuit should be removed although this will lose the facility of input mixing when half track mono recordings are being made. The source impedance then becomes approximately 1.3 kΩ, sufficiently low to avoid bridging loading.

The a/b switching on the Revox is carried out at a very low level so that if the machine has been set up normally only 9 mV are present when a level of 0 vu is being recorded or played back. Since the monitor amplifier has therefore to bring this up to a level of approximately 1.25 volts (43 dB gain) and also has a high input impedance it will be seen that when the replay volume control is 6 dB down from maximum the source impedance to the monitor amplifier is at its greatest thus causing audible hiss. The only way to reduce this is to decrease the gain of the monitor amplifier and increase the level at the a/b point. Thus the record amplifier will be driven 10 dB harder and will have a 10 dB worse clipping level. The record amplifier gain has therefore also to be reduced by 10 dB and this is best achieved by increasing the emitter resistor from 1.5 to 4.7 kΩ. So as not to alter the dc conditions seriously the first collector load should also be increased to 220 kΩ, thus stabilising the dc feedback. On some machines it may be found necessary to alter the capacitor

(continued over)

continued

in the lower speed equaliser to a considerably lower value to reduce the minimum amount of equalisation available at this speed. At the higher speed however no change need be made.

The reduction of gain in the record amplifier will also slightly reduce its contribution of hiss, and the 10 dB loss of record gain can be made up by increasing the record volume control. It is fair to point out that unless the 6 dB pads are removed this loss of gain will become significant when moving coil or ribbon microphones are used direct into the Revox for the recording of speech or quiet sounds. It is possible that an extra microphone preamplifier might then become necessary. This is desirable in any case since the Revox has only unbalanced inputs for microphones, often the cause of tricky hum and rf pick up problems.

In order to make a standard, low speed Revox record accurately to the DIN curve at 19 cm/s the RC circuit of 2.2 kΩ and 0.033 μF should be disconnected. This will be found to give a treble reduction at 9.5 cm/s which can easily be corrected by increasing the equalisation at the lower speed only. The DIN response achieved will be considerably more accurate than that produced by only reducing the equalisation at 19 cm/s for DIN response. On most machines it will not be found necessary to alter any components on the record circuit to give a bass response within specification for DIN although the best compromise between the two lower speeds can be achieved by increasing the value of the bass boost capacitor by 20 per cent (0.1 μF being changed to 0.12 μF) found in series with the equalisation pots.

The monitor amplifier gain should be reduced by short circuiting a 22 kΩ resistor between the slider of the balance pot and the first emitter of the monitor amplifier. It is also necessary to insert a hold off resistor of 2.7 kΩ in the feed to the top of the balance pot where it is driven via a capacitor from the output emitter. This prevents instability when the gain of the amplifier is reduced to near unity as the balance control increases the gain of the opposite channel.

The clipping point of the monitor amplifier is normally at approximately +13 dBm into open circuit and this prevents standard play tapes recorded at only fairly high levels from driving external equipment at as high a level as is frequently necessary. If a Dolby, for example, is required to be driven by the monitor amplifier to replay Dolbyed tapes and the gains are set up such that Dolby level gives an output from the Revox of +4 dBm into the Dolby, many tapes will be subject to clipping. Two modifications are therefore required which will improve the clipping level substantially. The dc conditions of the monitor amplifier can be controlled by altering the value of the emitter resistor of the second stage which drives the output stage. The best compromise is to reduce this from 1000 to 680Ω. In addition a 560Ω resistor is permanently in series with the output which is also effectively loaded by 9.4 kΩ produced by the resistors feeding the five pin DIN socket. The 560Ω resistor therefore gives 0.75 dB reduction in level at the output terminals and is best shorted out. The two 4.7 kΩ resistors however should be left in circuit to allow the output coupling capacitor to have a dc return enabling it to charge up. Care should be taken to avoid short circuiting the output of the Revox when this modification is done since the 560Ω is in fact present in the normal circuit to stop domestic users from overloading the output stage through misuse.

The clipping level of the monitor amplifier now becomes approximately +17 dBm in to as low as 5 kΩ and a 600Ω load will cause clipping at +12 dBm. The modification allows any but the most excessively highly recorded tapes to be played back at compatible studio levels. If necessary both the auxiliary input and output circuits can be provided with 1:1 balancing transformers, the input transformer being of nominal 10 kΩ working impedance whilst the output transformer should be of 600Ω nominal impedance. The input and output sockets will then have to be replaced by more suitable balanced sockets.

The replay preset gain control will be found to have an ample amount of gain to spare and will easily give the extra 10 dB required by the modified monitor line out amplifier. In the high speed version, as supplied direct from Switzerland by Studer, both positions of the equalisation switch at the higher speed normally have the same equalisation although on the lower speed version either NAB or IEC high frequency characteristics are available. It will be noticed on examination that this high speed version has a short circuit on the printed circuitry allowing only one replay characteristic at the higher speed. This should be replaced on the DIN version by a resistor of 1.5 kΩ which will then give a useful NAB 38 cm/s 50 μS time constant with the switch fully clockwise. A 3 dB rise at 50 Hz however may be noticeable but by adjusting the high value resistor across the replay amplifier time constant capacitor the error can be reduced to 1.5 dB at 50 Hz which will unfortunately also give a 1.5 dB reduction of bass at the same frequency on the DIN curve. With this latter modification however both bass responses will be found to be within the DIN or NAB curve specified tolerances.

The final recommended modification is first to couple a 100 pF capacitor between the bass and the emitter of the first transistor in the monitor amplifier to reduce pick up of rf interference. On my own machines I have also taken off the earth return from the output circuit to the auxiliary phono sockets and replaced these by short circuiting the capacitors coupling the phono sockets earths to the DIN socket earth. This changeover has removed almost all the earth looping problems experienced by the writer when four separate phono leads, or a combined lead with four individually screened phono leads as is supplied by Tape Recorder Spares, connect the Revox to external equipment.

The distortion was checked throughout after all the modifications had been introduced. On the three machines so far modified the distortion on monitor line in up to 1 dB below clipping point is less than 0.05 per cent total. At 1 kHz the recording amplifier distortion measured at the record preset point at a level equivalent to 10 dB above 320 pWb/mm with the machines set for EMI *815* tape was less than 0.06 per cent, although of course the tape distortion produced at this level is extremely

(continued on page 56)

Nagra 4S

WE waited a very long time for the debut of this tape machine and one wonders why. Is it because Kudelski have been too busy manufacturing the mono version for the film industry or have we just had to be patient until they were satisfied with the new model? Whatever the reason, the *4S* is with us and many people will be interested in its features and performance. As expected, it bears a close resemblance to the *4D*. It is not just a *D* with a stereo head and extra amplifier; many other minor improvements have been made.

The *4S* uses the same deck mechanism and case as the *D* but the control layout is as follows:

On the left hand face, reading from front to back, are the right and left microphone inputs (Cannon *XLR*). Above these inputs are six-position switches enabling the inputs to be adjusted.

Between the input selector switches is a two position switch for reversing the phase of the left microphone. Next, a Tuchel socket for balanced line input. A current feed of 8.5 μA to read 0 dB at maximum gain.

The next Tuchel socket can be used to connect the recorder to an external noise reduction system such as Dolby A, the final Tuchel giving outputs of 1V at 0 dB into greater than 500 Ω unbalanced.

On the front of the recorder, the controls are as follows: headphone level control with a position marked 'C' which switches the headphones to the centre pilot tone track which can be used for a commentary or other purpose.

Beneath this is a pushbutton which switches the phones to mono for checking the phase of the microphone and beneath this is a stereo jack socket for the phones. (25 to 600 Ω).

Next there are two visual indications. The upper one shows a white cross when the recorder receives a pilot signal of the correct frequency and amplitude; the lower shows a white cross if the general and motor power supplies are correct and if wow is within acceptable limits (defined for this purpose by DIN 45 507). Next to these is the stereo (coaxial needles) 'Modulometer' which, when used for level, is a ppm. To the right of this is a six position switch controlling inputs to meter. Positions are as follows:

(1) Pilot frequency indicated by the red needle.
(2) The red needle indicates the percentage groove depth of the disc. 100 per cent on the meter equals 50 μm. The green needle indicates the maximum level of signal recorded by both channels.
(3) The red needle indicates the recording level of the left channel, and the green the level of the right channel.
(4) The red needle indicates battery voltage in volts per cell, and the green the voltage needed by the motor. The difference between the two corresponds to battery reserve.
(5) The red needle indicates the frequency of the pilot signal, the green one the level of the pilot signal played back.
(6) The red needle shows the current absorbed by the motor (100 per cent = 350 mA), and the green needle as in position five. Below this is a filter switch with six positions.
(1) Flat (30 Hz to 20 kHz).
(2) Music; High pass filter (–3 dB at 40 Hz).
(3) Music plus low frequency attenuation (–7 dB at 4 Hz, –3 dB at 40 Hz).
(4) Speech; high pass filter (–3 dB at 80 Hz).
(5) Speech plus lfa (–3 dB at 400 Hz, –7.5 dB at 80 Hz).
(6) Roll off (–10 dB at 100 Hz, –3 dB at 400 Hz).

To the right of these is a three position selector, for double mono, stereo, and another stereo setting which increases the gain by 6 dB for use when the recording level is low.

Next are two toggle switches, the upper for selecting microphone or line inputs and the lower for switching to an external noise reduction system or to normal working. To the right of these are the level controls, coloured red and green to correspond to the modulometer needles. On the red control is a small catch coupling the two gains in any position by a friction clutch.

Between these controls is a small push-button which provides a ramp waveform at 1 kHz, –10 dB. To the right of the green level control is another small pushbutton which switches on a light to the modulometer. This can be locked on by twisting it when it is pushed in.

Next, a six position function selector:

(1) Stop.
(2) Test. Amplifier on but (after a small initial movement of the take-up spool which takes up any slack in the tape) tape stationary. The modulometer, phones and line output all read the direct signal.
(3) Record. The tape runs and the modulometer, phones and the line outputs are controlled by the AB switches to the right of the function switch. In this position, a limiter is in circuit and operates from 4 dB above +4 on the modulometer to a limit of +10 dB.
(4) Record. No limiter.
(5) Playback. In this position the monitor speaker is muted.
(6) Playback plus internal speaker.

Finally, on the front of the recorder are three toggle switches. The upper selecting A or B monitoring another giving A or B metering and the lower one switching between batteries and external power.

A Tuchel socket marked Cue gives output of the pilot signal and recording and playback of pilot track which can be used for commentary. Lastly, a power pack input for external supply (–12 to –30V).

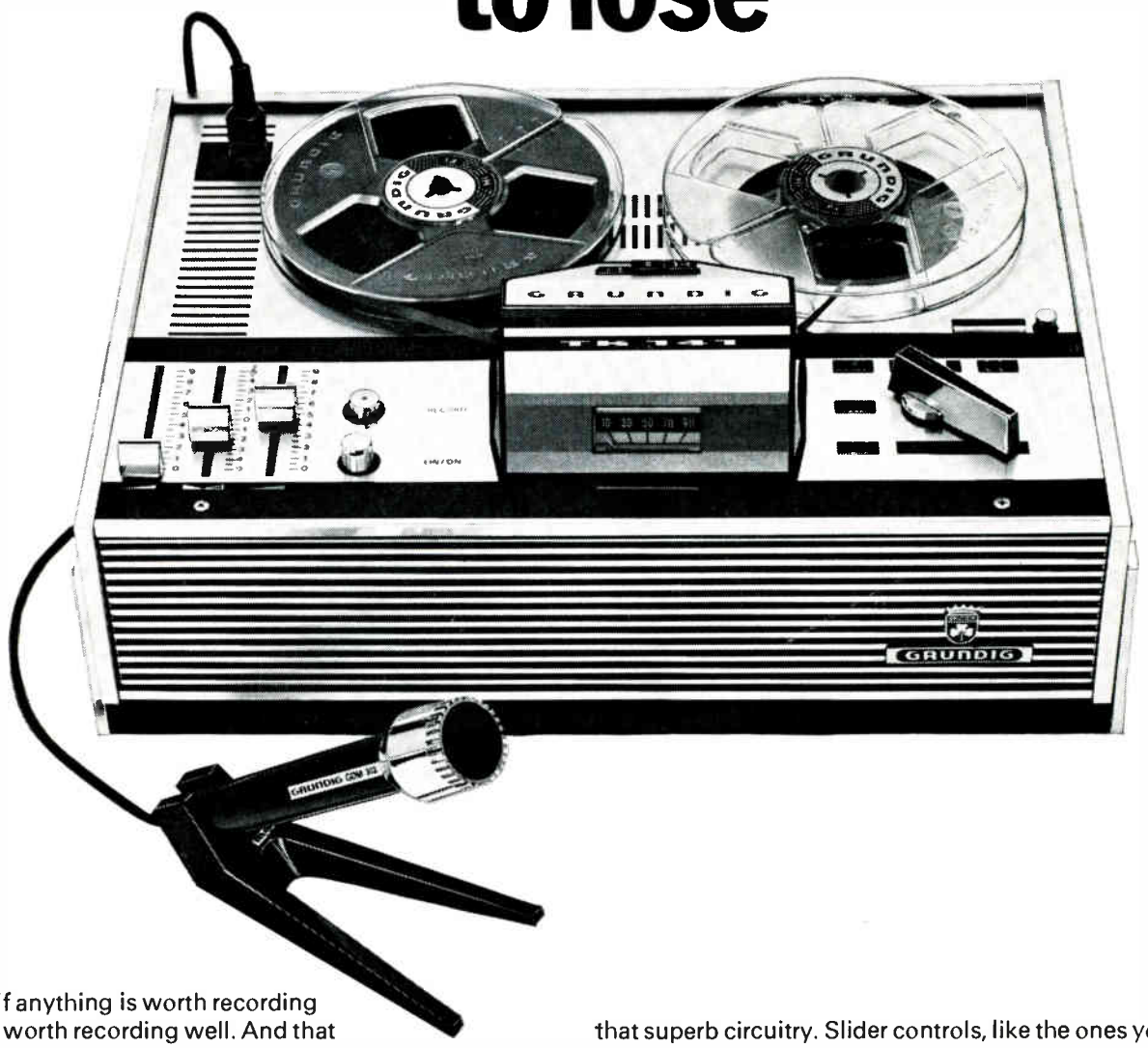
In the centre of the tape deck is the speed/equalisation switch with positions for 38, 19 and 9.5 cm/s plus a 38 cm/s Nagra 'master' position; in the latter, the tape runs at 38 but with 19 cm/s equalisation, giving slightly more distortion for a reduction in tape hiss.

Round this switch are preset recording equalisation adjusters for both channels and all speeds, these being reasonably protected by a cover which slides under the holes in the deck plate. Next to the supply spool is a tension roller which controls back tension, then a

(*continued on page 55*)

MANUFACTURER'S SPECIFICATION
(38 cm/s).
Basic specification as detailed for Nagra 4—see page 37.
Record track width: 2.5 mm.
Play track width: 2 mm.
Record head gap: 7 μm.
Play head gap: 3 μm.
Signal-to-noise ratio: 68 dB ASA A weighted, ref 80 pWb/mm.
Distortion: 0.8%.
Level meter: Coaxial twin needle, colour coded, peak reading modulometer.
Price: £649.
AGENT: Hayden Laboratories Ltd, Hayden House, 17 Chesham Road, Amersham, Buckinghamshire.

Sounds too good to lose



If anything is worth recording it's worth recording well. And that means getting a Grundig to do the job properly. A precision-built reel-to-reel tape recorder with a moving-coil microphone designed and made to hear as clearly as you do. A machine with a recording head precision-engineered to make sure every sound is recorded exactly as it comes in. A machine with a strong steel chassis to protect all that superb circuitry. Slider controls, like the ones you see on big studio consoles, for extra precision in setting. And for playback, a full-sized loudspeaker to make sure you hear exactly what you recorded with nothing missing! In short, a tape recorder designed by perfectionists, built with precision, rigorously tested, right for you for life. Worth while?
Just lean back and listen.

GRUNDIG

The difference is incredible

fixed pillar followed by the full track erase head and a strobe disc for checking tape speed. There are three further head positions: record, record/replay pilot (not fitted on review model), and replay. To the right of these is the control lever, then another tension roller before the take-up spool. Above the take-up spool is a switch for replay of CCIR or NAB tapes and just above the strobe disc is a five position switch for control or bias. In the front left corner sits a toggle switch to control rewind and wind on.

When the control lever is pulled forward, the fixed pillar, strobe disc and pressure roller move clear of the heads, leaving an easy path for tape threading. As the take-up spool is rotated to secure the tape, the supply spool rotates in the opposite direction. Unless a firm hold is kept on the tape, it grabs it back again.

If the toggle switch is set to rewind, the tape is rewound provided the main function control is in either of the play positions or on test. The rewind is adequate though not fast and care must be taken to either turn the function switch off or return the toggle switch to neutral before attempting to re-thread the tape, otherwise it will start to rewind as soon as the control lever is pulled forward again.

There is an intermediate position of the control lever where the tape runs but the recorder does not record though not at the correct speed and an operator who had not been shown the instruction manual found this position during one session. Provided the control lever is pushed gently but firmly home each time, however, this should not cause trouble.

When the function control is at play (through internal speaker) and the rewind toggle switch moved to the right, the tape 'winds on' but only marginally faster than 38 cm/s, this facility is only of limited use. The review model was taken on several sessions to record a wide variety of programme material with the two Sennheiser *MKM 405* microphones supplied by Hayden. The combination gave quite outstanding results on each occasion. The recordings were of the highest studio quality and had the clear clean sound only associated with the very finest equipment.

It appears that Hayden Labs are often asked if it is worth paying £105 each for the Sennheiser microphones to use with the *4S*. If these recordings are anything by which to judge, it most certainly is. Measurements of the recorder confirmed the good impression made by the recordings. The replay response from a full track CCIR test tape is given in the table and shows the expected rise at 40 Hz due to the fringe effect. On a stereo tape, the response would be almost flat.

Record/replay measurements were made using different types of tape. Recordings for this test were made at −20 dB and the results were all remarkably good.

Rms wow and flutter was measured using different tapes. The high flutter associated with *LR56* is probably due to the matt backing on the tape rubbing on the fixed pillar on the deck. Hence the lower flutter at lower speeds. The slightly higher wow and flutter with Scotch *202* may be due to the extra smoothness of the tape, giving slightly more slip, or perhaps some static build up.

The figure of .01 per cent rms for wow only is so low that the meter sat right at its lowest end and therefore the reading cannot be regarded as reliable, though certainly very low.

Signal-to-noise ratio was measured by recording a tone of 1 kHz at 0 dB and measuring the output on replay. The tape was then erased on the Nagra and the output of the erased tape measured on replay. The wide range figures given are quite remarkable. Distortion was measured at 1 kHz at 0 dB, 510 pWb/mm and +4 dB by recording tones and then measuring the signal on replay before and after the fundamental had been filtered out. The figures are excellent. Crosstalk was measured by recording a 1 kHz tone at 0 dB on one track with the recorder in stereo and measuring the output from the other track on replay. The latter was 60 dB down on the output from the recorded track.

It is understood that for audio purposes, a version of the *4S* will be available with a narrow guard band as the third track will not be needed for pilot tone. This model should have even better distortion and sn figures. Attempts were made to upset the working of the recorder by shaking it violently during use but, unless the movement was so violent as to make the supply spool throw a loop, performance could not be audibly affected.

During several sessions the recording level was set deliberately high to test the limiter. It worked perfectly each time with no audible breathing or other unwanted effects.

All the controls work with the smoothness one has come to expect from Nagra recorders. Attempts to adjust the recorder for optimum results with dfferent types of tape were not successful, as the bias control was incapable of sufficient variation to achieve this.

The equalisation controls were perfectly adequate and easy to use, and it is a pity that the bias control was not the same. Results with different tapes were, however, excellent. Replay equalisation is set at the factory and can only be altered at the hf end.

The Nagra modulometer with its red and green needles is easy to read and was found to be more satisfactory than the separate meters found on most machines.

The *4S* is an excellent recorder by any standards and is a worthy addition to the Nagra range. Highly recommended.

John Shuttleworth

Overall frequency response, 38 cm/s BASF *SP52*

	Flat	'Music'
15 kHz	0	+0.5
14 kHz	+0.5	0
12 kHz	0	0
10 kHz	0	0
8 kHz	0	0
6 kHz	0	0
4 kHz	0	0
2 kHz	0	0
1 kHz	0	0
500 Hz	0	0
200 Hz	0	0
110 Hz	0	−0.5
80 Hz	0	−0.5
60 Hz	−1	−2
50 Hz	−1	−2
40 Hz	+1	−3

Signal-to-noise ratio (38 cm/s)
Upper track: 66 dB.
Lower track: 64 dB.

Crosstalk:
60 dB (1 kHz).

Nagra master s/n ratio
Upper track: 60.5 dB unweighted.
Lower track: 60 dB.

Distortion (38 cm/s)
1 kHz 0 dB: 0.5%, +4 dB: 0.9%
1 kHz at 510 pWb/mm:
Upper: 2nd hc 0.18%, 3rd hc 0.18%
Lower: 2nd hc 0.13%, 3rd hc 0.18%
All figures relate to BASF *SP52*.

Wow and flutter	38 cm/s	19 cm/s	9.5 cm/s
Scotch 202	0.01% wow	0.03%	0.04%
	0.06% total	0.07%	0.1%
BASF LR66	0.01% wow	0.01%	0.04%
	0.14% total	0.08%	0.2%
BASF SP52	0.01% wow	0.01%	0.04%
	0.04% total	0.06%	0.1%
Agfa PE36	0.01% wow	0.01%	0.03%
	0.04% total	0.06%	0.09%

All figures rms.

Replay only frequency response CCIR

	Upper track	Lower track
1 kHz	0	0
15 kHz	0	−0.5
14 kHz	0	0
12 kHz	0	−0.5
10 kHz	0	−0.5
8 kHz	0	−0.5
6 kHz	0	0
4 kHz	0	0
2 kHz	0	0
1 kHz	0	0
500 Hz	0	0
200 Hz	+0.5	0
110 Hz	+0.5	+0.5
60 Hz	+1	+1
50 Hz	+1	+1
40 Hz	+2	+2

Overall frequency response, Nagra master, 38 cm/s

	Upper track	Lower track
15 kHz	+2	0
14 kHz	+1	0
12 kHz	+1	0
10 kHz	+0.5	0
8 kHz	+0.5	0
6 kHz	0	0
4 kHz	0	0
2 kHz	0	0
1 kHz	0	0
500 Hz	0	−0.5
200 Hz	0	−0.5
110 Hz	0	−0.5
60 Hz	0	−0.5
50 Hz	0	0
40 Hz	0	+1

STELLAVOX SP7 REVIEW POSTSCRIPT

MR SHUTTLEWORTH wishes to apologise for quoting his *SP7* distortion figures ten times lower than the actual measured value. We are informed that his 60 Hz, 1 kHz 10 kHz measurements were in fact 0.6 per cent, one per cent and two per cent respectively. Our apologies for failing to notice the original absurdity—**Ed.**

IMPROVING A REVOX A77

continued

high. At all normal levels the measured tape distortion is very close to the theoretical values obtained from the manufacturers published figures. It is curious that if the vu meter circuit is disconnected the distortion drops to 0.035 per cent and although a brief attempt was made to reduce the very slight distortion introduced by the metering circuit no significant improvement could be gained. It is felt that some users might prefer to drive the vu metering circuit from the monitor line out which has a considerably lower source impedance. This might well prove to be more useful allowing output levels to be monitored. I do not use the Revox vu meters on programme, however, because of their considerable inaccuracy in reading peak levels but they are useful when the Revox is driven from an external mixer.

Next month an accurate method of setting up the replay and record amplifiers will be described, which in principle can also be used for aligning many other industrial machines.

STUDIO DIARY

continued

singles, and David Bedford completing his album. Chris Barber laid down tracks with the Greaseband for his next album, and Jo Ann Kelly made a welcome return to the studio. Other artists have included Black Widow, Chas Peate's Pepper Box, Medicine Head, songwriter Kenny Pickett of *Grandad* fame, Richard Hewson, and the *Private Eye* team.

Future plans at Marquee include the enlargement of the studio by 37 m², and the rebuilding and extension of the reception area.

The **Jackson Recording Company** have been doing a lot of work for MIDEM, and have had several new customers in the studio recently. Songwriter and session organist Alan Hawkeshaw, who has played with Juicy Lucy, the Shadows and the London Symphony Orchestra, has been recording for the Ad-Rhythm label. Padlock Productions, a new company managed by ex-Checkmate Ken Street, have been using the studio, and Ray Brooks (of The Knack) and Mike King (of the King Brothers) have also been in. John Dunsterville, besides modernising the studio, has been doing a considerable amount of desk work.

Reception area at the new De Lane Lea Studios

INDEX TO ADVERTISERS

Classified Advertisements

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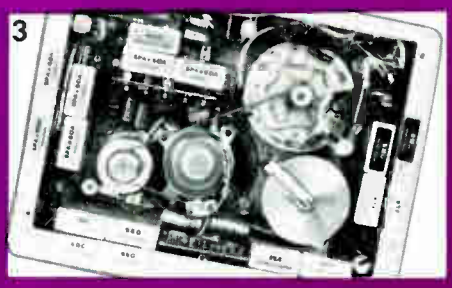

Stellavox

Quality and Reliability for the Professional Sound Recordist

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