JUNE 1971

15p

STUDIO SOUND

THE 'VIRTUAL EARTH' AS A MIXER
UNDERSTANDING TIME CONSTANTS
INSIDE ISLAND STUDIOS · PATENTS REVIEW
REVIEW: NAGRA 4D BATTERY PORTABLE

Good 16-track masters don't just happen.

Unless the Dolby System is used, the final stereo master may be only marginally quieter than an 8-track stereo cartridge.

A mixdown at John Mosely's Command Studios, London. Command, like every other London 16-track studio, is Dolby equipped on every track.

New sixteen-track recorders are essentially limited in performance by tape noise. No matter what tape is used, noise increases by about 9 dB when the sixteen-track original is mixed down to a two-channel stereo master. This is equivalent to cutting track width down to that of an 8-track cartridge and reducing tape speed to 7½ ips. What a waste of time, money, and effort.

The Dolby System eliminates all this. The noise level of a Dolby recording, even when it is reduced to stereo from sixteen tracks, can easily be better than that of a two-track original recording on the same kind of tape without the Dolby System. At the same time, print-through and crosstalk are also reduced by 10 dB, keeping stereo placement exact and silent passages velvet quiet. Sessions move faster because setting up pre-equalization is unnecessary. Instead, equalization can be worked out during mixdown without affecting the sixteen-track original and without watching the second hand of the clock as session time ticks away. Nor is there need to ride gain on dead channels during mixdown to keep out noise; the Dolby System takes care of that.

The Dolby System makes recording and reduction easier and faster, with time for more attention to creative values, less to technical problems. It makes good engineering 10 dB better.

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Impedance 30 OHMS.

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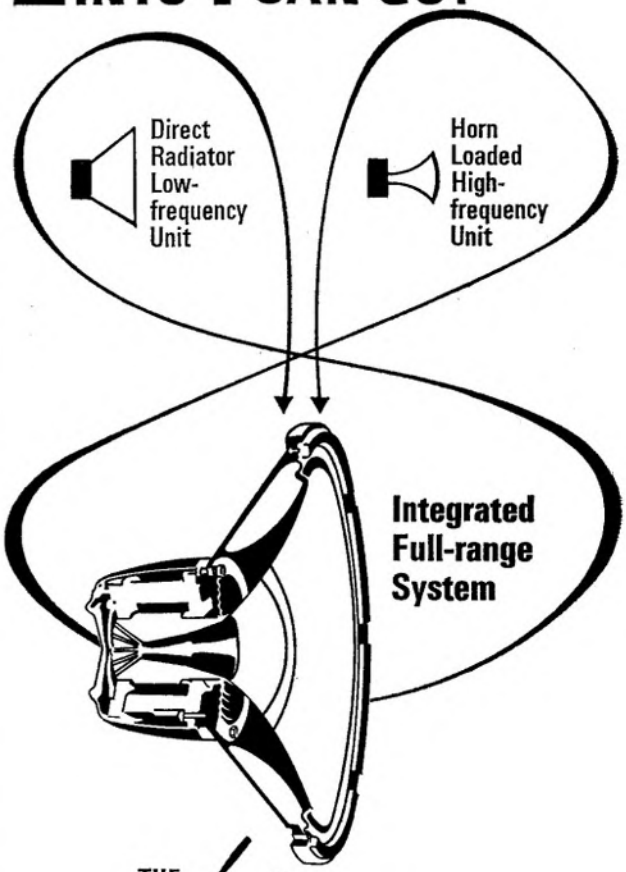
2 INTO 1 CAN GO!



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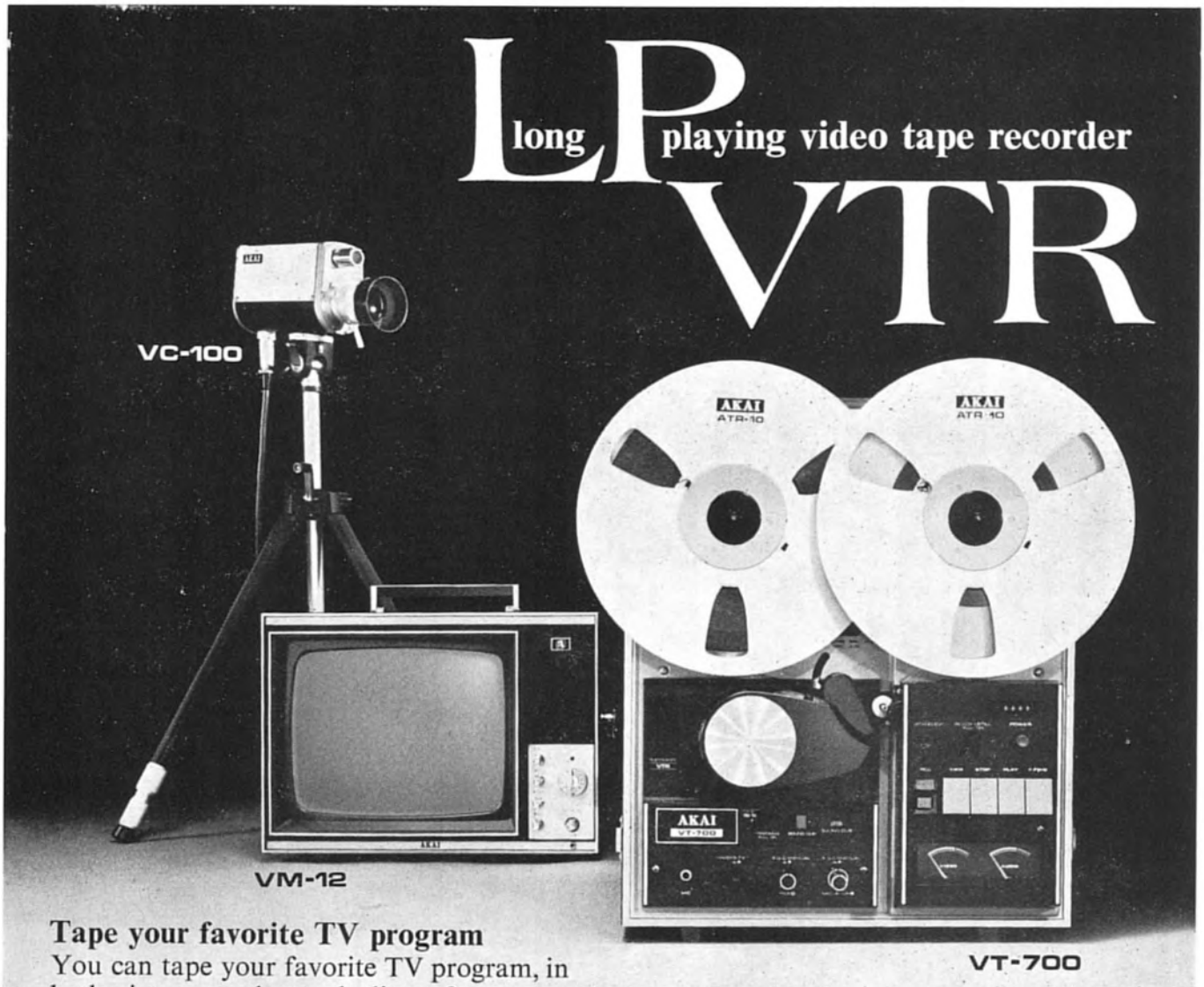

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1720L

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Create your own mood music with this wonderful tape recorder.

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PG

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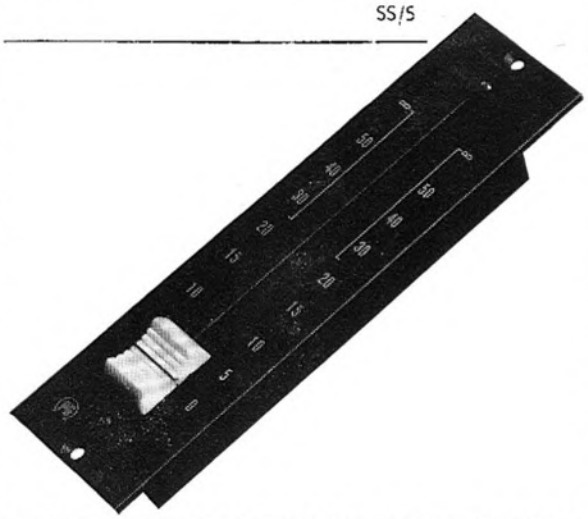

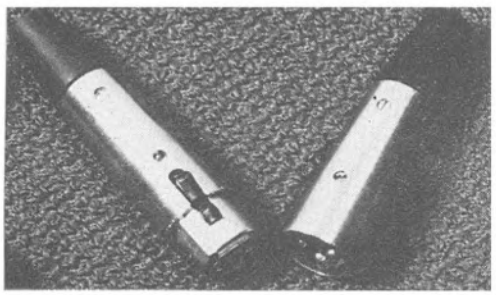

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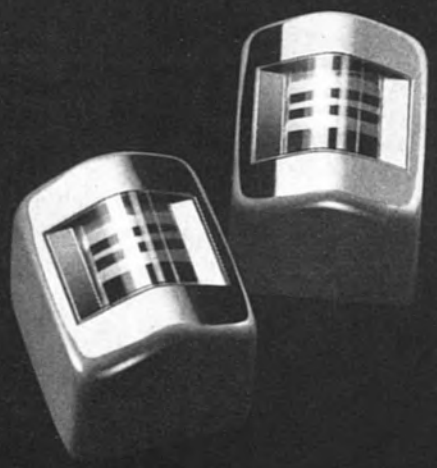
ALTEC LANSING®

Good news for tape recorder enthusiasts

what Akai's GX(glass & crystal ferrite)Head means to you



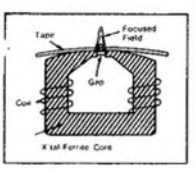
150,000 hours of recording/ playback service life!

It means you won't have to change the head of your tape recorder for 150,000 hours! And when you start calculating what 150,000 hours means, you'll be very much surprised. If you were to use this GX-HEAD for 8 hours every single day of the year, it would last you for over 51 years! If you were able to play your tape recorder continuously without stopping for a single minute, this AKAI GX-HEAD is guaranteed for a service life of little over 17 years! That's why you can really call this GX-HEAD a "wear free" lifetime possession

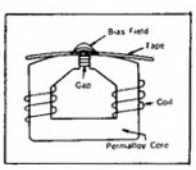
GX-365D ...one of our latest models with GX- Head.

GX-HEAD is "Dust Free"

It means you won't have to clean the head of your tape recorder as often as conventional heads. The core of the GX-HEAD is made of single crystal ferrite, and the inner circumference of the head shield is mounted and set in glass. Crystal ferrite is a magnetic gem, and as such has all the resolute, long-enduring qualities associated with precious, sparkling gems. As a result, the GX-HEAD is "dust free" from magnetic tape dust. Thus, sound quality is not affected even under excessively high temperatures and dense humidity. Wear and abrasion are almost completely eliminated and enhanced tape motion stability is produced because of the high degree of glass and crystal ferrite hardness.



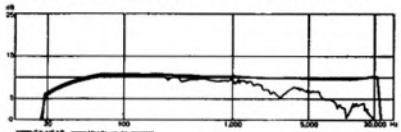
GX-Head



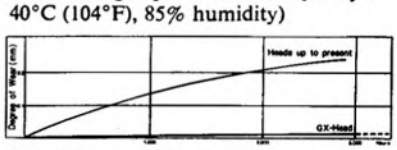
Heads up to present

GX-HEAD guarantees preeminent recording

It means highest quality recording sounds are now available to you. On conventional recording systems, when high frequency signals are being recorded on tape, the signals are weakened by the prevailing influence of the bias current. As a result, the frequency response is not good and sound is not reproduced in all its true dimensions. On the new GX-HEAD, AKAI engineers were successful in focusing the magnetic bias field so that the influence of the bias is drastically lessened. And greater frequency response was obtained because an ideal gap width and gap depth were developed and ultra-precision processing techniques were used in the manufacture of this head.



Change in the Characteristics of Frequency Response due to Adhesion of Dust (using tape of inferior quality at 40°C (104°F), 85% humidity)



Comparison of Degree of Wear

The sharply contoured shape of the GX-HEAD permits low frequency signals to be recorded smoothly without distortion. 20 to 30Hz super low frequencies can be recorded and played back with maximum stability.

AKAI's GX-HEAD is the answer to true sound reproduction. Don't settle for anything less.

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Freq Response	±0·1dB 20Hz to 20KHz into 15ohms. -1 dB at 150 KHz
Total harmonic distortion	Less than 0·04% at all levels up to 50 watts rms into 15 ohms
Input sensitivity	0dBm to 100mV
Noise	-100 dB
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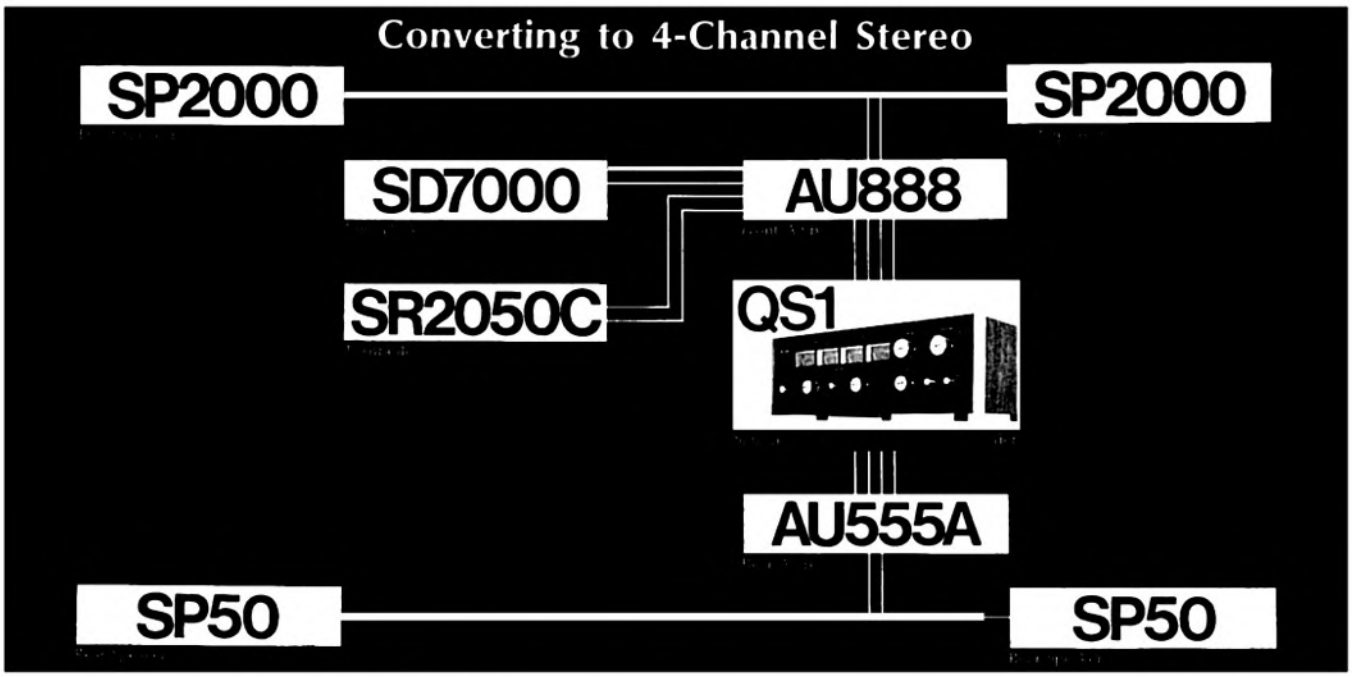

The Sansui QS-1 System: First and Foremost in 4-Channel Stereo.

Sansui's QS-1 system was the first and remains the foremost means of economically—and authentically—producing four-channel stereo.

Built around the new but already famed 4-Channel Synthesizer Decoder (QS-1), the Sansui system is the most inexpensive means yet devised of moving up to the incomparably richer world of four-channel stereo. And yet, as audio critics have testified, the effect is more than equal to, and often better than that produced by so-called "discrete" four-channel systems.

But the most attractive aspect of the QS-1 system is that it lets stereo enthusiasts continue to make use of their existing libraries of 2-channel discs and tapes, not to mention FM stereo broadcasts, and to enjoy them in the new 4-channel format. Which means more liveliness, more presence than those sources were ever thought to contain.

It's accomplished by the QS-1's unique decoding matrix, which translates 2-channel signals into four channels, and by a process known as "phase modulation," which produces the minute time delays necessary to the close approximation of an entire sound field.

The QS-1 is at its brilliant best when, as the illustration shows, it is teamed with quality Sansui components especially engineered to make the most of it.

These include the 3-motor 4-head SD-7000 stereo tape deck and the 2-speed Automanual SR-2050C turntable. For the front channels, get the new 140 watt AU-888 Control Amplifier and 70 watt SP-2000 speaker systems, and for the rear, the 85 watt AU-555A Control Amplifier and 25 watt SP-50 speaker systems.

And there you have it, four-channel stereo at its finest, by the first and foremost name in the field. Sansui.

Sansui

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Studio Sound

JUNE 1971 VOLUME 13 NUMBER 6

INCORPORATING
TAPE RECORDER
SOUND AND CINE

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COVER PICTURE

The RPO/Mothers of Invention film '200 Motels' was completed in 10 days (including four days rehearsal) using four TV cameras and Scotch *400* videotape. The tape was subsequently transferred to 35 mm colour film.

SUBSCRIPTION RATES

Annual UK subscription rate for *Studio Sound* is £1.80 (overseas £2.10, $5 or equivalent). Our associate publication *Hi-Fi News* costs £2.82 (overseas £2.65, $6.30 or equivalent). Six-month home subscriptions are 90p *(Studio Sound)* and £1.41 *(Hi-Fi News)*.

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

BINDERS

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

WHAT PRICE an EMT reverberation plate on the surplus market? And why surplus? Ironically, the UK agents for EMT, F. W. O. Bauch, are now importing a device which until recently belonged to the world of fantasy: a totally electronic audio delay system. The Gotham *101*, to be shown at APRS 71 on May 28 and 29, incorporates a 'megalithic' IC equivalent of six hundred thousand transistors. Digital coding is employed, though whether the circuits are based on Philips' much publicised 'bucket brigade' delay-line remains to be seen. HF response is limited to 12 kHz but this should be ample for reverberation purposes. The delay time produced by a Gotham unit is up to 350 mS.

A British company is currently developing what it hoped to be the first electronic reverberation synthesiser. Its designers visualise the unit as a tool of unprecedented value to the acoustician, largely automating the techniques of architectural acoustics.

Component miniaturisation a generation ahead of conventional ICs is in these forms beginning to find commercial exploitation. This will obviously not stop at audio delay lines. The same progress promises voltage controlled music synthesisers of lower price, greater versatility and smaller size than anything yet produced by Moog, EMS or Tonus. If existing synthesisers baffle the beholder in their profusion of dials, sockets and switches, this is due more to unfamiliarity than to any real complexity. In several respects, even the most elaborate VC synthesiser is easier to manipulate than an acoustic instrument. The latter requires a much higher degree of physical co-ordination than VC synthesisers. To date, all commercially available synthesisers have been monotonic, involving nothing more demanding in physical skill than the ability to play a single music line on a keyboard. Polyphony is achieved by multitrack construction or by the more elegant method of interacting several VC oscillators.

The real skill in operating a synthesiser is at the mental level—deciding the pattern of module couplings and the voltage levels and frequencies at which they interact. For the first time in history, music may be realised without the need for skilled instrumental manipulation. No need even to train vocal chords. The 'synthesist' (that word needs replacing along with 'sound mixer') succeeds or fails primarily on imagination, partly on intellect, and thirdly on serendipity. None of the mass-media publicity so far allocated to these instruments has conveyed their essential simplicity. On the contrary, even the late James Mossman's BBC-2 discussion with George Martin (Associated Independent Recordings) suggested some complex form of computer (on the telly, anything with knobs on is a 'computer') beyond the comprehension of the great general public. Described in cold print, voltage controlled audio generators may well seem involved; so might a written description of a violin. The television medium could do better than it has. Radio Four's 'New Worlds' description of the *VCS3* was so vague that the instrument emerged as a totally new concept in synthesisers rather than the logical extension of Moog technology it in fact is.

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.

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5 good reasons to use an Ampex MM-1000 recorder.

1. It's expandable.
Our 8-channel MM-1000 Master Recorder costs only moderately more than other 8-channel recorders. But with the MM-1000 you can readily expand to 16 or 24 channels. Add-on 'kits' enable you to add channels as you need them. Or you can buy the MM-1000—16 or 24 channels completely checked out and ready-to-go.

2. It's designed to handle wide tape.
The MM-1000 tape transport is designed to handle 1" and 2" tape. It's the same transport that's now in use on over 3000 Ampex video tape recorders. When you go from 1" and 2" tape, you just change the tape guides and the plug-in head assembly. Lets you quickly change from 1" for 8-channels to 2" for 16 or 24 channels,

3. It's versatile.
The MM-1000 offers more standard and optional features than any other master recorder. Tape Motion Sensing for instance. Allows you to change modes without going into stop and without stretching or breaking tape. Automatic Tape Lifters? Yes, and with manual override Ping Ponging? Sure, Sel-Sync? Naturally. Also remote Sel-Sync. How about Variable Speed Motor Drive Amplifier? Yes again, plus an Electronic Timer with up to 4 remote read-outs for pinpoint accuracy. Versatile? You bet!

4. It's promotable.
"New Generation" recording capability is built into the MM-1000. The new groups demand this capability and record at the studios that offer it. The MM-1000 is capturing the imagination of these groups, and challenging their creativity. With the MM-1000 you'll have a promotable edge over studios with past generation equipment.

5. Its applications are totally unrestricted.
The wide range of applications for the MM-1000 mean its cost is amortized over a very short time. The MM-1000 may typically be used for Pop music recording, master Classic recordings, multi-language synchronised with videotape recordings, multi-channel sound source for film transcriptions. Or simply as a 'soul mate' in the search for innovation in music.

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For further information on the Ampex MM-1000 recorder, send this coupon today.

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Events

QUADRASONIC REPLAY

REPLAY TAPE preamplifiers to match Miniflux *FCN3* 6.25 mm four channel in-line replay heads are now being produced by Miniflux electronics. The *MEG7* employs circuit principles described in the Miniflux Manual and includes 38, 19 and 9.5 cm/s equalisation to DIN, CCIR AND NAB standards. Signal-to-noise ratio of the amplifier is 85 dB and the equalised output greater than 1 V RMS across 20 ohms. Price is £7.50 per channel module from Miniflux Electronics Ltd, 8 Hale Lane, London N.W.7.

SONY DEVELOP LOW-COST COLOUR CAMERA

A COLOUR TELEVISION camera to sell in Japan at less than £330 ($1 000) has been developed by Sony. Like their *Trinitron* colour receivers, the camera employs a simplified video tube, in this case the *Trinicon*. Sony anticipate a demand both from broadcasters and the consumer retail market, the camera helping to expand sales of their colour VTRs. Another Sony development, the *D100* mass videotape duplication system was exhibited at New York's Hotel Americana on March 31 and April 1. An *MV-10000* master player feeds up to 500 videocassette recorders simultaneously, the latter mounted in racks of four.

LOW FREQUENCY RIVER

FELDON AUDIO Ltd have asked us to point out that the 'low frequency river' in their May advertisement refers to a J B Lansing *driver* rather than to any tidal effect. Our advertising department is contrite.

ACOUSTIC WALL CLADDING

INTERIOR ACOUSTIC wall cladding manufactured by Burgess Products Co Ltd of Hinckley, Leicestershire, has been incorporated in the BBC Outside Broadcasts Colour Mobile Control Room 4. The cladding is in white with a *Stelvetite* decorative finish, and can be cleaned with nothing more than a damp cloth. The cladding occupies the walls behind the engineers in both the video and audio control sections.

The CMCR vehicles function as a complete mobile control facility and can accept up to four camera and 23 audio inputs.

PERFORMING RIGHT SOCIETY GRANTS

GRANTS TOTALLING nearly £11 000 have been announced for 1971 by the Performing Right Society Ltd. These will be made to various musical organisations including the National Youth Jazz Association, Polyphonia Symphony Orchestra and National Youth Brass Band. The figure is in addition to £1 000 being supplied each year to the British Music Information Centre. As in previous years, the largest amounts go to the Composers' and Songwriters' Guilds and to the British Council Recording Scheme. The Society requires evidence of an organisation's financial situation and intentions before considering an application for support.

Further data : The Performing Right Society Ltd, 29/33 Berners Street, London W1P 4AA.

PHILIPS CASSETTES

A 'PROFESSIONAL CASSETTE' based on the domestic *C60* has been introduced by Philips as the basis of a digital recording system. This runs at 19 and 9.5 cm/s and incorporates simultaneous recording and off-tape reading. Skew effects are eliminated, Philips claim, by full-track recording. A metal construction is employed to eliminate electrostatic build-up.

At the other end of the scale, Philips have proposed a solution to the 4-2-1 channel cassette compatibility problem. Their idea involves placing eight tracks on the 3.66 mm wide 4.75 cm/s magnetic tape medium. Top-to-bottom disposition becomes Left Front, Left Rear, Right Rear, Right Front, guard band, Right Front, Right Rear, Left Rear, Left Front. Narrow minded.

LEEVERS-RICH APPOINTMENTS

MR NICK NICHOLS has been appointed by Leevers-Rich Equipment Ltd to the position of marketing manager. Formerly quality control manager, Mr Tony Costello now joins the sales force as field sales manager.

£100 000 COLOUR TV ORDER FOR AMPEX

A CONTRACT TO supply £100 000 of colour broadcast equipment has been awarded to Ampex by Radiotelevija Skopje. A *VR-2000B* colour VTR, two *VR-7800* VTRs, a *BC-230* colour camera and *VS-600* production video switcher are among the units involved. This will be installed in Yugoslavia's first colour broadcasting studio and will initially be used in training engineers and production staff.

Two new synthesisers from Electronic Music Studios. The standing model is a suitcase version of the £350 VCS3, significantly lower in price (£200) and the obvious instrument for live performances of electronic compositions.

NEXT MONTH

THE PROS AND cons of commercial radio will be examined from the production viewpoint by Keith Wicks. Adrian Hope contributes 'Music off the Streets' and Peter Levesley (Audio Developments) describes his approach to mixer design.

RECORDING STUDIO TECHNIQUES

PART 18—DISC PROCESSING AND PRESSING *by Angus McKenzie*

I HAVE previously commented that it is important to watch the maximum level of LF/HF boosts when making tape recordings for subsequent transfer to disc. Although most modern cutting lathes are completely, or almost completely, automatic, maintaining them is a very skilled job. The master tape reproducer feeding the disc cutter normally employs an advance head with a tape distance equivalent to the time taken for 1¼ rotations of the lacquer blank. The output from this head is applied to the automatic pitch control device which governs the groove spacing. The higher the modulation level, particularly at the bass end, the wider the groove spacing must be to accommodate the wave pattern.

The BSI specification for disc cutting allows a maximum of just under 9 cm of recorded grooves on a disc. The cutting engineer has to choose his minimum groove spacing consistent with obtaining the total playing time on the side to be cut.

If it is required to cut very long sides, the LF peak cutting amplitude must of course be restricted. Under these circumstances, discs of up to 37 minutes per side have actually been cut and issued on the market. Many records are available with single-side playing times well in excess of 30 minutes. An interesting example is Schmidt-Isserstedt's recording of Beethoven's *Choral Symphony* on Decca. Such very long sides require the disc replay volume control to be advanced beyond its normal position and the playback signal-to-noise ratio is therefore poorer than usual. It is necessary to deepen the cut for heavy bass modulation in order to prevent cheaper cartridges from jumping the groove, and also when there might be more than average vertical modulation applied to the cutting stylus—the difference channel. Most modern cutting suites have limiting and/or compression available in order to control the maximum lateral and vertical movement of a cutting stylus. Velocity limiters are also employed. Usually these limiters are employed on the left and right channels, linked so that the two channels are limited equally even in the presence of peak modulation on one channel only. Facilities are also normally available for limiting the sum and difference channels independently. In the old days, attempts were made to render stereo discs compatible in the hope that they could be played back satisfactorily with mono pickups. This was usually achieved by reducing the difference channel or at least the LF components of this channel. The industry soon realised that it was the pickup cartridge which should be made compatible, not the record.

Georg Neumann of Berlin has carried out considerable research in disc cutting and as a result his latest cutter head, the *SX 68*, contains some unique features. Apart from its relatively flat frequency response, it has an optional helium cooling system to transfer the heat developed in the driving coils quickly to the magnet assembly and thence to the air. Helium gas is passed at a rate of 0.4 cc per second into a small chamber containing the coils. Helium gas not only has the property of transmitting heat effectively but also is practically inert, stopping even the slightest oxidation of the metal in the wire of the coils. It also delays metal fatigue in these coils.

A good cutting room should be equipped with a microscope which can be swivelled over the surface of the record during cutting, allowing the engineer to check his depth of cut and groove pitch. I have known records released, admittedly a long time ago, where the depth of cut varied round the circumference. This might have been avoided if the cutting engineers had used a microscope. Faults such as this are not always in the cutting equipment and may well be due to inconsistencies in the surfaces of the lacquer blanks. A small coil wound round the stylus shank carries DC to heat the stylus tip. Different tip temperatures are required for different makes of blank, softer materials needing lower temperatures.

The main drive coils of most cutter heads are low impedance, usually between 4 and 10 ohms. Separate coils, electrically fairly well decoupled from the main coils, feed back to the cutter power amplifier to correct stylus resonance. A soft blank allows greater movement of the cutting stylus and will therefore feed back more and thus damp any extra movement. I understand that not more than 12 dB or so feedback is used in the *SX 68*.

Since the cutter head has an appreciable inductive component in its impedance, it tends to require volts at HF and amps at LF. For this reason, transistor cutting amplifiers usually have a higher output power than valve amplifiers, since the latter are able to drive higher voltages into higher impedances. Transistor units usually have a limited peak voltage available at its output but can deliver much greater currents. A 60 W valve amplifier, for instance, would be equivalent to a 100 W transistor amplifier for achieving the same peak cutting levels. This fact is stressed because a number of engineers have imagined it necessary to purchase new amplifiers for their cutter heads in an effort to pile still more modulation on a disc. Buying transistor equipment, they found themselves no better off.

Some years ago EMI produced a trackability test record which, they claimed, carried peak cutting level at frequencies between 80 Hz and 8 kHz, corresponding to the peak cutting levels on EMI records then available. Some months ago I calibrated the output of this record after velocity correction and very careful equalising in order to measure not only the peak velocities on the record but those on currently available commercial discs. Although I found that the quoted 12 cm/s velocity was in fact reached at approximately 2 kHz, the velocity then dropped back to about 7 cm/s at 8 kHz. Very few records reached the peak velocity at 2 kHz but almost all modern recordings peak well above the figure measured at 8 kHz. One single proved in excess of 30 cm/s at 8 kHz on sibilants. Polydor, not normally known for cutting really high velocities, managed to achieve 27 cm/s on their LP *Elizabethan Serenade*, while most Decca recordings achieve peak velocities of between 15 and 25 cm/s above 6 kHz, even as high as 14 kHz.

I also found a somewhat alarming state of affairs at the bass end of the audio spectrum: amplitudes up to 6 dB higher than those on the EMI test disc. It is hardly surprising that record retailers are getting more and more complaints from the public concerning the non-tracking of, in particular, pop singles and LPs. Although a worn stylus or faulty cartridge is often to blame, there are many cases where the gram equipment is in good order but the record will only track on better quality cartridges. Is it not possible for these records to be cut at a slightly lower level? I would like to see a standard velocity/amplitude compensated PPM with maximum cutting levels agreed upon between the different manufacturers and cutting companies. Perhaps the APRS could be persuaded to initiate such an agreement.

Once the lacquer has been cut (a 35.5 cm blank being necessary for a 30.5 cm record), it is placed carefully in a metal container and sent to the factory where a master negative is produced—with hills corresponding to the grooves. From this a mother positive is made, and from this the negative stampers. The latter are placed in the presses from which the records are made. Quite a number of faults can occur both in processing and pressing. Almost all rumble audible on good turntables is introduced at the pressing stage because of the differential rate of cooling through the plastic disc. 'Soup plates,' as they are called, can result from insufficient material being placed in the press or bad storage immediately after pressing. Spits and crackles can be caused as early as the cutting stage but are more usually due to poor processing or to using impure plastic granules. One frequent fault, often heard mainly on one channel only, is termed 'non fill' and has the effect of distortion before, during or after heavy modulation. It is usually caused by incorrect press temperature, or the plastic mix being slightly wrong. It can also be traced back to too hurriedly parting the electro-plated discs from the mother, master or acetate. Swishing and more localised noise spots can generally be traced back to faulty electro-plating.

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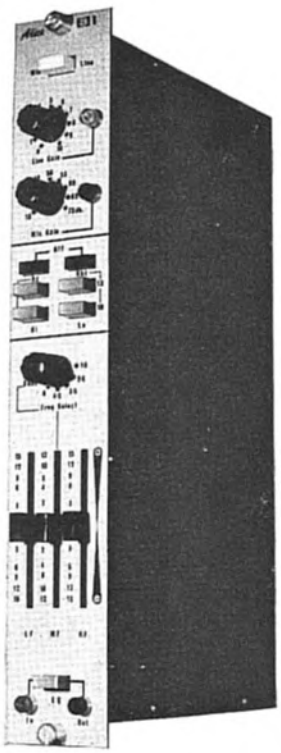

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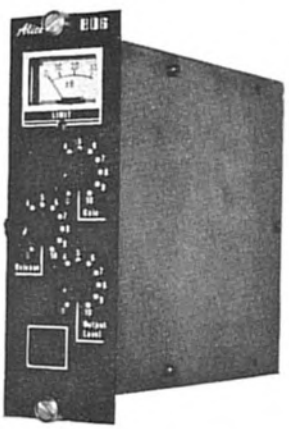

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THE 'VIRTUAL EARTH' AS A MIXER

BY L. HAYWARD

FIG. 1

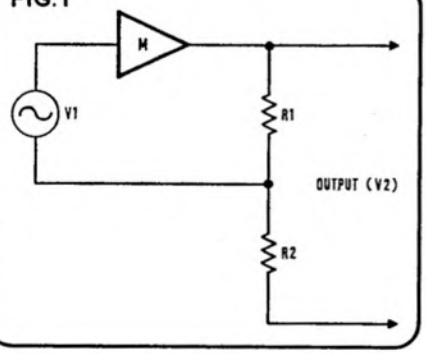


FIG. 2

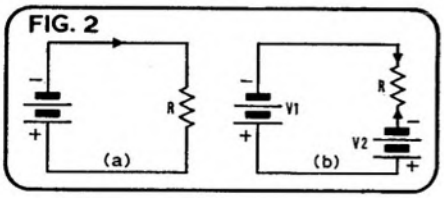


FIG. 3

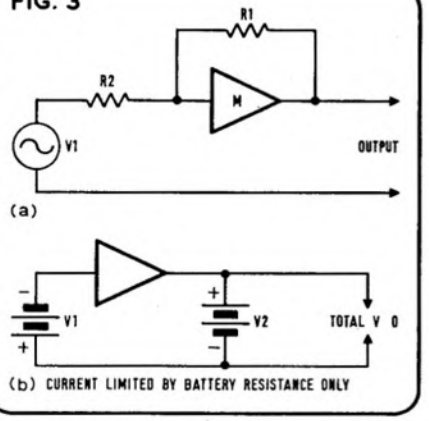


FIG. 4

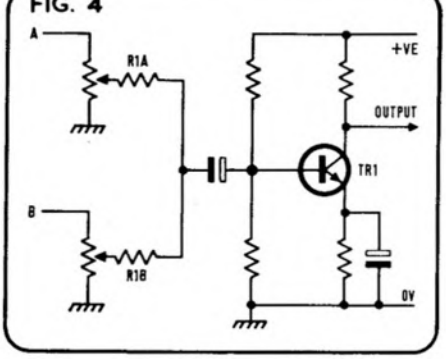


FIG. 5

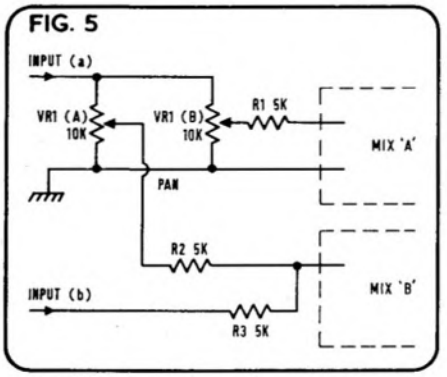


FIG. 6

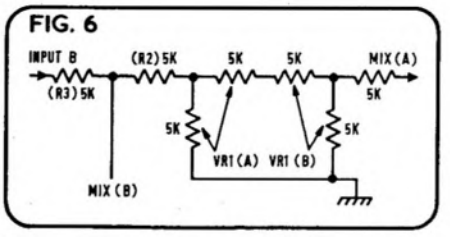
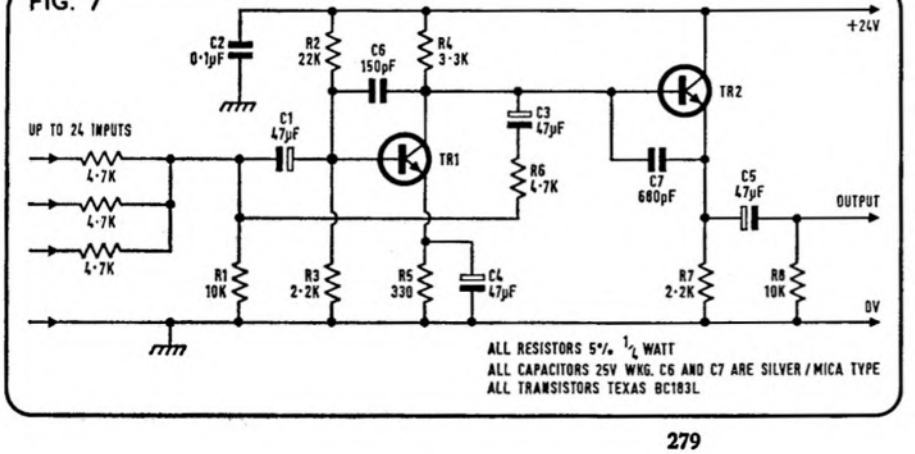


FIG. 7



IN order to understand the operation of the virtual earth amplifier, it is necessary to be familiar with certain basic facts of negative feedback. A brief and non-mathematical approach to the methods used will first be given.

When negative feedback is applied from output to input of an amplifier, the result will be an impedance change and a reduction in gain.

Fig. 1 shows an amplifier (M) where negative feedback is in series with the input signal. The open loop gain of M is assumed to be 100 times or greater. With feedback applied, the gain will approximately equal R1/R2 so that if R1 = R2 the gain with feedback will be unity. Since the feedback is in series with the input, the input impedance will be raised. A rough analogy of this is illustrated by **fig. 2.** This shows (a) a battery V1 driving a current through resistor R. Another battery of equal voltage, V2, represents a negative feedback voltage (b). Little or no current flows in the second case, even though R has the same value, so the impedance 'seen' by V1 is high.

Fig. 3a shows an identical amplifier with (R1 = R2) unity gain. The feedback is now in parallel with the input signal, in effect shorting it out in the **fig. 3b** analogy. The total V1 + V2 is zero, due to their reversed polarity, but in this case the impedance is low since maximum current is flowing. It will be seen how the term 'Virtual Earth' is derived since the voltage at the junction of R1 and R2 will be approximately V1 minus M volts, and the input impedance very low. This point is, therefore, virtually at 'earth'.

The advantage of this circuit when used as a mixer can now be shown. **Fig. 4** shows an arrangement commonly used for mixing. The resistors R1a and R1b are chosen to prevent interaction of pot A against the signal level of B and vice versa. This has the advantage that a loss occurs in the mixing network which must be made up by the following amplifier with consequent extra noise. A well-designed system on this basis is tolerable, if only mono signals are being mixed, but what of the case with stereo?

Fig. 5 shows part of a stereo mixer. VR1 is a pan pot for mixing signal (a) to output A or B. Input (b) is fed only to the output B. Should the pan pot be left in a central position, a coupling exists between A and B, which is analysed in **fig. 6.**

Fig. 7 shows a suitable design for a virtual earth mixer. The impedance at the base of Tr1 is about 50 ohms due to negative feedback, via R6 and C3, and the rejection using this system can be as much as 70 dB between two similar channels. A further advantage is complete freedom of interaction between faders. Up to 24 channels can be mixed into this one circuit. The gain due to feedback is unity and the noise level better than –70 dB, with an input of 0 dB (allowing about 12 dB overload margin). Tr2 is added to provide a low output source impedance, although the overload margin will be reduced if this is bridged with 600 ohms or less.

The mixer is flat over the entire audio range and cut above 60 kHz by the inclusion of C6.

As a footnote to this article, readers' attention is drawn, when reading the specification supplied with commercial mixers, to the figure given for stereo separation. In most instances, it is not even mentioned!

FILM SOUND TECHNIQUE

THE action of *Fiddler on the Roof* is set in Russia circa 1908. For several reasons, northern Yugoslavia was chosen for location shooting. Not least, it offered timber buildings of the right period and plenty of 'faces' for crowd scenes. The base used for the locations was Zagreb which had direct if somewhat erratic telephone and telex links with England and the USA. The sort of problems one might have faced if filming in Russia can be summed up by a conversation I had with a Russian engineer who was in Zagreb in connection with factory construction, staying at the same hotel as the film unit. 'What,' I asked after a bad day trying to telex London for some spares, was it like to get Moscow in a hurry?' In his very correct English came the reply 'Very difficult as we have cyrillic script'.

The unit and cast were housed in two Zagreb hotels. The production company had its offices in another part of the city. Studios on the outskirts of the city were used for cutting and viewing rushes.

The bulk of exterior shooting was done in two villages within 30 miles of Zagreb, with odd days out in the surrounding country. The story is set in the village of Anateoka, made up from the two villages Lekenik and Mala Gurica with sets constructed in each and the villages proper used as a background. At Mala Gurica, as well as the market place of Anateoka, there was a large air dome housing sets that could be used to continue shooting if the weather became unsuitable.

After the radiotelephone had been set up in the production office and 'dome stage', the mobile equipment was fitted to the sound truck—a Citroen van that had been bought for the job. We set about testing the equipment after its journey out from London by road; a few odd problems but in the main all was working.

A room adjacent to the hotel's basement carpark had been allocated to the camera and sound departments for battery charging and general storage. Of the 12 75 Amp-hour lead-acid batteries used for camera drive and PA power, six were carried on the truck and six were on charge in this room. Over the location period it worked out that we changed batteries on Wednesday and Saturday evenings. The six carried in the truck were two (24 V) for camera drive, two (24 V) for the PA and two spares. With some locations inaccessible by road, one pair only was unloaded and used both for camera drive and PA power. The sound truck had been fitted out at Location Sound to David Hildyard's specification. This gave plenty of cupboard space for storing mikes, spares and accessories. The cupboards were built under the bench tops in a U shape with the open end of the U at the rear entrance and broken in one place by a side entrance. The other side was used as the tape machines area with two Nagra *4L* (one for recording and one for playback), separated by the camera drive rotary converter which was let into the bench over the wheel arch with its controls at bench-top height. Thus, if necessary, one person could reach all the controls to start the camera, run the recorder and set the playback. Events proved this to be the rule rather than the exception. I used the bench on the other side as a work area whenever it was necessary to 'have the drains up' on any equipment. All the sound equipment was carried in the Citroen except the pram dolly for the Fisher mike boom.

After pre-production tests, the shooting proper began during the second week in August. We had plenty of daylight, allowing an early start to the working day.

Five-thirty a.m.! Get up and load Nagra recorders into truck (they were taken off at night to recharge). Load any special equipment that might not normally be carried. Leave hotel at 6.15. Drive to location counting the number of heavy lorries in the ditch on the way. One has the impression that in this part of Yugoslavia the lorries are just over half the width of the road.

Arrive on location between 7 and 7.15, walk over to camera truck and admire their ability to lock up bar in hotel at 2.30 a.m. and still arrive just behind us on the set. Run out camera cable and run the camera to warm up the motor. Root out Perfectone mixer, mixer table, sound mixer's chair, recording report pads, sun shades . . .

Sound mixer arrives on set. Run cables to and from sound truck to mixer for playback and record lines. The mixer works on the set so he can see and follow the action. Assemble the mike boom, activate 'Boris-the-tea'! Our Yugoslav helper Boris, who is attached to the sound crew for the duration of the location, gets the early morning tea. Out comes the rest of the equipment, loudspeakers and their stands, loudspeaker cable, remote control cable, and more tea. Now it is 8.30 a.m. All hooked up and tested; artists and director are arriving on the set. Electricians and lights are everywhere; that bright sun casts too deep a shadow.

The shot is rehearsed, the camera set up, and camera movements rehearsed. John Stevenson manages to fit the Fisher boom between two mini-brates (quartz halogen 6A 110 V bulb groups that can be used in any combination). 'Sorry I just can't get the mike close enough for that last line. Could you track the boom in? Yes you can have ten points if you run over the cameraman's toes but don't get into the shot.' Good, it works, there are a few lines of dialogue into a short piece of playback, back to dialogue and then more playback.

This is the master shot that will be supplemented by several other insert shots with different camera angles and/or lenses. 'Love to shoot,' the light is perfect. 'Turn over.' Camera drive turned on, camera switched on —speed (rotary converter output frequency) stable. Clapper boy marks shot and ducks out. 'Action!' Artist performs lines, camera pans, boom tracks in. 'Cut!' The goat has walked out of the shot in the background. Make-up and hairdressing swoop on the artists and off we go again. 'Turn over.' 'Speed.' 'Take Two.' 'Action.' 'Cut.' Suddenly it's all over. 'Print two, three and seven please.' 'Check the gate.' 'Clear the camera.' The camera drive is run to clear the end of the last take from the gate of the camera and then the camera opened up, the gate removed and checked for any 'hairs'. Camera and lights are then moved ready for the next shot, action as before but a close up. A small track has to be built to carry the camera dolly. It is 10 a.m. and the tea has arrived.

This time, as it's close, the mike is on a pole. John walks with it held overhead. 'Turn over.' 'Action.' The artist plays lines. 'Playback.' Dick Carruth, the music editor, starts the playback on the remote box and watches the lip sync playback cut; artist plays lines. 'Cut, perfect.' But the sun went in halfway through the shot. 'One more please'—take two—'Sorry, not quite the feeling of take one, just one more please.' 'Turn over.' 'Cut. Wait for the aircraft. Okay is it clear now for sound David?' 'Turn over.' 'Cut. Great. Print it but just one more please.' 'Thank you. Print nine and ten please.'

'Can I have three walkie-talkies?' one of the assistant directors asks. The constant problem of shooting sound on location is extraneous noise. Though we are shooting at the end of a cul de sac, cars are coming and going all the time. The assistant directors have this under control, all movement being restricted when shooting is in progress. Unfortunately the latest Yugoslav status symbol has started up in some nearby farm buildings: the chain saw. He will have to be bought off.

'Right, now this time an over-the-shoulder.' As before but from another angle. Sound is recorded, with all these shots, of course, so, however a sequence is edited, all the associated dialogue is available. It is possible that the dialogue used in the final cut version may have

Part Three
On Location

by Tim Blackham

come only from the master shot or from other takes fitted to the final cut action.

Lunch. A walk through the village to where the mobile kitchen is set up alongside two marquees. Afterwards, back through the village to the set. The grips, stage hands and clippy have been busy and laid a large area of tracking boards. Rehearsals. 'Okay, let's shoot it next time.' 'Action!' 'Cut. Print it! That okay for you David?' Director to sound mixer: 'Rather a lot of noise. I think it would be better if we covered it with a wild track.' 'Quiet everybody. Shooting a wild track. Turn over'. The mixer will record a wild track when the action involves noise that may make cutting difficult or lines muffled. That is to say the artists perform their lines for sound only, clear of extraneous noise but in the correct acoustic. Effects wild tracks are also recorded, of course, to provide the editor with a ready supply of the correct sounds for the action that can be fitted. As they are on a separate piece of tape, they can be held at the correct level during dubbing.

On the next shot, the artists walk from outside into a barn, talking as they go. The cameraman is busy with the electricians setting up lights inside the barn to reduce the change in light levels between exterior and interior. The camera will track in to the doorway behind the artists as they walk in.

'Could you move the sound truck? The radio mast is in the shot.' Though the sound truck is well hidden behind a haystack, the air radiotelephone mast linking us to the production office presented problems in a Russian-Jewish farmyard of 1908. So the truck is moved.

After this is done, I take another mike on a pole inside the barn. There is not room for John to get through the doorway as the camera tracks forward. Many shots involve two or more mikes, in most cases on the move. Hidden mikes are used. As they do not move, however, there can be errors in sound perspective when the artists move, making their use rather limited. When all else fails, there are always radio mikes though these usually result in perspective problems, being neck mikes in most cases and therefore too close.

The shot is in the can and the camera moved to get the artists' entry from the interior of the barn looking out. The sound truck is well hidden this time but, for most camera moves, plenty of the sound cables seem to be in shot so they at least have to be moved each time.

That shot over. Boris (it's 3.30) and afternoon tea have arrived. Three more shots inside the barn and we wrap up for the night. The tapes recorded that day are packed up as we drive back to Zagreb where they will be collected with the exposed film, taken to the production office and thence to the airport. The film is developed in London and the required takes printed. The chosen sound takes are transferred at Location Sound Facilities and marked up with the action, known as 'synching up'. This involves finding the first frame where the clapper board is closed on the action and marking it and the start of the clap on the sound transfer. All the chosen (printed) takes are married in this manner and made up into rolls for viewing as rushes. The film is then ready to be flown back to Zagreb on the afternoon flight for rushes viewing at Jachran Studios in the evening after shooting.

Shooting carried on in this manner through August and into mid September, six days a week. In the middle of September we did two weeks of night shooting which involved dusk shots leading into night shooting proper. Back to day shooting but starting later since the days were drawing in as autumn arrived.

November. The schedule demanded snow and dull weather but we had bright clear days with no sign of snow. Several hundred tons of marble dust were used to provide snow cover for the ground but there was no way of blacking the bright blue sky. The decision was made that we would shoot in the dome stage. This was a vast silver plastic bubble supported by air pressure inside, being maintained just above the atmospheric outside by pumps. It was entered by two air locks; one large for equipment and one house door size.

There were two main sound problems with shooting in the dome stage: the acoustics (akin to the Whispering Gallery) and the noise of the pumps. These were overcome by constructing screens that could be hung as a tent over the set and by turning the pumps off during a take. As long as the airlock doors were kept closed, the dome did not droop too much in 15 minutes without the pumps running.

Each night all the sound equipment had to be packed back into the truck as, if the weather changed the next day and became dull, we would go straight to the 'snow' covered exterior set and would not have time to pick up equipment from the dome. In this manner, alternating between exteriors with marble dust and interiors in the dome (it became known as the doom) stage, the location came to an end in early December. We would return in 1971 to get shots in the snow of open spaces too large to be covered with marble dust. The essential sound equipment (Nagras, mikes, etc) was air freighted back to London and supplemented with duplicate equipment from Location Sound to cover the heavy items that were not air lifted.

Shooting in the studios (Pinewood) is technically the same as shooting on location, apart from the camera, which is powered from the mains. In fact this was not used some of the time due to power supply industry problems. The working hours kept strict studio timetable. In some way, working was not as free and easy as on location.

We had a large area to cover with PA on the first set. Shooting was to take several weeks so speakers were slung from the lighting rails. After the big dance number (the wedding party), there were several days shooting inside a house set. John Stevenson spent hours in the rafters with the mike on a pole, doing a strange form of balancing act. Two other stages were used both for large musical numbers but with little or no dialogue recording. By early February all this and the bits and pieces were finished and we were ready to go back to Yugoslavia for the snow scenes.

We flew to Zagreb on the afternoon flight and were driven for 2½ hours to Daruvar, a spa town in the hills, not far from the Hungarian border. This new location was used because the action involved a railway station. A suitable length of track had been found in the area where the station set, a small halt, had been constructed. There were only traces of snow so a start was made on some back-up shots with marble dust. These were finished after a day and we moved on to the railway station.

The amount of sound equipment we had with us had been reduced to a minimum as it was all air lifted. John Stevenson, the boom operator, had gone on to another picture so I was boom operator for a few days. We carried the sound equipment in a mini-bus to and from the hotel and then off loaded it into the train that featured in the action, this moved us down the track about 1.5 km from the loading area, the real station, which was the nearest point that we could reach the set with the mini-bus.

The decision was made to go on and film the sequence without snow but in dull weather so as to look as bleak as possible. This involved plenty of train rides, sound effects, and that forgotten smell of steam trains. Late one afternoon it was almost too dark to shoot. We had just placed a shot in the can and it was unexpectedly all over. Hands were being shaken and people thanked; principal photography had been completed. A day was then spent packing and travelling back to Zagreb to view all but the last day's shooting. Next morning we were on the plane back to London as the last day's shooting was reported satisfactory by the Labs. Shooting lasted from early August '70 to mid February '71.

Sound Crew

Sound Mixer	David Hildyard
Boom Operator	John Stevenson
Sound Camera Operator	Pat Heigham
Sound Maintenance	Tim Blackham
Yugoslav Sound Assistant	Boris

STUDIO DIARY

BY KEITH WICKS

UP in Cricklewood, Philip Cecil and Tony Apple have been doing a lot of demo work at their **Gemini Studios.** Among the clients this month were Plynth, Krishna Kudo, and Offspring.

At **Wessex Sound Studios** in Highbury, Mike Thompson has finished work on a double album featuring various hits from the past few years. Mainly instrumental numbers, they were produced by Les Reed and Jack Baverstock for a budget label. Mike also engineered a ballad/pop session by Tony Jacklin, produced by Keith Mansfield for CBS, and was again at the desk for another CBS star. Described by studio manager Adrian Ibbetson as 'a modern day Mario Lanza'. Robert Young was recording an LP which should be released shortly. The group Putney Bridge have been laying down tracks for the Les Reed organisation, Chapter One Records.

For the same company, Harrod Geller produced a Magenta session. American producer Jesse Peterson laid down some beaty orchestral tracks for nine or so albums in one week ! These were mostly spiritual numbers, and the vocals will probably be added in the States. For the Gem Company, Milkwood have been recording some folky numbers reported to be in the Crosby, Stills, and Nash category. Instruments used included six and twelve string acoustic guitars, and acoustic and electric pianos. Johnny Johnson and the Bandwagon have just completed a single with engineer Robin Thompson and producer Tony MacCauley. The Westminster Symphonic Orchestra recorded a lot of material for some American clients, and Ricky Beaumont made a single. Nine year old Ricky played Tiny Tim in the film *Scrooge*, and is now doing well with *Never Never Change*, which has already been played a lot on the radio.

Impulse have had a busy month in Newcastle. Their mobile unit has been working at the University theatre on *Joe Lives*, a one man play starring John Woodbine. An extensive editing session with playwright Alex Glasgow reduced it to 50 minutes, and this presentation is now available on an LP. Preparatory sessions with Trilogy, a contemporary folk electric group, have produced excellent results so the group's album sessions, due to start soon, should yield something worthwhile. John Allison (of the Allisons) has been recording song demos for his new company Alice Music. Ginhouse paid a lightning visit to put down three songs, and the Redcar jazz-rock group, Backdoor, were in to record original material. Impulse's associate company, Hazy Music, are the publishers for all but four tracks on Lindisfarme's Impulse-recorded LP, *Nicely Out of Tune*. Impulse, in conjunction with Hazy Music, help songwriters to get their material into shape, and then record and promote it. Studio director David Wood told me that a good deal of their time is now taken up by this work. It seems likely that they will discover a lot of useful talent, as they have in the past.

Sound Developments is a new studio in London's Primrose Hill. With commercial radio approaching, this studio has been built to cope with the special needs of the new radio advertising industry. With an area of 38 m², up to 15 musicians can be accommodated, which is more than adequate for jingle recording. Experience has already been gained in the radio field, as this is the company that built and now operate Radio United Biscuits. This internal station is situated at the Osterely biscuit factory and run along commercial lines using jingles and other professionally recorded programme aids, together with commercials produced by Sound Developments. These consist exclusively of public service material on safety and hygiene, and other subjects relevant to the factory. With this successful project under way, Sound Developments are now ready to launch into commercial radio proper. The facilities provided at their new studio include a typical self operational disc-jockey set up at £6 per hour, editing and copying services at £5 per hour, and programme assembly at £6 per hour. For use of the main control room and studio, the hourly charges are £17.50 for four track recording, £12.50 for two track, £8.50 for mono, and £12.50 for reduction. Equipment includes a 12 channel four output Neve console, an EMT stereo echo plate, and Ampex recorders. A Baldwin grand piano is available, and customers can obtain background music and effects from the studio library. Potential clients can contact the studio director, Roger Sinclair, on 01-586 4488/9.

Multicord Studios of Sunderland, opened eight months ago by Ken McKenzie, have been busy producing local radio programmes and demo discs. Some masters have been made for independent record companies as well as for release on the Multicord label. Work continues on radio and TV commercials and cinema trailers, for which the studios have a pool of songwriters, musicians and announcers.

George Pastell's **Recorded Sound Studios,** featured last month, are now known as **Nova Sound Recording Studios.** Clients may like to note that the telephone number has been changed to 01-493 7043/4/5. The studio was acquired by Scotia Investments (hence Nova). George Pastell, being connected with Scotia, remains as studio manager. Twenty Dolby *361* have been added, and a 3M 16 track recorder is now in operation along with the best Neve desk I have seen. In addition, a new monitoring system has been installed, consisting of Altec speakers and Audix amplification.

Freddie Starr was in during April with Jackie Rae for London Management. Johnny Johnson and the Bandwagon were produced by Tony MacCauley as were the Fantastics. Maurice Gibb has produced numerous sessions including vocals for Lulu. Shel Talmy has produced for a number of groups, among them Blues Project, a new American band. The production of English language DJ shows for Radio Monte Carlo International has now ceased as this radio service proved uneconomical during its trial period and was discontinued.

Spot Sound Studios have also changed their name, and now operate under the title of **Mayfair Sound Studios.** Gary Levy tells me that they consider it a better name, appropriate because the studio is in Mayfair. Apart from this everything else remains the same, including the name of the parent company, **Spot Productions Limited.**

With producer Mike Leander, Iron Horse recorded their Bell Records release, *Obeah Man*, early reviews of which forecast a big hit. For Hit Records, Des Dolan produced a master by the Castaways, entitled *Wild Weekend*. Other work included country and western LP masters for Avenue Recordings, featuring Patsy Powell and the Playboys, and the Kentuckians. Both of these albums were produced by George Watkins.

Command Studios are currently recording a Pink Fairies album for release on Polydor, Pentangle are completing an album for the Transatlantic label, and Liz Pearson has been making her debut solo album. Strings were scored by Richard Hartley, and the producer was Tim Satchell. These two also worked on the second album by the much acclaimed classical-jazz-pop quartet, Continuum. The record is due to be released in June on RCA's new progressive label, Neon.

Singer Joe Brown is busy putting the finishing touches to a studio he is building in converted stables at his Chigwell home. A four track recorder will be used in conjunction with his 16 channel Neve desk, and an echo plate is on order. Meanwhile, for experimental sessions, he is making do with a Grampian spring device and has been recording some country groups. The studio measures about 9 x 4.5 m and is complete apart from some slight alterations which have to be made

(continued overleaf)

to the acoustics. Joe is very pleased with his *D202* AKGs for acoustic guitars, and has also been trying out Shure microphones on bass drums. When everything has been sorted out, he will get down to serious recording for himself, and possibly for Jaw Bone and Country Fever. This will not be until he is completely happy about the operation of the equipment.

Sutton Sound have been spending a considerable amount of time producing their own space science fiction album, for which the record companies are now bidding. Numerous instrumental effects are used on this album which features a nameless pop group, with added strings and brass, and is about four chaps who go into suspended animation for 300 years.

The **Jackson Recording Company** in Rickmansworth has been busy with masters for Tamlin, Pale Light, Forbes Bainbridge, and Japanese organist, Kohithi Oki, who used a Yamaha *Electone* instrument. Ray Cameron, who was responsible for the recent number one hit *Grandad*, has been producing backing tracks for Ray Brook, who appeared in *The Knack* and *Cathy Come Home*. Malcolm Jackson has also been occupied with various tape-slide presentations and with the recording of a 17-piece school band. For this sort of work, Malcolm records a four track master but simultaneously mixes the four signals down to stereo, and records them on another machine. The four track master is handy if a different stereo balance is later considered desirable. Assuming all is well, the customer ends up with an instant stereo master without the need for a reduction session. Hiss and distortion are therefore lower, and so is the customer's expenditure.

The **Squire Sound DJ** studio has been accommodating Australians, South Africans, Rhodesians, Canadians and Americans, who want to send programmes back to their native lands. Nicky B. Horne and Chris Grant are now regular users of the studio, having been asked to supply programmes to American radio stations as a direct result of demo tapes made at Squire. Henry Henroid, manager for Horne and Grant, went to the USA to sell prerecorded programmes. Although unable to secure an expected contract with station 77WABC New York, he managed to find other customers. Tony Mercer, who has been supplying material to 77WABC for some time, now uses the Squire studio in preference to his own setup, and is very happy with the quality he obtains.

Radio DJ techniques can now be acquired by taking a course at this studio. For a total cost of £35, the aspiring record spinner gets five 1½ hour sessions of instruction and practice in the studio. Chris Grant and Peter Gooch, both very experienced in this field, are the tutors, and students are taught in pairs, one operating the equipment, and the other watching. Homework is set, and consists of such things as programme planning and scripting, and at the following lesson the students have to attempt to put their plans into practice.

Robin Cable (left) and Gus Dudgeon at the Trident desk.

Trident director Barry Sheffield is acting as studio manager in place of Malcolm Toft, who is now looking after the technical side of the studio. Gus Dudgeon has been in again for Audience, with Robin Cable at the desk, and these two teamed up again for an Elton John album. Ringo recorded a single with George Harrison producing, and Roy Baker engineered a self produced Ginger Baker session. The Mixtures have been doing a lot of work with producer Dave Mackay and engineers Ken Scott and David Henshaw. Also at the studio this month have been T. Rex, Badfinger and Cat Stevens.

At Tony Russell's recently opened **Atlantic Recording Studios** in Dublin, musicians who don't need multitrack facilities have the opportunity to experiment at fairly low cost. For recording or copying on a stereo machine, the rate is £4 per hour. For editing, £3. The control console by Allen & Heath has a built-in limiter, and high and low pass filters. The eight input channels all have equalisation, echo, foldback and pan pot. Monitoring equipment consists of a Spendor amplifier feeding Richard Allan speakers employing 381 mm bass units. Other information on this new studio appeared in the March issue.

Now the promised information on the new console installed at **Metronome Records,** Denmark's leading studio, which is located in Copenhagen. Elektroakustik, an engineering firm run by N. P. Petersen, manufactured this unusual desk, which has 24 input channels, eight group channels, and two stereo channels. The input signals are fed direct to a multitrack machine without passing through the bass, treble, presence and absence circuitry. While linear signals are recorded, the various filters may be adjusted to give a suitable tonal balance as heard on the monitoring system. Final reduction down to stereo or mono is then carried out by playing the multitrack tape through these same channels. Mixing is done in the usual way, the balanced signals being selected to the desired groups by means of push buttons, then passing via panning controls to the input mixers of the stereo/mono channels. Vertically mounted edgewise VU meters monitor the signal levels in all input and group channels and the stereo/mono signals are checked on a dual light-spot PPM. In the stereo channels, sum and difference signals are generated, the sum being used as a mono signal and, in conjunction with the difference signal, as input information to a correlation degree meter, independent of amplitude. In addition to these facilities, the console has three monitoring systems, three separate reverberation systems, four compressors, announce and talkback microphone and an alignment oscillator with five fixed frequencies. This elaborate desk is very smart in appearance and all the controls are clearly labelled. Elektroakustik claim that their standard of engineering is of the highest standard, and it seems likely that we will eventually see their consoles in some of London's studios.

Last month, I mentioned that the **Record Plant** had invested just over £100 000 in the rebuilding of their New York premises. During the reconstruction, two of their three studios will be in operation at all times. The expansion will enable the Record Plant to provide all studios with closed circuit TV, 16 and 35 mm projection capability, and full quadraphonic sound. The expenditure will also allow them to standardise the equipment in all three studios. The acoustic redesigning of Studios A and B will be undertaken by Tom Hidley of Record Plant's Research and Development department. When completed, Studio A will be able to accommodate 48 musicians, and will also be equipped with a new SpectraSonics console, designed for flexibility and costing over £30 000. Both Studios A and B will be provided with MCI-RP 24 track tape machines. Studio B will also have a new console installed, and its control room will be enlarged and made more comfortable. All areas of the New York complex will be redecorated with the aim of improving the engineers' and artists' working environment.

From its inception a year ago as a three-employee operation with an initial $500 000 investment, the West Coast branch of Record Plant is now celebrating its first anniversary with the addition of a third studio. Having

grown within the past year into a 13 man staff headed by Gary Kellgren, with engineer Bob Hughes, business manager Margie Sisco, and research and development man Tom Hidley, the West Coast studio, with its new consoles and 12 track tape machines, can now boast of being the only Los Angeles recording complex to offer such a capability. The 24 track system was designed and assembled by the Record Plant, incorporating the firm's own deck design and cabinetry, and enables artists and producers to begin work in the New York studio and wrap up in Los Angeles, or vice versa, using the same 16-24 track sound mixing systems. The new studio, which is being added to their current two, will be built on their sound stage with a 9 m ceiling and dimensions of 13 x 16 m. It will have quadraphonic mixing, recording and editing capabilities, a SpectraSonics console, new MCI-RP tape machines, and Hidley custom monitoring systems. Another reason for the Record Plant to celebrate on its birthday is its success in serving so many major artists in the past year. Among those to record were The Association, The Jackson Five, Captain Beefheart, Three Dog Night, Jimmy Witherspoon, Smokey Robinson, Diana Ross, Frank Zappa, B. B. King, Jimi Hendrix, Country Funk, Steppenwolf, James Gang, Sioux City Zoo, Crosby, Stills and Nash, Salvation, Johnny Rivers, Hedge and Donna, The Rolling Stones, Delaney and Bonnie, Eric Clapton, Love, Tim Buckley, Country Joe and the Fish, Jesse Davis, Dave Mason, Buddy Miles, Ike and Tina Turner, and Turley Richards. No wonder they are celebrating.

The very successful **Woodland Sound Studios** in Nashville are now in their fourth year, and have just reopened their Studio A after extensive research and redesign. The control room is shaped and treated to provide a natural atmosphere for the creative producer and engineer. The new console design is the result of the combined efforts of the engineering staff of Woodland, and is engineered for simplicity and reliability of operation. Construction and installation of the 24 input 16 track console was handled by Suburban Sound Corporation, a division of the A & R Recording Company. The next project, already under way, is to reconstruct Control Room B to match the environment of Studio A. This will ensure that the quality produced from either facility will be the same. Glenn Snoddy, president of Woodland, explained: 'We believe in consistency of sound when taking a tape from one control room to another. This fact, together with the need to have quadraphonic facilities in both control rooms prompted us to remodel Control Room B'. Perception Incorporated of Los Angeles, California, was responsible for the acoustical design. Altec Lansing 'acousta-voiced' both control rooms. In spite of the current rebuilding programme, Woodland are getting through a lot of recording work. Nashville pianist Bill Purcell recorded an instrumental album for Cartridge Control, using the services of engineer Tom Semmes. Producer Buddy Killen has been in with Diana Trask to complete her next single for Paramount Records, engineering here by Ernie Winfrey and Rex Collier. Buddy also produced Joe Tex and the Nashville Edition for Dial Records. Ernie Winfrey engineered for independent producer Charlie Daniels on a session by Jerry Corbitt for Capitol, and by Roy Buchannan for Polydor. Warner Brothers artist Gordon Lightfoot completed an LP at the studio with engineer Rick Horton, and producer Joe Wissert flew in from Los Angeles for the session. Described as a 'very together group', New York City's Manhattan Transfer completed an album for Capitol. Lee Hazen and Tom Semmes engineered, and the flying producer here was Adam Mitchell from Toronto. Del Reeves and Penny DeHaven completed some album tracks assisted by engineers Rick Horton and producer Scotty Turner. Advertising man J. Walter Thompson was in for Hamm's Beer, with Kelso Herston handling the production. Kelso also produced a single for Target Records, featuring 13 year old Mark Howard, with Jack Reno and Alice Creech. Other artists in the studio have included Bill Laundy for Kelso Herston Productions, Dick Bush for St Jude Productions, and Bucky Wilkin for Don Tweedy Productions. Besides recording solo artists, and small groups, Woodland have been handling much bigger things. Lee Hazen recorded a cantata by the choirs of the First Baptish Church of Nashville in the Church auditorium. With Rex Collier, Lee recorded a 35 piece orchestra in the studio. The result was a single for Ovation Records, arranged by Don Tweedy and produced by Bob Montgomery. The B.C. & M. Choir recorded *Our Brother's Keeper* for Crickett Productions, with Ernie Winfrey engineering, and the session was co-produced by Bob Montgomery and Bobby Goldsboro.

The Society of Motion Picture and Television Engineers held a meeting at the studios, guest speaker on this occasion being Dr H. G. Trythall, Associate Professor of Music at George Peabody College. Dr. Trythall, who is one of the best known authorities on the Moog, presented a short film followed by a demonstration and descriptive talk on its performance capabilities. After the demonstration, Glenn Snoddy, president of Woodland gave the group a guided tour of his studio.

Nashville's **Mercury Custom Recording Studio,** operated by the Metropolitan Music Company, was started in June 1970. Since then, they have recorded for Mercury, MGM, GRT, Paramount, and a score of smaller independent labels. Artists who have used the studio include Patti Page, Michael Parks, Jerry Lee Lewis, Bobby Bare, Roy Dusky, Tom T. Hall, Max Curtis, and Stan Hitchcock.

Also in Nashville, **Jack Clement Recording Studios** have been busy with a number of recordings for Capitol Records. George Rickey produced on sessions for Roy Rogers, Tex Ritter, and Dick Curless. Larry Butler produced for Jim and Jesse, and Artie and Happy Traum undertook their own production. For Warner Brothers Records, Steve Young has been in with producer Andy Wickham and Paul Tanner, and Smoke Ring, produced by Allen Reynolds and Dickey Lee, have recorded for Riverton Productions. The Imperials have been in for Heartwarming Records with producer Bob MacKensie, Billy Carr produced a Martha Turner session for Marr-Carr Enterprises, and Nick Nixon has been in with producer Larry Butler for Opryland Records. For Dot Records, Norro Wilson produced a Joe Stampley session, and Joe Allison produced string section over-dubs on some Roy Clark material. Other recent work has included self-produced sessions by Ray Walker for World Records, and by Ray Stevens for Barnaby Records. Jingle work was carried out for the J. Walter Thompson Agency, and McCann Erickson.

The **Bill Rase Recording and Film Studios** at Sacramento, California, seem to corner every aspect of the business—audio and video recording, radio and television production, record manufacture, songwriting, arranging, music copyrighting, jingle singing, and comprehensive film facilities, to mention just a few of their activities. They also record and duplicate tape cassettes and cartridges, and chief engineer Bill McCray recently designed and installed some new switching equipment to simplify operations during tape duplication.

Messrs Chris Grant (left) and N. B. Horne in the Squire Sound disc-jockey studio.

Understanding Time Constants

TAPE SPEED AND STANDARD	TIME CONSTANT	3 dB BASS TURNOVER	3 dB TREBLE TURNOVER
76 cm/s IEC/DIN	35 μS	0	4.5 kHz
38 cm/s NAB	50 and 3 180 μS	50 Hz	3.2 kHz
38 cm/s IEC/DIN	35 μS	0	4.5 kHz
19 cm/s NAB	50 and 3 180 μS	50 Hz	3.2 kHz
19 cm/s IEC/DIN	70 μS	0	2.5 kHz
9.5 cm/s IEC/DIN/NAB	90 and 3 180 μS	50 Hz	1.8 kHz
4.75 cm/s IEC	120 and 3 180 μS	50 Hz	1.35 kHz
4.75 cm/s NAB	9 and 3 180 μS	50 Hz	1.8 kHz
4.75 cm/s cassette	120 and 1 590 μS	100 Hz	1.35 kHz
Proposed new IEC 4.75 cm/s chrome cassette	70 and 3 180 μS	50 Hz	2.5 kHz

BY ANGUS McKENZIE

BEFORE dealing with an explanation of time constants, it is important to understand what takes place when a replay head converts tape magnetisation into a low level electrical output which has then to be amplified and equalised to give a flat audio output at the line out socket of the tape recorder.

Assume that a playback head is a current source generator in series with an inductance, a secondary equivalent circuit giving a high frequency roll-off of increasing amount down to a null where the recorded wavelength is equal to the electrical equivalent playback gap width. This limits the highest frequency that the head will reproduce at a particular tape speed, the frequency of course doubling when the tape speed is doubled. The effect is on wavelength rather than any intrinsic frequency response.

It will be realised that the current at any one wavelength is more or less proportional to the level of magnetisation. Because of the head inductance, the actual voltage across the head developed at any frequency will be proportional to the frequency, provided this frequency is well within the wavelengths where there are no electrical losses or peaks in the head itself. We also assume that the head is effectively working into an open circuit. To correct the response, a basic 6 dB per octave cut is required between the lowest and highest frequencies to be played back, disregarding once again any head characteristic other than inductance.

On the record head side, because of the presence of high frequency bias, HF tends to be partly erased at the point where the tape leaves the head gap. Generally, the thicker the oxide coating on the tape, the greater the amount of bias required to record low and middle frequencies to the given distortion level. It is therefore obvious that tapes with thick oxide coating (such as BASF *LR 56* and Agfa *PER 555*) will not only require quite a high bias to take advantage of the higher recording level permitted by the extra oxide thickness, but high frequencies will tend to be erased more on the surface of the tape. To combat this, greater than usual treble boost is usually necessary with such tapes to achieve a flat response. In addition, ferric oxide tape tends to reduce magnetisation efficiency at high frequencies.

For these reasons, the replay curve already explained has to be modified to give a treble boost symptotic to 6 dB per octave above a certain frequency determinable by the basic characteristics of ferric oxide tape itself at different speeds and therefore different wavelengths. In the early 1950s, representatives from many countries sat on an international committee and decided on various high fre-

quency boosts to be made in the replay amplifier for different speeds. The committee also determined the frequencies at which the curve boosted 3 dB above the basic 6 dB per octave fall off. It was felt easiest to represent these turnover points as a combination of capacitance and resistance in series in a feedback loop, the figure being quoted as capacitance in microfarads and resistance in ohms. The choice of the capacitance in any particular network is determined by the lowest frequency to be replayed flat through the curve in question, allowing the feedback to increase by 6 dB per octave above this frequency. To achieve a flat response and low bass distortion it is necessary at this low frequency to use several decibels of feedback. A circuit giving really accurate replay equalisation could require up to 60 dB of feedback at high frequencies were it not for the fact that the HF time constant stops a treble roll-off above a certain frequency rather than boosting it above a flat amplifier response. Nevertheless an open loop gain of 1 000 is necessary to achieve the correct asymptotes. In the days of valves this could be achieved round a double triode. It can easily be achieved in a transistor circuit having say three stages of amplification. Since the capacitor in the feedback loop has to be set to give the correct amount of LF gain, the only resistance in the time constant network should theoretically be changed to give the correct replay time constant.

Some replay characteristics also require a bass roll-off time-constant, for instance 3 180 μS for NAB characteristics, or DIN (IEC) 9.5 cm/s. This is best achieved by switching an appropriate resistor across the HF time constant capacitor, which has the effect of decreasing the boost below the frequency proportional to the 3 dB bass fall off point; 3 180 μS being equivalent to a 3 dB drop at 50 Hz and approximately 7 dB drop at 25 Hz. With such an addition it will be necessary in many circuits to add an additional DC blocking capacitor in the feedback loop of at least ten times the value of the HF time constant capacitor so that the latter's bass by-pass resistor will have its DC path blocked.

It should be noted that the lower the time constant in microseconds the less high frequency hiss will be noticed in the playback amplifier. At 38 cm/s, the NAB curve of 50 μS and 3 180 μS is more hissy than the IEC/DIN recommended 35 μS. At 19 cm/s, however, the identical NAB curve which is used for this speed will be less noisy than the IEC/DIN 70 μS curve, the hiss at each speed being approximately 3 dB different at the high frequency end. The 3 180 μS bass replay cut was originally introduced to improve the 50 Hz hum level in replay amplifiers in the days when replay head screening was not so effective. For a similar reason, a bass roll-off of 1 590 μS was adopted for 4.75 cm/s cassettes by IEC/DIN with results that I feel are disastrous, curtailing the response at 100 Hz by 3 dB and 50 Hz by 7 dB, and requiring an equal and opposite recording boost to give a flat response. This amount of recording boost has led to severe distortion at the bass end of many prerecorded tapes, while others have needed their peak recording levels reduced to accommodate passages of heavy bass. It is ironic that the British Standards Institute may shortly be publishing 1 590 μS as the official standard at a time when I understand many manufacturers are changing back to 3 180 μS or in some cases to a flat bass replay curve.

In the recording amplifier, the time constants necessary to produce the correct HF lift depend on the tape's HF characteristics. Provided good heads are used, I have usually found a network approaching a 6 dB per octave boost with the turnover frequency variable all that is necessary, but a resistor must also be incorporated to prevent the boost continuing above 30 kHz or so. When the reader has learnt the turnover frequencies of a number of time constants, he should divide or multiply in order to get further time constants. This is simpler than continually using the usual impedance formula $Z = 1/2\ \pi\ fC$ where Z is the impedance in ohms, f is frequency in Hz and C capacitance in farads (one farad being equal to 10^6 μF). A 1 kHz turnover frequency, as an example, can be obtained from a resistor/capacitor combination of 159 μS (1.59 K in series with 0.1 μF, or again 15.9 K ohms with 10 kpF).

Although the time constants have not been changed internationally at the higher speeds, there has been progressively more and more confusion over the replay time constants for 9.5 cm/s. Originally when the speed was regarded as only suitable for amateur speech recording, the usual time constant used was approximately 180 μS. This was rationalised to 140 μS (double the 19 cm/s 70 μS time constant). This was most convenient since it allowed 9.5 cm/s copy tapes to be made from masters at double speed, preserving the correct time constants. To make this clearer, a 19 cm/s master tape played back at 38 cm/s with a 35 μS curve and copied at 19 cm/s with a recording curve that gives a 70 μS flat playback response, when played back at 9.5 cm/s with a 140 μS curve will have a flat response.

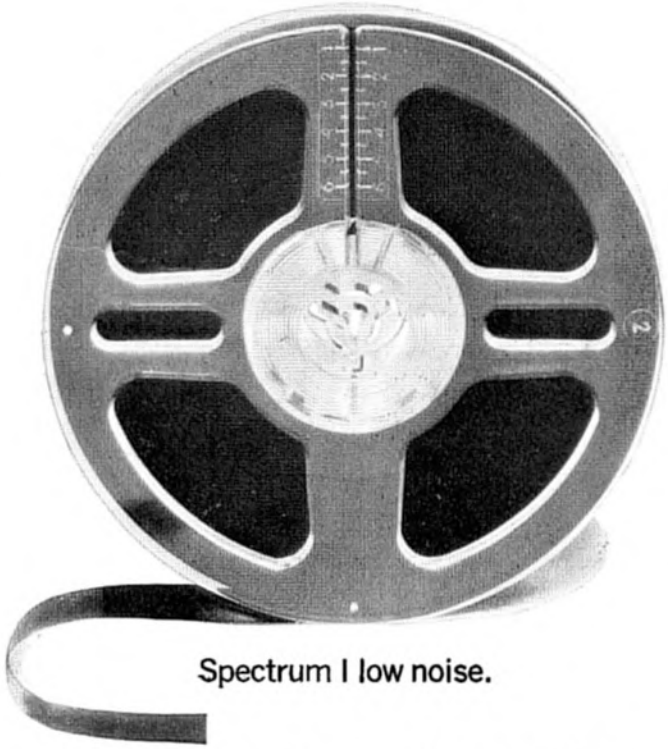
Because of the HF improvements in LP and DP tape in the last few years, the recommended playback curve for 9.5 cm/s was decreased first to 120 μS and later to the new standard of 90 μS. This will in fact mean that recordings made at the lower speeds many years ago will now play back on modern machines with significantly less top, although the ratio of extreme top to middle top may be better because of the improvement in playback heads. It should also be noted that recordings made on modern machines may well sound too toppy if played back on older ones at 9.5 cm/s. Since the change in response starts occurring below 2 kHz, the differences will be clearly audible especially if the playback machine is old and the recording machine new, or vice versa. Although it is simple to modify the replay response of old machines to the new standard, difficulty may be experienced in getting enough compensatory HF boost in the recording amplifier. Many old machines lack sufficient recording amplifier power at high frequencies, although possibly satisfactory at middle frequencies.

Fortunately, most modern makes of tape are actually more sensitive at high frequencies or, to be more correct, shorter wavelengths, in addition to having the facility of giving a higher output at these wavelengths. Typical examples of these tapes are BASF *LH*, EMI *Afonic* and Agfa *PE36*, which all have short wavelength performance greatly superior to earlier types made by the same manufacturers. We may see a further reduction of time constant for a number of tape speeds when the properties of chromium dioxide tapes are considered. The latest recommendation for 4.75 cm/s cassettes is for a new time constant of 70/3 180 μS. This applies to chromium dioxide, referred to internationally with the somewhat loose term of 'high density' tapes.

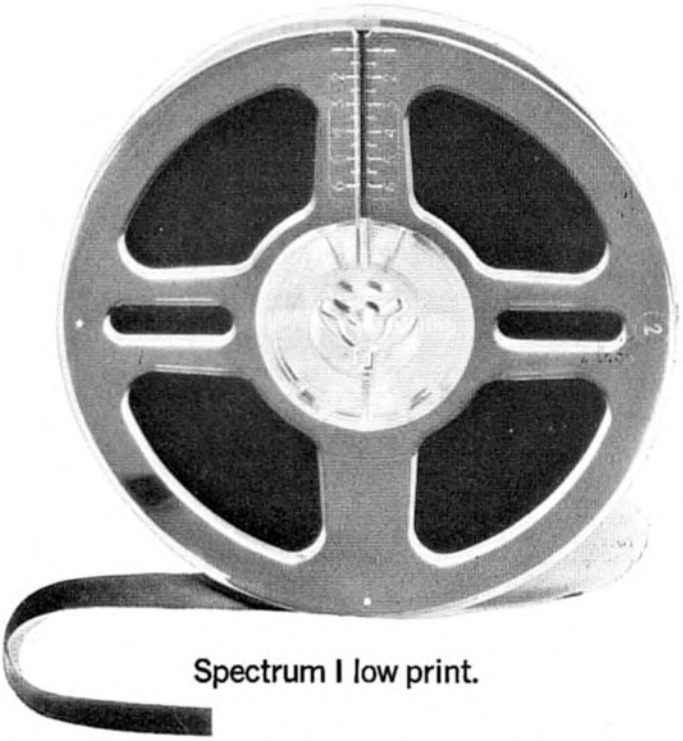
The effect of playing back tapes with a wrong time constant is that of a shelf boost or cut above a certain frequency. It is not a continuous rise in response at the top end. It is therefore difficult to correct any errors with normal tone controls. For this reason, some more enterprising recorder manufacturers have made the treble equalisation playback controls purely time constant correction at the higher speeds, particularly when ferrite heads have been supplied. The latter should not require any extra treble compensation at 19 or 38 cm/s. I would nevertheless like to see all studio recorder manufacturers put in switched replay time constant compensation for different curves to encourage the correct playback of all tapes recorded on other machines. On the recording side again, if the suggested type of equalisation is used, it is an easy matter to change to any standard. To play a NAB characteristic recorded tape on an IEC/DIN standard professional machine, remember it will also be necessary to introduce a 3 dB bass cut at 50 Hz with 7 dB cut at 25 Hz. Otherwise, particularly in disc cutting, dangerous bass modulations may be introduced.

In a later article, I shall deal with the problem of time constants for disc recording and reproduction, with the reasons for their choice.

Pray silence for Spectrum I.



Spectrum I low noise.



Spectrum I low print.

These new low noise and low print tapes show an input/output improvement at 2% distortion of 4dB, or better.

It would take a real effort to overload them. (That should take some of the worry off your mind).

With low noise you'll get a signal to noise ratio as good as you can get.

The low print tape gives remarkably low print through across the whole range of audio frequencies.

In other words, what you put on it, you'll get off it.

You'll notice they're black.

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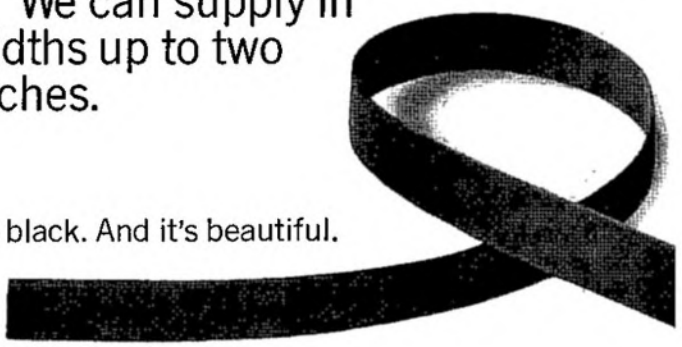

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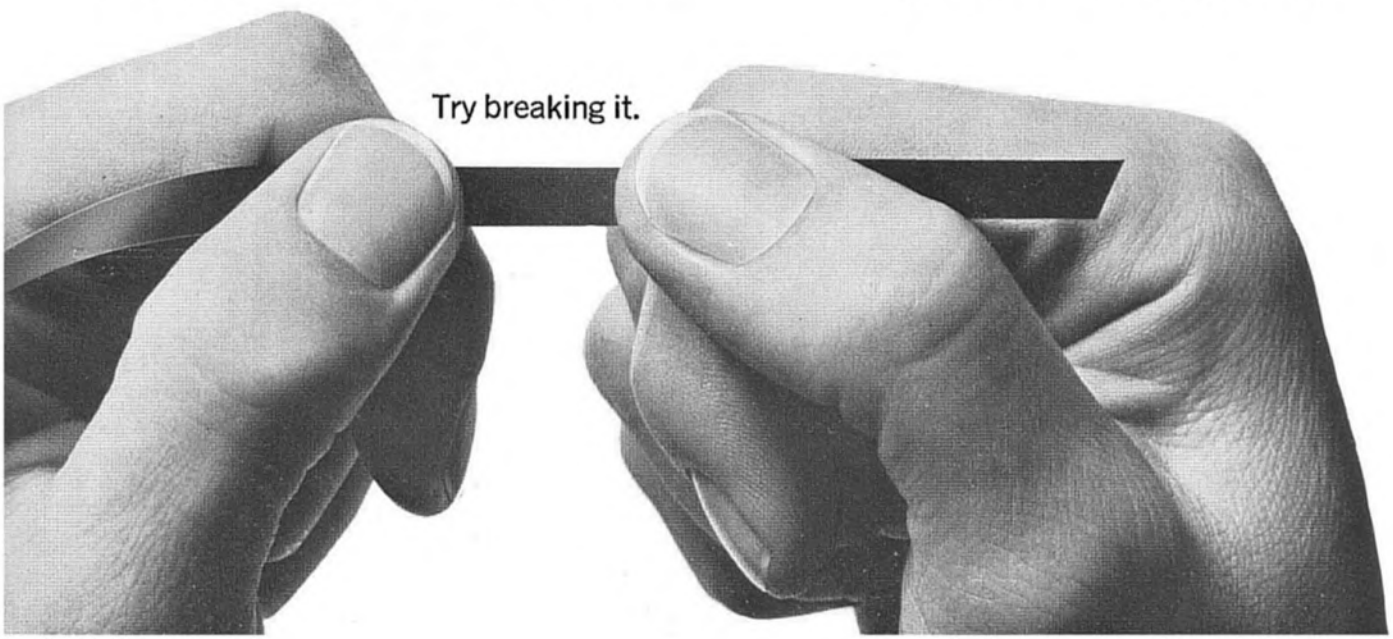

At last, Eagle admit to having a rotten mike.

We admit it, the CA 27C is a stinker. It's awful. It makes after-dinner speakers sound like Donald Duck. And the feedback would deafen a rhinoceros.

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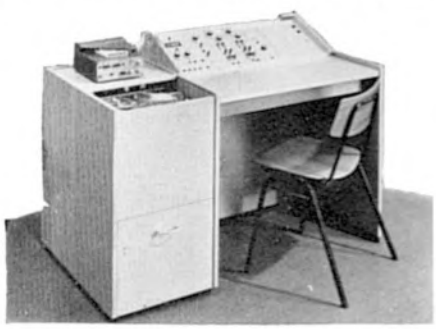
The Tandberg Language Laboratory

by Richard Golding



Upper and lower left: Two examples of Tandberg instructor consoles.
Upper right: Pupils booths, again using basic Tandberg recorder.
Lower right: Tandberg endless cartridge recorder, used with short loop to provide instant repeat.

THE function of any language laboratory is to train students to hear and absorb sounds of the target language and then drill them into mastering these sounds as near as possible to perfect reproduction. The most elaborate method is the *audio-active-comparative*. This consists of the master material being replayed from the instructor's console to the tape unit in the student's booth, with time-gaps between each phrase to allow the student to record and hear his own responses. On replay, the student can listen to both tracks at the same time and compare his speech with the original.

The normal practice with advanced students is to record a complete text in the target language and to follow this with the same passage exploded, i.e. short phrases with time-gaps between. The student listens to the complete passage, replaying the whole or parts of it, until he is sure that he understands more-or-less what it is about. He then goes on to the second part of the tape to make his own responses to the short recorded phrases. He will find that he has just enough time to make his response before the next phrase comes up. If he wishes to erase his own track and to re-record his responses, he may do so but he will be unable to erase the master track.

The third part of the tape comprises questions on the master track to test the student's comprehension of the passage, followed by time-gaps for more responses. The exploded tape may be used in conjunction with visual-aid material such as an 8 mm film loop or a 35 mm film strip, with the presentation of the visuals taking the place of the first passage, and the questions will relate to the content of the pictures.

The *audio-active-comparative* system can bring very high achievement but it is expensive. There is a simplified system, however, the very much cheaper *audio-active*. The student here has no tape deck in his booth. His headphones are connected to the master console. He listens to the master track and then repeats it during the silent time-gaps. His speech is fed back into his earphones so that he can hear his own responses but he cannot make an immediate comparison with the master. Both tracks may be monitored and recorded on the spare recorder at the console and then played back to the student afterwards. The disadvantage is that there can be no immediate check on correct pronunciation. There is also the adverse factor that only one student can be accommodated at a time as far as playback of the whole recording is concerned.

The language laboratory is no longer a novelty. During the past decade leading educational bodies have carried out continuous and extensive tests from which they have laid down certain requisites for sound quality, flexibility and reliability. This reliability angle is very important since few colleges and schools have adequate technical staff available at all times. Although servicing and emergency repair arrangements can be made by most suppliers these usually take at least a few hours to be put into effect, if not a few days. A very slight fault in the system can easily put the language department's timetable out for a whole week. On the other hand, some labs seem to go on forever without the slightest attention. The Harvard University Language Lab, for instance, ran for 23 000 machine hours before the first running repair had to be undertaken. The Tandberg Language Laboratory at the Chelsea College of Science and Technology enjoyed the same experience. 'In two years,' said Peter Long, senior technician of the A-V Aids Unit of the college, 'it has only been necessary to replace two small bulbs in the students' modules. There has been no trouble with sticking solenoids; the system is simplicity itself.'

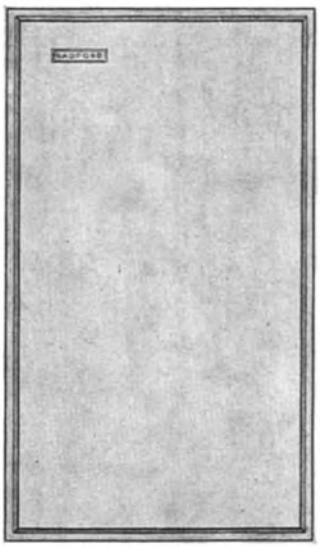
The Chelsea College lab is fully *audio-active-comparative* and is laid out in such a fashion that the many visual aids used by the department can be seen to best advantage by all students. The booths do not occupy the usual position of being face-on to the teacher and are arranged around the walls, with the students facing the wall. The central floor-space is free and, when a visual aid is shown, the student simply swivels round in his seat to watch the screen. Language learning here is at present an extra-curricular activity and the lab is used mainly at lunchtimes, evenings and weekends, with one full-time lecturer and two part-time teachers.

The Tandberg Master Console houses all programme and control equipment. The control panel consists of a set of control modules (in strip form, one for each student), the teacher's control panel, and a number of predetermined blank strips for later extension

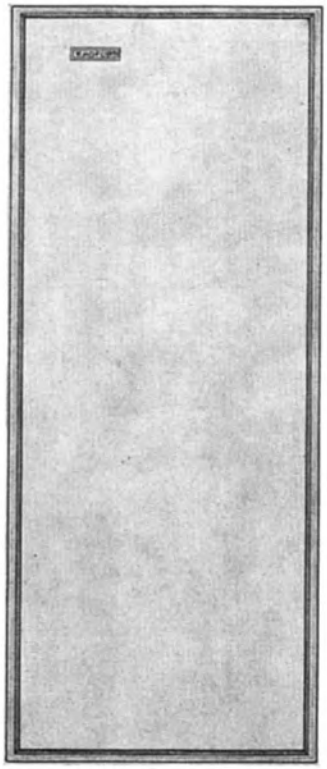
(*continued on page 293*)

What is a reference standard ?

The development of loudspeakers would be very much simplified if a true reference standard of sound reproduction were available. Years ago the axial frequency response characteristic was used as a standard for comparison but this was found to have considerable pitfalls. It has been stated that a good loudspeaker has a sensibly flat frequency response characteristic but a loudspeaker with a flat frequency response is not necessarily a good loudspeaker. This is very true as the static frequency response can be considerably different from the dynamic response i.e. the response to transients. Transient distortion exists in all loudspeaker systems in varying degrees and it can be demonstrated that the lower the transient distortion the more lifelike the sound. During the last few years Radford have concentrated particularly on eliminating transient distortion from drive units and a realism of reproduction is obtained not previously possible. The two loudspeakers shown here can be considered as reference standards for their size. The TRI-STAR 50 is probably the smallest size wide range high power loudspeaker system available to-day. It uses a closed back type mid range unit as it operates in the same enclosure as the base driver. The MONITOR uses an open back type mid range unit and is therefore contained in a separate enclosure from the bass driver. Both loudspeakers have a frequency response ±3½ dB from 60 Hz to 20 kHz which is just about as flat as can be obtained from present techniques.



TRI-STAR 50 A sealed enclosure for shelf mounting having three units. Mid range driver is a pressure type with enclosed back. Provides high performance with small size. Power handling capacity 50 watts. Matching impedance 8-16 ohms. *Size:* 21 x 12 x 9 in. (53 x 32 x 23 cm.) *Weight:* 35 lb. (16 Kg.) *Price:* **£42·50.**



MONITOR For shelf and floor mounting on a suitable stand. Uses three drive units. Sealed enclosure for bass driver. Open back type mid range driver fitted in separate enclosure. Power handling capacity 50 watts. Matching impedance 8-16 ohms. *Size:* 30 x 12 x 10½ in. (76 x 30½ x 26½ cm.) *Weight:* 43 lb. (19½ Kg.) *Price:* **£60·00.**

Electronics is a more precise science than acoustics and standards can more readily be established from specific data. The performance standards of the SC.24 pre-amplifier and SPA.50 power amplifier are not equalled by any other amplifier system at the present time. However, many people with sensitive hearing believe that they can hear the difference between good quality amplifiers of different makes having a high specification. The SC.24, SPA.50 combination has been designed to provide a high standard of listening performance as well as a high specification. Among the subtle factors to achieve this are the elimination of cross-over distortion by complementary symmetry output and an extraordinary overload capacity of all the sections comprising the amplifier system with virtually zero hum and noise output.

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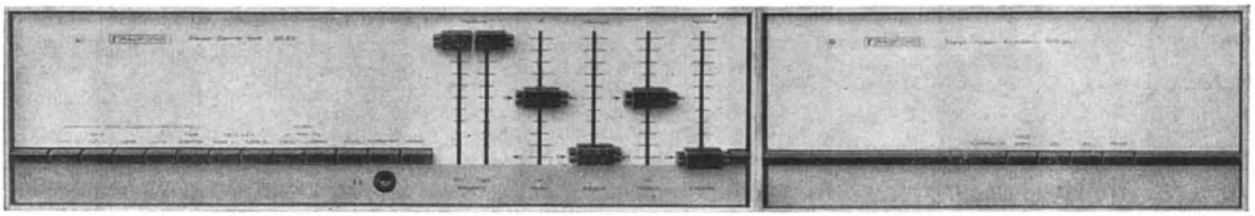

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TANDBERG LANGUAGE LABORATORY
CONTINUED

of the system. The student control module contains a programme selector which allows him to receive any one of six selected programmes provided by tape recorders, record players, FM and/or AM radio, and microphone. By means of this selector and the VU meter on his own panel, the teacher may adjust the maximum of six programmes to a predetermined level of volume. Alternatively, he can make an audible check with his headset for volume and quality. The selector also carries switches so that selected students may work as two distinct and separate groups. In this grouping, each student has full intercom with others in his group, permitting group conversation with the teacher able to monitor and to join in with the group at will, while students outside the group continue to work individually.

When the selector is set to a desired programme, the master track on the student deck is ready to receive the recording. After the master has been transferred from the console to the student deck, the teacher operates one control and simultaneously places all students on the Student Master mode. The students are now free to work independently with record and playback facilities under their own control, with the master track fully protected against accidental erasure. There are a number of other keys and lights on the module to assist the teacher in his work. A red light indicates that the student tape recorder is accepting the master track; an amber light that the student is recording his responses on the second track; and a white light that the student wishes to speak to the teacher. When the intercom/monitor switch is put into intercom position, the student recorder is stopped automatically and the teacher can speak to the student; monitoring is made without the student being aware of it. With the Student Recording Key the teacher can record individual students or whole working groups for reference and later examination. If a stereo master recorder is used on the console, two separate recordings from groups or individual students are possible on the one recorder at the same time. The stereo recorder may be used to send out two different programmes at the same time, for instance with French on one track for Group One and German on the other track for Two.

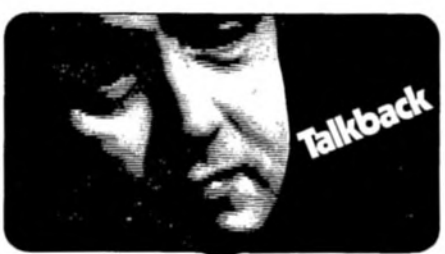
The teacher also has an 'all call switch' which enables him to speak to all students simultaneously and a loudspeaker switch connecting a speaker placed in front of the console.

Each student's booth contains a Tandberg recorder which drops into a well in the booth desk. (In the event of a failure, these can be exchanged by simply unplugging one and plugging in another.) The recorder carries all the normal tape recorder controls plus an output selector which provides master programme and student response simultaneously or master track only or student track only. A spring loaded calling button, when pressed, calls the teacher. One booth has a repeater unit. This enables sections of the master programme to be repeated by means of a continuous loop. It is a tape recorder in its own right, restricted to continuously record and store the last few seconds of the master programme, dependent on the cycling time selected by the length of tape inserted in the cartridge. Another repeater unit is carried on the console so that a cycle may be presented to the whole group if needed.

Where master recordings are concerned Peter Long buys Scotch 203 tape in bulk and tranfers all originals immediately a new course is purchased, placing the original tapes in store. The transfers are usually made on a full-track Nagra and then dubbed to a ½-track Tandberg. He is a sound recordist of many years experience and often shocked by the poor quality of the commercial tapes he receives. 'Some of these recordings are simply terrible, full of pre-echo and hum, and the strange things that get on these tapes makes me wonder just how they are dubbed.'

Besides the Nagra, his equipment includes a Weircliffe Bulk Tape Eraser which he considers essential to his work, a Revox two-channel recorder, a Leak FM tuner, Leak and Quad amplifiers, transcription turntables, Leak and Tannoy speakers, and a variety of mikes. This is all in constant use for he is responsible also for the maintenance of the college cinema.

I was keen to know whether there was ever any consonant confusion among the students. (Where the master is somewhat less than perfect, students can sometimes be confused over similarities of certain consonants—such as *hund* and *pfund* in German and *boisson* and *poisson* in French.) Peter finds no difficulty there. 'I try for the best transfer possible, if any confusion does occur, the student can always use the repeater unit.'



by Peter Bastin

HAVING, with great fortitude, listened to the whole of the television broadcast of the Eurovision Song Contest, I am forced to dispute the whole system of judging in contests of this nature. This particular battle was judged by panels of two jurors from each participating country, one juror being under, and the other over 25. This was presumably to bridge the generation gap, whatever that is. The songs were the usual trite unmelodious rubbish, with one or two exceptions. In an effort to be serious about the whole thing, I made up my own score sheet as the thing progressed. My first three, which earned over 80% of my marks, didn't even appear in the first four, and the winning song didn't even reach 60% according to me. In fact, it came third from the bottom.

All right, a matter of opinion, but what qualifications did the jurors possess to be in the position of judging the work of professional songwriters? Probably none at all. Therefore, the results could well be based on preferences—the girl singer's dress, her hair style, her performance and, very important, the language. Bearing in mind that there are four countries who submit their songs in French, and five French-speaking juries, the little matter of lyrics (so important to the women listeners) assumes some importance.

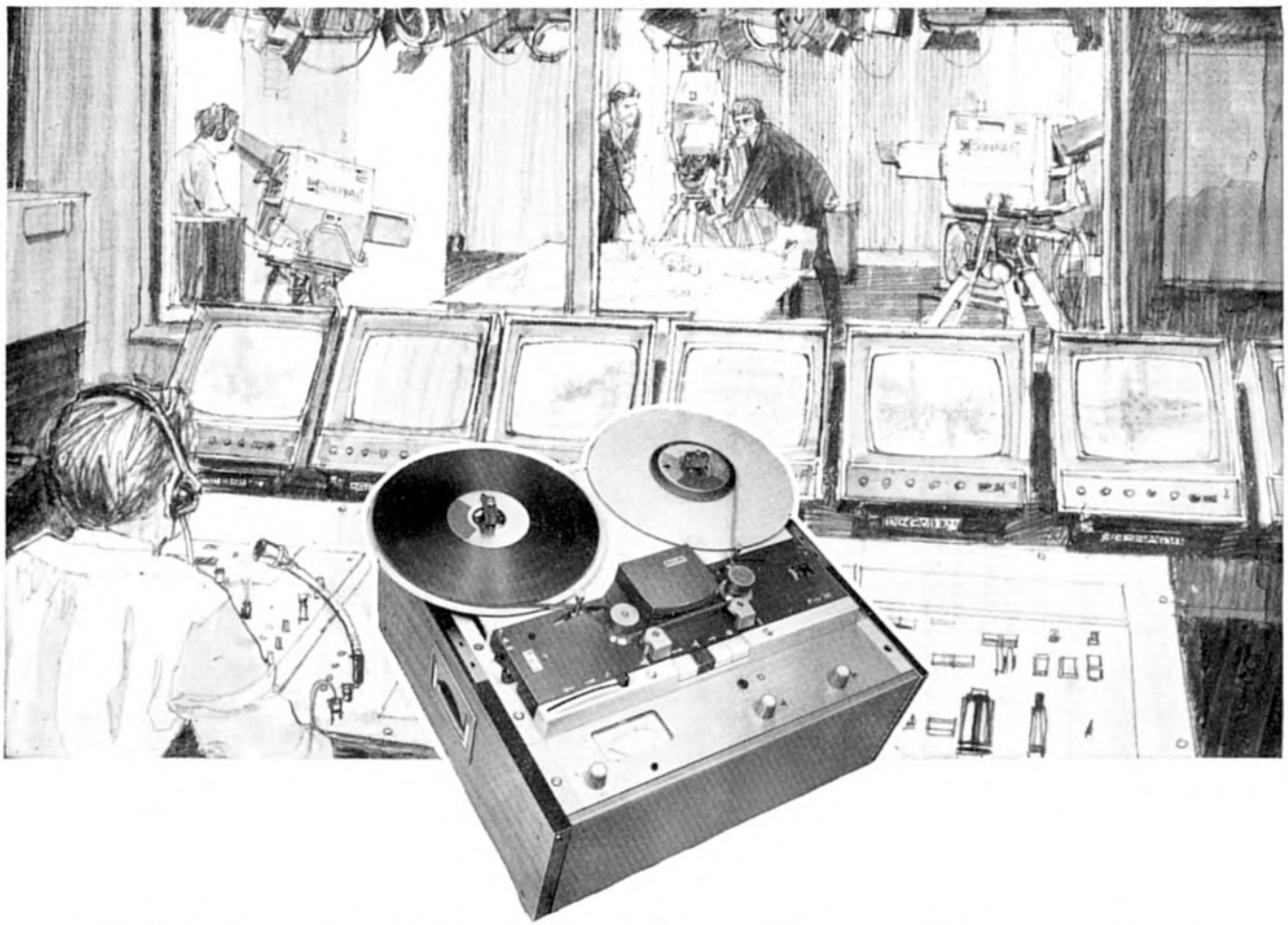
By and large, the standard of singing was chronic. The only obvious artistry was the high standard of orchestration. The songs themselves were mostly downright drab, or catchy little themes linked together with rambling and incompatible passages of no merit whatsoever. There was an obvious attempt by some countries, including Great Britain, to emulate *Puppet on a String*, creating, as it were, a standard type of Eurovision song.

I have always held the very strong opinion that people should be judged by their equals, by people who have gone through the same sort of thing, or by people with professional experience in that particular field. I am opposed to empty headed 'celebrities' and greengrocers judging the sweat, blood and tears of contestants. They know nothing of the problems and difficulties of doing something better than the next bloke; how could they, if they have never done the same thing themselves?

RE-READING THE April editorial, and in particular, Jerry Bruck's view that people *like* to be surrounded by microphones, I am reminded of a very recent occasion when I had to record a conference at which a minister of state was speaking. The other speakers were local politicians. Everyone who rose to their feet to talk ignored the microphones moved about, and spoke in any direction except that of the microphones. Except the minister. He stood there and spoke firmly into the battery of BBC and Bastin microphones. He knew perfectly well what the things were—and their potential.

GEORGE TUGHAN of Tape-Music Distributors wrote recently telling us that liquid-filled rubber headphone cushions are a Koss patent. Splendid, but what about utilising the space for something more potent than inflating-fluid? Whisky, perhaps, fed to the mouth via a nice screened hollow rubber tube.

SOMEBODY THE other day wanted his typist to transcribe a talk. The typist prepared herself. Sharp pencil, hair tidy, notebook at the ready. The machine, a prehistoric Brenell, wouldn't work. No mains plug. One fitted. Still wouldn't work. Joe Soap consulted. The thing would wind on and rewind, the amplifier worked, but the capstan wouldn't go round. Top plate removed. Three kilogrammes of dust, fluff and dirt. In fact, the flywheel was stuck solid. I looked sadly at this shadow of a recorder and replaced the plate. The machine had been borrowed and I wondered who owned it. What barbarian could allow any sort of instrument to moulder like a French bicycle in an abandoned pig farm?



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SUNDAY SOUND

Michael Naylor describes the production of Yorkshire Television's 'Stars on Sunday'.

YORKSHIRE Television's 'Stars on Sunday' is a religious musical programme transmitted every week of the year. The programme is always fully prerecorded. In this way, many performers can be integrated in several elaborate sets during the 25 minutes running time. This article is intended to convey the manner in which the programme is produced, with the emphasis on sound. Only television sound men, I suspect, are fully aware that 50% of a television studio's output is in fact audio. Pictures, particularly now they are colour, definitely take priority in the minds of the powers that be, which can be very frustrating at times.

An artist booked by Yorkshire TV does not come just for next Sunday's show. In fact he often comes for no specific show at all, rather to videotape a number of items in a day. In this way a stockpile of canned inserts can be built up on each artist so that balanced programmes can be built up at a later date.

Nearly every singer in the programme is accompanied by a Lowrey organ feeding a Leslie speaker. These speakers have slots at the top and bottom. The higher frequencies tend to emerge from the top and the lower register from the bottom slots. If one microphone were to be used, it would have to be placed about 2 m away to achieve an equal balance. It would also require a quiet studio and, for this reason, more than any other, such a method cannot be used. Our studios are certainly soundproof, and the reverberation time quite low, but cameras have to track about, trailing their cables and generally contributing noise. Close mikes at the top and bottom of the speaker have the further advantage of giving greater balance flexibility.

We have four studio crews and no crew does the same programme all the time or necessarily employs the same techniques. I prefer two Neumann *U77*, set for a figure-of-8 response, each with bass cut, and placed about 10 cm away. The disadvantage of close-miking the Leslie is LF rumble from the draught caused by the spinning of the drive units inside. A cardioid pattern is the noisiest and an omni next best. Second best to *U77* in my experience is the *M130* ribbon.

I use no desk equalisation, as ample control is available just by balancing the two mikes against each other. No limiting as, by constantly reminding the organist not to get carried away, the natural dynamics of the music can be better controlled on the faders.

With solo artists, the sound is usually recorded at the same time as the pictures giving better lip-sync than miming and so a boom has to be used. Stand mikes not only tie the artist to one spot but would be out of place in this type of situation set. The closest the mike can get depends on the headroom of the wide shots. This can place the mike a frightening distance away. A further compromise is made here as a gun mike is the only answer. Good as they are, a Sennheiser *805* is not quite, as good as our standard, a Neumann *KM75*. Further complications arise from shadows that might be cast where they can be televised. To make matters still worse, as the artist walks around, the boom may have to move in several directions, pick-up distance varying all the time, to avoid shadows on the floor, on the walls, furniture, and of course the artist. Sometimes the voice becomes drowned by the organ. Then the camera shots have to be altered. I should add that lavalier radio mikes are of relatively poor quality and not good enough for singing of any kind.

On the desk the signal is first passed through an equaliser. Any bass lift is usually impossible as this would make boom rumble and studio ventilation noise worse. Unlike a sound-only studio, TV ventilation has to cope with the heat generated by the lighting. Top and presence lift depends entirely on the singer. I then use a limiter, the decay time dependent on the individual voice, and echo send is taken from this point. Our echo facilities are artificial (EMT plates fitted with remote control allowing the reverberation time to be altered from about 250 mS to five seconds). This reverberation is then time-delayed by about 100 mS on a *BTR4*, passed back to the desk and equalised to about +6 dB at 60 Hz, −6 dB at 10 kHz, once again depending on circumstances, before being mixed with the output. This echo equalisation helps to fatten the overall sound. Remember that the only accompaniment is an organ.

This set-up gives to hand six operational faders: organ LF, organ HF, boom (before limiter), organ group, boom (after limiter), and echo return. Our desks in each studio are EMI with Lockwood monitor speakers.

Other facilities provided are foldback of organ to artist and of artist to organist, Lockwood speakers in each case. The director's talkback is also provided on cans to the organist.

Whenever the performer is joined by a choir in vision, it is either entirely mimed or the choir and organ are prerecorded. The star would then sing live. Foldback always has to be on a Lockwood as cans look peculiar on vision. Some readers may have seen Harry Secombe's miming sketch on his BBC show a short while back. I think we gave him the idea. During a rehearsal, when he was miming with the choir, the number ended with a long note. We had made a copy of the playback tape and, at the end of the song, were able to extend this note to breathtaking lengths.

Better results can often be obtained when the sound is prerecorded but there is still one problem: time. A typical set would be two *U77* on a small choir, split into male and female, either a *KM75* or a *U77* on the soloist (a *KM75* for a male voice, giving 'bite', and the *U77* for a female, giving a much flatter response) and the usual two mikes on the organ.

Violet Carson often plays the piano as she sings. If a boom were used here, we would have little control over balance and echo. A microphone (*U77* would be too large too here) is secured as neatly as possible to the piano for her to sing into. Another, an AKG *C29*, is placed inside. A group of children who surround her, pretending to sing, while another group sing out of vision—clustered tightly round another mike and conducted rather forcefully by their music mistress.

A Joe Brown instrumental that was recorded live had a choir added to it at a later date. On the guitar I had two mikes, the boom at about 2 m and, to add mellowness, a *C20* hidden away in the shrubbery behind him. Tape delayed echo at about two seconds and also straight echo at four seconds really added depth.

Still on the subject of prerecording, I must mention the Yorkshire Police Choir. It was on their second visit that I had the pleasure of working with them. I had heard that on their previous visit they had found singing in an acoustically dead studio less than ideal. The choir is about 200 strong and for one end to hear the other is essential. I thought it would be interesting to try out an ambiophony system and I opted for an arrangement completely independent of the recording chain.

A few days before the weekend transmission, the links are recorded. Either the producer, Jess Yates, or a well-known performer presents himself in front of a camera to introduce the 'next' piece, reading various requests from viewers. The links are edited in later.

I have up till now referred to the compilation of the finished programme as 'editing'. In fact the editing is done in a studio control room via the vision mixer and sound mixer. Two VTR machines are used for playing in and a third for recording. One of the playback VTRs is loaded with the tape containing all the links and the opening/closing titles; the other with the tape containing the first song.

The director asks VTR 1 to play the opening titles and first link. This is fed via the studio mixers and in to VTR 3, switched to record. At 15 seconds before the end of the link, he rolls the other playback machine (VTR 2). When the link ends, either a mix or cut is made into the song. VTR 1, now 'off air', readys at 15 seconds before the beginning of the next link and waits for his roll cue from the director which will be 15 seconds from the end of the song. After this transition has taken place, everything grinds to a halt while VTR 2 changes tapes for the next song. VTR 3 now has to rewind and wait ready at 30 seconds before the end of the last recorded link. VTR 2, once again cued at 15 seconds, is faded up, sound and vision, in the studio. VTR 3 is cued to replay. Fifteen seconds later, VTR 2 is rolled and at zero VTR 3 thrown into record. An edit is thus made. This procedure is carried on until the entire programme is compiled on VTR 3.

There are other ways of making electronic edits but this appears to be the most suitable for our purposes, particularly as so many visual mixes and sound overlaps are used.

Vortexion

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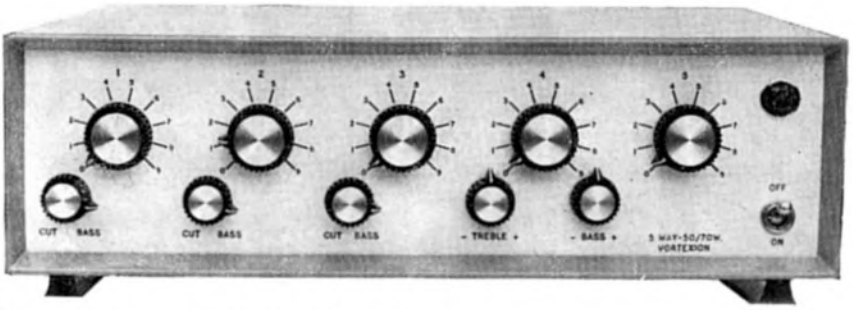
WITH BUILT-IN 5-WAY MIXER USING F.E.T.S.

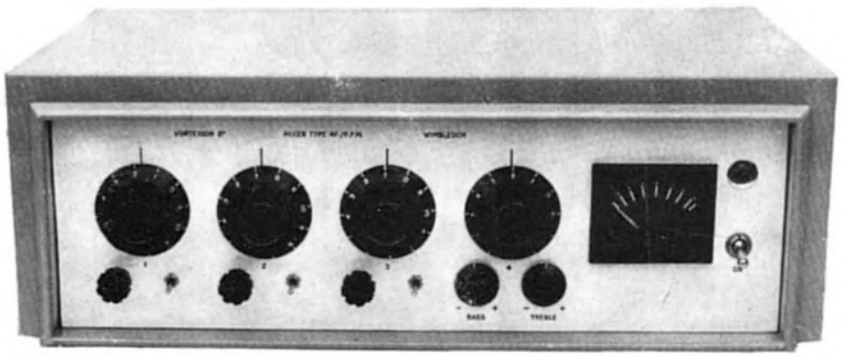


This is similar to the 4 way version but with 5 inputs and bass cut controls on each of the three low impedance balanced line microphone stages, and a high impedance (10 meg) gram stage with bass and treble controls, plus the usual line or tape input. All the input stages are protected against overload by back to back low 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 8-16Ω output are selected by means of a rear panel switch which has a locking plate indicating the output impedance selected.

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-Hi-Z 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 wider range of voltage and temperature. Also available in rack panel form.

F.E.T. MIXERS and PPM's



Since we have been supplying professional mixers for 25 years we have delayed the introduction of solid state units until they were at least as good as their valve counterparts. (Which will continue where required.)

The various sections of the F.E.T. mixers and BBC type PPM's have been performing successfully for several years in other equipments with complete reliability. The PPM also uses an F.E.T. in its time constant circuit so that polyester capacitors can be used.The response from the 600Ω output (25Ω source impedance) is level 20 Hz to over 30 kHz with very low intermodulation distortion to zero level +12 dB. The input signal voltage range is over twice that of the valve unit and the noise at least halved.

VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, S.W.19

Telephone: 01-542 2814 & 01-542 6242/3/4

Telegrams: "Vortexion London S.W.19"

INSIDE ISLAND

Keith Wicks visits Island Studios

3M tape machine in Studio 2.

Studio 1 Helios desk.

ISLAND Studios, situated in Basing Street near the Portobello Road, is a division of Island Records Ltd. When the directors—Christopher Blackwell, David Betteridge and John Leftly—acquired the premises, they found themselves with the unusual task of converting a church into a recording studio.

By May 1969, offices had been constructed, and Studio Two was completed by January 1970. Interior studio walls and a special floor were mounted on resilient material for sound insulation, and a suspended ceiling was installed. Above this, Studio One was built in a similar way. To prevent the transmission of structure-borne noise from one studio to the other, a problem which a very well known London studio suffers from, Island's Studio One sits on 10 anti-vibration pillars. These support a total of 400 tons of concrete, which once caused them to be described as 'ten little miracles'.

Attention has also been paid to other aspects of the studio, such as decor, and variable lighting has been installed. Seven kilowatts of light is available for 'readers', although only a fraction of this power is used for groups. At Island, the combination of dim lighting and the dark rubber-covered floors give the studios an unusually pleasant atmosphere, which will ideally suit many artists.

Studio One measures 18 by 12 m, is 7 m high, and can hold up to 80 musicians. Near one end of the studio is a small separation booth, roughly 3 x 2 m, accommodating up to four people. Like most of the better studios, Island use AKG and Neumann microphones. Number One control room has a Helios mixing console with 28 input channels, 16 outputs, and all the usual facilities for equalisation, echo and monitoring. Island are well equipped for echo, having six EMT stereo plates. For microphone limiting, they have a number of Universal Audio units, and some Audio and Design *S.700*. An unusual feature is the use of limiters at the other end of the chain in order to prevent the loudspeaker cones being blown. If the signal is above a critical level, it is limited to a safe amplitude, and a panel light comes on, warning the engineer that a speaker is being overdriven. These money-saving devices were designed and built by Island's own technical staff, and are used whenever the studio artists are thought likely to turn up the volume of guitar amplifiers or get much closer to their microphones without telling anybody. The loudspeakers, four in number, are the popular early Tannoy *Monitor* which the studio manager, Joseph Yu, prefers as they have a smoother top response than the *Monitor Gold*. Housed in Lockwood cabinets, these speakers are fed by Crown *DC300* amplifiers which can deliver about 100 W into 15 ohm loads.

Recording facilities are comprehensive, consisting of eight and 16 track 3M machines, Philips stereo and mono recorders, and a stack of Dolby noise reduction units. Island consider Dolbys to be standard recording equipment and they are used unless the client specifies otherwise.

Studio Two, which is about 10 by 6 m and 3 m high, has room for up to 20 musicians. The control room mixer is again by Helios Electronics and has 20 input channels and 16 outputs. Apart from having a smaller desk, the facilities here are similar to those in the other control room.

In addition to the two studio suites, there is a small room containing two Studer *A62* stereo machines and a simple two channel desk constructed by the studio staff. This room is used mainly for the straight copying of tapes, and for listening, although it can also be used for other things such as re-equalisation. As in the control room, PPMs are used for checking levels rather than the more common and much less expensive VU meters.

At the moment, Island are in the process of building a reduction room. The desk, again by Helios, has 20 inputs and four outputs and will be used in conjunction with 16 track, stereo and mono tape machines. The type of multi-track machine used will depend to some extent on manufacturers' delivery dates. With so many studios expanding it is becoming increasingly difficult to obtain some makes of 16 track machines in a reasonable time. With the new reduction room is a small voice-over booth which holds up to four people.

The studio plans eventually to install disc cutting equipment and possibly film recording equipment when the film industry recovers from its present difficulties.

The rates at Island are £27.50 per hour for all work done in Studios One and Two. This is very reasonable for 16 or eight track work, although a lot to pay for mono. These rates are made more attractive by the fact that a number of instruments are freely available. Not only Steinway pianos, which are fairly standard in studios, but things like a Hammond *C3* organ, and a Mellotron, which are usually several pounds per hour extra.

In addition, instruments not kept at the studio can be made available for hire to clients at their request.

A PREVIEW OF THE 1971 ASSOCIATION OF PROFESSIONAL RECORDING ENGINEERS EXHIBITION

BY DAVID KIRK

THE APRS annual exhibition of industrial audio equipment has this year been moved forward of its usual July, and to a new venue. The place: Old Royal Horticultural Hall, Vincent Square, London S.W.1. The time: embarrassingly close to the Montreux International Television Symposium and Technical Exhibition. Montreux opens Friday May 21 and closes May 28. APRS 71 opens Friday May 28 (12.00 to 21.00) and closes May 29 (10.00 to 19.00). Several companies attending both exhibitions will be involved in a very rapid transfer. Others will be suffering staff shortages due to the Whit weekend. At the time of writing, Ampex are understood to be sharing an APRS stand with Dolby. Apparently this helps.

Entry to APRS 71 is restricted to individuals nominally involved in the communications industry. Tickets are available from the Association Secretary: W. J. H. Barrett, 3 Strathray Gardens, Swiss Cottage, London NW3 4PA (01-794 2474).

As can be seen from the exhibitors list, the event is more strongly supported this year than at any time in its history. This reflects a continuing expansion in the number of manufacturers servicing the recording industry.

Acoustic Consultants, formed by Eddie Veale, neither manufactures nor imports. It offers a consulting service, specialising in the control of acoustic environments. Acoustic analysis equipment will be demonstrated, with a range of sound insulating and absorbing materials.

AEG may not attend the exhibition, due to excessive demand for their *M10* and *M28* recorders. Representative, if they do attend, will be Brian English.

A new dynamic omni microphone, the *D160*, and the *CK60* variable-pattern capacitor capsule will be seen on the AKG stand. A wide range of capsules for the *C451* will also be displayed. Representative: Peter Eardley.

Alice Electronics, a division of Stancoil Ltd, is planning a Special Attraction no less original than a guess-the-weight competition. The object (no, not Ted Fletcher) is a chrome-plated *BD6* limiter, also serving as the prize. Entry will be free. The Alice stand is to be devoted largely to the *BD* range of modular mixing equipment. This comprises equalisers, routeing modules, talkback and signal generator modules, limiters and complete channel amplifiers. The display will take the form of a console so that visitors may try a complete modular desk. Also working on the stand, the *SM2* portable mixer and the *SM5*, the latter designed specifically for film location work. Representatives on the stand will be Jack Keene and the aforementioned Ted Fletcher.

A sub-miniature mixer (25 mm thick by about 300 mm square) is among several new products to be displayed by **Allen & Heath.** Price of this six into two channels unit, with twin output VUs, is around £100. A reasonably priced quadraphonic pan pot, a single-channel spring reverberation unit, a compact limiter and modular mixing system are among other planned exhibits. Up to eight input channels may be combined from the latter system at a basic £30 per channel. Allen & Heath hope also to be demonstrating quadraphonic headphones. Representative: Andy Bereza.

Audio Developments merged TRD into their complex shortly after APRS 70, after vaguely denying that they had any such plans. The two companies have been developing a new series of logic-controlled recorders. These are being produced in two and four channel versions using 6.25 mm tape and four and eight track versions using 12.5 mm tape. A memory circuit operates in conjunction with a tape motion detector to guard against tape breakage. This allows an operator to pre-select a record or play mode while fast spooling. The recorder generates a tape motion signal which may be used to encourage a remote operator that all is well. The same signal may be fed to a digital clock, if necessary programmed for automatic return to the start of the count. The logic system is incorporated in a plug-in IC module to aid servicing.

On the same stand, Audio Developments are to show a rationalised version of the *AD71* Mixer System, now comprising six modules of 38 x 440 mm dimensions. These include a twin 20 W monitor amplifier, with its own sub-mixer, and an improved microphone module. Routeing is now by push-button (even the switch banks plug in). Representatives will be Peter Levesley and R. D. Cleverley.

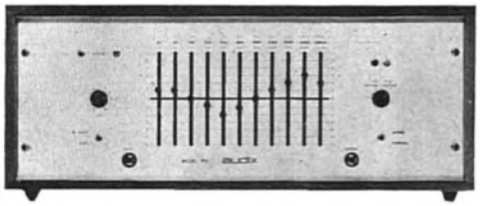
Audio Synthesisers' *Freeman S100* is a polyphonic IC keyboard unit designed to simulate orchestral backing. This will be demonstrated via tape and headphones by representative David Burrows.

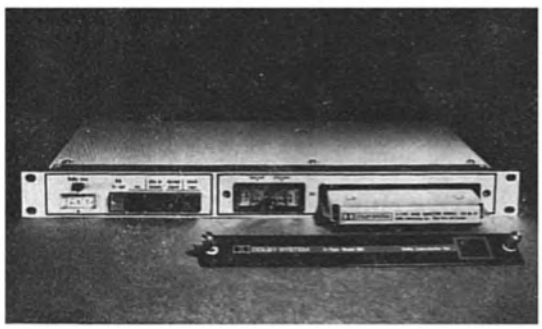
An 11-band *901* graphic equaliser is to be displayed by **Audix.** The unit will accept an input level of up to 20 dBm and incorporates log spaced ±12 dB sliders at 45, 80, 140, 250, 450 and 800 Hz, 1.4, 2.5, 8 and 14 kHz. A frequency switch allows the centre frequencies to be moved up or down by a third of an octave, providing a total of 33 spot frequencies. Input requirement is 0 dBm, 12 K floating, output being 0 dBm, 600 ohm floating (40 ohm source) and 1 ohm unbalanced. A bypass switch removes all equalisation. Mid position frequency response is 20 Hz to 20 kHz ±0.4 dB. A maximum or minimum setting thus becomes 35 Hz to 18 kHz ±1.2 dB. Typical distortion level is 0.01% at 0 dBm out. Dimensions are 178 x 483 mm (PO rack) or 216 x 508 x 292 mm in cabinet. Facia finish is satin anodized extruded aluminium. The *Studio* 80 power amplifier will again be shown, so too will the established *MXT/800* mixer. The latter was conceived for use in small recording studios and local broadcast stations. Recent additions to the range of modules available for this series include a limiter and miniature amplifier/loudspeaker.

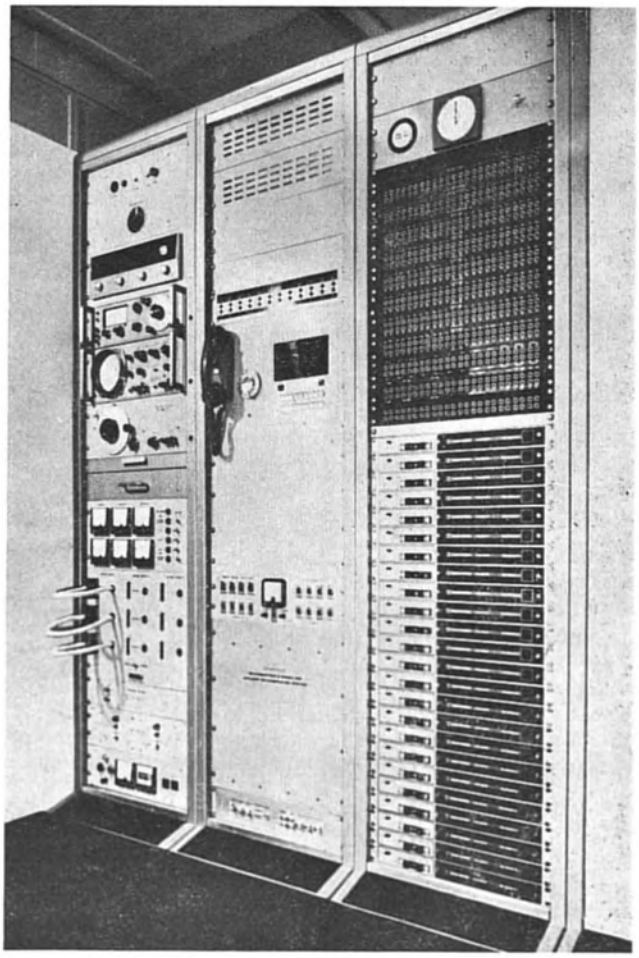
The most interesting signal exhibit this year must surely be the Gotham *101* Digital Audio Delay System, developed by a computer design team at MIT. In omitting the mechanical limitations of plate, spring, drum and tape devices, the *101* is both more versatile and of potentially higher quality than any previous commercial unit. The small size (480 x 180 x 430 mm) is made possible by the application of MSI (medium scale integration) components. In terms of discrete semi-conductors, the complete unit would require more than 600 000 transistors. The *101* in its basic form provides time delay in switched periods of 5 mS up to a maximum of 40 mS. Up to seven additional 40 mS delay cards may be plugged into the chassis to achieve a maximum 320 mS capability. No routine maintenance is ever required and any defective components would be replaced with an exchange card. Published specification quotes a 20 Hz to 12 kHz ±2 dB frequency response and less than 1% distortion at +22 dBm. A −20 dBm input produces +4 dBm output. Dynamic range is 60 dB, an internal or remote limiting indicator showing when the internal clipping level is reached. Time delay accuracy is within 0.01% of the selected period. The *101* will be shown on the **F.W.O. Bauch** stand alongside the ARP *2500* electronic music synthesiser. This is manufactured by Tonus Inc., Mass., USA and was until recently imported by Eddie Veale who in turn represented Moog until Feldon entered the picture. The *2500* employs voltage control techniques comparable with those incorporated in Moog and EMS systems. Bauch are holding a series of lectures to demonstrate the ARP. Readers wishing to hear and try these units are asked to ring 01-953 0091 to reserve an invitation.

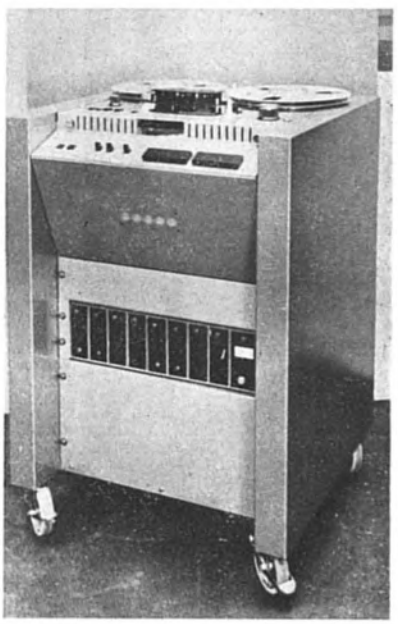
A 6.25 mm stereo version of the Studer *A80* recorder will be shown for the first time in the UK, the multitrack model having made its debut in 1970. The *A80* differs from earlier Studers in using a tachometer-controlled capstan motor to achieve its 38 and 19 cm/s speeds. Another newcomer from this company will be the *189* mixing console.

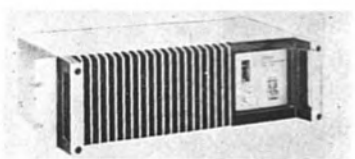
(*continued on page 303*)

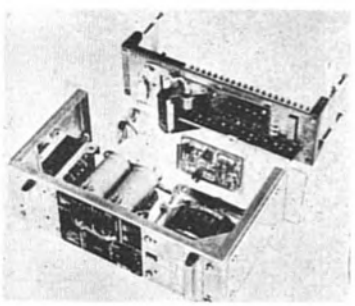












Top to bottom left: Audix 901 equaliser; Dolby *A* module; Philips *Pro 36*; Grampian power amplifier.

Top right: Bank of 24 Dolby modules at Command Studios.

Above and right: Leevers-Rich *E-200*.

ELECTRONIC SOUND BY TONUS

THE ARP 2500 electronic synthesizer now available in the U.K., Ireland and Scandinavia through F. W. O. Bauch Ltd. of Boreham Wood presents a completely new approach and dimension to the world of synthetic music. Gone are the separate modules and units with the myriads of inter-linking cables. For here, in one neat attractive package are provided all the facilities currently available from existing systems, plus a host of exciting new functions and features certain to appeal to the serious musician and studio technician alike.

The control panel and keyboard form a natural complementary unit, with circuits and functions clearly displayed so that the operator has fingertip control. A comprehensive manual supplied with each unit gives valuable information on the application and range of the various electronic modules, which can be selected or expanded by the user to suit individual requirements. New features include multi-voice keyboards, cordless patching, and finger-adjustment selector slides. This latter facility provides simplified repeatability; by simply noting the numbered positions any given sound can be reproduced at will—a feature enabling the 2500 to be used as the composing tool.

The Basic Works

The electronics are provided in module form, and mounted on the control panel fascia. A Dual Noise/Random Voltage generator contains two separate white noise generators with pink noise and slow random outputs. Output attenuators and on/off switches provide full output control, whilst jacks are located on the front panel to provide direct access to external equipment for special effects, etc. Waveform shaping and tonal modulation is provided by a Multi-Mode Filter/Resonator module, and this is most useful in synthesizing instrumental timbres. A Keyboard Percussion feature enables the filter to be used as a tone source or resonator. The Modulator/Amplifier is chiefly employed for developing textures rich in harmonics or overtones, and accepts two audio inputs signals (A and B) in the range from d.c. to 20 kHz. By modulation process output signals of A+B or A–B can be obtained, which when they are complex waves with harmonics means that sum and difference frequencies of fundamentals and harmonics are produced.

A compact and versatile Sequencer Module effectively controls the basic oscillators, filters, amplifiers and envelope generators, and includes an internal clock for automatic sequencing of rhythmic structures. The clock can be turned on and off by external signals, and its rate controlled from external sources. Potentiometers provide three independently adjustable outputs for each step of the counter.

Other modules permit not only the production of the basic sine, square, triangular, saw-tooth or pulse waveforms, but also include envelope generators and a sample and hold module for the production of discrete pitches in periodically related form—i.e. scales or arpeggio.

As with all synthesizers the difficulty is less to explain the technicalities than the method and range of application, which in the case of the 2500 is virtually limitless. As the musical teaching aid, the 'engine-house' for the sound studio or the Group Instrument, this synthesizer represents a true second generation concept. It is complete, simple and extremely versatile. An hour at the controls during one of the many demonstrations planned by Bauch throughout the year will convince readers of the range and fidelity of the system, which has already received wide acclaim since its introduction in the U.S.A.

One of several Universal Audio exhibits will be the *963* digital metronome, providing 320 different tempo beats. It is intended for the production for live music film scores and employs IC/discrete components. Thumb wheel switches select the tempo (from one to 40 frames per beat) in 1/8-frame steps. These are synchronised with the 50 or 60 Hz line input.

Klein & Hummel have added an *OZ* monitor to their established *OY* amplifier/loudspeaker.

A new company being represented by Bauch is Allison Research Inc., their trademark a sketch of the original Allison. Their product is the Kepex keyable programme expander. Up to 16 channels may be accommodated in a 480 x 180 mm rack. Gain reduction or transient peaks may be monitored on a sequential light meter. The latter reaches full indication within 25 μS.

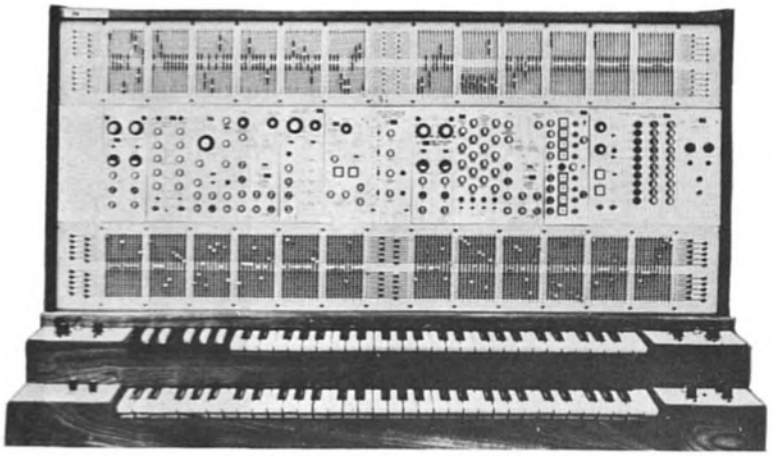
Studio faders are now being imported from Seydel Regler Electronic, Berlin. This will be shown for the first time together with a new series of VU meters from Weston.

The existing range of Neumann FET capacitor microphones, EMT's turntable. compressor/limiter, *104* portable mixer, *160* polarity tester and AF cables, Danner faders and microphone stands, Teletronix *LA-3A* levelling amplifier, Albrecht *MB41* magnetic film recorder, and Switchcraft audio connectors wraps up the most enterprising agent in the UK audio market.

The new Calder/IMF studio monitor loudspeaker and examples of the company's range of modular mixers will be shown by Calder Recordings. Among new Calrec microphones. the dynamic *CM450* and detachable-capsule *CB1000*.

Crown *DC300* and *D40* amplifiers and Sharpe headphones will be among Carston exhibits.

Dolby have expanded their range of noise reduction equipment considerably since the *A301* first appeared. The latter is their basic stereo record or play costing £560. Model *A301-S* is at £340 a mono record or play unit, as are the *360* and *361*. The latter are of slim construction for easier rack mounting or inclusion in tape recorder cabinets. The *360* costs £240 and the automatic-switching *361* £265. All work to the four-band Dolby A standard and were designed for studio mastering. Model *320* is a single-band B-type processor intended for broadcasting and record mass production. Typical domestic products employing Dolby B circuitry will be shown on the stand.



The Tonus ARP *2500* voltage controlled music synthesiser.

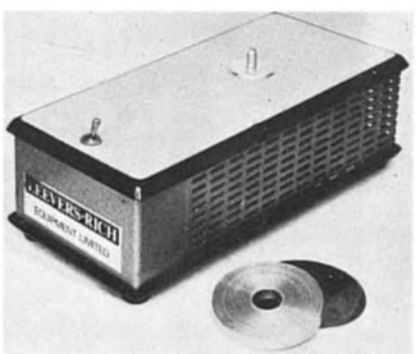
EXHIBITORS LIST

Acoustic Consultants
AEG (?)
Agfa-Gevaert
AKG
Allen & Heath
Ampex
Audio Developments TRD
Audio Synthesisers
Audix
BASF
Bauch
Cadac
Calder Recordings
Carston Electronics
Difona Electrik
Dolby Laboratories
Feldon Recording Ltd
Future Film Developments
Grampian
Hayden Laboratories
Helios Electronics
HH Electronics
Leevers-Rich
Levy Professional Recording Services
Lennard Developments
Ling Dynamics
3M
Neve
Pye TVT
Scopetronics
Shure
SNS Communications (Bournemouth)
Sound Techniques
Studio Sound

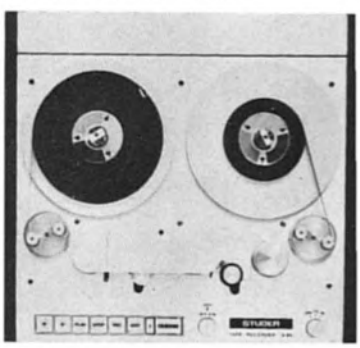
A 16-track Scully *100* recorder is to be exhibited by **Feldon Recordings.** External controls have been reduced to a minimum, a compact penthouse unit being allocated entirely to the 16 VU meters. All channel and mode selectors are located on a sloping strip forward of the deck, apart from the main on/off switch which is down at foot level. The *100* is a single speed 38 cm/s recorder (76 cm/s versions are available to order) and accepts spools of up to 28 cm capacity. Full remote control is available and plug-in circuitry simplifies maintenance. One or more Moogs will be demonstrated, this range of voltage-controlled electronic synthesisers now comprising the *Mini*, the *10*, *1c*, *2c* and *3c* in ascending complexity. The *c* models are available in portable form, then adopting a *p* suffix. All are supplied with separate keyboards except for the *Mini* which incorporates its own 3½ octave keyboard. Lastly, Feldon will show the J. B. Lansing *4320* and *4310* monitor loudspeakers.

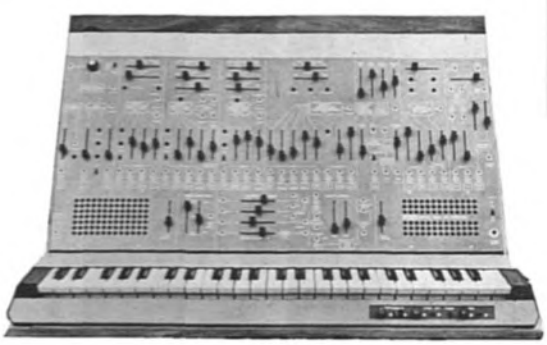
A 100 W musical instrument amplifier will be exhibited on the **HH Electronics** stand. It is designed to be used by professional musicians and is described as the most advanced unit of its kind in the world. The

(*continued on page 305*)



Leevers-Rich bulk eraser.





Left: Smaller of the two ARP synthesisers being imported by Bauch.

Far left: Deck of the Studer *A80*.

DC300

The Finest Power Amplifier in the World!

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

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

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

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

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

Harmonic Distortion at 1,000 Hz at a level of 75 Watts into 8 ohms is a mere 0.077%. At 150 watts this becomes 0.01%. For comparison we can quote at 50 watts RMS at 20,000 Hz THD is 0.1%. At 150 Watts RMS at 20,000 Hz it becomes 0.2%.

Safe so far we feel!

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

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

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

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

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

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

CARSTON ELECTRONICS LIMITED
SHIRLEY HOUSE, 27 CAMDEN ROAD, LONDON, N.W.1 9LN
Telephone: 01-267-2748

company's TPA *Series D* range power amplifiers are the first European amplifiers to combine power ICs with IC driver stages.

Fifty and 100 W monitor amplifiers will be shown by **Grampian.** These are built from interchangeable modules which can be replaced without further adjustment. A substantial heat sink forms a major part of the front panel area and functions at body temperature on rated output programme. This permits easy stacking. An optional peak-reading output level meter indicates amplifier drive level. The specified output powers are RMS figures to the IEC four hour test. Grampian's standard range of microphones and portable mixers will be displayed.

Hayden Laboratories, UK agents for Kudelski, have lately been appointed distributors of Sennheiser. The latter's range of microphones and accessories will be shown, along with the Nagra *4* and miniature recorders.

Lennard Developments will again concentrate on the Miniflux *301* wave analyser and the *102B* and *104* wow and flutter meters.

Ling Dynamics are to exhibit studio monitor and communications equipment from the Altec Lansing stable.

Latest of the *E* series 6.25 mm machines, on the **Leevers-Rich** stand this year, will be the *E-200*. A stereo unit with two VU meters, it is available in an *M* or a 'De Luxe' console, or for custom mounting. Basic price is £635. A revolving platform will display the mechanism of the Leevers eight track mechanism, showing a new webbed casting and revised presentation. The recently restyled LeeRaser bulk tape demagnetiser will also be seen. Representatives: N. V. Nichols, W. A. Costello, Peter Lindsley, and R. D. Aitchison.

A PAL/NTSC dropout compensator, dropout profile recorder, Mincom multitrack audio recorder and Cantata *700* background music equipment will be shown by **3M** at Montreux, though whether any of this will find its way to London remains to be seen.

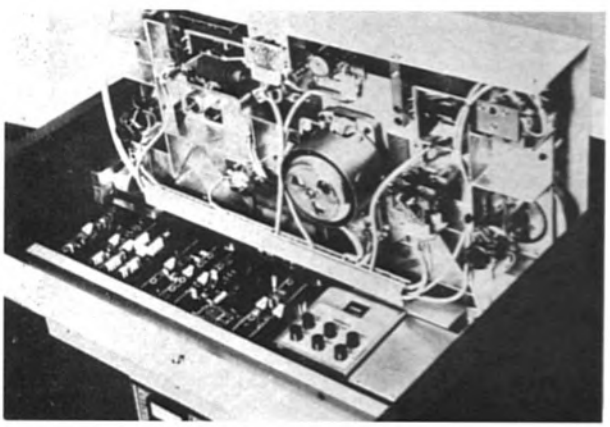
One of the largest stands will be occupied by **Rupert Neve.** The company is to display a large console recently completed for a USA customer. A series of new portable units will also be exhibited. Detailed literature on the new *S* range of consoles will be available to visitors. This series is described as meeting the requirements of the smallest studio up to customers requiring 24 inputs and eight outputs. Larger systems can be supplied to individual requirements.

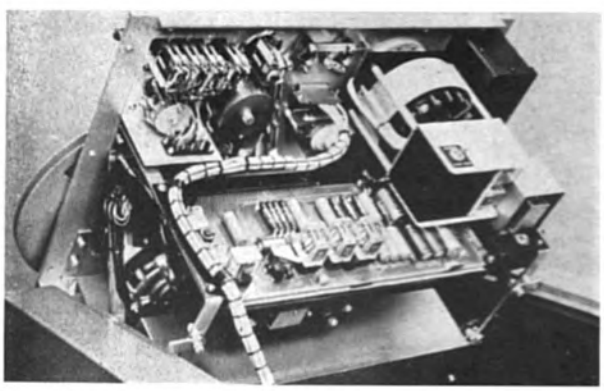
The **Philips** *Pro 36*, first seen at last year's International Broadcasting Convention, will be shown by Pye along with the *Pro 51* and *Pro 71*. The *36* is a three-speed portable stereo unit employing an unusual form of capstan servo with a belt drive. Model *51* is available in mono and stereo forms with speeds of 76 and 38 or 38 and 19 cm/s. Capstan drive is direct from a synchronous motor. *Pro 71* is a more elaborate version of the *51* console, available in three and four track forms, and employs 12.5 mm tape. Ferroxcube heads on all three models virtually eliminate the need to adjust for wear. Tolerance between segments is claimed to be 1 μm. A new series of mixer modules, the *MM-2*, will be shown alongside Philips' standard *SSM 14* console and *MP4* miniature mixers. The *MP4* accepts four input channels and feeds stereo or mono systems.

The *1151* studio recorder, available in 6.25 and 12.5 mm forms, will be displayed by **Scopetronics** together with transports handling up to 50 mm tape widths. Modular electronics are being produced to match these mechanisms or for use with customers' own decks. Among a variety of tape heads will be a 9.5 cm/s broadcast-standard type. Scopetronics are now using a hard lamination material claimed to give longer head life. Representative: David Worth.

Among **Shure** lines, the *SM5* unidirectional boom microphone, *SM51* lavalier, *SM60* omni and *SM58* unidirectional. At £88.80, the *M67-28* portable mixer accepts four Lo-Z microphones and one line source, feeding out at line and low levels. Two headphone monitor sockets and automatic noiseless switching to internal batteries in the event of mains failure are among its facilities.

Sound Techniques will concentrate on the virtues of their new series of compact mixers. Selling at a basic price of £5 025, these are designed to meet 16 track studio requirements and carry features previously incorporated on mixers three or four times the price. The mixers are available ex-stock and can be installed within 36 hours of order.





Interior views of Studer *A80* (top left) and Leevers-Rich *E-200*

Philips *MP4*

Alice transportable mixer

Tape Recorder Service

Akai 4000

By H. W. Hellyer

AFTER much delving into the Uher *4000* series, we keep the ball rolling with another *4000*, but this time far removed from the West German concept. Unashamedly Japanese, quite distinctive in style (early Ampex), circuitry and construction.

This is a machine that the Rank Organisation would be pleased to call semi-professional. What does it mean? In the words of one of my colleagues: 'a domestic model that has been tarted up to make it slightly beyond the pocket of the ordinary chap.' Which would not be fair to Akai, so let us begin with a short description.

The price is £124.90. For this, you get a two-speed (19 and 9.5 cm/s) ¼-track stereo machine of 18 cm spool capacity, with an 8 W per channel rated output from the external LS sockets (but a measured 7 W at little over 3% distortion from the internal 153 x 102 cm loudspeaker units). This is the 'complete' version of the well-known and highly regarded Akai *4000D*.

Claimed frequency response is 30 Hz to 22 kHz ±3 dB at 19 cm/s; s/n ratio better than 50 dB. THD within 2% at 1 kHz, 0 VU. Crosstalk better than –65 dB (mono), –40 dB (stereo). Wow and flutter, less than 0.15% RMS.

From this potted specification, one might gather this lays claim to being a good machine. Reading through the complete published spec would convince a potential owner he had the product of a company that really cared about quality. We even find insulation resistance (50 M) and insulation durability mentioned, the latter 1 kV AC for more than 1 minute. Power consumption is 30 VA and the Akai *4000* can accommodate supplies from 100 to 240 V AC, at 50 or 60 Hz.

A look at our circuit will reveal that this last is simply a matter of changing the power factor capacitor (start capacitor for the motor) from 2 μF (60 Hz) to 2.5 μF (50 Hz) operation, raising the supply 10 V at the same time. Motor rotation, 50 Hz, is 1450 RPM; 60 Hz, 1740 RPM. In service, the larger of these two start capacitors can be bothersome, causing wow in its earlier failure stages and complete loss of motor torque finally. It is quite accessible but I should perhaps warn against the paralleling with a known good substitute. The only real check is to disconnect the existing capacitor and temporarily clip in a test one. Incidentally, I have known a couple of cases of motor replacements having been made—because of vibration—when all that was really wrong was a combination of the suspect 2 μF capacitor and a low operating voltage.

Check also that the interconnecting leads, plugs and sockets are in order. Akai have always had a Christmas tree tendency of distributing bits and pieces of apparatus within a box and interconnecting them with plugged leads. All is well so long as joints remain undisturbed and sockets untainted by humidity and general pollution. Careless servicing can too easily disturb connections. The resoldering must be undertaken with great care. Despite these being hefty plugs, there is really little room to spare and the insulation of the leads Akai use dislikes heat. When reassembling, make absolutely sure of all the earth clips, leads and wires. You will see what I mean if and when you come to take an Akai to bits.

Which brings me neatly to the subject of dismantling.

I've been wary ever since a poor chap said—'All very fine, this information about adjusting the drive mechanism, but how do we get the deck out of its case?' This was in the days of the Fidelity *Playmasters* and things, with screws hidden under handle clips. Most frustrating.

The Akai *4000* is not quite so bad as that. Starting with the deck, we remove the track selector knob and pressure roller—where the securing screw, a shouldered screw, is hidden under a pull-off cap—and then the head cover comes off for preliminary maintenance.

Unfortunately, the next step is not quite so rational. To get the deck plate off and do what I would regard as the next line of maintenance work, one has to remove control knobs, electrical and mechanical—and watch the very tight screws in those Record/Play and Fast Forward/Rewind levers. Then the plate over the amplifier panel has to come off.

Four screws hold the top panel on. Two are by the spool carriers, the other two about half-way down the deck, adjacent to the left tape roller and between the microphone jacks.

Now comes the tricky part. To get the mechanism out of the case, one first removes the obvious screws (the two at the side of the case facing you when it is lying on its back, then the four that hold the feet) and then the whole assembly can be cajoled from its box. This really needs a helping hand—not because it is especially heavy but because it is usually reluctant to lift straight out.

If you want to separate mechanical from electrical sections, there are three plug/socket combinations to split, one at the left, two at the right, looking in at the rear, then four screws in the corners of the deck. Amplifier blocks and the deck then separate but to operate these apart will need extension harnesses.

It is not too bad a job getting at all the parts that matter but I would have felt happier if Akai had made the lower back plate more easily removable for access to the printed circuit panel on the bottom of the chassis.

Reverting to the mechanism: principal adjustments that are needed are—pressure arm, take-up, back tension and brakes. I shall not waste space on head adjustments, for each of the three head mounting plates has lateral adjustment screws and 'fore-and-aft' grub-screws, and the head gap finish is so well defined that initial optical setting is quite easy.

Drive to the capstan is by belt from the induction motor, and speed changing is the regrettable device of a sleeve on the capstan spindle. This is normally mounted on a threaded pin behind the deck cover. Voltage conversion is by a carousel at the rear, and the AC fuse is concentric with this.

The clutch assembly of this Akai is no less complicated than its predecessors—**fig. 2.**

In the case of pinch-wheel and interwheel, the only true adjustment is alteration of spring pressure. Correct tensions should be between 1 kg and 1.15 kg at 19 cm/s for the former, 50 gm for the latter. But most of the bother will be with the clutches, so let's concentrate upon them.

Take-up is by interwheel between the motor pulley and the lower part of the clutch assembly, which has a friction pad driving the upper. This is not a gravity clutch but a spring-loaded device with the spool-retaining bushes playing a large part in maintaining correct conditions. The driving interwheel is another of these 'sprung-on' drive parts, with pretty long leverage running up the right side of the deck. Any stiffness in the pivots, or dislodgement of the crescent lever, will cause poor take-up. The amount of upward pressure imparted from the felt pad is determined by a conical spring under the lower clutch part. To check, use a 12.5 cm. spool of LP tape, loop the end, measure with a spring balance, and see that 120 to 150 gm will hold against drive, or cause movement when not driven. This can be effected, we are told, by a 400 to 500 gm upward tension of the spring. I have not cross-checked at this stage, being happy to adjust take-up for full and empty drive (i.e. maximum and minimum spools at start and finish—and be warned, many machines cannot pass this test, even when new!).

Usual trouble with Akai is not a failure to take-up but rather an excessive pull from one

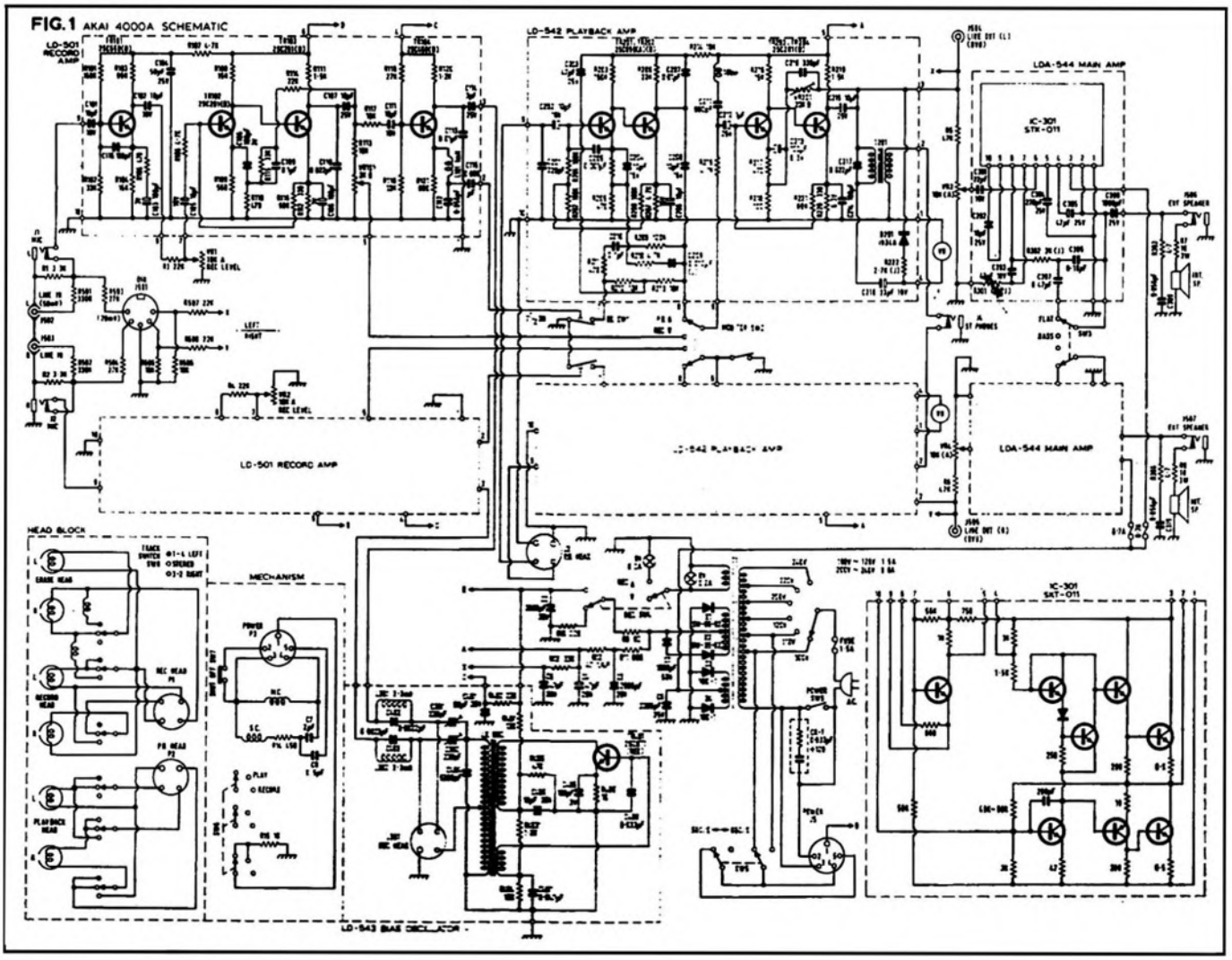
Inputs

Function	*Impedance*	*Sensitivity*	*Plug*
Microphone	30 K	0.5 mV	6.25 mm jacks
Line	330 K	50mV	phono x 2
DIN	100 K	20 mV	5-pin, 1-4

Outputs

Line	25 K (load)	1.228 V	phono x 2
DIN	50 K	400 mV	5-pin, 3-5
Power L S	8 ohms	8 W	6.25 mm jack x 2
Headphone	8 ohms	40 mV	6.25 mm stereo jack

FIG. 1 AKAI 4000A SCHEMATIC



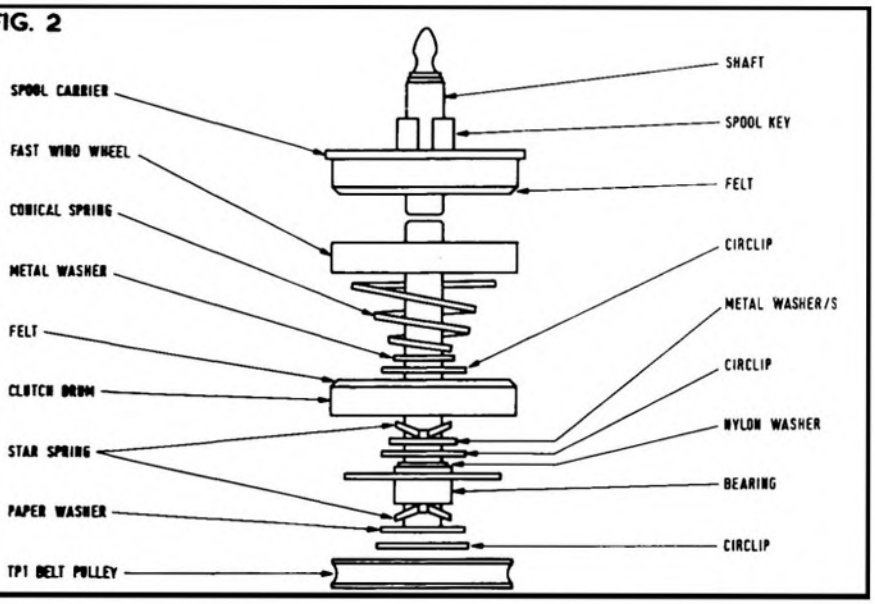
or other spool assembly. The trick is to adjust the star spring beneath the lower clutch part for a correct upward pressure. I have found the best way of doing this is to doublecheck with rewind back torque. Switch to fast rewind and note that there is only 20 gm of *forward* pull at the right clutch assembly. Then, on take-up, the basic drive should be right.

Rewind is also by idler drive, with two wheels coming into play. Again a fairly complicated clutch mechanism to worry about. The basic operation is by the cam on the main lever, and first check is that this is moving correctly, with the required contour impelling the lever system. After this, again check the torque, allowing for around a 100 gm slippage, certainly not less than 80, adjusting the conical spring as need be. The fast winding friction should be between 15 and 20 gm.

During record or play, some back tension is given by the supply side brake, which is a slightly larger roller than on the take-up side. Brake action has a differential effect, by the rollers being free to move with the direction of the spool rotation for a decreasing amount as

(continued on page 315)

FIG. 2



TURNTABLE

A column of readers' problems and correspondence

COINCIDENT MICROPHONES

From: Robert Auger, Halfacre, Bix, Henley-on-Thames, Oxfordshire.

Dear Sir, With reference to your editorial comment and Angus McKenzie's suggestion that on some classical recording sessions where multitrack recording equipment is available the engineer should take the opportunity of recording a coincident pair of microphones on two of the tracks for later comparison with the multimike balance.

This is not a new suggestion, and in fact such a system was specifically set up at the recent Unicorn *Mahler Third* sessions at Fairfield Hall. The idea on this occasion was not only to allow the producer the luxury of subsequent technical comparison but also to allow additional natural reverberation to be added to the multimike tracks if this was deemed to be necessary.

During the dubbing sessions it was very quickly decided by the producer and myself that the multimike balance was far preferable to the coincident pair, both from the sound quality and balance point of view. Indeed, adding even the slightest touch of the coincident pick-up to the multimike tracks produced quite an unpleasant string quality. It may well be, of course, that insufficient time was taken on the session to locate the stereo microphone in precisely the best place in the hall, but this leads me back to my recent article (Why Multitrack?) when I stressed that a professional engineer must pay particular regard to the financial side of the operation upon which he is engaged.

In the case of the Mahler sessions the orchestra was ready to record within 15 minutes, and any delay on my part would have involved the record company in an expenditure of something like £20 *per minute*. Without in any way detracting from Jerry Bruck's experiments on the same sessions, I think it is only fair to point out that he was still experimenting with microphone placement on the second day. I sincerely believe that a lot of the discussion and comment on various recording techniques which appear in your paper are written from an idealistic standpoint, without regard for the economics of the modern symphony orchestra. If readers refer back to my article (February) they will notice that practically the whole of my case for multimike and multitrack recording is based on a twofold financial premise: firstly, it is most important that when the artists are ready to perform the engineer is ready to record. This also means that, once a recording project is under way, it is very difficult for the engineer to make other than minute adjustments to the overall sound quality. Secondly, I cannot overstress the fact that I believe recordings of classical music should be made in such a manner as to provide the company with some form of investment for the future. By making use of multitrack and multimike methods we can come back to the master tapes another day, and re-mix to another standard. It is always possible to diminish any feature of an existing recording. It is not possible to make clearer, or bring into close-up, any feature of a recording which was not there in the first place.

In conclusion I would like to mention that the idea of assembling an orchestra specifically for the purpose of carrying out a large number of simultaneous recording experiments would also not be new. In 1959 I arranged for a full symphony orchestra from one of the London music colleges to play for a full day at Walthamstow Assembly Hall for an agreed figure. Six different stereo microphone systems were planned to be recorded in three separate control rooms. The whole of the arrangement was on the clear understanding that this was purely an engineering experiment and that no recording of any commercial value would result from the day's work. Much to my dismay, a day or two before the sessions were due to take place, the Musicians' Union stepped in and insisted that the full recording session rates would have to be paid to the students for the two sessions planned. Naturally enough my employers were quick to point out that they were in the record production business and were not prepared to spend something between two and three thousand pounds to set up an engineer's playground for a day. I don't think I blame them, do you? *Yours faithfully*

WHOSE INTERPRETATION?

From: Desmond Longfield, Glenfern, Coxheath Road, Crookham, Nr Aldershot, Hampshire.

Dear Sir, I would like to add my support for the views expressed by Michael Gerzon in his article on Coincident Microphones (March issue).

Who can disagree with the contention that the main aim of a classical recording should be to reproduce the conductor's attempt to portray his concept of the work? If this is not the case, why bother with a good conductor at all?

Unfortunately, however, the producer and engineer often appear to consider themselves superior to the conductor in matters of interpretation and regard his efforts to improve the performance with ill-concealed irritation. A good (or should I say bad?) example of this attitude occurred recently when a choir in which I was singing was making a BBC recording. The performance was complex and involved soloists, two small choirs and several groups of instrumentalists. Needless to say, the BBC used quantities of microphones of different types and response patterns, placed at various distances from the performers. The conductor naturally wished to listen to one of the takes to hear whether he was achieving the balance intended. Unbelievably, he was not permitted to do so by the producer.

This attitude is unforgivable in that it frustrates any attempt by a conductor to produce his desired effect since he cannot possibly guess what the integration of so many sources will sound like.

In my experience, the BBC is the greatest offender in achieving totally inaccurate balances. If its producers would try the Blumlein technique occasionally, they might be pleasantly surprised. Unfortunately there seems to be a widespread theory that multimiking is 'professional' whereas using one or two microphones is 'amateur'. It may be that pop musicians 'consider themselves in safer hands when surrounded by microphones' (April Editorial) as they rely for their effect on electronic interference but I believe that many classical musicians share my distrust of multimike techniques. *Yours faithfully*

COINCIDENT MICROPHONES

From: Ken Cameron, Anvil Film & Recording Group Ltd, Denham Studios, North Orbital Road, Denham, Nr Uxbridge, Middlesex.

Dear Sir, The discussions in your admirable publication concerning the relative merits of using a stereo pair of microphones and the multi-microphone technique are becoming most interesting. You might care to hear the views of one whose studio principally operates in the field of major film music.

We are faced frequently with large orchestras playing music *which has never been heard before*. Our balance engineer may be provided with a lead sheet a few moments before a session begins, but that can serve no more than a useful guide during the recording. He has to set his orchestra and his microphones the day before with only his experience and his knowledge of the composer to guide him as to the most suitable arrangement. And he has very little time, as a rule, to achieve the correct balance. Furthermore, and this is very important, he will normally make a three-track recording split between the sections of the orchestra so that the balance can subsequently be changed during the re-recording session to satisfy the compelling demands of the dialogue and sound effects. But from this three-track record will probably be prepared a normal stereo tape for album purposes. It is obvious that these two factors are completely incompatible. The end disc is not, of course, a true stereo sound. But short of doing the whole operation twice there is no alternative. The film must take priority.

Here then is perhaps the prime reason for using the multi-mike technique in film sessions. The engineer cannot know beforehand whether the composer has written a viola solo accompanied by a big muted brass sound, or an important celeste part—or in these days more terrifying things which come out of humming black boxes! If he started out with a stereo pair, and every five minutes had to rush out with another sweetener mike, he would soon be out

(continued on page 315)

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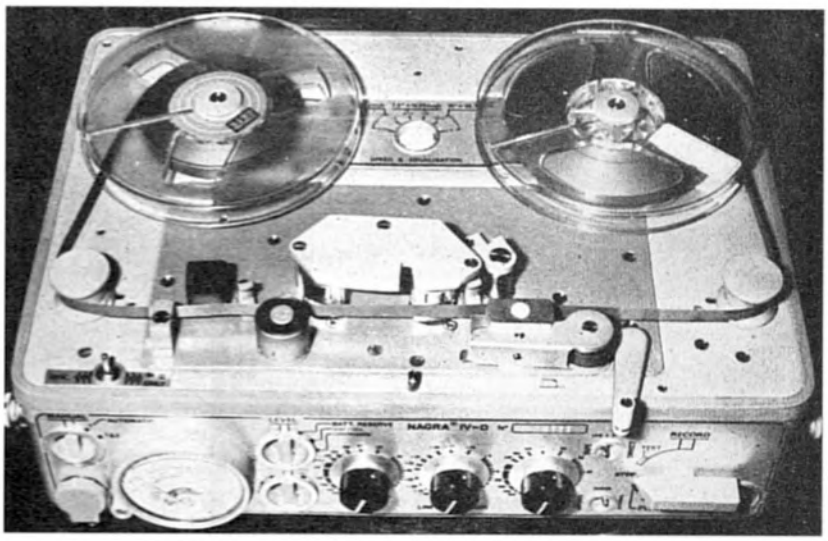
RD 708V Solid state, 4 track, 2 channel stereo/monaural. 3 speed. Circuit 14 transistors, 3 diode. Type 7", vertical/horizontal operation. DIN jack. Output (3.5W+3.5W) RMS max. Speaker size 6½". £95·00*

*recommended U.K. retail price

equipment reviews

NAGRA 4D
BATTERY TAPE RECORDER



MANUFACTURER'S SPECIFICATION
(Scotch *202* at 38 cm/s).
Channels: One.
Tape width: 6.25 mm.
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: 500 pW/mm.
Wow and flutter at end of reel: 0.1% p-p. unweighted.
Spool capacity: 18 cm cine.
Level meter: PPM characteristic, dB calibrated.
Inputs: Two balanced microphones: 50 μV at 50 ohms and 100 μV at 200 ohms. Line: 370 mV at 100 K unbalanced. Mixer: 880 mV at 10 K unbalanced.
Output: 9.6 V into 600 ohms, balanced.
Drive system: Single motor, tachometer, controlled. Switched motor speed (direct drive) for 38, 19 and 9.5 cm/s.
Equalisation: CCIR or NAB to order.
Dimensions: 333 x 242 x 113 mm excluding handle.
Weight: 6.4 kg with batteries and 13 cm tape.
Power source: 12 UPU2 cells or equivalent.
Price: £533. (Model *4L* with Neopilot facility: £595.)
Manufacturer: Kudelski S.A., CH 1033 Cheseaux/ Lausanne, Switzerland.

DISTRIBUTOR: Hayden Laboratories Ltd, East House, Chiltern Avenue, Amersham, Buckinghamshire.

THE Nagra *4D* occupies a 2 mm thick Anticrodal sheet container, the deck being 3 mm thick. On the left hand end of the recorder are two microphone inputs and these, together with the interchangeable microphone preamplifiers obtainable, can be arranged to match a wide variety of microphones, or be converted to extra 'line in' inputs. A microphone amplifier capable of powering a Sennheiser capacitor microphone is available. The microphone inputs are balanced. Next along this end of the cabinet is a six pin Tuchel accessory socket. Pin 2 is the common chassis and Pin 3 a low-level input (3.73 μA RMS modulates the tape to 0 dB at full gain on the potentiometer). Pin 6 gives 10 V, stabilised and filtered for powering an accessory unit. Up to 100 mA current is available.

An alternative line input is via the banana sockets above the Tuchel sockets. Impedance is 100 K and minimum voltage is 0.37 V RMS with a maximum of 150 V! Normally it is recommended not to exceed 10 V but the Nagra can be connected occasionally to 100 V line sound distribution systems if required.

Both these inputs are controlled by the central potentiometer on the front of the machine.

The other Tuchel socket is a seven pin mixer input of fixed sensitivity (560 mV modulating the Nagra 0 dB). The input impedance is 9.38 K, purely ohmic.

Pin 1 is the signal input and Pin 2 a 10 V 50 mA power supply output.

Pin 3 is a 'direct' signal output of 560 mV into a load of 5 K, allowing a monitoring signal to be fed back to the mixer.

Pin 4 is a non-stabilised supply similar to that which powers the Nagra.

Pin 5 is a 560 mV 'Tape' output of 3.5 K internal impedance.

Applying −10 V to Pin 6 stops the motor on play or record and can be used as a pause control in these modes. Pin 7 is chassis.

The last control on this end is the speaker volume control. On the front of the recorder, the controls are as follows, reading from left to right:

Above a jack socket output for headphones is the manual/automatic microphone selector. In the manual position, both microphone inputs are connected to their respective potentiometer on the front of the recorder. The two can be mixed.

In position *automatic 1*, the microphone input A is controlled automatically while input B is still controlled by the potentiometer on the front of the machine. In the position *automatic 1+2*, both microphone inputs are controlled automatically.

In all these positions, the line inputs are still controlled by the centre potentiometer. The mixer input remains at its fixed level. Using the master fader on the mixer, four inputs can be mixed using the controls on the Nagra. To the right of the headphone jack is a small knob for adjusting headphone volume. The modulometer is situated next to this. The meter is a PPM of extremely rapid rise time. The upper scale is marked in dB and is as accurate as my test instruments. The middle scale is a measure of the pilot signal frequency when the Nagra is used for synchronised film sound recording. The model *4D* under review does not have this facility.

The lower scale reads:

1. 'Battery reserve', when it acts like a fuel gauge in a car. If the needle lifts off the stop, there is enough power for recording.
2. Volts/cells ½ the voltage of the battery supply).
3. Bias voltage.
4. Motor current. When full scale deflection corresponds to 250 mA in 'no load' running, normally the indicator should read between 200 and 300 mV and a current in excess of this indicates that the motor commutator probably needs cleaning.
5. The amount of compression when the Nagra is working on automatic gain control.

The upper control to the right of the meter selects the meter readings required. Below this is a similar control. The position marked 'Ref' switches on an oscillator which gives a 400 Hz reference signal at −8 dB. Recorded at the start of each tape, this is of course invaluable for lining up. I am surprised more recorders don't include this facility.

In position *L*, no filters are included in the circuit. In positions 1, 2, 3, and 4, low fre-

(continued on page 313)

send for big Money Saving Catalogue before you buy!

AKAI TAPE DECKS AND RECORDERS

Prove for yourself the outstanding merits of the Akai 4000D. Having all the essential functional facilities, it also has many extras normally found on more expensive machines. The Akai 4000, the full tape recorder version of this excellent deck adds playback amplifiers and a pair of fine built-in speakers for stereo monitoring or just listening. And the Akai 1710 is surely one of the best complete tape recorder buys on the market today, combining all the best features of Akai engineering and construction. The above three models and the whole Akai range are available from Caves at very low prices.

AKAI 1710L

AMPLIFIERS	P & C 70p List	Cash
Armstrong 521	£56·00	£42·90
ARD 2000	£46·20	£38·25
Cambridge PSO	£88·00	£74·80
Duet SA300	-	£33·95
Leak 30 (Ch)	£56·50	£48·00
Leak 70 (Ch)	£69·00	£55·58
Lux SQ1220	£124·50	£84·00
Lux SQ77T	£66·37	£54·00
Metrosound ST20	£36·00	£29·00
Quad 303 + 33	£98·00	£83·95
Philips GH925		£19·95
Pioneer SA900	£133·83	£107·00
Rogers R/bourne (Ch)	£59·50	£49·25
Rogers R/brook (Ch)	£47·50	£39·25
Rotel RA310	£42·50	£35·95
Rotel RA610	£65·00	£54·95
Sinclair 2000 MKI	£32·00	£22·75
Sinclair 2000 MK2	£33·00	£25·95
Sinclair 3000	£45·00	£34·75
Sansui AU222	£62·88	£53·50
Sansui AU555	£86·34	£73·50
Ferrograph F307 Mk 2	£59·00	£46·95
Teleton SAQ203E	£27·75	£19·95
Radon 404		£16·95

BASF LOW NOISE HIGH OUTPUT TAPE		List Price	Single Cash Price	3 or more Cash Price
5″	900′	1·89	1·40	1·25
5½″	1200′	2·17	1·60	1·45
7″	1800′	3·10	2·30	2·05
5″	1200′	2·16	1·60	1·45
5½″	1800′	3·09	2·30	2·00
7″	2400′	3·83	2·85	2·50
5″	1800′	3·09	2·80	2·05
5½″	2400′	3·82	2·85	2·50
7″	3600′	4·75	3·50	3·15

BASF & PHILIPS CASSETTES		6 or more
C30 (Philips only)	0·53	0·50 0·40
C60	0·76	0·65 0·50
C90	1·02	0·90 0·70
C120	1·52	1·20 1·00

SCOTCH DYNARANGE—LOW NOISE		10 or more
C60	0·76	0·70 0·50
C90	1·02	0·90 0·70
C120	1·52	1·25 1·00

TAPE RECORDERS

	List Price	Cash Price
Revox Tape Recorders	Special prices on application	
Ferrograph 713	£188·50	£166·00
Ferrograph 702	£207·35	£175·00
Ferrograph 722	£242·54	£199·00
Ferrograph 704	£207·35	£175·00
Ferrograph 724	£242·54	£199·00
Ferrograph Plastic Cover	£6·28½	£5·77
Grundig TK121	£54·78	£45·25
Grundig TK141	£59·23	£50·00
Grundig TK146	£68·14	£54·25
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quency roll-off attenuators are included, giving ranges from −5 to −17 dB at 50 Hz.

Next we came to the three level controls: microphone 1, line in/playback and microphone 2. These are calibrated in dB, the microphone controls being calibrated so that, with the potentiometer on X dB, a sound of X dB picked up by a microphone of sensitivity 0.2 mV/μB into 200 ohms and through the correct preamplifier produces a recording at nominal level (0 dB on the meter).

The middle potentiometer is calibrated in dB. It controls the line input in the record mode and the output level on playback when the 'tape-direct' switch is in the direct position. With this potentiometer on the 0 dB, the switch in this position, and no input to the recorder, the meter reads the level recorded on the tape.

The upper of two small toggle switches selects tape or direct signals for the output. In the record mode, the direct signal is that coming into the recorder after filtering and mixing. The tape signal is that coming off the recorded tape. In the playback mode, the direct signal is that coming off the tape, together with any further signals coming into the recorder. The tape signal is just that off tape, replayed at a fixed level, regardless of the potentiometer settings. The lower toggle switch selects power from batteries or external supply. An accessory mains unit is available for the Nagra.

The last control, on the right of the front panel, is the principal function selector. This has six positions. With the control horizontal, the recorder is switched off. One position below this engages playback but with the internal loudspeaker muted. The next position below gives playback with the internal speaker in use as well as the signal at 'line out'.

The first position above the horizontal is labelled 'test' and, in this position, all parts of the recorder function except the motor. Thus recording levels can be set before starting the tape.

In the second position up, the motor starts and the 'direct' signal is recorded at very low level. When the switch is moved to the 'record' position, the signal fades up giving a clean start to the tape.

When the function switch is returned to the intermediate position, the signal fades out and the tape can then be stopped by moving to 'test' or neutral.

To the right of the main mode selector is the 'AR indicator'. In normal functioning, a white cross appears, vanishing when the power supply becomes insufficient, when the meter is switched to battery reserve, when the motor current reaches maximum, when the mode selector is in the 'fading' position, or when the recorder is in the rewind mode.

On the right hand side of the case are the power supply input and the loudspeaker. Two banana sockets give a floating line output of 4.4 V into 600 ohms from a fully modulated tape. This is at standard level when the tape direct switch is on 'tape', adjustable with the centre potentiometer when the switch is on 'direct'. Two more banana sockets are ground connections.

The deck will take 13 cm cine spools with the lid closed and up to 18 cm with the lid open. Between the spools are the speed and equalisation switch with positions for low noise and 'standard' tape at 38, 19 and 9.5 cm/s. On leaving the supply spool, the tape passes round a roller tension servo, behind a fixed pillar and across the erase head, past a roller strobe, across the record and replay heads, between the capstan and pressure rollers, round another roller tensioner, and on to the take-up spool.

A toggle switch in front of the fixed pillar selects forward and reverse wind. A lever to the right of the pressure roller, when pulled forward, lifts the roller and strobe wheel clear of the heads to simplify tape threading and engages rewind if the toggle switch is preset appropriately. The tape will then rewind if the principal function selector is in the test or play position.

The fast forward switch only operates when the function selector is in the 'play through internal speaker' position.

All the controls on the two models I tested worked smoothly and reliably and had the 'silky' feel associated with really good equipment. I have few minor criticisms and perhaps it would be as well to state these first, though none of them would deter me from purchasing the recorder if I wanted a mono machine.

When the pinch wheel and tape guide control lever are pulled forward, the rewind mode is engaged. Though the tape path is then uncluttered and easy to thread, the act of turning the take up spool anticlockwise tends to turn the supply spool clockwise. Unless the tape is anchored on the take-up spool in some way (pressure from a finger will do), it comes off and one has to start all over again.

When the control lever is pushed forward, the tape is still slack and looks as if it might jerk when the machine is started. I couldn't persuade the recorder to damage or mishandle even thin tape but this bothered me at first.

It would seem to me to be more logical to put all visual indicators together and the AR indicator would have been more valuable near the meter. I must admit that I have paid little attention to the indicator, tucked away as it is below the function selector.

A tone from the WHM meter oscillator was recorded at 0 dB and the tape rewound. The RMS wow and flutter were then measured—see **Table 1.** Most of this is flutter, I suspect caused by the fixed pillar just before the erase head. Wow-only was below the sensitivity of the WHM meter. These figures would be remarkable even for a good studio recorder. On a portable they are quite outstanding.

Signal-to-noise ratio was measured by recording 1 kHz signal at 0 dB using the microphone input, rewinding the tape and then measuring the signal on replay.

The tape was then rewound and a 200 ohm resistor placed across the microphone input. With the gain control at the same level as before, the Nagra was switched to record and the signal off the tape found to be 64 dB below! This figure is remarkable as some bias breakthrough is usually encountered in this mode. No filters were in circuit.

When the tape was rewound and replayed, I found to my surprise that the s/n ratio had dropped to 54 dB. In moving some of the test gear, I had placed the Nagra in a hum field. Turning the machine through a few degrees, the s/n ratio went up to 65 dB.

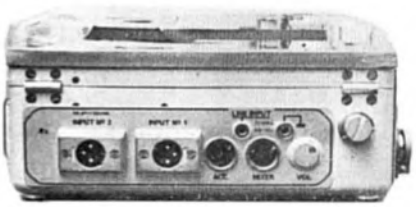
TABLE 1 RMS wow and flutter at end of 13 cm spool

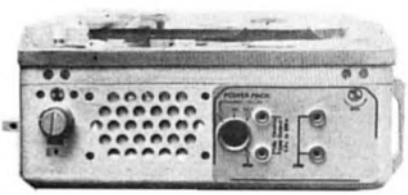
	38 cm/s	19 cm/s	9.5 cm/s
First recorder:	0.03%	0.06%	0.1%
Second recorder:	0.05%	0.09%	0.14%

TABLE 2 Frequency response at 38 cm/s

	PLAY ONLY	RECORD/PLAY*
30 Hz	0 dB	−0.5
40	0	−0.5
60	0	0
100	−0.5	0
200	−0.5	−0.5
500	0	0
1 kHz	0	0
2	−0.5	−0.5
4	−0.5	0
6	0	0
8	0	0
10	0	0
12	0	0
14	0	0
15	0	−0.5

* BASF *LP35LH*





I next measured 1 kHz, 10 kHz and 30 Hz distortion at a level of 0 dB by recording a signal at the given frequency, and then replaying through a filter to pass all except the fundamental. The total distortion was 0.4% at 1 kHz, 0.5% at 10 kHz and 0.6% at 30 Hz.

The replay response figures were measured using a 35 μS test tape. The record/replay curve was obtained by feeding a signal at −12 dB into the recorder at varying frequencies and measuring the signal off tape with reference to −12 dB. **Table 2.**

The LF equalisation in the replay amplifier is operative at all speeds and should therefore be adjusted for the speed most commonly

(continued on page 315)

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used. I suspect that the machine measured was adjusted for use at 19 cm/s. The response was so flat at this speed that I began to wonder if the needle on my meter had stuck. The tape used for these tests was BASF *LP35 LH*.

One important factor in a recorder of this class is the ease with which it can be set up for different types of tape. After completing my tests on the BASF tape, I lined up the recorder for Scotch *202*. I decided to adjust all the controls in accordance with the procedure provided by Hayden. The inside of the recorder gives the same impression as the outside; careful design and first class workmanship and materials.

A metal shield held on by two small screws has to be removed to get at the controls on the replay amplifier. Anyone as ham fisted as I am in such matters may find himself fishing about in the dark, searching for one of these. Apart from this, setting up was easier than on any other recorder I have tried.

When two retaining screws are loosened, the deck hinges open like a book. Using the lid as a prop, the machine can be run with the deck vertical and the recorder horizontal so that all preset controls are readily at hand.

When a full-track Nagra is set up carefully according to the procedure recommended, it is good enough to make extremely accurate test tapes. A limiter in the record amplifier prevents accidental overload of the tape and rapidly attenuates the signal if it exceeds +4 dB. In normal use, where care has been taken in setting levels, this should not be required very often. It is nevertheless reassuring to know that a sudden and unexpected burst of sound will not ruin the recording.

I have tried the *4D* with an AKG *D202* both for interview and music recording. For the interview I used the internal AGC. This enabled me to concentrate on the interview itself and forget the recorder. Even played back at high volume on wide-range monitor speakers, it was not possible to catch out the AGC. I could detect no sign of 'breathing' or sudden changes in volume or background noise, and I would recommend the use of this facility for interview purposes.

The music recordings were made simultaneously with a stereo version (AKG *C24* and Philips *Pro 20*). Comparing the results at leisure it was obvious that the *D202* Nagra combination was a very good one. In fact until then I had refused to believe that a dynamic microphone could be so good.

I next tried a battery powered AKG *C451* capacitor microphone. This is conveniently interchangeable with the *D202* as far as microphone amplifiers are concerned. I took advantage of a calm day to record my voice and that of a friend in the middle of a field. This tape will be used in future as part of my speaker test procedure. When we returned, we played the tape through Spendor *BC1A* speakers and took turns to listen while the one whose voice was recorded stood by the speaker and spoke during gaps in the tape.

This I think is the acid test of a recording/reproducing chain. I was surprised how near the original the recorded voice was. The combination of *C451*, Nagra and Spendor amplifier/speakers is in the very highest class.

As I said at the beginning, anyone who wants a portable mono recorder could not do better than the Nagra *4*. I think it is well worth its price.

One final plea. Please Mr Kudelski, when can we expect a stereo version?

John Shuttleworth

of business. Okay, you say, put out your two dozen microphones, but only use the close ones when you have to. The snag here, and it is a real one, is that there is a psychological urge to open a fader if it is there.

There also is the factor that a film music budget rarely permits a composer to use the 60 or so strings to balance the accepted line-up of brass and woodwind. He may be allowed a total of 50 men. Something has to suffer and the strings are always the poor men out. The mixer needs all the help he can get from overmiking the strings.

How we should love to get away with a stereo pair! How easy life would be. But I can think of a great many successful film composers around today who judge the efficiency and results of a studio by the number of microphones scattered around and the number of tracks used for recording. This is terrible, but it is true! *Yours faithfully*

DETACHABLE CAPACITOR CAPSULES

From Peter Eardley, Director, AKG Equipment Ltd. London W.8.

Dear Sir, I have just read *Studio Sound*, as always with great interest. The fact that so many users and independent writers refer to AKG equipment gives, needless to say, added pleasure to my reading.

However, I feel I cannot leave without comment your report (Sound 71) about another manufacturer's new capacitor microphones. You say it is a remarkable innovation that screw-on capsules, omni and cardioid, can be added to their basic preamplifier. May I point out that AKG first introduced the idea of detachable capsules in 1958 with the original *C28A*. This microphone and the *C28B* and *C* units are still extensively used by TV studios in this country. Ten years later the same idea was introduced with the FET *C451*, to which a variety of capsules and accessories can be added. *Yours faithfully*

SQUIRE SOUND

From W. J. H. Barrett, Secretary, The Association of Professional Recording Studios Ltd, 3 Strathray Gardens, London NW3 4PA.

Dear Sir, I was surprised to read Keith Wicks' comments (Studio Diary) regarding Squire Sound and the APRS. Squire Sound were not refused membership. They were offered Affiliated membership, with the suggestion that they apply for full membership at a later date. One reason given in the secretary's letter was that the executive committee was 'concerned at the lack of test facilities'.

I am at a loss to understand how Mr Roger Squire concluded that the committee is entrenched in the past. It comprises 11 members aged from 25 upwards. Among them are representatives of some of the most modern studios in the country. *Yours faithfully*

pressure is applied. This gives us an immediate clue to the causes of tape spillage and increased back tension—seizing of the small rollers. Look also for juddering action imposed by erratic roller action—and by similar faults caused by the rotating left tape guide.

Electrically, we have a few more cautions. Although the tape supplied is generally Scotch 150, or similar, and the specification figures are supposed to have been obtained with this tape, I find that Ampex *344* gives better results, and BASF LGS35 *LH* can improve the ratio by several decibels. The tone switch is the simplest of contouring devices, and, in my experience, a likely source of noise! It alters the feedback around the output stage for an 8 dB bass lift around 100 Hz. Methinks it would have been a better idea to try and chop the hiss.

Readers who want to do this for themselves may have a go at adjusting the bias. We have a 60 kHz oscillator with no frequency adjustment—pity, for this is rather low—and the only recourse is alteration of the capacitor across the secondary of the transformer. This chappie is nominally 5.3 kpF. If you are fiddling around here, put an oscilloscope across the output from the oscillator and monitor the waveform. It is all too easy to get a dirty recording because of an impaired oscillator.

Bias proper is available from a pair of 130 pF preset capacitors. These, and the rest of the oscillator components, are available on the single printed circuit board that also contains the main 130 ohm wirewound dropping resistor for the power supply to this section. First clue of malfunction can be a horrible smell! Adjust the presets to give between 5 and 10 V AC at 60 kHz from the 'head' side of the preset capacitors, and check the oscillator again after adjustment. Easiest way to ensure that oscillator power is in order is to measure the erase voltage, which should be between 23 and 33 V. Unfortunately, the most usual cause of failure seems to be the erase head itself, followed by the oscillator transformer. A word, of warning: when you are making tests that involve 'killing' the oscillator, do not short-circuit the erase head or shunt with a large capacitor. It might be wise to make that a general rule on transistor equipment.

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PATENTS REVIEW

ADRIAN HOPE

THE British Patent Office publishes getting on for a thousand new British patent specifications every week so they are in effect publishing the details of an equal number of supposedly new inventions. The American Patent Office publishes even more per week and just about every other civilised country in the world puts out at least something.

The purpose of this column is to make mention of any invention of possible interest as and when it turns up. With any patent number that I give, any interested reader can do as much further research as he wants.

Any reader who has not heard of the Dolby system has been asleep for the past five years. For their benefit though, it is a breakthrough in noise reduction which relies on a new approach to amplitude compression and expansion. I thought it might be interesting to have a look at the kind of patent protection that Ray Milton Dolby has for his system in this country.

The main Dolby patent is BP 1 120 541. It was published in July 1968, following applications dating back to August 1965. The patent specification (available to anyone for 25p from the British Patent Office) is interesting because it not only concisely sets out the principles of Dolby's work but also gives a useful breakdown of past compression/expansion systems.

The Dolby patent refers to previous systems that have proved generally unsuccessful. For instance, pre-emphasis has been used at the lower and upper ends of the audio range but Dolby explains that this creates a risk of overloading when the original audio signal is fairly heavy in the ranges pre-emphasised. He also reminds us of attempts at using two channels in a parallel relationship with one channel recorded at a higher level than the other (up to 30 dB above). On playback the high level channel is automatically selected for low level passages and vice versa. The snags are obvious. Another idea has been to control a low pass filter automatically in response to signal level, so as to filter out hiss during low level passages only. It has also been tried to vary the degree of expansion on playback automatically in response to the signal level.

The main problem with all these techniques has been the introduction of distortion. What the Dolby system succeeds in doing is to provide reasonable freedom from distortion with a reasonable degree of carefully used compression and expansion. Dolby sums up the essence of his original idea as splitting the signal into two components: an unaltered component which contributes mainly the high level signals, and a low level differential component from a limiter circuit. The overall compression character is then derived by adding the two components together. The most basic circuit as claimed by Dolby is a signal compressor with a straight-through signal path and circuitry for adding to its output the output of a further path. This has an amplifier for the input signal and a linear limiter for limiting the further path output to a fractional part of the maximum amplitude of the input signal that is being treated. This basic circuit functions so that at high signal levels the output of the compressor is more or less unchanged from the input signal whereas at low signal levels the amplifier in the further path effects compression. The necessary expansion—as and when necessary—is by an expander which is complementary to the compressor. The further path is in this case connected between the output of the expander and circuitry for subtracting the output of the further path from the input signal.

For the technically minded, Dolby's own breakdown of the system principle is as follows:

If the input signal to the compressor is x, the signal in the information channel is y and the output signal of the expander is z we have $y=(1+F_1)x$

and $z=y-F_2z$ or $z=\frac{y}{1+F_2}$

where F_1 and F_2 represent the transfer characteristics of the further paths in the compressor and expander respectively. Therefore we have

$z=\frac{1+F_1}{1+F_2}\ x$ and if $F_1=F_2$

$z=x$ as required.

There's a lot more interesting comment on Dolby's theories but the crux of it all of course is that the system functions to reduce only perceptible noise. In other words, noise doesn't matter if you can't hear it behind a high level signal but it does matter if it is behind a low level signal. And that is when the Dolby attenuation comes into effect.

It's quite a surprise to find that Dolby's patent concentrates heavily on noise reduction in video systems. In such systems noise shows up as a grainy picture and he first of all describes noise reduction techniques for both monochrome and colour TV. It is only then—it seems almost as if his main interest was initially in video systems—that he details the actual audio noise reduction systems that are now in use. Some informative circuit diagrams with component values are given for some parts of an audio noise reduction system with four separate paths. In this system each path has a filter and a limiter for a particular frequency range (filter 1 : 30 Hz to 150 Hz; filter 2 : 150 Hz to 1.5 kHz; filter 3 : 1.5 kHz to 5 kHz and filter 4 : 5 kHz to 20 kHz).

In following reviews I will report on some of the most recent patents for developments in the area of industrial audio.

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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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