April 1974 25p

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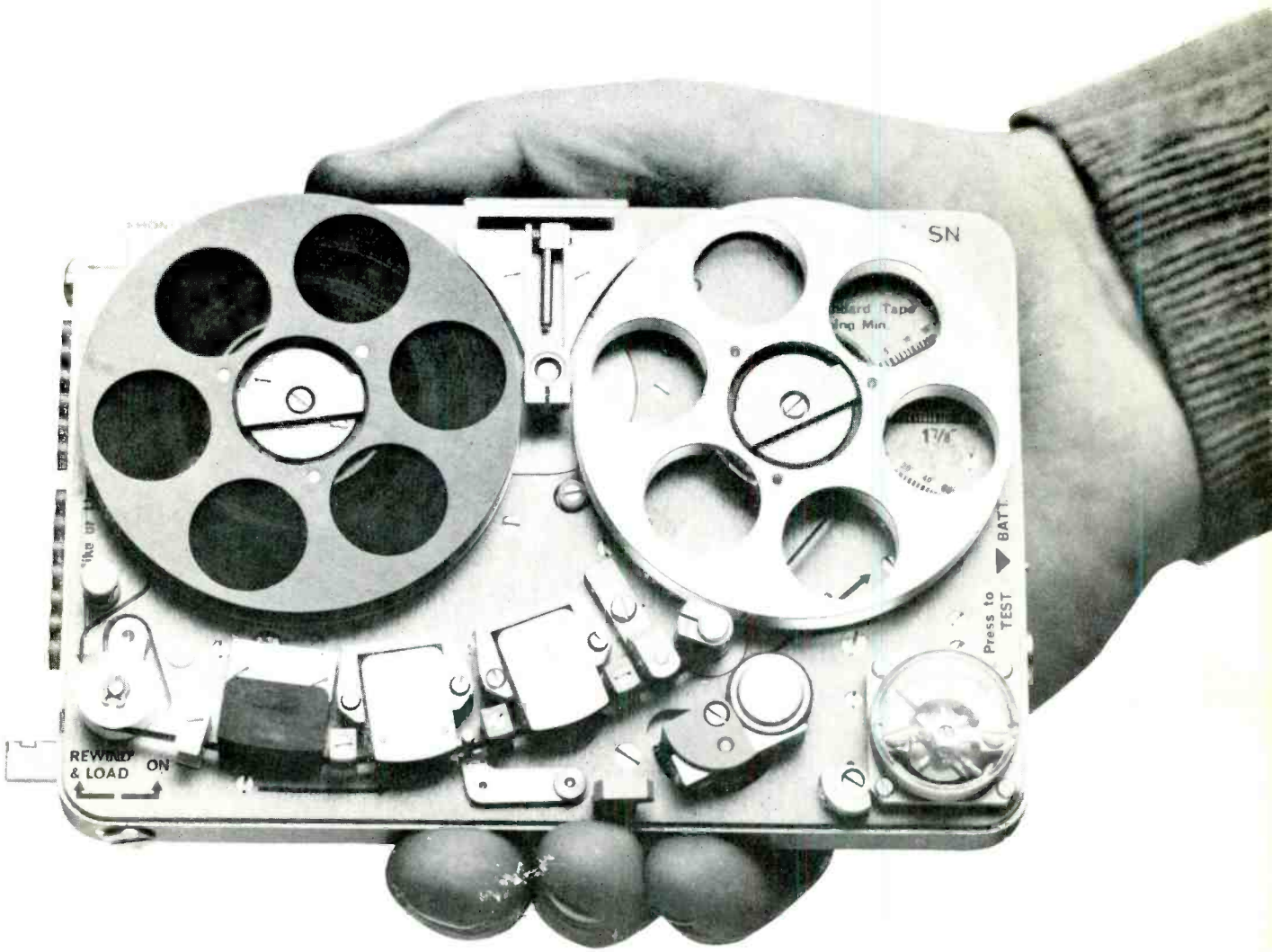
Reviews : Nagra 4SL, Nagra SN and Stellavox Stellamaster battery tape recorders.

Mains interference and its elimination.

Copyright explained.



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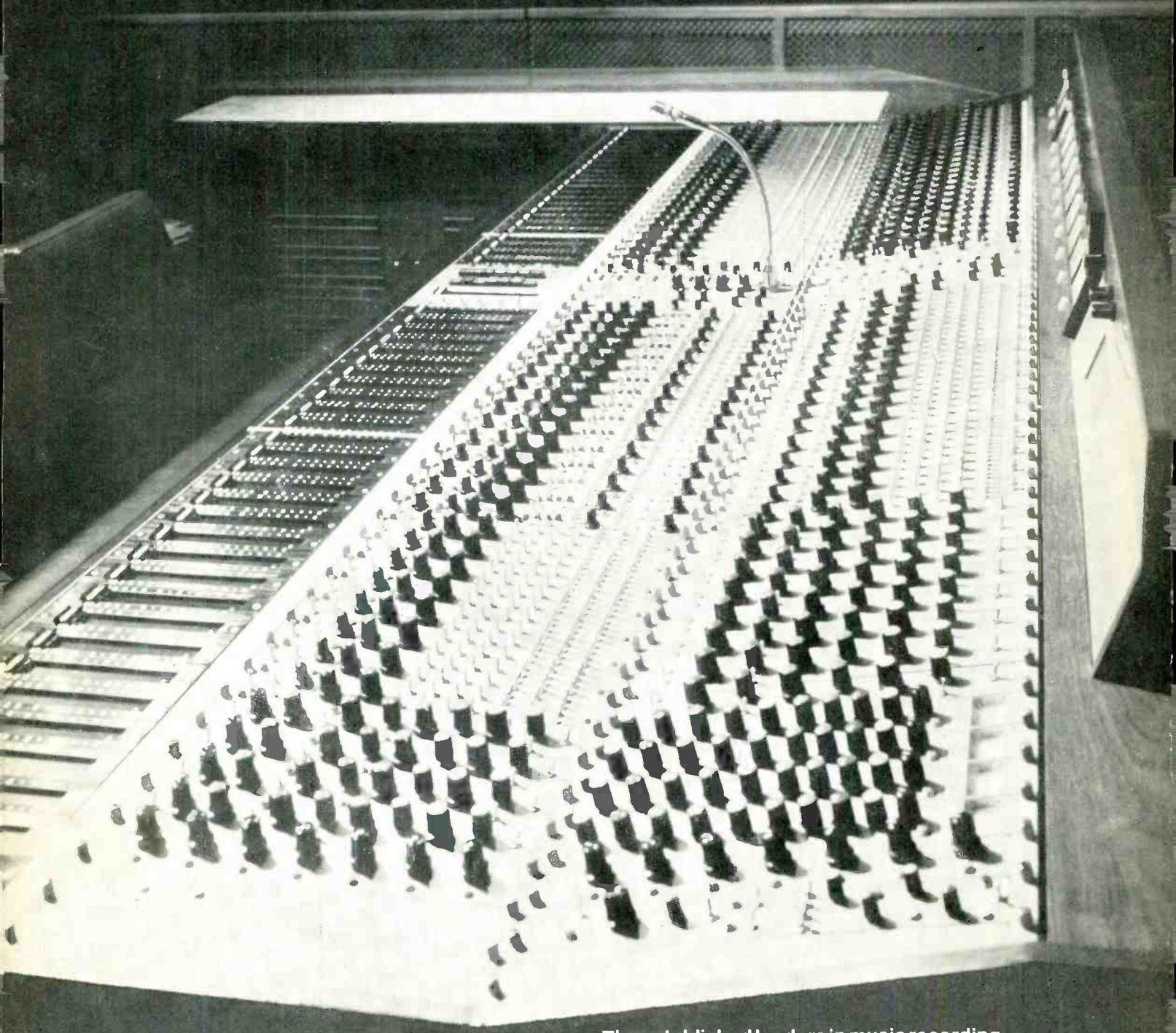

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STUDIO SOUND, *published monthly, enables engineers and studio management to keep abreast of new technical and commercial developments in electronic communication. The journal is available without charge to all persons actively engaged in the sound recording, broadcasting and cinematographic industries. It is also circulated by paid subscription to manufacturing companies and individuals interested in these industries. Annual subscription rates are £3 (UK) or £3.30 overseas.*

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APRIL 1974 VOLUME 16 NUMBER 4

NOT SO MANY years ago, 'mobile recording' almost invariably implied a small van or estate car, a small stereo tape recorder and a smaller mixer. Only the most ambitious operators troubled to carry a Dolby or two. Equipment of this kind was by no means limited to recording weddings, indeed the inconsistent nature of location recordings from certain cheap labels suggests that very elaborate works were often recorded on (or subsequently processed by) equipment of very dubious quality.

As tape recorders and mixers became larger, so it became increasingly common practice for studios to transport almost their entire contents to concert hall locations, setting down as conveniently as possible in backstage dressing rooms. Recently, however, this nightmarish mode of working has been superceded by the 'mobile studio'. Here, the vehicle previously used merely to transport the equipment becomes instead a permanent control room complete with lighting, heating, ventilation and working space for one or more operators. The advantages are obvious: faster set-up and departure times, reduced risk of accidents during loading and unloading, greater operational reliability, and total sound insulation between the control room and the temporary studio. To these might be added the psychological benefits of working in familiar surroundings and under consistent audio monitoring conditions.

All very fine. Yet one wonders to what extent many studios are being forced to 'go mobile' for the same reasons that forced them to upgrade from four track through eight to 16 and 24 track working. Certainly there are technical advantages even in the latter but the spread of large-scale multitrack operation is generally attributed to pressure (often uninformed pressure) from the local Beatle and his agent. Casual commercial whim has had several curious effects on the recording industry, of which the mobile Pop studio could be considered the latest. Note also the way in which a newly-opened studio tends to be patronised as The In Place to Lay Down for a few months before the wealthiest customer and his entourage disappear to some new favourite. The In Place at the time of writing appears to be Jamaica, though a studio on the west coast of Africa is likely soon to replace it in those fickle affections.

We have taken the term 'mobility' perhaps too literally in this issue by reviewing three of the finest (and let's hope *that's* not fickleness) battery recorders currently available: the Nagra *4SL*, the tiny *SN*, and the Stellavox *Stellamaster*. If the shift in emphasis from static to mobile control rooms increases, it is likely that all three recorders will be imitated to some extent by manufacturers anxious to reduce the size of their systems. Ampex and 3M have both made considerable advances in compacting multitrack recorders though few manufacturers have shown comparable ingenuity in the design of audio mixers. Any designer preparing to tackle this problem might note the increasing use being made of closed circuit television links between performers and control room. A little originality here could eliminate the embarrassing need to tap around for cross-wired microphones. The camera with built-in microphone already exists; how long before the microphone with built-in camera?

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

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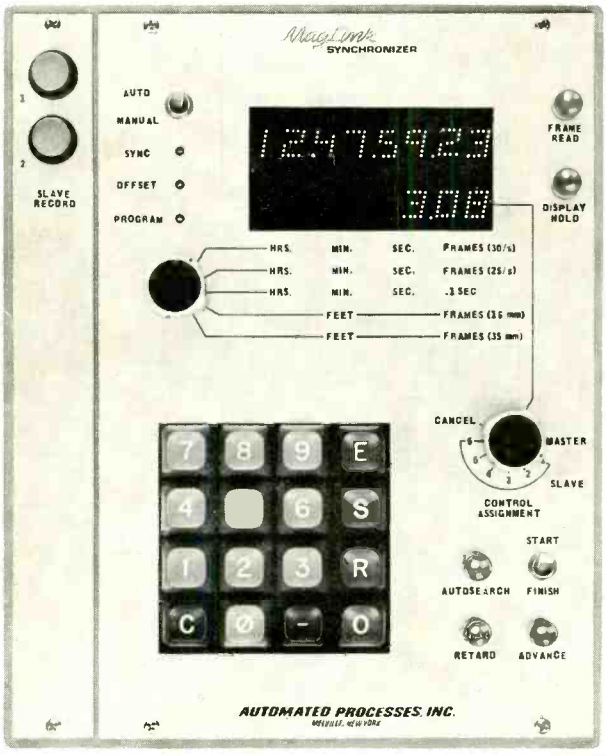

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HUGH FORD review
STUDIO SOUND Oct. 1973

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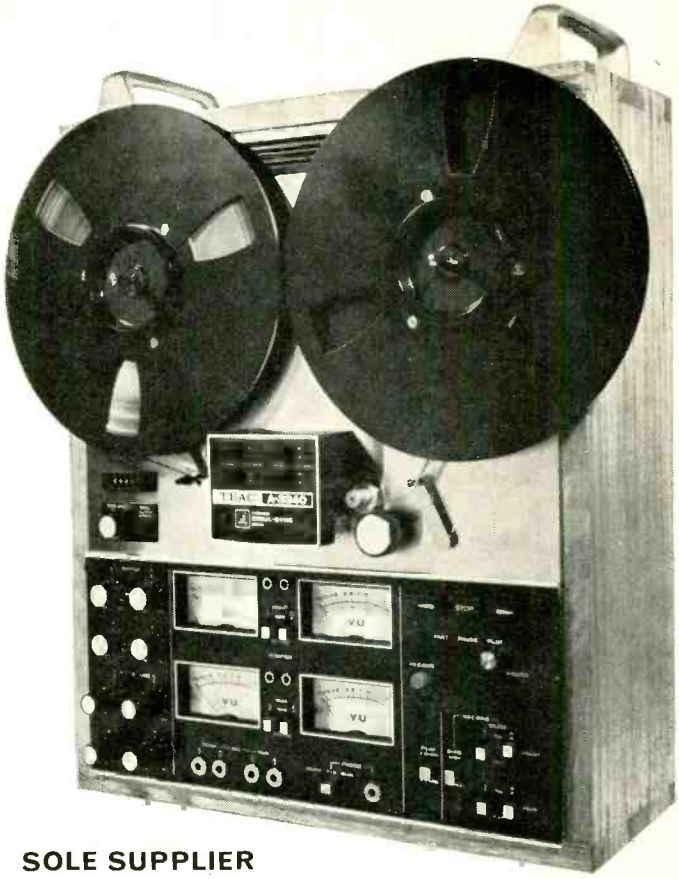

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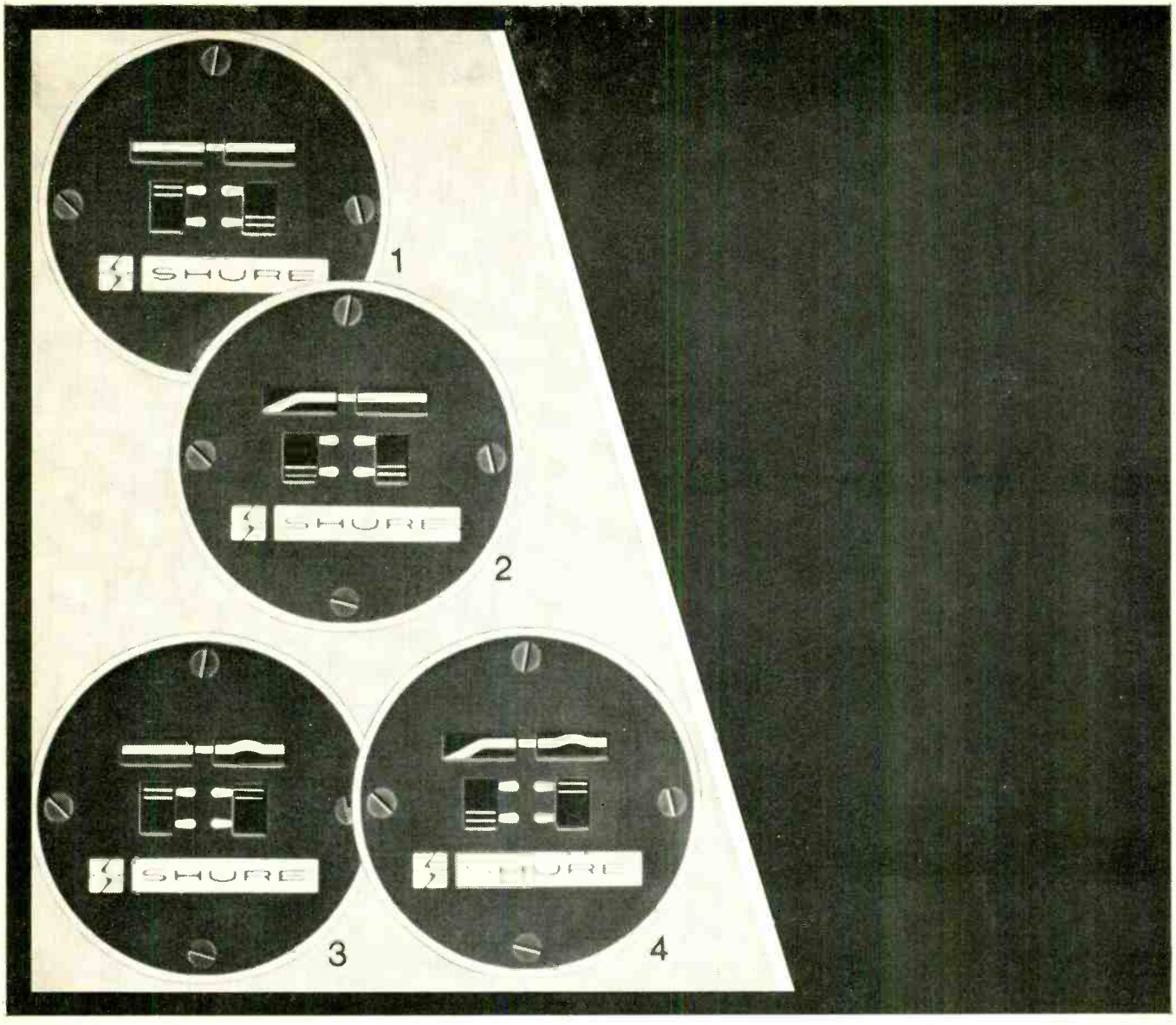

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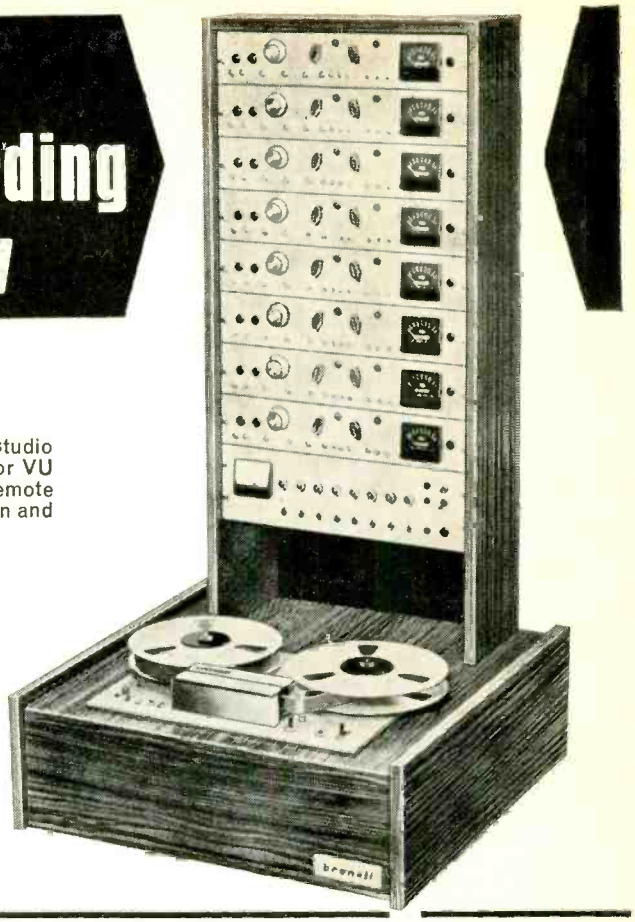

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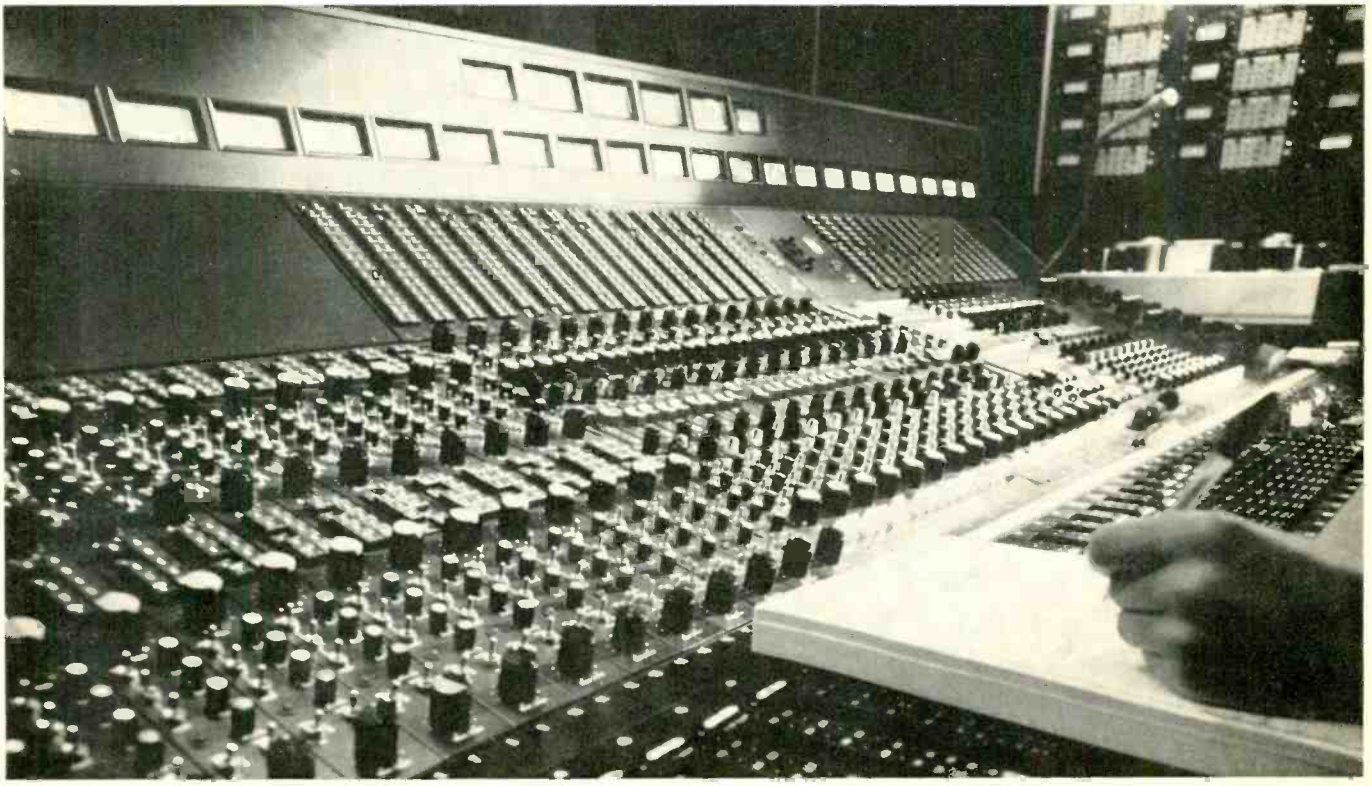

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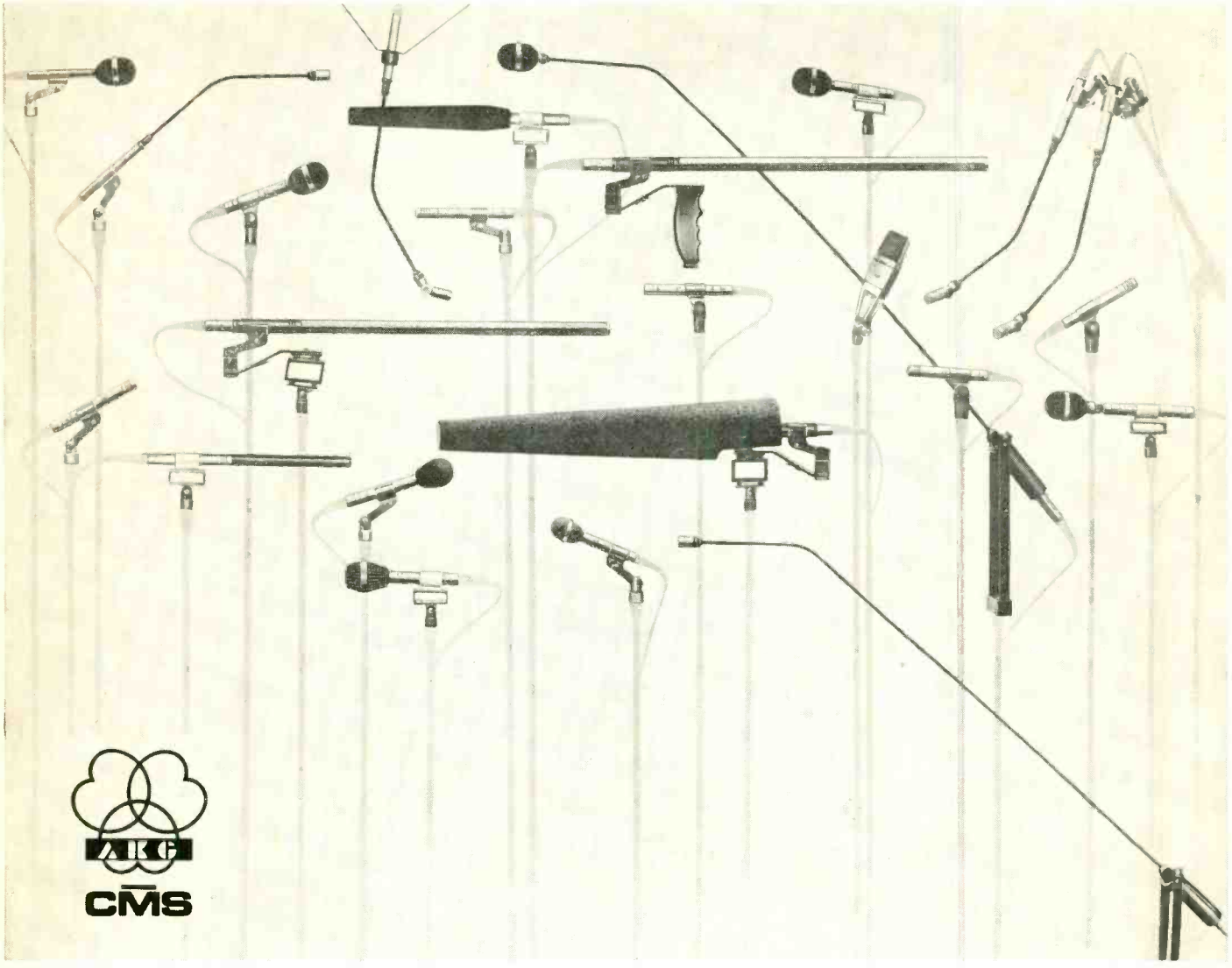

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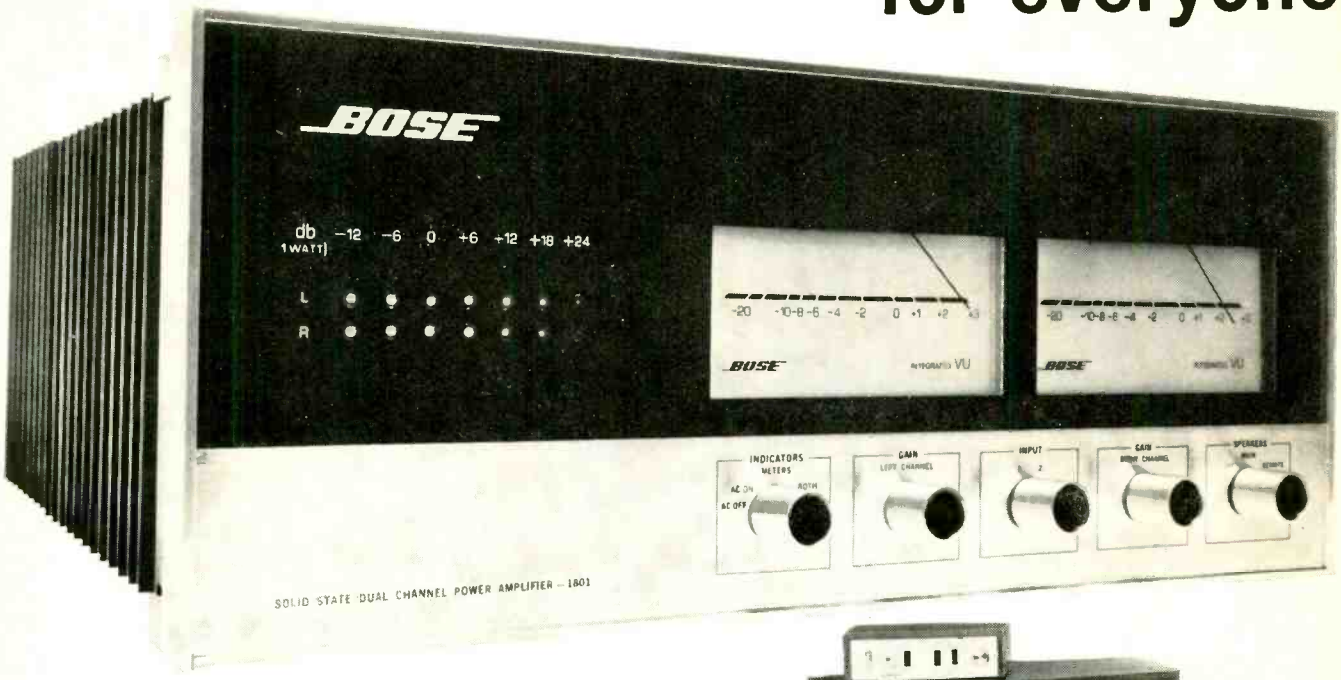

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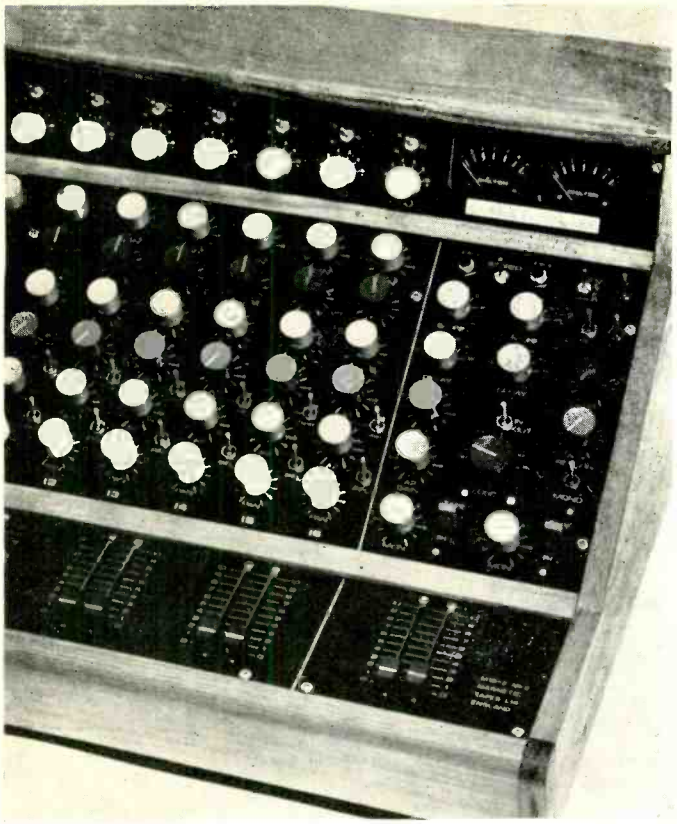

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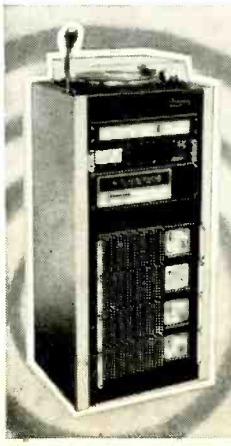

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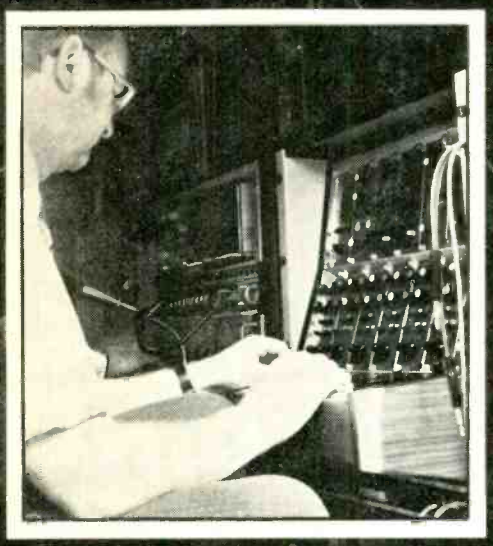

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ENQUIRY INTO MANX RADIO

THE ISLE OF MAN parliament, the Tynwald, have passed a resolution to set up a committee of enquiry into the management and general principles of Manx Radio. The resolution was passed in the House of Keys, the elective assembly, on December 11 last year.

Manx Radio is Britain's oldest commercial Radio station; it will be ten years old in November 1974. The enquiry will be held by six 'specially qualified persons' who will be asked to bring back recommendations to the House within six months of their appointment.

An unconfirmed report said 'these recommendations will presumably cover audience research (of which there has been little or nothing); presentation of current affairs; financing of the station, which is reported to work on a budget of £50,000 a year and is expected to make a loss of £5,000 this year; and circumstances under which staff work.

'The ABS have indicated that they would be happy to assist in any enquiry, especially in relation to their responsibility for the welfare of the station's staff.' The report goes on to cite the case of one relief disc-jockey who produced 'some of the most stimulating programmes on the station' while being paid 50p an hour.

A spokesman for Manx Radio said he had no authority to make any comment on the report and that the only person with such authority would be the Vice-Chairman of the Manx Radio Commission, the island's broadcasting authority. He said that, because of the tension that existed in broadcasting matters between the British and Manx governments, the enquiry was a very political matter which they could not discuss until the report had been published. 'There's nothing secret about it—the report of the commission will be made public.' A major source of tension was the British government's refusal to allow Manx radio to increase its transmitting power. The British government still had authority over the Isle in broadcasting matters.

Mr Kneale was unavailable for comment. His secretary said that the members of the committee had not yet been named but that she could make no comment other than to say the figures mentioned in the report probably derived from news reports in the local papers.

A spokesman for the Association of Broadcasting Staffs said the ABS did welcome the setting up of a committee of enquiry because pay and conditions for some of those at Manx Radio were 'wholly unsatisfactory'. He said pay was related to the financial state of the station, which was 'also unsatisfactory'. This was one of the reasons why the ABS welcomed the committee of enquiry.

Asked how he thought the financial position of the station could be improved, he said he could not comment because to do so would be to anticipate the findings of the enquiry. Neither could he comment on the running costs and losses quoted by our source.

During the Tynwald debate a member of the Manx Broadcasting Commission said that the Staff of Manx Radio were getting 'deplorable' salaries. Top announcers were getting less than builder's labourers and the general manager was getting the same as a medium grade civil servant. Unofficial ABS sources say that the salaries at Manx do not compare at all with the rates recommended by the ABS for local radio stations. The ABS are now preparing a report which will be presented to the as yet non-existent committee of enquiry. The report is expected to recommend increases in salary which are expected to come 'as something of a shock' to the Commission.

The Broadcasting Commission do not seem to be obliged to report to the Tynwald in any regular fashion; before last December the last Commission report to the Tynwald was in 1968. Manx Radio are not obliged to publish accounts and one consistent complaint about the station has been that little information is available to the public about the way it conducts its affairs.

The week after the Tynwald debate had taken place it was announced that in June, 1973, after almost a year of negotiation with the Broadcasting Commission, an offer to take over Manx Radio, made by a private enterprise group comprising bandleader Ronnie Aldridge, broadcaster Tim Gudgin (both Manx residents), and Cliff Michelmore, had been temporarily rejected. The group received a letter saying that the Commission believed the station should remain wholly in government control 'at this stage'.

On December 20 a Manx newspaper reported 'while the government had temporarily turned down their proposals, those that remained in the group were still keen and the offer to take over the station remained open.'

Since the announcement Tim Gudgin has been made public relations officer to the Manx government.

Edinburgh Radio Contract

THE EDINBURGH commercial radio contract has gone to Radio Forth. The company chairman is Sir James McKay, managing director of an insurance company and a former Lord Provost of Edinburgh.

Other members of the company include Sandy Brown, of acoustics and clarinet fame; Peter Balfour, boss of Newcastle Breweries; a woman's columnist for two local papers; the general manager of St Cuthbert's Co-operative Association; a chartered accountant and professional footballer; the director of the Scottish Old People's Welfare Council; an actress; the managing director of John Menzies, the newsagents; a merchant banker; and the head of educational, religious and children's programmes for Scottish Television. There are also two newspaper proprietors.

By the time this appears the IBA will have invited tenders for the Nottingham and Teesside radio contracts, probably around the middle of February. The closing date for applications is about the end of April, ten weeks from when the applications were invited.

The IBA said the populations to be covered would be 600,000 for Nottingham and 680,000 for Teesside. The transmitters for Nottingham would be at Trowell (vhf) and Colwick Wood (mf). The Teesside transmitters would be at Bilsdale (vhf) and Stockton (mf).

During February an eight-man group from the IBA interviewed prospective candidates for the Plymouth and Sheffield contracts.

At the end of December the IBA announced that the Liverpool franchise would be offered to Sound of Merseyside, chaired by local businessman Mr Ken Medlock. The team also includes Ken Dodd; the managing director of the Mercury Press agency; a bishop's wife; a clutch of newspaper proprietors; a property developer and former director of Granada tv; a solicitor; and an organ builder.

Film festival

THE 13th BRITISH Sponsored Film Festival will be held at Brighton from May 14 to 17. The Festival is sponsored by the British Industrial and Scientific Film Association. According to BISFA the film market has grown to an annual turnover of more than £5,000,000 and British industry and commerce produced some 1,200 sponsored films last year. Universities and colleges produced another 800.

This year BISFA say they have revised and extended the film entry categories and will actively involve the film users as well as those making and sponsoring films. Other changes will include the ways of judging films and making awards and the introduction of a speakers' programme. More films will be shown and three cinemas will be booked instead of the usual two.

Prince joins Hollick & Taylor

MICHAEL PRINCE, ATV and Southern TV linkman and newsreader, has joined Hollick & Taylor's newly-formed broadcast facilities company as marketing controller and head of radio activities. Over the past few years Mr Prince has made several study tours of the US to examine American broadcast techniques.

John Taylor, managing director of Hollick & Taylor, said in a statement: 'The production of radio commercials is a most important addition to our group activities'. He was confident Mr Prince would be an invaluable member of the team. As well as announcing, Mr Prince had had considerable experience in the production of radio and tv commercials.

BBC staff change

MR S. N. WATSON will be retiring as chief engineer, BBC television, after 41 years with the corporation. He will be succeeded by Mr C. R. Longman, C.Eng, FIERE.

Vcr installations

ZOOM TELEVISION have equipped each of 34 IBM locations in the UK with Sony *U-Matics*. The IBM order was the first major British order for the *U-Matics*, and each unit comprises a *U-Matic* which can replay NTSC or PAL formats and a 450 mm Sony *Trinitron* with a mobile stand. Zoom say they will be used for internal communication nationally and internationally. Each centre will be able to share programmes on methods of training and so on.

Cctv installations

TELEVISIONS SYSTEMS & RESEARCH installed a closed circuit system in The Palace Theatre, Euston, for a Royal Shakespeare Company comedy called 'Section Nine'. An actor's face was projected on to a screen 1.8 by 1.2m while he stood backstage speaking into a microphone. A second actor carried out a conversation with the face on the screen. The device was used twice in the play, and the Theatre Company's sound technician, Keith Clarke, used a TSR *Teledidakter* to project the image.

TSR have also installed a CCTV system at the new headquarters of the Automobile Association at Halesowen, Worcestershire. The system gives motorists information about driving conditions. Three mounted cameras feed 12 monitors which show a map of any part of the country a driver is interested in.

Static eliminator

EMI HAVE installed a static eliminator bar at their record pressing factory at Hayes. The bar, a 3M Model *210*, was put just before the rotary trimmer. The 3M Company say it causes local ionisation of the air and produces a conductive path to drain off any charges on any nearby surface. The result is less dust on the pressings. EMI have also bought a 3M *703* static meter to measure static levels.

Amplifier survey

PYSER-BRITEX (SWIFT) Ltd, agents for Marantz, have pointed out to us that, in our survey of power amplifiers, we published the price of the Marantz model 250 amplifier as £329, when we should have published it as £346.50 (including VAT). As a trade magazine we do not include VAT in quoted prices. Nevertheless there is a discrepancy and, if the fault was ours, we apologise for the mistake.

They have also asked us to correct the price of the Marantz *500*, which we gave as £775, to £852.50 including VAT. As we do not include VAT in our prices, this figure is correct as printed.

Pyser-Britex also said that readers would get a better service if they phone them on 073-271 4111, as this has a large number of lines.

TDK agency

TDK HAVE set up a new company, TDK Tape Distributor (UK) Ltd, to market their range of recording cassettes and tapes in the UK. Their products had been handled by Peter Bowthorpe & Associates. 'TDK feel that the increased demand for its products make the formation of a separate company a logical step in their expansion programme.'

The new company's managing director will be John Buchan, who has been in charge of TDK sales since the products were launched in the UK in 1971. The company intends to improve sales and service to tape distributors and nine main agents have been appointed in the UK. A team of representatives will operate from South Croydon, in Surrey.

U-Matic duplicators

AUDIO & VIDEO Ltd have started a duplicating service based on the *U-Matic* cassette system. They use Sony *D100CE* duplicators and the master programme can be 'from film or tape library, video tape recording, live action, off the air recording or any combination of these'. The duplicator puts the programme on cassette, and eight copies can be made at once.

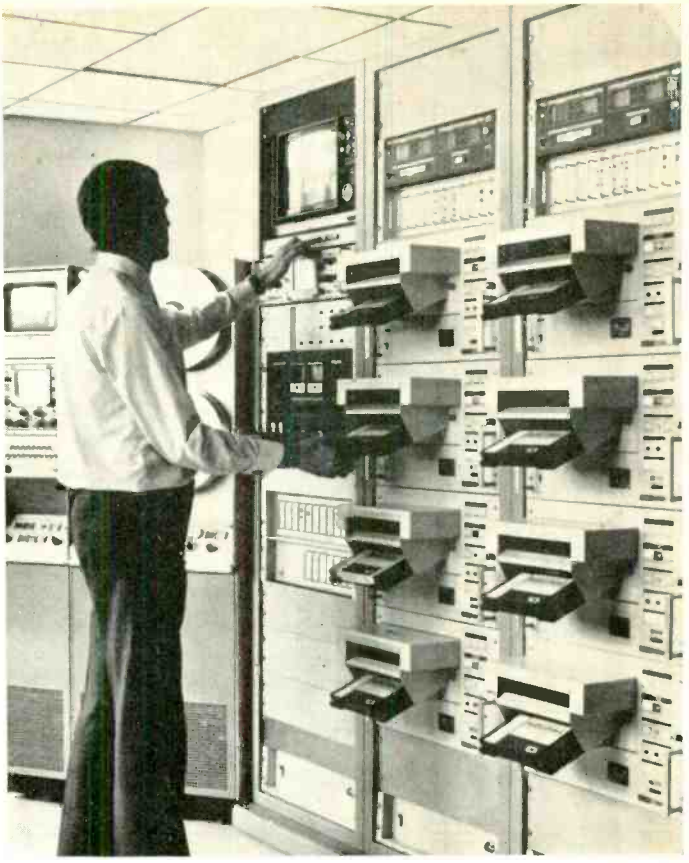
Audio & Video will do editing, telecine, titling and final labelling and despatch. They say the service is operated exclusively by them.

Memorex agency

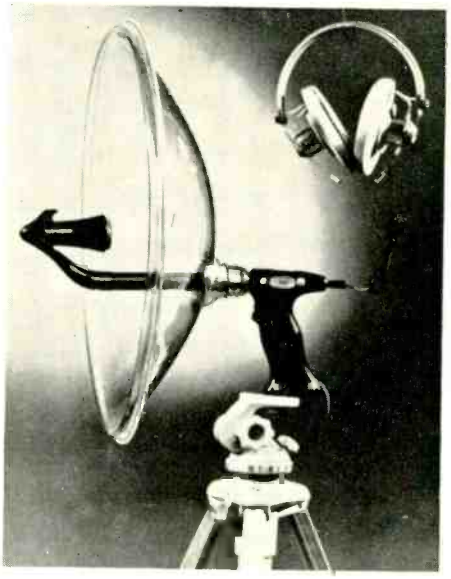
A BRISTOL firm have been appointed sole distributors of the Memorex range of videotapes for the South Midlands, West Country and South Wales. The firm, Western Sound Visual, said in a statement that they were the West of England's only specialist in CCTV and VTR equipment and applications. 'We can now also supply, from stock, Memorex tapes suitable for any recorder currently available,' said one of the firm's directors, Mr Stuart Wickham. He said that the deal would enable them to offer prices that were very competitive with those of other makes.

Bonochord increase Neve shareholding

BONOCHORD have increased their stake in Neve Electronics from 50 per cent to 76 per cent of the issued share capital. The increase in share capital is part of the agreement by which Bonochord took over Neve in December 1972.



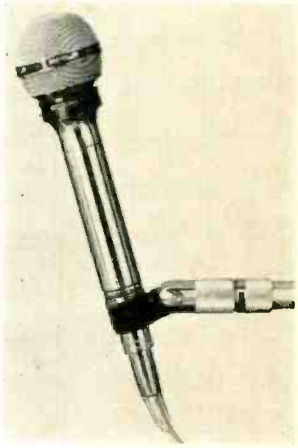
NEW EQUIPMENT



Chilton *P100* (far left).

Gibson reflector (left).

Superstar 80 (below).



Two-speed tape recorder

A NEW SERIES of 6.25 mm tape recorders with 27 cm NAB spool capacity has been announced by Magnetic Tapes. The *P100* is available in 38 and 19, 19 and 9.5 or 2.375 (logging) cm/s formats and incorporates a three-motor transport, electronic speed control and totally foolproof mode selection logic. All deck functions are selected via illuminating touch buttons, fast forward or reverse wind being selectable from any function other than record. Optical tension sensors are located on both feed and takeup sides of the plug-in headblock, giving stable rewind of 720m standard play tape in 90s. Claimed rms wow and flutter is 0.05 per cent at 38 cm/s, 0.1 per cent at 19, 0.12 per cent at 9.5, and 0.12 per cent at 2.375. Using EMI *815*, the 38 cm/s bandwidth is 30 to 20k Hz ±2 dB for 60 dB signal-to-noise and 2 per cent distortion. Erase efficiency is 70 dB at 1k Hz (3 per cent distortion level) and the normal erase/bias frequency is 120k Hz. Line input requirements are −10 to +20 dBm balanced (20 kΩ maximum source), line output being up to +19 dBm into 600Ω.

The *P100* can be supplied for mono, two or four channel operation. Peak programme meters and jack connectors are supplied as standard though Cannon *XLR* are available at extra cost. Operation is from 110 or 200 to 250V, 50 or 60 Hz, and the dimensions permit vertical rack or horizontal console mounting. A portable version is available in 515 x 515 x 165 mm teak plinth with carrying handles.

Manufacturers: Magnetic Tapes Ltd, Chilton Works, Garden Road, Richmond, Surrey.

Frequency shifter

AN UNUSUAL means of combating acoustic feedback in public address systems is now being made by Surrey Electronics to a design produced by the University of Manchester Institute of Science and Technology. By shifting (5 Hz) the audio spectrum of signals fed to the loudspeakers, an increase in gain of 6 to 8 dB may be obtained before the onset of feedback. The frequency shifter incorporates a signal overload led and is housed in a weatherproof diecast box. Prices are £58, £68 or £84, depending on input/output configurations. The shifter is also available as a mains-powered fibreglass circuit board, at £29, suitable for insertion into an existing chassis.

Manufacturers: Surrey Electronics, The Forge, Lucks Green, Cranleigh, Surrey GU6 7BG.

Low distortion oscillator

A DISTORTION RATING of 0.05 per cent at 1k Hz (0 dBm) is claimed by Cathedral Sound for their *LDO* module. The card requires 15 mA dc at 18V and delivers 100, 1k, 2k and 10k Hz tone.

Manufacturers: Cathedral Sound Ltd, Fourways, Morris Lane, Halsall, Ormskirk, Lancs L39 8SX.

Parabolic reflector

DAN GIBSON parabolic reflectors with built-in microphones, manufactured in Canada, have been introduced to Britain and the Irish Republic by Reslo following their demonstration at the last Internavex exhibition. Based on a 476 mm diameter optically transparent plastic reflector, the equipment is available in two forms. The *P200* at £36 comprises the basic dish and microphone while the £120 *EPM200* incorporates a compensating equaliser, wind/speech/music switchable bass roll-offs, and a headphone monitor output. Both models are available at high or low impedance.

Agents: Reslosound Ltd, Spring Gardens, London Road, Romford RM7 9LJ.

Dynamic microphone

NOW AVAILABLE from Reslo, the *Superstar 80* moving-coil cardioid microphone has a claimed 14 dB front-to-back ratio and a nominal working bandwidth of 50 to 15k Hz. Output impedances are 30/600Ω or 250Ω/50 kΩ, case finish being black and satin chrome. Price with DIN connector is £34 though *XLR* versions are available at extra cost.

Manufacturers: Reslosound Ltd, Spring Gardens, London Road, Romford, Essex RM7 9LJ.

Cassette cleaning tape

A CASSETTE CLEANING tape that actually works is now available from BASF. Designated type *CR*, the cassette contains 55m of chrome oxide designed to give some 600 2s cleaning passes before necessitating the re-use of any length. Price of the *CR* is £1.62.

Agents: BASF UK Ltd, PO Box 473, 197 Knightsbridge, London SW7 1SA.

WHO'S WHO IN SOUND

RUPERT NEVE

Anyone who is anyone in sound knows, if professional audio control and distribution equipment is to do its job, only the best is good enough. They know what they want. The highest standards of quality and reliability and technical performance as near the theoretical limits as possible. Plus the fact that Neve equipment is custom built to individual requirements and tailored to fit neatly into limited studio space. Naturally it all goes to produce a very impressive list of Neve customers.

Here's a list of some of their 1973 customers:

Radio and TV: RTV Romania; Link Electronics; B.B.C.; Marconi; Granada Television; Radio Luxembourg; Tyne Tees Television; Damascus Radio; HTV Ltd.; Radio Telefis Eireann; Greater Manchester Radio; Gospel Radio Fellowship; HSV7, ATN7, ATVO, Australia; B.F.B.S. (British Forces Broadcasting Service); R.T.V. Singapore; Yorkshire Television; Capital Radio; Ampex; Rediffusion; London Weekend Television; I.B.A.; Radio Sofia; Nigerian Broadcasting; United Evangelistic Church; WGBH; WRMF; Encounter Ministries; KBYU; KHOF TV; WSM; WBZ; CBC.

Theatres: Royal Opera House; Congress Hall, Bucharest.

Communications: Pye Business Comms.; Fernseh GmbH.

Film: Shepperton Studios; Felix Acaso; Pinewood Studios; Consolidated Film Industries; Imperial War Museum; Zaar Films.

Recording: J. Albert; Metronome Records; Preview Sound; R.C.A.; Radio Triunfo; C.T.S. De Lane Lea; Federal Records; CBS-Sony, Japan; Cockatoo Sound; R.G. Jones; Music for Pleasure; Pye Records; Weir Sound; Polydor; West of England Studios; Maritime Studios; EMI; Festival Records; Bavari Atelier; Arne Bendiksen; Gallo; Belter Records; Carbo; Elliot Mazer; CBS Records; Decca; Iyanda Records, Nigeria; Multi-Media; Creative House; Caribou Ranch; Eastman Kodak; Harcourt Brace; His Masters Wheels; PAC Inc.; Sound City; Track Recorders; Whitney Recording; Griffith Gibson; Les Productions Paul Baillargeon; Marc Productions; Mercey Brothers; Jeff Smith Interchange; Linkage Sound; Studio Marko; Studio 3; Intervideo; Mahogany Rush; Sound Toronto; Chatham Square; Neil Young; Belafonte Enterprises.

Universities and schools: Syracuse University; University of Surrey; Plymouth Polytechnic; Yale School of Music.

Neve internationally sound people

Rupert Neve, Cambridge House, Melbourn, Royston, Herts. Telephone: Royston (0763) 60776. Or Cambridge (0223) 53454. Telex 81381.
Cables Neve Cambridge. 2719 Rena Road. Malton, Ontario L4T 3K1, Canada. Telephone: 416 677 6611. Telex 0696 8753.
Berkshire Industrial Park, Bethel, Connecticut 06801, U.S.A. Telephone: (203) 7446230. Telex 969638. Hollywood Office: Telephone: (213) 465 4822.

PATENTS

Fault indicators

SIEMENS AG in BP 1,310,987 describe a signal channel fault indicating system for carrier frequency data transmission systems. In such systems, if there is a breakdown of one channel section in a transmission direction, transmission in the other direction is still possible. But, as nothing is coming back down the line, an operator will not know whether it is transmission or reception that has failed. Probably the Siemens system could be of interest to broadcasters relying on landlines.

Fig. 1 shows stations *A* and *B* with a carrier frequency system *TFH*. Pilot transmitters *S* at each station relay the tone frequency applied to input *S1* via *TFH* to pilot receiver *E* at the other station. Output *E1* is for the data signal and output *E2* for an alarm indicating breakdown, with output *E3* produced by an analyser on drop of signal strength. Output *E3* feeds transmitter input *S2* to produce a mid-frequency alarm signal to trigger the analyser at the other end. *E4* is a level monitoring output which controls *TFH* to maintain signal level during normal working.

When there is a breakdown and no pilot tone is received by receiver *E* at station *A*, the output *E3* blocks further transmission by causing transmitter *S* to send an alarm signal down to receiver *E* at station *B*. This produces an alarm at *E2*. The arrangement operates correspondingly in the opposite direction.

If the transmission level drops for both directions *E2* and *E3* are actuated at both stations. **A.H.**

Filters

THERE ARE many occasions when the frequency response of a piece of equipment needs to be altered deliberately, for example on a recording console. Siemens S.p.A. (Italy) in BP 1,320,744 refer to existing arrangements built on cascades of active or passive filters switchable into and out of action. Siemens then go on to propose some refinements. In fig. 2 a filter network can be connected either in cascade with differential amplifier *A2* or in the feedback network of the amplifier to provide a boosted signal. Choice is under the control of switch *K*.

Input signal *Vi* is fed to one movable contact of switch *K* and output signal *Vu* to the other movable contact. When these two movable contacts engage the first pair of fixed contacts (in the mode not illustrated), *Vi* passes via *R1* to amplifier *A1*. *A1* produces voltages *E1* and *E2* in antiphase which are fed to the filter circuit. The filter output is fed to one input of the amplifier *A2* and also fed via resistor *R2* back to the input of amplifier *A1*. Output signal *Vu* is fed to the other input of amplifier *A2*. This circuit mode provides filtering with the resistors *R1* and *R2* defining the ratio of *E1* and *E2*. They can be altered to vary attenuation.

When the switch *K* is moved over to the mode illustrated, the input signal *Vi* is fed directly to the upper input of amplifier *A2* and the output signal via the resistor *R1* to *A1*. Siemens suggest that the circuits are particularly suitable for audio amplifiers and recording consoles. If the switching is effected by an ac control voltage rather than manually, this will introduce into the audio output a vibrato or tremelo effect. **A.H.**

Disc fault compensator

THE BBC in BP 1,317,297 patent a simple but probably valuable device for counteracting cyclical variations in recording media. In practice this will usually mean the cyclical variations in recording characteristic which can occur as a disc rotates.

Fig. 3 shows the basic theory behind the invention. Two large area photoresistive cells *10* and *12* are connected in series across audio input *14*. The audio output *16* is taken from across the cell *12*. Lamp *18* can be moved between the two cells. As it is moved to the left the output of the circuit reaches maximum, the circuit output reaching minimum as the lamp moves to the right.

Fig. 4 takes the theory a step further towards practice, the lamp *18* being positioned halfway between the cells *10* and *12* with a mask on top. The mask has a central non-reflecting area *20* bounded by two reflecting areas *22*. If the mask is moved to left or right, then the cell output will change in manner comparable to that produced by movement of the lamp.

Applying this principle to disc record or playback systems, the under surface of the disc or turntable carries an eccentric band *20* of non-reflective material (fig. 5). As the turntable rotates, the bank *20* moves between the cells *10* and *12*. Thus the band *20* is effectively functioning as the mask of fig. 4. The circuit output will vary sinusoidally once or twice per revolution and this sinusoidal variation can without too much difficulty be geared to compensate for the sinusoidal variations inherent in the rotating media. **A.H.**

24 ▶

FIG. 1

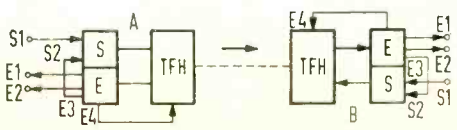


FIG. 2

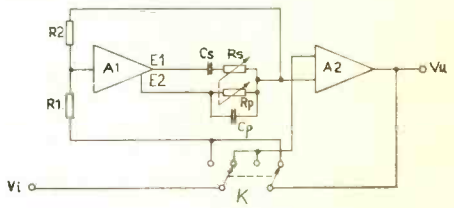


FIG. 3

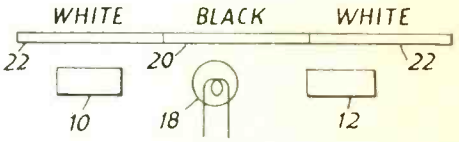


FIG. 4

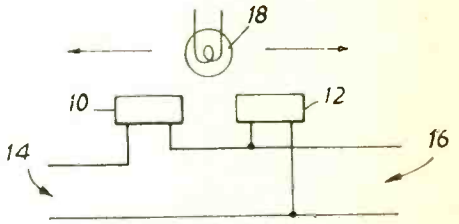
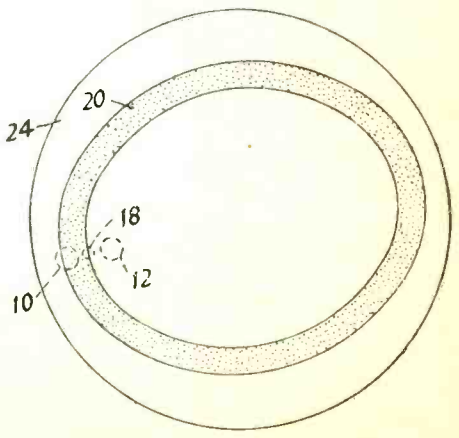


FIG. 5



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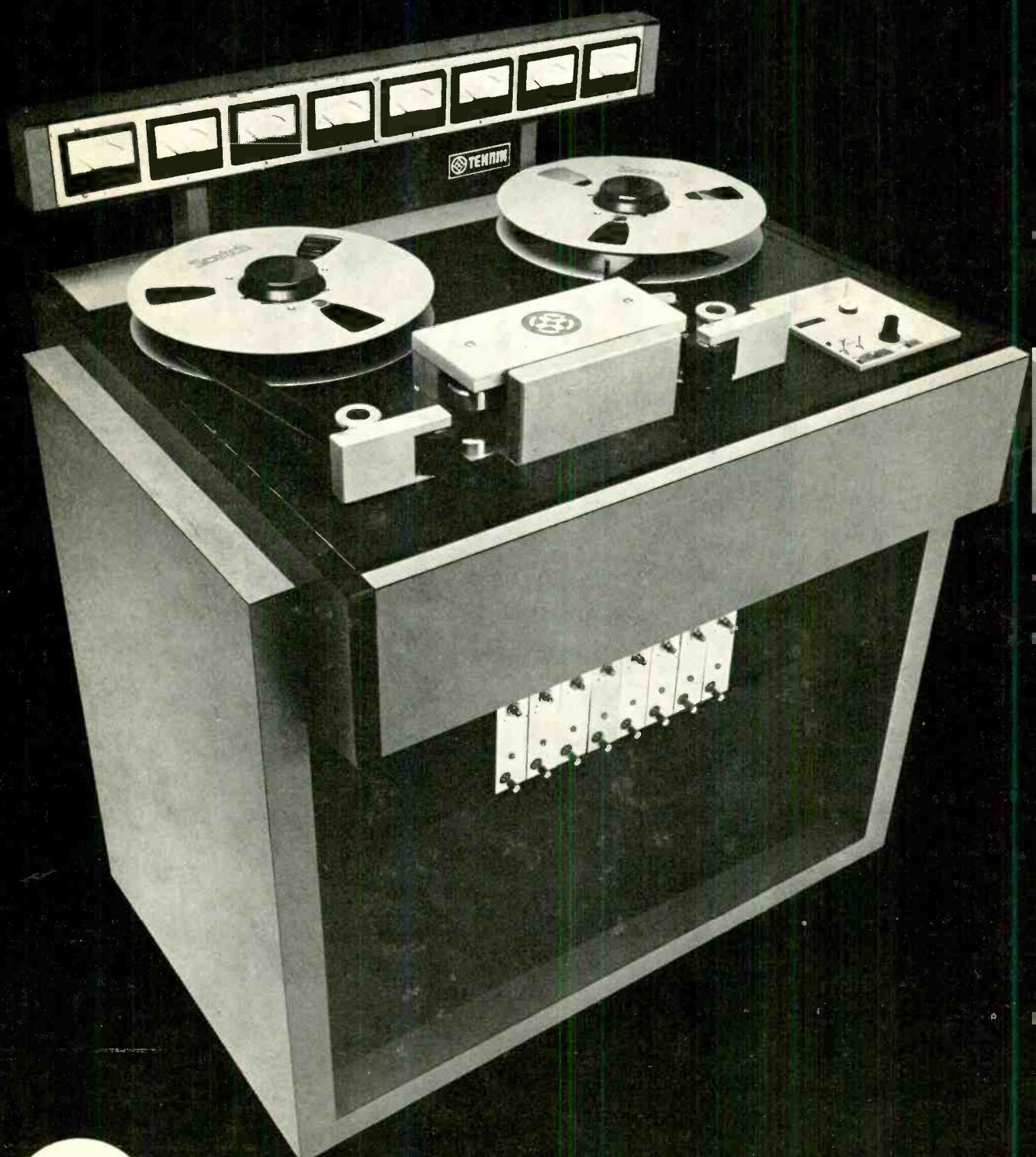

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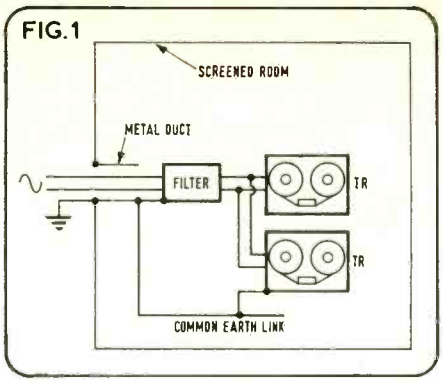
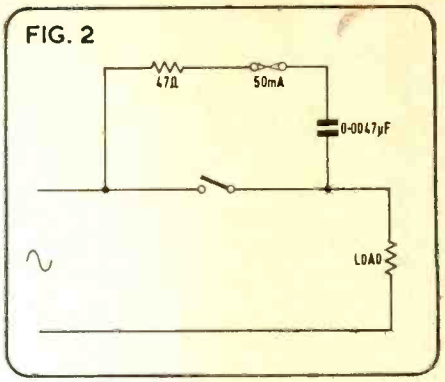
Mains interference: cause and cure

JOHN FISHER





ABOUT A YEAR ago I moved house in mid-winter and had a rush job of editing and tape copying to do shortly after. I might have known better. The building had been empty for a while and the prehistoric fan-blown central heating system was running night and day to thaw it out. Unfortunately, being out in wildest Berkshire, our mains regulation is not good. There were a lot of new problems after living in town. When the fan cuts in on the heating system, the lights dim; when it cuts out they flash. The result is a hefty thump which gets past stabilised power supplies and into low-level wiring. Probably also due to poor regulation, every light switch, thermostat, time-switch, motor or heater switch produces a click that either needs editing out or, worse, means recopying. I hope the following may save someone some of the time, sleep and frustration that suppressing the house and equipment cost me!

The first cure someone suggested was running all wiring through metal conduit, earthing the pipes to cut down radiated pulses. No joy. Much of our wiring is already in conduit and in any case this is an expensive structural job. One can also, I'm told, paper a room with aluminium foil and chicken wire (the mesh over the windows), bringing the wiring in at one point, filtering the supply and earthing both the wiring conduit and the metal on the walls. The result is supposed to be a room free of all interference from radiated and mains-borne clicks **(fig. 1)**. Unfortunately it is not always practical to treat your sitting room in this way, let alone a studio.

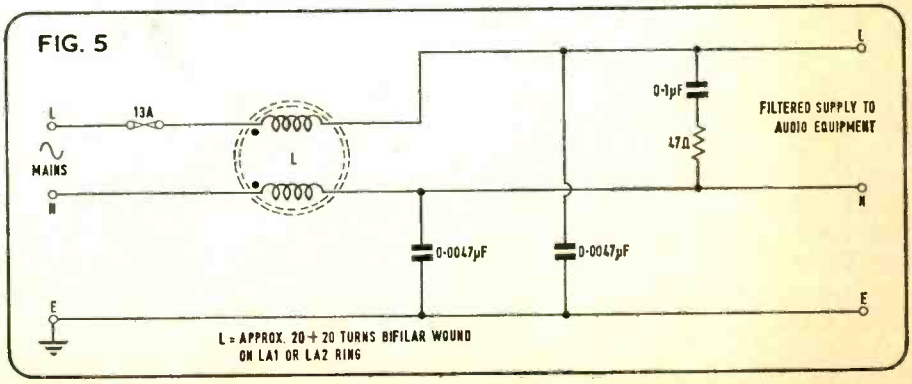
Another suggestion not yet tried is transforming the supply down, rectifying, stabilising and filtering, and regenerating ac with a multivibrator!

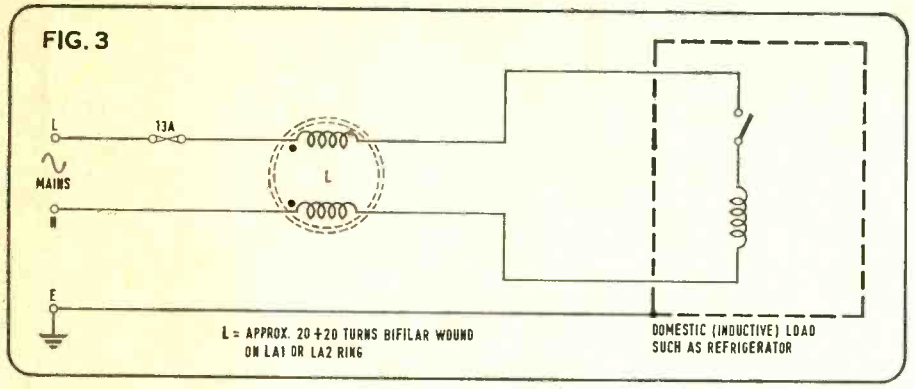
The simplest cure for light switches is at source. A small R and C series combination across switch contacts 'ties' them at the same potential and cures or drastically reduces the clicks. The worst offender we found was a door-operated microswitch, presumably because of contact bounce. There is a small danger that, if the capacitor breaks down, the resistor will overheat and cause a fire risk. An 00 size 50 mA fuse should therefore be inserted in series with the RC combination. If the capacitor breaks down sufficiently to be dangerous, the fuse will blow, removing suppression and indicating component failure **(fig. 2)**.

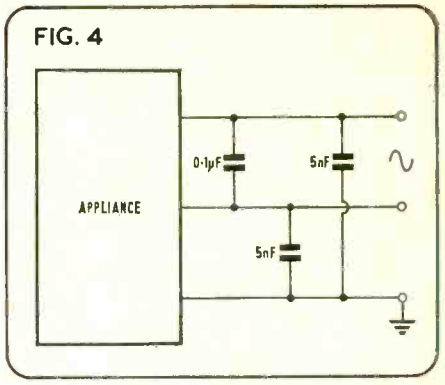
A similar suppressor may be used across some turntable switch contacts. I have not found the small 1A or 2A commercial suppressor chokes very successful as suppressors on their own.

The fridge-freezer did not respond even to 0.25 μF across the supply and it was not practical to fit capacitors across the thermostat. However, the unit is now fed by a simple suppressor wired permanently in series with the power socket, consisting of a bifilar-wound toroidal choke in series with the live and neutral supplies. The choke **(fig. 3)** is about 20 turns of twin flex wound around the ring of an LA1 or LA2 ferrite pot core. This partially suppresses the clicks.

Refrigerator clicks were suppressed further by fitting a Radiospares filter capacitor unit. This is a three terminal device, a delta arrangement of 0.1 μF across the supply and two 5 nF capacitors from earth to each leg of the







supply. The unit is rated at 250V ac and is considerably more convenient to use than separate components (**fig. 4**). Fitted at the refrigerator terminal box, the unit made a useful reduction in click level. The device is available from Electrovalue, 28 St Judes Rd, Englefield Green, Egham, Surrey.

Removed worst clicks

Used with the tape recorders after suppressing the fridge, the mains filter arrangement of **fig. 5** was found by experiment to remove the worst of any residual mains-borne clicks generated locally, and also mains-borne interference from outside the house—of which there appeared to be a surprising amount. It did not completely overcome central heating surges so we just froze instead. Complete removal of these surges would probably require an improved mains supply, or a bank or a high-wattage thermistors in series with the fan to limit the switch-on surge, coupled with varistors (see below) to catch the switch-off surges. The bifilar choke of **fig. 5** is again wound round the ring part of an LA1 or LA2 core. If the suppressor is mounted out of sight, it may be advisable to incorporate a fuse or fuses once again to guard against capacitor breakdown.

Fig. 6 is a very simple suppressor for mains-borne vhf pulses which may interefere with tv reception. It uses the remainder of the ferrite core from the LA2 used in **fig. 5**, and consists of some 10 to 15 turns of twin flex wound round the core between the cheeks, the whole held together by the end plates and bolts of the LA2. The idea of **fig. 7** was suggested to me by a Rank field-service engineer during one of many service engineers' visits to attend a Bush colour receiver that failed regularly for a variety of reasons. In this instance, breakdown of the SCR was suspected to have been caused by a mains transient and in our discussion during removal of the corpse I learned that Rank's engineers had found that rf interference carried by the mains could be considerably reduced by wrapping half a dozen turns of the mains lead around a ferrite ring. Quick, simple, and apparently effective. The interference signal is cancelled out while mains is passed freely.

Despite all this filtering (and shivering), our troubles were not yet over. It was now possible to copy tapes without getting clicks on the copy, but they were still getting into the monitoring amplifiers, even when used with the filter unit. This suggested pickup of residual radiated interference, which was mildly irritating when playing tapes but excruciatingly loud when playing discs through the same system. Also the turntable now produced clicks, despite suppression . . .

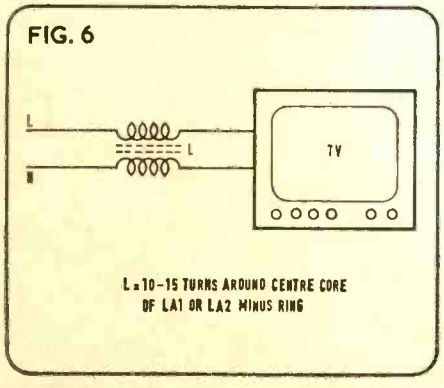
Careful attention to earthing and earth loops reduced, but did not remove, the problem. Some of the radiation was being picked up in the speaker leads, as moving them improved or worsened matters. The magnetic pickup input was the main culprit and even changing turntable, arm and cartridge did not help. Excessive bandwidth in the amplifiers seemed a possible cause.

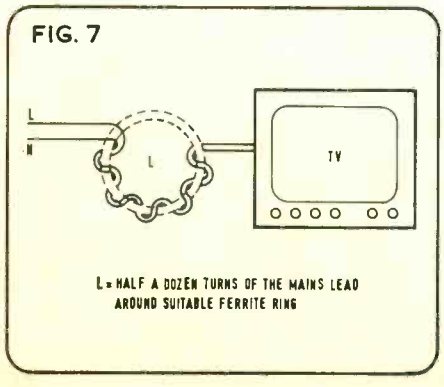
The final, and fortunately simple, cure to the problem of radiated interference was to go through the amplifiers, strapping together the base and emitter of the input transistor of each stage in the chain preamp, tone controls, power amp with small ceramic disc capacitors. Some 1.5 to 2.2. nF seems to do the job, but the values in a particular case would have to be found by experiment. The effect is to hold the base and emitter to the same ac potential at rf, preventing amplification (and subsequent detection) of the rf pulses while passing audio frequency signals normally (**fig. 8**).

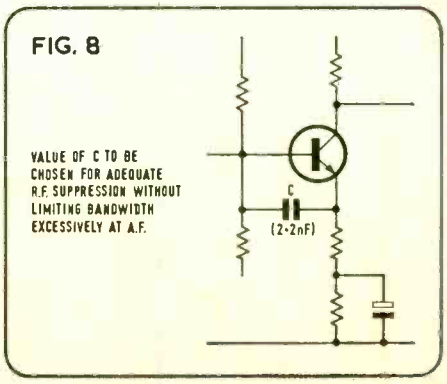
Finally, a semiconductor suppression and protection device, the varistor. This is a voltage dependent resistor that under normal conditions presents a very high resistance to a supply voltage but collapses temporarily when the voltage exceeds a set value; in this state it will pass very high current for a very short period of time and effectively clips the transient. The device is chosen so that the peak value of the supply waveform is just below the collapse voltage of the device; any greater voltage produced by a transient will then cause the device to collapse sharply, suppressing the spike, until the transient is past. The precise nature of the device and its operation need not concern us here and are covered in an application note *GE-MOV Varistors: Voltage Transient Suppressors* by F. B. Golden and R. W. Fox published by the manufacturers: General Electric Company, Semiconductor Products Dept, Electronics Park, Syracuse, New York 13201.

The foregoing application note and varistors of various voltage and transient energy ratings are available from Jermyn Industries, Vestry Trading Estate, Sevenoaks, Kent. For general purposes the three devices *VPA250A15*, *VP250120* and *VP250A40* (the 250 indicates

24 ▶







MAINS INTERFERENCE

250V rms) are the most suitable for normal British mains supplies. The *VP 250A40* has an average dissipation of 900 mW maximum and will handle pulses of 1,250A (*yes, Amps!*) lasting less then 7 μs. The final figures of the device number gives the energy rating in joules for the suppression of a single transient. A full data sheet by GE is available, together with suggested applications. There are several ways in which the devices can be used but the two most likely to be of interest are outlined in **figs. 9** and **10**.

In **fig. 9** the varistor is used to clamp transients at source and is shown across a switch in an inductive-load circuit. If the switch is opened or closed at a peak in the mains cycle, a large transient is generated. However, with the varistor across the switch contacts the resistance drops when the voltage exceeds the breakdown value and the transient is damped. It is very important that the device rating is adequate for the current it may have to handle on transients and this can be calculated by reference to the data sheets.

The alternative use is as a protective device across equipment (**fig. 10**). In this case any incoming voltage spikes are clamped by the device, as are any spikes generated within the equipment which could be self destructive. If the device is mounted across the equipment side of the mains input switch, it damps any transient caused by switching off the equipment. Adequate ventilation must be provided.

The device is certainly worth considering to protect equipment such as colour television receivers or other items which appear unusually prone to costly breakdown from mains-borne transients. I look forward to more manufacturers incorporating protection devices of this sort in equipment with a view to cutting unnecessary servicing costs and customer complaints. More details of the operation and application of the devices are covered in the application note mentioned above. It should be noted that varistors are protective devices rather than removers of interference as the filter devices described earlier are. They may be used in conjunction with one another.

FIG. 9

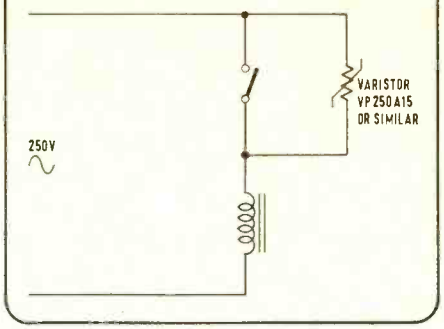
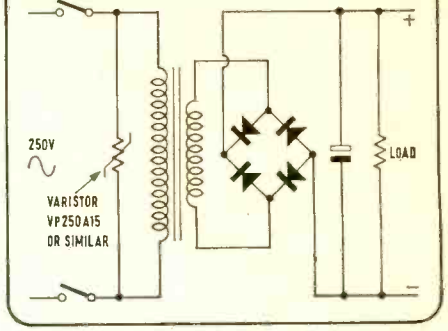


FIG. 10



A word of warning. It is most important that the capacitors used withstand both the normal ac supply and transients which in extreme cases may be several times the normal peak voltage. Consideration must also be given to safety: equipment casing, switch dollies, and their like, must not become alive in the event of a capacitor breaking down. The method of filtering and the capacitors chosen must take account of this. A good earth line must always be provided and adaptors (popularly known in some quarters as overloaders) must be avoided as the earth connection they provide is often inadequate. I have 'cured' a number of hum complaints in domestic installations by removing adaptor plugs. In one case, at least one of the outlets had a totally ineffective earth terminal. A properly made up adaptor board or multiple outlet wall socket, checked for good earthing, is much to be preferred. As well as the Radiospares capacitor unit mentioned earlier, a range of capacitors specially designed for mains filtering is available from Jermyn Industries: the Swedish Rifa company's type *PME 271*. The Y series is suitable for all applications and meets the safety requirements of many European countries while the X series is rated as suitable for applications where capacitor breakdown will not cause a chassis to become alive even if earthing is poor. Both ranges have an advantage of low series inductance, improving suppression at RF, and this can be improved further by reducing lead length.

A concluding warning: *before wiring in any suppressor, do check that any breakdown will fail safe and will not cause a hazard through electrical shock or fire.*

PATENTS

THE FOLLOWING list of Complete Specifications Accepted is quoted from the weekly *Official Journal* (*Patents*). Copies of specifications may be purchased from the Patent Office, Orpington, Kent BR5 3RD.

January 3
1346605/6 Adams, W. J. C.
Bagpipes.
1346954 British Aircraft Corporation Ltd.
Circuits employing camera tubes.
1347075 Fuji Photo Film Co Ltd.
Magazine for movie film or magnetic recording tape.
1347096 Agfa-Gevaert AG.
Cine projectors.

January 9
1347127 Western Electric Co Inc.
Filter circuits.
1347218 Wang, H. T.
Apparatus for simultaneous reproduction of sound and pictures.
1347343 RCA Corporation.
Image projection system.
1347416 AKG Akustische U Kino - Gerate GmbH.
Artificial reverberation device.
1347458 General Corporation.
Colour killer system for colour television receiver.

January 16
1347728 Philips Electronic & Associated Industries Ltd.
Magnetic head system.
1347729 Magnetic Head Corporation.
Dual gap magnetic head assembly.
1347794 Standard Telephones & Cables Ltd.
Speech transmission system.
1347869 Fujitsu Ltd.
Methods of and devices for constructing holograms.
1347993/4 Columbia Broadcasting System Inc.
Sound recording and reproduction.

January 23
1348240 'Viennatone Horgerate' Produktions GmbH.
Hearing-test equipment.

January 30
1348445 Motorola Inc.
Cartridge tape recorder/reproducer stripper assembly.
1348477 Pedrick, A. P.
Colour television circuit arrangements.
1348644 EMI Ltd.
Loudspeakers.

E200

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Going mobile

JOHN DWYER

AS FAR AS I can judge, the pioneer of mobile recording in this country was Bob Auger. For the purposes of this article, the way he operates —by toting his gear around rather than having a vehicle which is used for no other purpose than recording—puts him outside the brief I've been given, but no article about mobiles would be complete without mentioning him; the frequency with which he works, the good things said about him by people who use his services again and again, and the catty things said about him by some whose services aren't used at all speak for themselves.

Had I the task of listing every van, car motor or pedal cycle, wheelbarrow, boat, sleigh, crutch or leg (real or artificial) that is used to transport recording gear to a given place for gain you would be here reading this all day (dare I hope?) and I would be counting the cotton stitches in a straitjacket. Therefore I must confine most of my remarks to those vehicles in which the equipment is fixed permanently and in which the recording is done.

The oldest of these, it is said, is the Pye mobile. Pye have been recording on the hoof for years, but, until 1970, their gear was humped around a la Bob Auger. In 1957 they had a stereo mobile which they improved two years later to three track. Ken Attwood, now at Nova, was the engineer. The mixer was a Vortexion and the machine an Ampex *300*. In 1961 they upgraded to four track, in 1969 to eight track. In 1970 they bought a new Neve and went 16 track in 1972.

Above: The Pye mobile.

Below: Bob Harper (right) at the Pye mobile's Neve desk.

Pye's field

Until a year or so ago Pye had the field almost to themselves. Technically, the development of reliable and high powered transistorised equipment meant that it would have been possible to go on the road long ago, had anyone wanted to bother. But the recording industry develops, like other industries, when those it is serving ask for what hasn't been available before. Multitrack recording arrived by the same process and kept groups in the studios assembling very complicated albums. As bands regained the impulse, or the financial necessity, to tour, the live act became as much a part of a band's expression as records. So the recording industry went on the road too.

Recording also became increasingly costly, and some musicians wanted their own recording facilities. Some developed a permanent base, like Joe Brown, the Kinks and others. Some wanted a movable setup, of which the first was the Rolling Stones mobile, the original bandwagon about which Adrian Hope wrote in STUDIO SOUND in September 1971.

The last estimate of the cost of the Pye mobile was about £48,000, which is well below what some people have been spending and, in the nature of things, find they have to keep spending to keep up with events. It's important to emphasise, though, that that figure was an insurance estimate made at least a year ago, before Pye put in their Dolby units.

Indeed, if you're not very careful you can find that the amount of money a mobile needs to soak up to stay competitive in what is a very faddy business can drive your accountant hairless. This applies even if you're Ronnie Lane, formerly of The Faces, whose widely publicised remarks about his LMS mobile taking all his money would, one hopes, discourage all but the boldest from telling the boss where to get off and taking to the road for a living. On the other hand, when I asked round I did get the feeling that I was witnessing a competition for the display of the most prestigious price-tag.

Various figures have been quoted for the amount Lane's Airstream trailer has cost him; some press reports put the figure at £40,000 or £45,000. Paul Lambert, who is in charge of bookings for the mobile, said that development costs had risen to about £55,000. 'The basic price at today's costs, with all the rigmarole, would be around £80,000.'

The Ronnie Lane mobile, built

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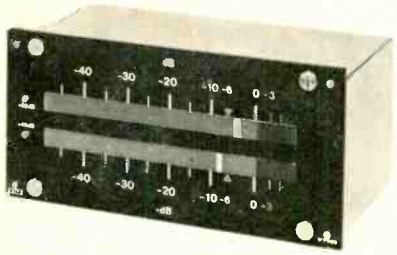

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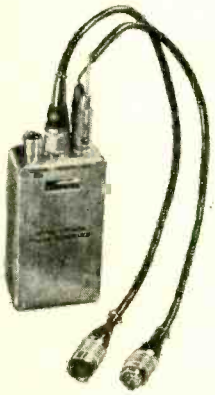

SPECIFICATION

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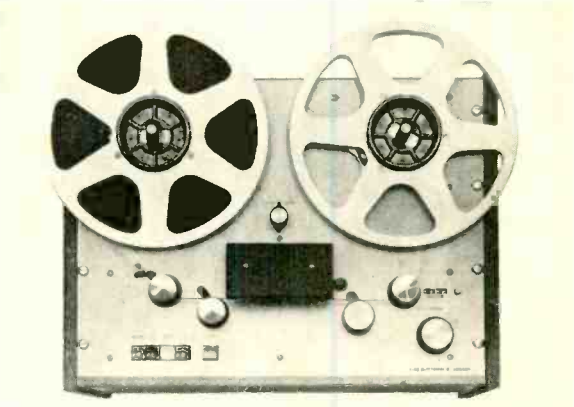

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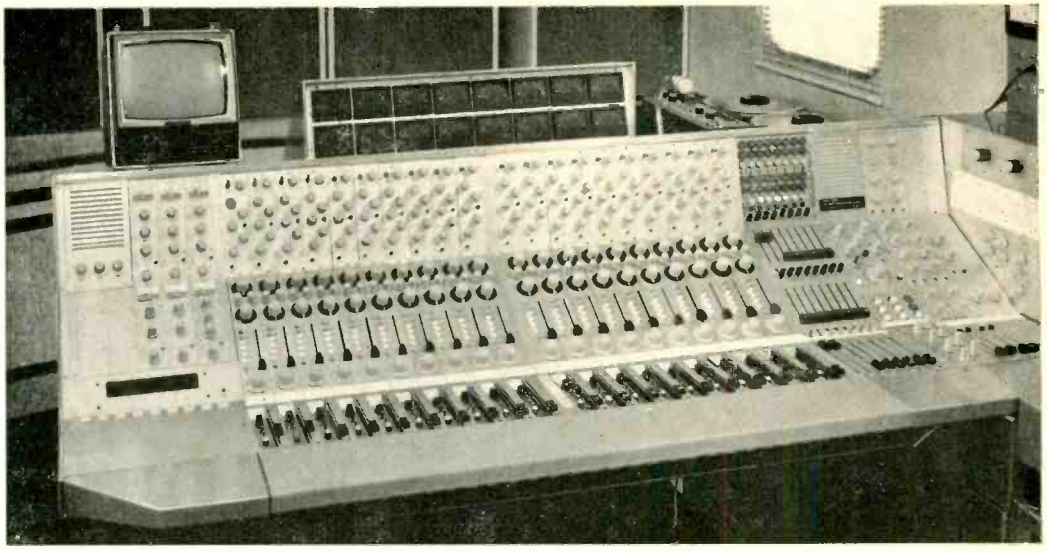
GOING MOBILE



into an airstream trailer, is 16 track. Originally, so the story goes, Lane bought the thing for his own amusement and then discovered that it was beginning to swallow all his loot. Each time he did a tour he would bring back more money to sate the trailer's appetite. Eventually he asked Ron Nevison, late of Trackplan, to do the thing properly for him, after which, Ronnie decided, the trailer would have to earn its keep.

Phil Newell, managing director of the separate company that is running the Manor's mobile for Virgin Records, put the cost of their containerised 24 track Monster as '£60,000 to put together'.

When Ian Stewart, veteran of the mobile business, came into our office to talk about the Stones mobile he mentioned a figure of £80,000 for theirs.

One development in the mobile world is that the units are being used increasingly for mixdowns. The Pye unit doesn't have echo facilities, which they now admit they need.

I asked Ian Stewart how much mixing they did actually in the truck. 'Not a great deal. The truck is usually rented by engineers; they do all their tracks and then take the tape away to their pet studio.' The truck is equipped with a small EMT plate and a Binson *Echorec*.

Phil Newell said the first Manor session was to record Gong at the Pavillon du Hay, near Saens in France. They spent three weeks there and all the mixing for the album was done on the truck.

'We've done a lot of mixing. We've got a tape delay, two echoes, and we're now getting a digital tape delay.' For the Bernstein thing at Ely Cathedral they were doing a film, a tv show and making a record, so we had to have two 16 tracks, two eight tracks, two two tracks and two mono machines.' They used the 16 tracks for the record, the eight tracks for the film sound, mixed that down to stereo for the orchestra to mime to and mixed that down to mono for the film editors to use.

Phil and co-engineer Alan Perkins used to work at Pye. From Audio Developments came maintenance man Steve Cox. They've had five years on the road doing Phil told me, all kinds of music. He enjoys being on the road: 'I hated studio work. The thought of going back in a studio now . . .'

All the mobiles have to spend a great deal of time abroad to keep busy. This is one of the reasons why Phil Newell built the Manor mobile into a container wagon. 'It saves us no end of time at customs —the thing is sealed up before it starts and is sent straight through. It doesn't have to be looked at again till it gets to the other end.' Of course a container is also cheaper, but then the Manor have just spent extra cash buying another traction unit. 'We can go off somewhere with one while the other's being serviced.'

Phil saw no irony in the fact that the mobile was insured through Pye. The Marble Arch Insurance Company was set up to insure television vans for ATV. 'They're used to that kind of insurance. They benefit and so do we, so why not?' He's also on good terms with Bob Auger, and says that Bob has put a great deal of work his way. 'Bob's booked up to March next year, although he does more classical work than anyone else and classical work tends to be booked a long time ahead.' It was through Bob that they recorded Bernstein at Ely, Chet Atkins and the O'Jays.

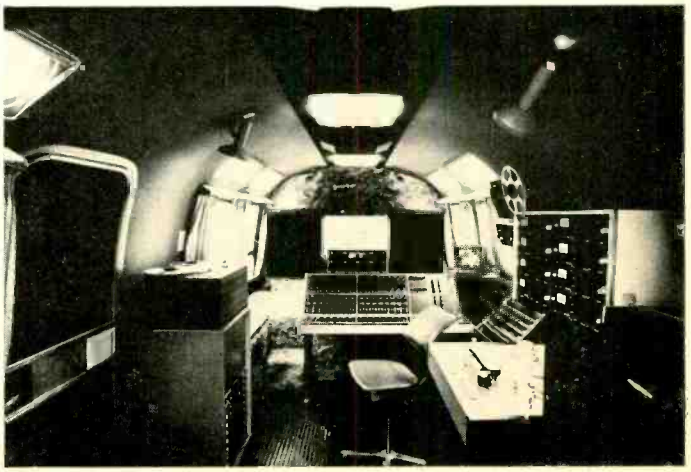
I asked him if he had much trouble with equipment, bearing in mind that whatever goes into the van gets a fair bit of knocking about. He said he had had little trouble, apart from the odd mechanical failure. 'Most of the gear was chosen because we knew it would get bumped around. Another thing is that we knew Dick Swettenham of Helios, who'd done the Stones' mobile, and we reckoned he would know the bits that would last.'

He had benefited from the experience that others had had in their trucks. 'Pye had lots of types of recorders in their truck . . . They now use an *MM1100* and so do we.' He seems pleased with the Ampex: 'I'd get another. It takes 36 cm reels for one thing—you

30 ▶

Above: The Rolling Stones' mobile's Helios desk before five new channels were added to the left hand side.

Below left: Ronnie Lane stands outside his Airstream trailer.



Below: Inside Ronnie Lane's mobile.

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don't have to change spools. I only need to do one tape change per session usually. The machine's had constant use—we don't switch it off because if you do the heating and cooling causes problems.'

Manor are now doing a great deal of work for the BBC, Phil told me, such as the Shirley Bassey concert at the Royal Albert Hall, shows like the Old Grey Whistle Test, and a series of six Steeleye Span concerts in medieval settings.

Every press release I've had about the Island truck has mentioned the price-tag, giving the operation just the faintest air of one-upmanship. I must say though that their pride seems justified. Joe Yu showed me the van, which is 9.6m long and 2.4m wide. 'We can't give them a studio but we can provide most of a studio's facilities.' It has a kitchen, a fridge, sleeping accommodation for the engineer, and heating and air conditioning. 'These things do help a lot. It's amazing. For example you don't have to go away for ten minutes to bring back drinks.'

The Island mobile has two 3M 24 track machines. These can be overlapped, as for Stevie Wonder's gigs at the Rainbow. The engineer was Brian Humphries. The Altec speakers are driven by Amcron *300A* amps. Joe said that, in the event of anything going wrong, a power amp changeover panel they had would stop the breakdown's becoming too much of a nuisance.

There's also a radio link between stage and truck. 'It was a couple of thousand for the equipment but it has saved a lot of trouble. We haven't had any problems. We've been very happy with the comments people have made. They say: "It didn't feel like a mobile," and "It's pleasant to be here for hours on end".'

Towed generator

Unlike the Manor and Stones mobiles the Island truck has a generator, towed behind the truck. Until now it hasn't been too much of a hardship to be without one, however. Both Ian Stewart and Phil Newell said bands had to have mains power anyway, so what was the point of having a generator. According to Ian: 'We've never had any trouble with mains supplies—the mains at Nice was a bit up and down but we've managed all right. All the same the power situation isn't going to get better so we might think about getting a generator now.'

He also told me the inside of the Stones' truck was being altered: 'We're altering the acoustics to make it a bit more flat—it was a bit bass-light before'.

Top: The IMS mobile outside the AES Convention in Rotterdam.

Above: Inside the Manor mobile.

Below: Inside the IMS mobile.

He had reservations about the competition, and felt that some of the other trucks were just copies of the Stones' truck but less roomy: 'The whole thing about our truck is that we built it for location work and we do have room for all the group to get in and listen. We can get a dozen in if we want to . . . I want to emphasise the spaciousness of it.' He also gave credit where it was due: 'Nevison did a lovely job on that, considering he did it all by himself'.

Stones' history

Since the Stones' truck has a little history to look back on it was inevitable that he'd look back over some of the work he'd done: 'We've recorded albums in all sorts of daft places'. To the next, obvious, question he replied: 'Well there was Hedley Grange, with Led Zeppelin. They were doing it in a living room and there was no acoustic treatment at all. They put the drums in the hall and that was the only separation there was. Fleetwood Mac was similar.'

He needed no prompting to talk about the famous Frank Zappa job: '*2000 Motels* was murder. There were endless sub-mixes and god knows what. Still, it was all right in the end. A bit noisy but all right.' On *2000 Motels* they used 45 microphones. The van normally has 25 mic inputs so they had to use small Shure mixers for sub-mixes. The Manor had a similar problem recording Bernstein: there were 40 microphones and 30 inputs so they hired a small mixer from Pye.

So the number of mobiles on the road increases. Some of those already on the road, such as the Orange and Studio Republic mobiles, are having improvements made. Others are being built. Mark Sutton is working on the first mobile to have its interior designed by Ken Shearer: 'I'm trying to fit us in between the Rolling Stones monster and the bloke with two Revoxes'. For multitrack work he'll hire a machine as necessary. The van is a Bedford with a Luton body and will give him a working space 3 by 2 by 2.2m. Martin Maynard, of a new company called Sun Recording Services, is building a four track mobile based on a Sound Techniques *System 12* desk and a Teac.

The Team mobile will be the latest large multi-track to go on the highways. Until a couple of months or so ago Doug Hopkins was head of sound at TV International. He has spent 15 years in tv outside broadcast sound. Now, with free-

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lance sound engineer Don Warren, whom he met at ATV, Doug is building Team.

In multitrack terms, it's the daddy of them all. It will use the 3M *Maglink* system to connect and synchronise two *M79* tape machines; Doug told me he could use two 24 tracks or a 24 and a 16, which he says will be more normal, or a 24 and an eight, and so on. The desk will be a basic API, 24/88 console modified to accept an additional 30 microphone inputs, making a total of 54 inputs. The additional channels will have no equalisation.

The rig is likely to be finished about half way through March. One of its major attractions may be that it will be equipped for quad monitoring—there will be four JBL *4310* speakers in there. The truck will have an EMT stereo echo plate and I asked Doug how many mixdowns he thought he would do in the truck: 'We hope to come to an arrangement with a studio: for instance I do a lot of work at Advision and they've got computerised mixdown'.

I can't help wondering, I must admit, just who is going to want 30, 40 or more tracks. Neither Manor nor Island do that many 24 track sessions. Island's Joe Yu said: 'We tend to do 16 track sessions . . . 24 is about all anybody wants'. Phil Newell said: 'Most of the sessions are 16 track. In fact we've done three 24 track jobs so far, and all of those were abroad. Jethro Tull will be the first in this country on February 11 at the Conway Hall.'

One mobile operator told me that with two machines you'd have trouble during the reduction. 'It means you're tied to that truck unless you go to a studio that's got that equipment.' Aren't trucks tending to do more mixdowns? 'Yes but it's not as good as in a control room. Some groups want three or four echo plates and you may have a tape delay and one echo plate but it's still no good in the truck.'

Another said he could understand record companies setting up mobiles but he wasn't too sure where Team would be able to get into the market.

Don Warren told me Team would record for record companies, television and film companies, especially musicals. Doug added: 'The Maglink will synchronise any master and up to six slaves. It's also compatible with SMPTE, via an interface.' They, at least, seem pretty sure which part of the market they're heading for and they should, with their background, have plenty of contacts.

As for the future, there are faint signs, and I put it no higher than that, that we have mobiles enough already. Phil Newell told me he was looking at the possibility of taking the Manor truck to Jamaica, hiring a house near a beach somewhere, and leaving it there for a little while so that bands could use both house and mobile. Among the advantages of Jamaica that he mentioned particularly was that it was near the States. Busy as the Manor mobile is—they told me they were getting well over the £20,000 they need annually to break even—they seem to want a bigger market. All the mobile operators I spoke to preferred longer bookings. As one put it: 'One night gigs are a pain in the ass. By the end of the first night you're just getting a good sound.' Another is that it's cheaper to stay in one place than to move to the next booking.

Manor's monitor mixer, routing and compressors.

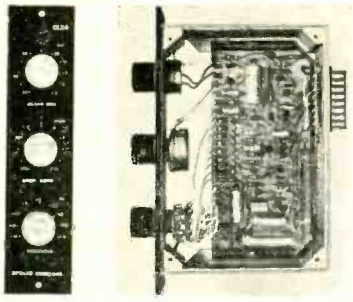
Other unconfirmed reports indicate that one mobile is about to disappear for good. If true, it isn't necessarily the fault of the mobile or the people operating it. It's just that now is a bad time. The amount of touring has to decrease because of petrol restrictions, the number of new bands going on the road for promotion will lessen because record companies are cutting back on the number of records they issue and, with the economic climate as it is, rock music shows are going to seem a little over and above what we need to survive.

We all know, though, that there is a large, oft penniless, group on the fringe of show biz who would make coathangers for Billy Smart if they thought that that was the only way to get near the circus. Last year these characters were busy opening studios—at one time it seemed they were doing so at the rate of one a week. Even now a 24 track studio about to be opened is looking for a manager. This year, I fear, they will build mobiles. The air will be thick with the sound of hammering as they build their gash into Land-Rovers, or the caravans that, unmoved, have graced their lawns for years. To them just four words: Try The Coathangers First.

34 ▶

Inside the Island mobile.

APOLLO ELECTRONICS



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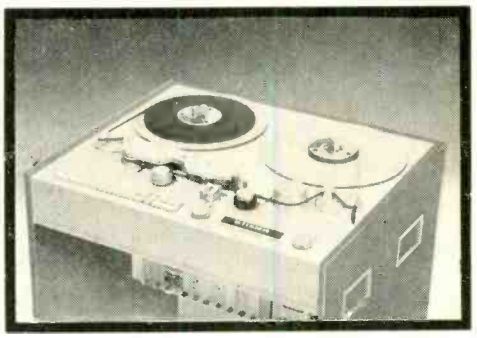

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GOING MOBILE

Island

Desk: Helios 30/24. 24 group monitor mixer.
Machines: two 3M *M79* 24 track with vari-speed two Studer *B62* two tracks.
Mics: 40; Neumann, AKG, Beyer
Monitoring: Altec *9846* driven by two Amcron *DC300A* amps.
Dolby: 24 units, M series.
Echo: EMT plate, EMT *440* digital delay line.
Limiting/compression: six Universal Audio, eight Kepex.
Equalisation: Universal Audio graphic equaliser, Pultec equaliser.
Cctv: Sony.
Cable length: 100m to 200m.
Rates: £400 a day plus tape within Britain. Outside Britain add travelling expenses.
Work: Island's truck has been on the road since November last year. Since then they have recorded Fairport Convention, Mott the Hoople and Stevie Wonder, among others.
Extras: machine remote, 3m *Selectake* unit, radio communication between van and stage, 3M sound and picture synchroniser.
Crew: Island or own engineers, by arrangement.
Power: 12 kVA generator.
Name: Penny Hansen.
Phone: 229 1229.

Lane mobile studio

Desk: Helios 26/16.
Machines: 16 track Studer *A80*, 2 tr Studer *B62*, two two track Revoxes Teac *A350* cassette recorder.
Mics: Neumann, AKG, Beyer, Sony.
Monitoring: JBLs driven by Crown and HH amps.
Dolby: Ten *A361*s.
Echo: AKG *BX20*.
Limiting/compression: Universal Audio *1176 LN*.
Equalisation: Leevers Rich graphic equalisers.
Cctv: Sony camera and lenses, Sony videotape recorder.
Cable length: 100m.
Rates: £1,500 a week (equivalent to £37.50 an hour for a 40 hour week). Daily rates are from £350 for the first day to £200 for the fourth and subsequent days.
All plus VAT.
Work: Faces, the Who, Eric Clapton, Reading Festival for GM, Tommy at the Rainbow for A & M, Rory Gallagher, Rick Wakeman (through A & M), Peter Frampton, Free, Led Zeppelin
Extras: Air conditioned. Split feeds for pa.
Power: Generator. Can be powered at 12V, 110V or 240V mains. The supply is rf filtered, isolated and automatically stabilised.
Name: Paul Lambert.
Phone: 995 5959.

Manor

Desk: Helios 30/24.
Machine: Ampex *MM1100* 24/16/8, Ampex *AG440*, two track.
Mics: 40. Neumann, AKG, Beyer, Shure, Calrec, Pearl, etc.
Monitoring: Choice of Tannoys or Altecs, driven by EA power amps.
Dolby: 24 *M* range Dolby channels.
Echo: EMT plate, AKG *BX 20*, tape delay and a digital tape delay.
Limiting/compression: Four in the desk, Audio Design cards in Helios modules. Two Universal Audio and two Westrex.
Cctv: Shibaden recorder, Marconi monitor, Nivico camera.
Cable length: 100m.
Rates: £350 a day, less for more than one day.
Work: Gong, Don McLean tour, Shirley Bassey, Nazareth, Silverhead, Gary Glitter, Chet Atkins, Steeleye Spann, O'Jays, Manfred Mann, Carol Grimes, Hatfield and the North, Woody Herman, Fuzzy Samuels, Jethro Tull, Petula Clarke, Edgar Broughton band, Tony Bennett at the Festival Hall, Magna.
Extras: Eight Ampex foldback speakers with built-in power amps; 148 gallon diesel tank; fridge, usually filled with beer; copying truck with three Ampex stereo machines, Goldring *G99* deck and pair of JBL *4320* monitors, Langevin Equalisers, portable Dolby unit and two compressors.
Crew: Three engineers.
Power: Mains.
Name: Philip Newell.
Phone: (08675) 2128/5576.

Pye

Machine: 2 x 8 tr 3M, 16/8 tr Ampex *MM1100*, Studer *B62* and Ampex.
Mics: AKG *D224*, Neumann *U67* and *U87*, Sennheiser.
Monitors: 2 x Tannoy Reds in Lockwood cabinets.
Dolby: *M16*+spare *A361*.
Echo: To be fitted.
Complimiters: Four Neve compressors.
Cctv: Sony system and extra 430 mm ITC monitor.
Rates: Various, depending on number or tracks used and whether in or out of London—top rate is 16 tr outside London:
1st day £385+tape.
2nd £250+tape.
3rd £200+tape.
subsequent days £200.
Crew: Bob Harper, Neville Crozier (1st and 2nd Engineer) and Steve Cater (maintenance).
Work (recently): Don McLean at Liverpool, Manchester, Bristol, Albert Hall, King Crimson in Zurich, Amsterdam, Glasgow; Chicken Shack, Caravan, Roxy, Nektar, Sweet, Jimmy Edwards, Hawkwind, Stevie Wonder. For the BBC, various bands at the Dorchester —Buddy Rich, John Dankworth, Count Basie. Ken Dodd in Belfast.
Extras: Two separate foldbacks, two eight-group monitor mixers.
Power: From 13A plug—stabilised supply.
Name: Pat Godwin.
Phone: 262 5495.

Pye supply truck/two track

Desk: Neve 8/2.
Machine: Studer *B62* two track.
Monitoring: Two Ampex *AA620*.
Mics: Neumann.
Rates: Two track out of London:
Day one £250 plus tape.
Day two £150 plus tape.
Day three £120 plus tape.
Subsequent days: £120.
Book through Pat Godwin as before.
Many of the facilities are shared between the two vans.

Rolling Stones

Desk: 26/16 Helios.
Machines: 2m 16 tr 8T Ampex; two Revox, one with a 5 to 30 ips varispeed.
Mics: 'At least 50'. Neumann, Beyer, AKG, Shure.
Monitoring: Four Tannoys Reds at one end.
Dolby: Nine *301*s.
Echo: One small EMT plate, rack-mounted Binson Echorec.
Limiting/compression: Universal Audio, four Kepex. One Altec compressor.
Equalisation: Two Pultecs, Langevin and Altec graphics.
Cctv: Sony.
Cable length: 100m.
Rates: £370 a day. Location work £2,000 a week.
Work: Paul Simon and Jeff Beck, McCartney, Wishbone Ash, Stones, Led Zeppelin, Fleetwood Mac, two Deep Purple albums, Family, Spooky Tooth, Traffic, Black Sabbath, Billy Preston and the Stones, Faces, Blood Sweat and Tears.
Extras: Heated, air conditioned, double-glazed.
Crew: Two or three engineers, by arrangement.
Power: Mains.
Name: Anna Menzies.
Phone: 637 3771.

Team

Desk: Automated Processes 2488, each input can act as an output. 54 mic inputs.
Machines: Two 3M *M79* connected by Mag-Link facility, Studer *B62*.
Mics: *KM84*, *U87*, *U47* fets, Shure *SM58*, AKG *D224*, Beyers.
Monitoring: Four JBL *4310*s.
Dolby: *M16*.
Echo: EMT plate.
Equalisation: Two graphic eqs by Aengus.
Cctv: Shibaden.
Cable length: at least 300m.
Rates: around £400 a day, according to location.
Work: Mobile launched at AES, Copenhagen.
Crew: Three—two engineers and a rigger, by arrangement.
Power: Mains.
Name: Pauline.
Phone: 629 7895/499 1520.

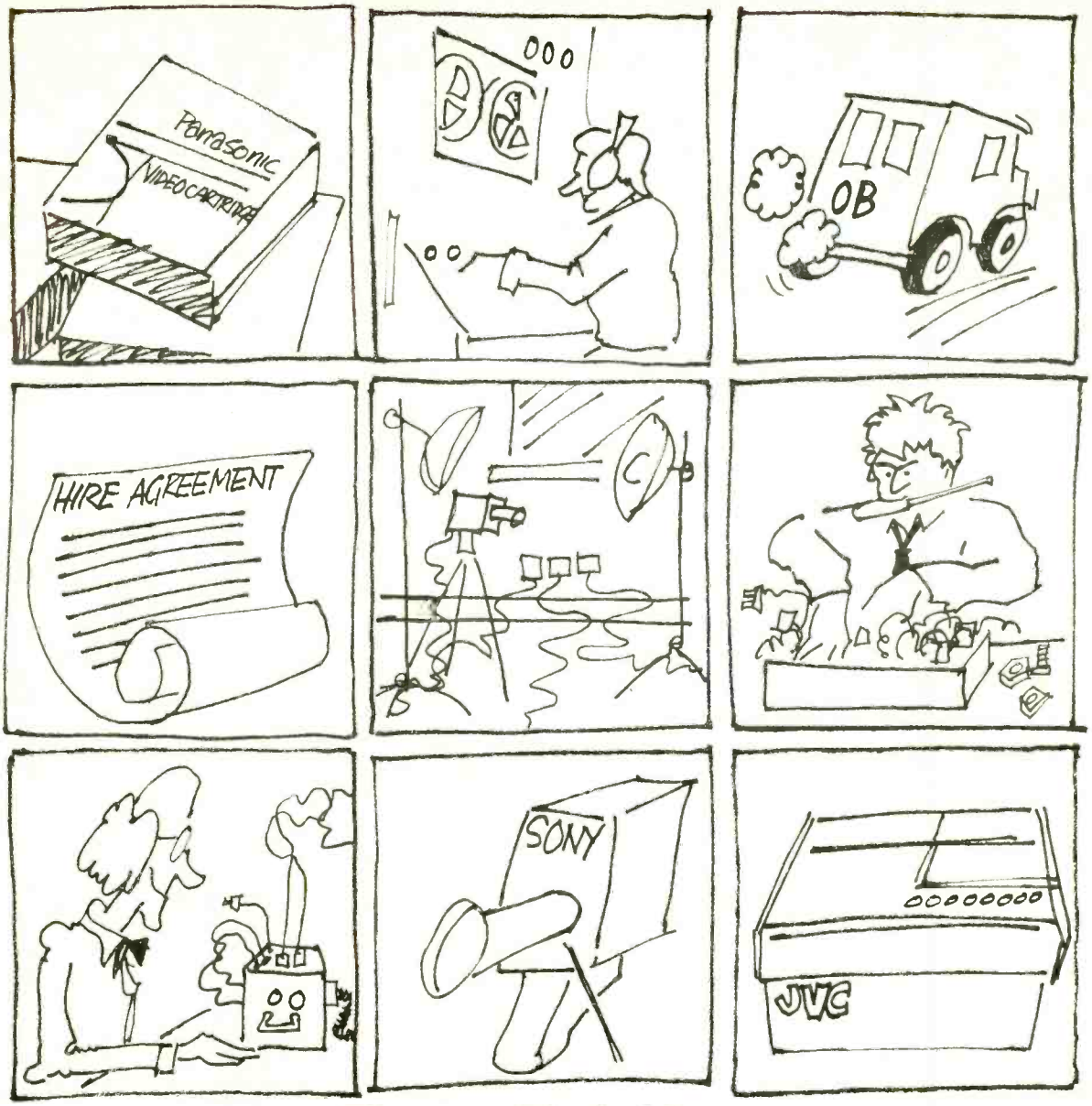
Footnote:

The above list covers the most well-known multitrack trucks in this country. At the other end of the market there are any number of transportable recording rigs on the road. Bob Auger records on a Neve. Angus McKenzie has also been recording for years. Last June he got himself a Calrec 10/4 portable console which he uses almost entirely for classical work. The mobile sessions of Barry Ainsworth and Gary Lyons, partners in Sound and Recording Mobile, have been appearing in these columns since the Keith Wicks days. On many occasions they have used the Pye Mobile, depending on the size of the session. Somewhere between the transportable and the mobile is Bob Woolford, whose Sound Techniques *System 12* built into a VW van makes him the owner of a mobile recording unit though he doesn't have a multitrack tape machine; he's just one of the old school who mixes down to stereo on the spot.

Abroad there are any number of mobile units. Neve tell us they have supplied desks to Peter Willemoes of Copenhagen, a transportable 32/16 desk to RCA, Harry Belafonte, Westinghouse, His Master's Wheels (Elliot Mazer), United Evangelical Church, Yale University, Bavaria Atelier and International Entertainers.

Our photographs show the IMS mobile of Rotterdam, Holland. The studio will do 16 track work but Hans Saris of IMS told us it was used mostly for two track work. They have done open air jazz and rock concerts, and have operated in co-operation with Dutch Radio and Television. The cable length is 100m. They have a Faylon 20 channel mixer, Spectra Sonics limiters, Telefunken and Otari recorders, and JBL monitors. Note that the truck is shown parked outside the site of last year's AES convention. There is, therefore, no connection between that and the APRS exhibition.

The Island mobile.



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Although a motionless human eye embraces a wide angle of vision, the angle of usefully high definition is much smaller than most people realise. Hence the danger of relying on off-axis vision when monitoring a wide array of programme level meters. The author describes an unusual method of displaying up to four signal channels on an oscilloscope.

Constructing a peak-reading oscilloscope

PART THREE

JAMES CRABBE

RECORDING IS AN art, if the latter may be defined as a science with more than seven variables. Whether working purely for pleasure, for money, or for both, the recording engineer must be a master craftsman. Not only must he have an excellent working relationship with his equipment, he has to be in harmony with the performers as well. The situation is complex enough in a studio but at least there are few unnecessary external interruptions.

Recording on location can be a completely different experience. A strange building, difficult acoustics, and awkward mains sockets. I am convinced that there is only one thing worse than simply recording on location and that is recording on location with an audience present. I undertook a recording recently in a church in Yorkshire. I shall not describe how difficult it was to get to and, having arrived, how I dragged all my equipment into the church unaided. It would take too long. Exhausted, I sat in a pew listening to the aircraft fly overhead. It seemed to be around for a long time and it took me several minutes to work out what the noise was: the church heating system. Recording with it was, of course, impossible. After hurried consultations with the conductor, we decided to leave the heating on during rehearsal and turn it off only at the points during the performance which I was recording, so that the audience would not freeze. It took me some time to set up my equipment (I couldn't use the PRO on that particular occasion) and used a reasonably distant mic set-up as I assumed the heating would be silent during the important parts of the concert. Having spent some time deciding on a programme which would give the heating system plenty of time to warm up, the conductor and I approached the vicar with our projected plan 30 minutes before the concert was due to begin. 'Oh, you can't do that, the heating system's too old. It'll have to be switched off for the whole concert or not at all'. We decided to switch it off just before the first item I was recording. Luckily, it was not too cold that evening, and the audience were very appreciative of the performance behind a background equivalent to some hundred vacuum cleaners. Zero hour approached and nothing happened. My microphones were too far away from the performers if the noise kept on. At the last second (literally) the heating went off, and I thought all was saved. But, as the evening progressed, the audience began shifting in their seats and coughs became more audible than before. You just can't win.

Morals

The moral of this story, or rather one of the morals, is to always be prepared for every contingency. This means having everything at your fingertips the whole time so that you can be in control of as many variables as possible; plenty of unseen ones usually crop up. I prefer having as compact an arrangement as possible when recording so designed the PRO as part of a complete monitoring system. So far we have just dealt with the various two and four channel combinations of the visual PRO monitor. The block diagram of **fig. 1** shows a comprehensive four channel monitoring unit. Signals 1 to 4 are fed in via balanced microphone transformers to four PRO amplifiers (b) and four power output amplifiers (d). The PRO amplifiers feed a four channel visual display while the power amps feed either loudspeakers or headphones. The power supply (h) is built into the unit, as are talkback facilities, comprising microphones amplifier (f) and power amplifier (g).

The circuit of the power amplifier is shown in **fig. 2** and is taken from a Mullard design. The output is a fairly modest 10W rms into 8Ω at 0.1 per cent total distortion, which would probably be too low for studio use but adequate power for monitoring on location. If cans are used, the high impedance variety are probably the best (notably Sennheiser *414* or AKG *K60*). The circuit is fairly simple and easy to construct. It uses a *BD131/BD132* complementary pair of output transistors. A four transistor direct-coupled configuration is used, with an additional transistor to stabilise the quiescent current of the output transistors. The preset potentiometer R1 sets the mid-point voltage for symmetrical clipping. Power is taken from the 25V unstabilised output of the power supply described last month although the maximum supply voltage is rated at 40V. Current consumption is about 600 mA. Sensitivity for full output is 430 mV into 90 kΩ. The frequency response is 20 to 35k Hz (–3 dB points). Construction is not critical. The 0.5Ω resistors (R13 and R14) can be made up either from other resistors in parallel or from heating element or similar nichrome wire wound on to a suitable small former. Constructors may be fortunate in finding resistors of the correct value in second-hand or government surplus shops. The microphone amplifier is also taken from a Mullard design which uses *BC108* transistors. As these are so cheap now it is a good idea to select two for lowest noise. **Fig. 3** shows the circuit; VR1 is a (preset) potentiometer for varying the gain from 13 to 40 dB by altering the feedback. With an output voltage of 2V, the distortion is 0.75 per cent for a gain of 40 dB and 0.15 per cent for a gain of 13 dB. The noise voltage referred to the input for all settings of the gain control is less than 1 μV, and the frequency response is flat from 20 to 20k Hz. The input impedance is 145 kΩ, making it suitable for high impedance output microphones or for those with a matching transformer. The output impedance of about 100Ω makes it suitable for feeding into a 5 kΩ or 10 kΩ fader and thence to the talkback loudspeaker amplifier, which could be that illustrated in **fig. 1**. The microphone amplifier, incidentally, is a good low-noise design which could well be put to more taxing assignments, for example as microphone amplifiers in a good quality mixer. Indeed, one firm market the design with this purpose in mind.

If it is contemplated building a complete audio-visual monitor, construction should be fairly straightforward; but don't forget to keep the inputs and outputs separated and use screened leads where necessary. Only one earth point should be taken to chassis and the power supplies should be kept away from the cathode ray tube. Linear faders are best used as they give a good symmetrical appearance and come easily to hand when needed. As to inputs and outputs, I prefer Cannon *XLR* plugs and sockets as they are lockable and not easily broken. They are not the cheapest plugs in existence, of course, and for the impecunious, standard jacks are probably the next best thing. If it is necessary to monitor loudness as

well as peak level (assuming this cannot be done by monitoring over loudspeakers) then VU meters could easily be connected to the PRO amplifiers, preferably after a buffer amplifier to minimise any impedance effects. If one were really ambitious, an electronic circuit with a long rise time (99 per cent after 300 ms) could be connected to feed the PRO monitor and the input routed via a switch to give either ppm or VU characteristics. The trace for each channel would then have to carry two calibrations, one linear for peak monitoring and one logarithmic for the loudness monitoring.

Storage circuit

One basic part of the ppm not incorporated in this design was a storage circuit. As the PRO is not a mechanical device, a storage circuit is not necessary to enable the pointer sufficient time to reach its peak position. However, if no time constant is incorporated, the device will respond to peaks of very short duration which will have no audible effect. Theoretically, then, one will tend to undermodulate when recording. No untoward effects were noticed in regard to this on the prototype but the fastidious could put a time constant of about 2.5 ms between the rectifier and amplifier stages. The interesting led ppm circuit by D. C. Threlfall in September STUDIO SOUND uses a 1 µF storage capacitor and a decay through 1 MΩ or 1 MΩ in parallel with 470 kΩ. This device, though similar in some respects to early neon type peak indicators, could also be adapted for visual display on an oscilloscope screen. This brings us to an interesting possible modification: brightness modulation of the trace. The design for the visual monitor incorporated a socket connected via a capacitor to the crt grid. If an alternating voltage is applied to this terminal the trace will be visible on the positive half-cycles and blanked out on the negative half-cycles. So, by increasing the voltage applied to the grid, one will obtain an increasingly bright trace. Thus, to make the signal peaks more visible when monitoring, one could apply an amplified rectified output from the PRO amplifiers to the crt grid socket. One will therefore have a gradation of brilliance, dim at low signal levels to very bright at high signal levels.

It has already been said that the instrument is applicable for use at higher frequencies, such as radio and video work. With regard to the latter, it could be useful to monitor say three audio channels and one video channel on one instrument.

The unit was tried out at a recent Harrogate Festival concert, by kind permission of the director, Clive Wilson. The York University Chamber Choir, under their director Peter Aston, were giving a performance of both modern and Renaissance choral works in the delightful acoustic of St Wilfrid's church, Harrogate. The concert included Dr Aston's own composition *Haec Dies* for choir and organ and had an extremely wide dynamic range. A two channel recording was made with figure of eight microphones arranged as a stereo pair. Monitoring with the PRO was very easy, peaks being very clearly defined, and the beams of light were generally thought easier to gauge in the heat of the session than meter reading. Certainly, it was less tiring.

FIG. 1 BLOCK DIAGRAM OF COMPREHENSIVE 4 CHANNEL MONITORING UNIT. INCORPORATING (a) BALANCED INPUT TRANSFORMERS. (b) INPUT AND RECTIFIER AMPLIFIERS. (c) DB SCOPE. (d) MONITOR AMPLIFIERS. (e) 4 LOUDSPEAKERS (OR HEADPHONES) IN PERIPHONIC ARRAY. (f) MIC AMPLIFIER. (g) TALKBACK AMPLIFIER. (h) POWER SUPPLY.

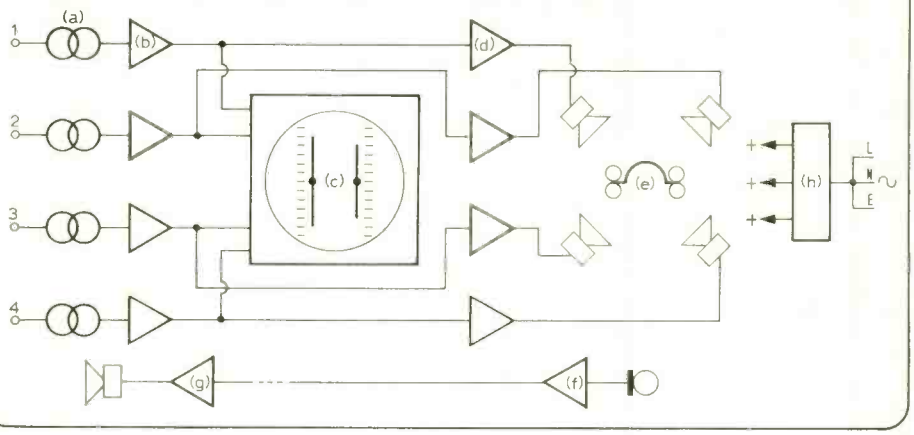


FIG. 2 AMPLIFIER SUITABLE FOR LOUDSPEAKER MONITORING AND TALKBACK. OUTPUT 10WATTS R.M.S. AT <0·1% TOTAL DISTORTION.

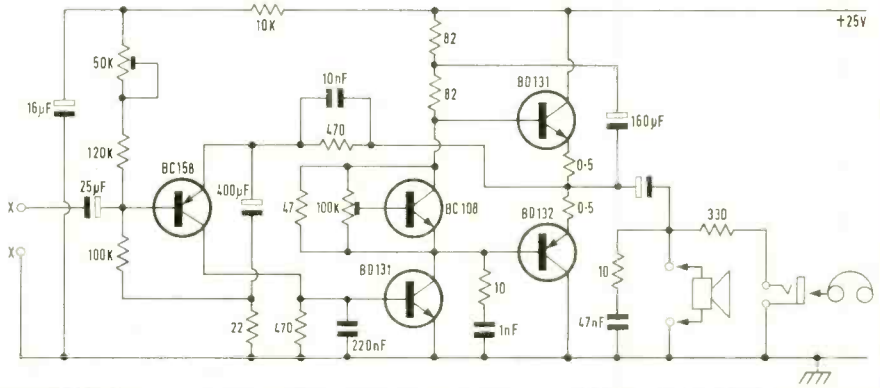
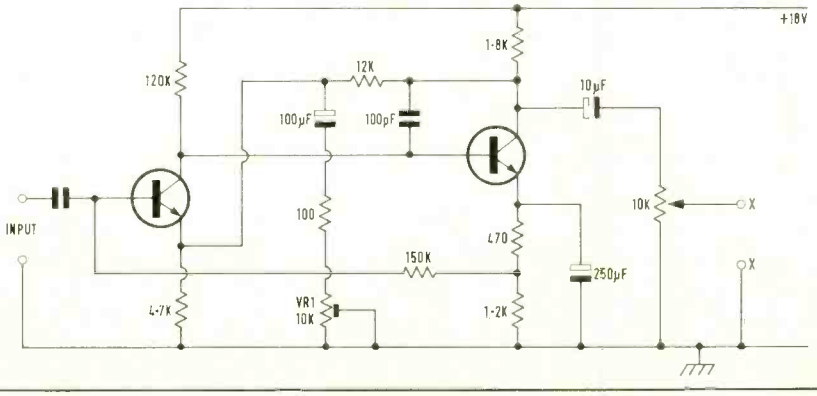


FIG. 3 MICROPHONE AMPLIFIER SUITABLE FOR TALKBACK MODULE. FOR MICROPHONES WITH A BALANCED OUTPUT, A TRANSFORMER SHOULD BE USED AT THE INPUT.



How to ruin a good recording

MIKE ANTHONY

WHATEVER ONE'S opinions or tastes in recording technique, there are in universal use several methods of ruining classical recordings that have absolutely nothing to do with microphone or mixdown techniques. In case there is anyone in the business who has not yet come across these, and who feels that he is missing out, this is how it is done:

The musicians and the producer have long gone, and each movement has been edited and balanced on to a stereo reduction. Now is the engineer's moment of glory. This is the moment when spacer tape is inserted between movements and between works, ready for the cutting of the disc. The first step is to look up the APRS recommendations and to note that the recommended length of spacer between items is 4s. So, you go ahead and splice in 4s of silence between, say, the end of Beethoven's *Fifth* and the start of the fill-up, perhaps the *Coriolan Overture*.

Different engineers have their own reasons for following this practice. A few might fondly imagine that the APRS had set up learned committees who, after lengthy debate, reported that it was the custom in Josquin's day to perform two Josquin masses one after the other with 4s in between.

A second economical school of thought is very worried by the high cost of leader tape, or by the wastage of acetate swarf.

A third contingent consists of the two or three people in the industry worried about technical quality. They realise, after hasty slide-rule computations, that the end-of-side distortion will increase if they cut longer silences between tracks.

A fourth group follow this practice because of their lack of concern with technical quality. They point out that the longer the silence, the more crackles and pops will be heard by the overfussy public.

Clearly, with such a powerful body of opinion behind the practice, it would be foolish for newcomers to use longer time intervals between items. Also, it must be observed that the public has become used to hearing all of Handel's *Concerti Grossi* as a single work, and would much resent having their attention constantly drawn to the fact that one work is ended and another is about to begin. Any lack of emotional impact caused by this continuity can, after all, always be made up for by the use of close microphones with a sharp treble peak.

There is a foolish body of opinion which asserts that, if successive works on a classical record are different in mood or volume or tempo or ambience, then a minimum of 15s should be left between items. There are even those, evidently thinking leader tape grows on trees, who assert that if the recorded work leaves the listener in an intense emotional state, or has occupied him for the last 1½ hours, then a full 30s should be left before the next item. Quite apart from anything else, this goes against the tenets of modern information theory, which aims to pack the maximum information density in the minimum space.

It is interesting to note that the discrepancy between the intervals between items at live concerts and on disc has a sound commercial explanation. Long pauses are good in the concert hall because they make concert-goers believe that the concerts are of reasonable length and that they are thus getting good value for money. No doubt this is the main reason why conductors often leave long pauses. On the other hand, if a long pause occurs on a disc, the buyer feels that he is spending his money mostly on silence. It is therefore much better to omit pauses and cut a coarser spiral so as to keep the side looking full.

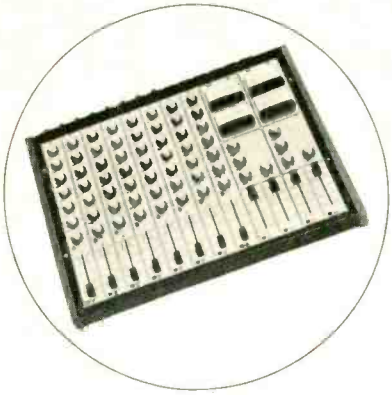
However, the engineer who wishes to splice items together creatively has many parameters to play with other than length of silence. One practice which is now obsolescent is that of splicing on trailer before the reverberation has died away. Now rising in the popularity stakes is the converse practice of cutting off the start of the initial transient of the next item. This gives a really sharp attack to the beginning of items and has the advantage of not allowing the listener's ears to adjust to the new acoustics, thus adding the element of surprise and novelty to the experience. While this practice is still controversial, it does have in its favour the elimination of tape hiss before an item—yet another undesirable clue that the music is about to begin. How much better to come in once the music has already started.

While cutting out the rise of the transient is a relatively new development requiring great editing skill and extreme accuracy, another related art has long been practised. This is that of editing out the first note or the first bar. Everest *SDBR 3170*, for example, has been awarded by *High Fidelity* magazine their Order of the Rusty Razor Blade for an outstanding early example.

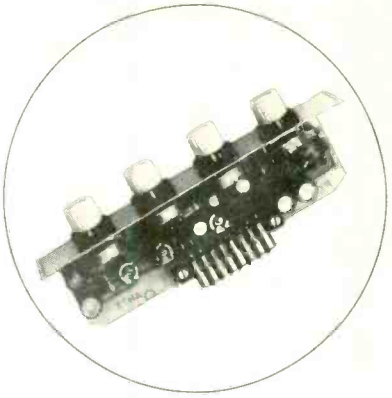
However, even when completely 'classical' editing is used, with full reverberation decay and full starting transient, there is still much creative scope. The trick is to record two different items with totally different acoustics and differing perspective, and to place one item a few seconds after the gentle reverberant die-away of the other. This helps either to keep the listener awake (through wondering what is 'wrong' with the new item) or else helps send him to sleep (by so distracting him during the first few bars that he cannot follow the subsequent music).

It is to be hoped that engineers not conversant with these editing methods will quickly adopt the correct procedures, so that complete industrial standardisation is achieved irrespective of what the music recorded happens to be.

Right: The Eagle Universal Coder/Decoder adds new meaning to the concept of total subsystem compatibility.



The **QUASI RANGE** presents a low cost custom semi-modular mixer. The units are robustly constructed on an all-steel chassis, with attractive teak side cheeks. Connectors may be of jack or Cannon type. Up to 12 modules can be accommodated with two or four outputs. The inputs may be high or low Z and jack switching may be incorporated. They feature continuously variable sensitivity, three-band equalisation, echo and cue outputs, linear fader, panpot and routing switch if applicable. The output module contains two channels incorporating equalised echo return, main faders and output meters.



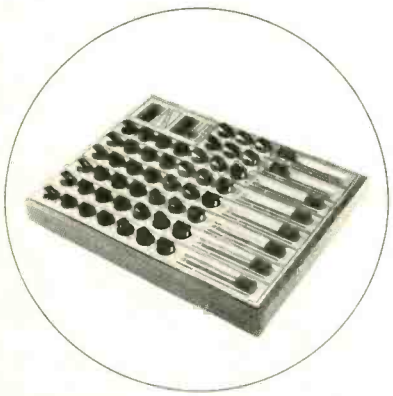
Two new low cost signal processing modules are available, these may be fitted to any existing equipment by the four potentiometer bushes. A front panel and connector are supplied. The 6:1 **COMPRESSOR** has variable input, output, attack and release controls. It can be used for special effects, peak level control and for automatic mixing. The **NOISE GATE** is an electronic gating device. The control parameters are input level, gating threshold, attenuation depth and gate release time. Possible applications are: Noise reduction, feed back suppression, intercom, special effects.

The original black **MODULAR RANGE** has been re-designed to provide an economical multi-track system. All new system modules incorporate their input and output connectors, and this minimizes their base cost.

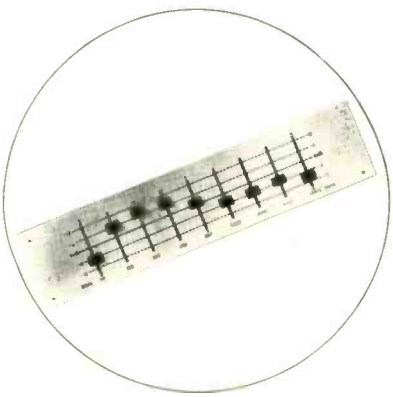
Input modules XLR mic. input and line on jack, mic./line sensitivity, three-band equaliser, echo and cue circuits, channel fader, panpot, decade routing switch to eight outputs, PFL/channel cut facility.

Ouput modules mix amp, output fader, echo return with two-band equaliser, monitor fader and panpot.

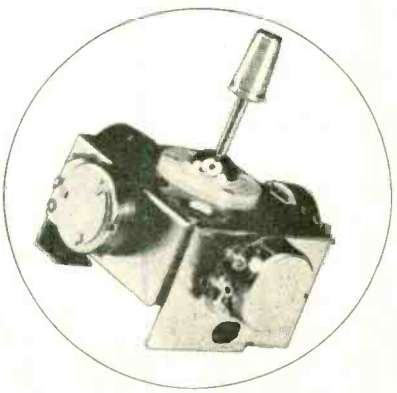
Auxiliary modules echo send with top lift, cue send with two-band equaliser, talkback to studio and cue, oscillator, main monitor level, monitor select, voltage regulator.



The **MINIATURE MIXER** is a six channel stereo unit employing a single P/C board construction and incorporating facilities found in mixers many times the size and price. The console is mounted in a teak case and connection is via phono jacks. The input channels feature sensitivity, treble, mid bass, echo, cue pan and fader controls. Main outputs have individual echo returns and VU type meters monitor the outputs. The unit may be operated from batteries or an external low voltage supply.



The new **GRAPHIC EQUALISER** allows the response curve of an audio system to be varied at nine frequencies at octave intervals by an amount of plus or minus 12dB. The curves are designed so that they blend in to give a smooth response. The slide faders give a graphic indication of the response. The unit is constructed on a single P/C board and is available in rack mounting format. Various applications include: Wide range programme, monitor and P/A environmental equalisation and noise suppression.



The **QUADROPHONIC POTENTIOMETER** provides a third dimension in electro-mechanical control technology. The joy stick enables independent control of two functions, using a single control. The unit consists of four potentiometers mounted at 90° on a steel chassis. These are mechanically inter-linked to the joy stick assembly. The resistive units are carbon type with a very low hop on/hop off resistance at the stick's extremities Circuit diagrams are available listing possible applications: Quadrophonic control, combined tone network, two or four-channel cross-fading and mixing, control systems.

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Adding audio to the visual

ADRIAN HOPE

IF THERE is one thing that the Great British Public really enjoys doing, it is toasting its collective toes to the limits of human endurance in front of a roaring log or coal fire. Manufacturers and shopkeepers alike know only too well that night storage heaters, electric fires and gas fires are not really relished. The gas people have long been looking for an answer to this 'something to sit round' problem and at last they have found it—a lava-based rock from the Sierra Nevada in California which glows red when put in a gas flame but does not actually burn.

Having made the discovery and built the hardware, the problem confronting the manufacturers (New World) was how to sell it to the Gas Council, the press and the Great British Public. This kind of launch is usually handled by means of a boozy press reception at an ostentatious Park Lane hostelry (The Hilton, in this case) with an equally ostentatious audio-visual presentation. The days when managing directors simply stood up to waffle are gone. Audio-visuals (slides or movie film with sound) have taken over and the kind of budget involved in preparing what is in fact nothing more than a lengthy radio or tv commercial is rarely less than £2,000 and often well over £5,000.

Audio presentation

I went recently to the recording session for the audio side of one of these presentations. It was held at the London studio of Radio Luxembourg, in Hertford Street, and was set off-duty from McCann-Erikson. Hertz mainly up by Tony Hertz, an ad man and jingle writer, shortly before he formed The Radio Operators (in partnership with Peter Perrin and Jeff Wayne). Hertz worked on the project with Clive Reece (of J.B. Presentations, an audio-visual consultancy) Reece being mainly responsible for the visual side and Hertz for the audio side.

'We deliberately keep either the audio *or* the visuals content strong' explained Reece. 'Because if they are *both* strong, there will be conflict. Although I concentrate on the visuals and Tony on the sound, the whole script usually comes mainly from one or the other of us. We establish beforehand which side of things is to be dominant, and in this case it's the sound. So the script in this case is pretty well entirely Tony's'.

The usual form of presentation for slides plus tape (and the style Hertz and Reece were working on in this instance) is a panorama of three separate screens, each covered by a pair of slide projectors (making six projectors in all). By having two projectors for each screen, slides can be mixed and faded on any screen, between screens and in all kinds of complicated sequences. Projector control is by the fairly conventional technique of sync pulses and paper tape but the sound in this case was to be in stereo rather than the usual mono. Also in this case the presentation (intentionally and successfully very funny) aims to end with a cod quiz game which was a mixture of live action and tape-slides. The marketing director of the company selling the product was going to be quizzed, grilled and abused by voices off tape. He would stand to one side of the screen (back-projected for obvious reasons) and answer the abuse 'live'. But he was not happy with his own voice so the taped track would contain an actor speaking his lines. Good stereo separation between the two loudspeaker channels was therefore crucial. And to make matters more complicated, there were to be two final versions of the tape, one with an actor reading for the marketing director and one read by another member of the firm. That way the presentation could if necessary be put on again later but with a company second string miming to his own voice.

'Essentially this kind of thing is a radio programme with visuals', explained Hertz, who for years worked in the USA on commercial radio. 'It's a combination really of radio broadcasting and advertising—we are getting the commercial message across in radio language but with visuals as well.'

A Radio Luxembourg studio had been booked for four hours. It was small but friendly and ideal for this kind of commercial work. And the engineers (like Peter Hoskins, who was working with Hertz on the day we went) are more deeply steeped in broadcasting techniques than most engineers in larger studios, handling mainly music recording. In fact the Luxembourg studios are a 'good buy' at £12 an hour for four track facilities, including a couple of Studers, an old EMI warhorse and a Philips. The console is a Neve and the monitors are Lockwood driven by Quad *303*.

Hertz and Hoskins were using the four track facilities as an aid to editing, adding music and effects before reducing down to a final stereo mix. By the time that the session I attended had been arranged, some of the visual stills had already been shot. But the final shooting and editing would not be done until the soundtrack had been finished. Tony Hertz had brought in four actors and an actress for the eight page script and hoped to get all the voice passages down on tape in two hours—leaving the editing, effects and music drop-ins until later. The total budget was £6,000 (mainly on presentation and elaborate colour photography) which, bearing in mind the fact that the main end in view was a single performance, realised the philosophy that if a thing is worth doing at all, it is worth doing well. Success or failure of the whole sales venture might depend on that one performance.

Success or failure

'*In the beginning it was very dark and very cold and man lived in caves and was not comfortable*', read an actor with a plummy narrator's voice. First and second cavemen mumbled about the shocking weather.

First caveman: (*Various exclamations.*)

Second caveman: *What's the matter?*

First caveman: *That thing bit me!*

Second caveman: *That little flickering orange and yellow thing?*

And so fire was discovered. After a rehearsal and some friendly banter about how real cavemen sounded, the sequence was taken a couple of times.

First caveman: *Let's go back to the cave and tell the others . . . what are we going to call it?*

Second caveman: *We'll think of something . . . I've got it. How about . . . the wheel?*

Section One ended where 30s of the *New World Symphony* would be dropped in during editing.

The next section started with the plummy narrator's voice again.

'Will you read that again, but a bit more sententiously' said Hertz over the talkback.

'Eh?' chorused the actors. After a brief but friendly argument about what the devil he meant by sententiously, the next take went down. It involved Welshmen coughing, spluttering and stumbling around in thick wood smoke. The actors performed the effects live, moving from microphone to microphone to give some stereo spread.

First Welshman: *I couldn't find any wood but these might do for the fire.*

Second Welshman: *What? . . . those horrible black lumps. Where'd you get them?*

First Welshman: *Down a hole in the ground. It wasn't half fun crawling around there.*

Some discussion then ensued between studio and control room on whether the Welsh accent should be North or South.

Suitably impressed

We were all impressed by the way in which the five actors in the studio have already clocked up at least ten voices, all totally different. Above all, they were completely consistent—no falling back into the wrong dialect on odd words. A far cry from amateur theatricals and a useful memo to anyone up against the studio clock and a tight budget. It is always cheaper in the end to use professionals.

Back in the control room the end of the section was being taped.

First Welshman: *. . . and thousands of miners scrabbling around in them digging coal.*

Second Welshman: *Coal? . . . coal . . . that's a good name for it. Yes, I see it all . . . we'll have unions.*

First Welshman: *And pit ponies!*

Second Welshman: *And labour disputes!*

First Welsman: *And funny hats with lamps on them.*

Second Welshman: *And we'll get nationalised and subsidised.*

First Welshman: *And victimised . . . oh, the future really looks grand.*

And so it went on, next with a scene in the Sierra Nevada and prospectors discovering lava that looks like coal but doesn't burn.

Prospector: *Well ain't that just grand. If I ever need a lump of lava that don't burn but looks like it oughta I'll let you know. In the meantime suppose you get off your behind and dig for gold.*

'That's fine,' said Hertz. 'But just a little less Gabby Hayes.' And a little less Gabby Hayes it was. By now we were up to what must have been the 14th or 15th voice to be tried and the engineer rewound the tape before the next take.

'We're on a tape conservation programme', joked Hertz.

Next came the tricky quiz game sequence. Whole new ranges of voices had to be tried and Tony Hertz went through to the studio to run the actors through the quiz.

MC: *Hello again, and welcome to 'Thrust and Parry', the fun-filled game in which a contestant presents a premise or idea . . and our intelligent, witty panel attempt to destroy him and his idea with devastating comments and a smattering of logic.*

The panel included Kenneth Williams and Clement Freud impressions, both effectively done. The voice that the marketing director would mime to was a nice balance between a degree of dignity on the one hand and, on the other, the need to maintain the comic effect. A balance like that is hard to strike, but they achieved it very easily. However, because of the need to run between mics, there was now a problem of studio noise.

'Can you give her a little longer to get from one mic to the other', asked Hertz, trying to cut down on the sound of the actress rushing from left to right.

The quiz scene was taken again. By now there could easily have been at least 20 actors in the studio instead of a total of five.

'Take it a bit slower—no, a lot slower' advised Hertz about one piece. 'Make a meal in the reading, but not in the timing about another.'

Finally the quiz section was down on tape, with a couple of double takes where there were holes to drop in edits. The idea of the quiz, apart from being really very funny, was a clever one. It would give the marketing director a chance to answer obvious commercial objections in advance. The eight pages were finally through with three minutes to go before the two-hour target was up—but the quiz scene had to be taken all through again, using the other voice, so all but one actor went over on to overtime. The other went off to feed the parking meter.

The amateur

The new voice—the 'amateur' under those circumstances—handled things remarkably well after a run through for balance—'Come closer to that mic' and they tried a take. There was a foul-up first time when an actor introduced the new boy by the wrong name. Take Two was a bit slow, but take Three was fine.

He was 2½ hours into the session and eight pages of script were down on tape—some lines twice.

'Now the real work begins', said Hertz. Editing out the dud takes and dropping in the good ones, dubbing in the commercially recorded music passages and adding on a few disc effects. 'Feet on rocky ground' and 'sound of hammer tapping' would doubtless run Hertz and his colleagues into studio overtime. So I made myself scarce.

We learned later that editing had taken around four hours. That 'sound of hammer tapping' had presented a problem all of its own—none of the recorded effects available really fitted the bill—so Hertz had nipped round the corner to a construction site, pinched a brick and brought it back to the studio for hammering.

Postscript

Since the foregoing was written, lava-glow fires have been temporarily withdrawn from sale following minor technical difficulties—i.e. one customer managed to melt the stuff.

Perhaps as part of a wider effort to convince other nations and their satellites that the Irish Republic isn't still living in the nineteenth century, Radio Telefis Eireann have made great technical and political advances in recent years. In an effort to combat the wealth of propaganda that encourages us to believe British is always Best, John Dwyer recounts his impressions of Irish broadcasting in general and the new Irish Radio Centre in particular.

Inside Radio Telefis Eireann

PART TWO

RTE HAVE BEEN broadcasting day-long radio since November 1968. Radio transmissions begin at 0730, except on Sundays when they begin at 0800, and finish at 2345. According to audience survey figures available from RTE 91 per cent of households have radios and 94 per cent of adults live in households where a radio is available. The 1330 news bulletin attracts an audience of 935,000 adults, or 45 per cent of all adults.

In 1968 860,000 radio licences were issued and 441,000 television licences. Per head of population these figures work out at 296 and 152 respectively, compared with 326 and 280 per thousand in the United Kingdom. Thus radios were then by far the most important source of broadcast information. Radio licences were abolished on September 1, 1972. In 1973 there were an estimated 850,000 radio sets and 550,000 television receivers.

The television service went on the air on December 31, 1961. Sixteen satellite transmitters spread through Dublin, Cork, Waterford, Kilkenny, Kerry, Mayo, Donegal, Galway and Monaghan, all on or near the coast, supplement the five main transmitters I have already mentioned. Those five are equipped for colour broadcasts. In 1966 the Broadcasting Authority (Amendment) Act changed the name of Radio Eireann to that of Radio Telefis Eireann—Irish Radio and Television. RTE now employ a staff of about 1,500 of whom about a third work in radio.

RTE maintain two orchestras, a small choir and a string quartet. The symphony orchestra has 72 members, the light orchestra 32 and the RTE Singers have ten. RTE have sponsored public concerts in Dublin and the provinces and commissioned the work of Irish composers. Irish radio won the Italia prize in 1961 and 1965 with literary and dramatic programmes.

The Irish language

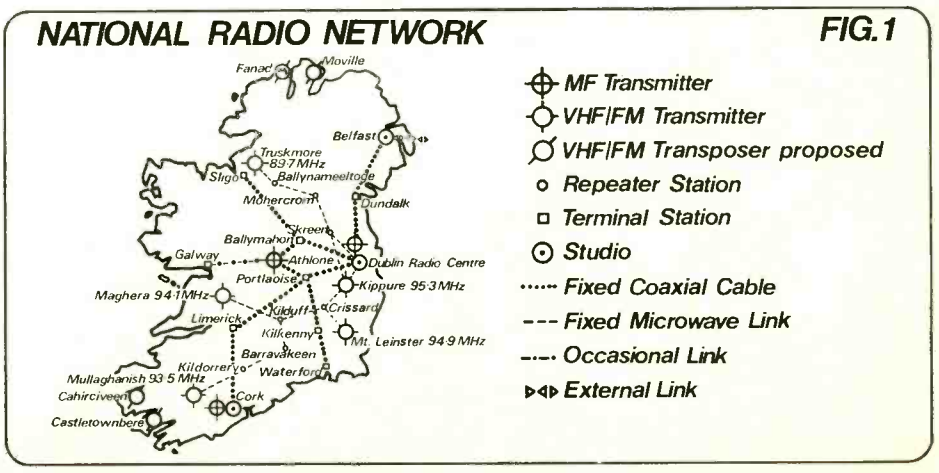
The growth of the Irish radio system has accompanied a revival of the Irish language. Irish was the common speech until the 15th century, after which long periods of enforced anglicisation made the numbers who spoke Irish decline rapidly. In 1855 more than half the inhabitants of Ireland still spoke Irish. By the first year of Irish radio, 1926, the number who said they could speak Irish was 18.3 per cent, according to the census, so that the number who usually spoke it would have been much smaller—one estimate I found said as low as 12,000 or 0.4 per cent, but this is probably too low. By this time, as I have said, the resurgence of nationalism had been responsible for the founding of the Irish Free State, and one of the ways in which the state chose to express its freedom was to make Irish the official language, with English as a second official language.

The acceptance or otherwise of the Irish language shows up some of the complications in the Irish social structure. On the one hand you see the Irish government asking RTE in July 1971 if it would provide a special radio service to the Gaeltacht, those remote parts of western Ireland where Irish is spoken, and on the other you see the present Irish Government saying that Irish will no longer be a compulsory examination subject.

There is in Ireland a strong pressure group comprising members of such organisations as the Gaelic League and the Gaelic Athletic Association. The GAA has more than 3,000 clubs in Ireland and 174 in Britain. It was founded in 1884 to combat the pernicious spread of soccer, which was played mostly by the British armed forces and, through contact with its players, led many Irishmen into the British Army. The members of the GAA are not allowed to play soccer, rugby, hockey or cricket.

This Gaelic lobby is pressing for all-Irish schools, where every subject is taught in Irish, and other measures. Another important part of the Gaelic cultural movement is Gael Linn. This was formed in 1953 to deploy modern media for the promotion of the language: films, records, plays and so on. The organisation started with a capital of £100 and ran a small football pool. By 1966 it had 1,500 organisers and today it has the biggest football pool in the country. Its record label, also called Gael Linn, has over 100 titles. Gael Linn's biggest successes were probably the two documentaries made by George Morrison in Irish from rare newspaper files and newsreels: *Saoirse?* (*Freedom?*) and *Mise Eire* (I am Ireland). Sean O'Riada's theme music for *Mise Eire* made him one of Ireland's most famous composers and made Gael Linn Records a going concern.

Equally important, though, is the large section of the Dublin middle class who, for



years now, have had to force themselves through the Irish exam. The descendants of English settlers in Dublin make up a substantial part of this middle class. Therefore the present government's abandonment of Irish as a compulsory subject has just as much electoral appeal as the Lynch government's promotion of it.

Some observers of the Irish scene have been a little sceptical of the value of Irish. On broadcasting Tim Pat Coogan has been more cutting than most: 'Unfortunately, much of what is published and broadcast in Irish is junk which would never come to eye or ear if pressures and subsidies were not so prominent a feature of the movement. One reason why Radio Eireann, for instance, is such a poor quality radio station is because of the high quota of mediocre Irish programmes it is forced to carry.'

It's some years since he wrote that but, although it is probably too harsh, there are still some who would share his view. Less, perhaps, than the number who would say that Irish television seems to carry too many American soap-operas. Apart from the lobby I have mentioned the only pressure on RTE is that contained in the Broadcasting Authority Act of 1960. Section 17 says: 'In performing its functions, the Authority shall bear constantly in mind the national aims of restoring the Irish language and preserving and developing the national culture and shall endeavour to promote the attainment of those aims'. A spokesman for RTE told me that the amount of broadcasting in Irish, including all-Irish programmes, announcements and bi-lingual programmes, was ten per cent of the total output.

RTE began the service to Irish-speaking parts of the country, Radio na Gaeltachta, in March 1972. On May 18, 1973, the service, which is on vhf only, was extended to the rest of the country, and those who wish to listen to all-Irish radio in Dublin may now do so.

The service has three studios. The main studio is at Casla in County Galway, and there are two more in Donegal and Kerry.

Finance

The philosophy of RTE's financing is simple —they are expected to be self-supporting. Their capital is provided by repayable government advances up to a permitted limit of £3,000,000 and by surpluses earned on the operating account. The current account is financed by licence revenue, from which the Ministry of Posts and Telegraphs subtract a collection fee, and from advertising.

Since October 1973 a television licence has cost £9 for black and white and £15 for colour. Official figures for the number of colour sets are not available at the time of writing but the Confederation of Irish Industries told me they agree with the Ministry of Posts that a conservative figure would be around 50,000.

By comparison, the latest UK figure for issued colour licences is about 4,239,000 up to September 1973. At the end of the first year of colour (1968), 20,000 licences had been taken out and so, by comparison, the Irish aren't doing too badly. Exact figures are as hard to come by as they are here, because of the large number of sets that have been imported.

In 1972 the *Dail* passed a law involving tv dealers in the registration of potential licence-holders. Revenue for the year to March 31, 1972, was £7,006,247. This includes £3,600,000 in advertising revenues and £2,400,000 in repayable advances from the government. Expenditure in that year was £6,997,016. The difference, you will see, was only £9,000, but a fairly reliable estimate has been made that the surplus for the 1972/3 financial year will be around £200,000.

RTE have already said that they will need to increase the licence fee for 1973/4. In this way they can finance their development works, like the radio centre, from current account instead of from capital loans which involve heavy interest payments. They must charge more in order to spend less.

The radio centre

The radio centre was started on June 9, 1969, and its building was directed by a radio control group chaired by the head of central technical services, Mr T. J. Murphy. The radio centre is set in 3.2 hectares of quiet, tree-surrounded land in Donnybrook, just outside Dublin. RTE's television centre, which was built in 1960, is a short walk away on an additional six hectares.

Other nearby buildings include the restaurant, a three-floor plus basement office building, a large set-construction building and a well preserved Victorian house. The house, Montrose House, was once the home of Annie Jameson, who emigrated to Bologna to study music. There she met and married the half-Irish Guglielmo Marconi, the pioneer of radio. The other structure on the site is a 9.3m high microwave link transmission tower.

When you see the radio centre it looks like a single-storey office block. The brown-tinted shatterproof glass stops you seeing clearly into the building. But once inside it you realise there are three floors, but that only one of them and part of the second appear above the surrounding land. Only the lowest floor is fully below ground level. The ground all round the building has been scraped back to allow light into the middle floor, and when staff look through the windows they see a pleasant grassy slope.

The top floor of the building houses open plan offices, a gramophone library and archives, a music department and eight small booths about 2m by 2m which will provide producers with the basic equipment to plan, and select and time, material for programmes.

This top floor is 1800m² in area. Below it is 1700m² on which there are 13 studios, two rehearsal rooms, a maintenance area, an artists' rest area which opens out into a large courtyard, a communications centre, and a central switching room which serves both radio and television buildings.

The communications and central switching area

All incoming and outgoing sound and vision circuits pass through the communications area for monitoring and for routing to the radio and television centres and to national and international destinations. Part of the equipment is allocated to line termination and equalisation.

In the communications area there is the following equipment: amplifying and equalising equipment for incoming and outgoing vision and sound circuits; source and route switching matrices; routing jackfields; two presentation control consoles and two control positions; three source/route switchers for radio, tv sound and transmitters; and an engineering manual exchange.

The equipment is mounted on a central control desk. The switching relays are in cabinets outside the operational area. The amplifying and equalising equipment comprises the send and receive amplifiers for the incoming and outgoing sound and picture circuits. Enough eq is provided on the sound circuits to equalise 48 programme lines at once. The equalised signals pass through the routing jackfields. These select the appropriate circuits required on the input or output of the source/route switchers from the 200 inputs and 350 outputs.

After the jackfields signals pass to the source/route switchers. These connect any of a number of sources to any of a number of routes. Three types of switcher are used: the first type is a six-level switcher with 80 inputs and 100 outputs. It is used for routing radio sound. The six levels, two per circuit, comprise two programme circuits for stereo and one control circuit. There are facilities for monitoring sources and routes.

The second switcher is for routing television

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RADIO NA GAELTACHTA **FIG. 2**

sound and is a ten-level type with 25 inputs and 25 outputs. The ten levels which can be switched at once are: programme international sound; programme commentary sound; engineering control circuit; talkback from source; and talkback to source.

The third switcher handles network and transmitter distribution. It is a six-level preset type with ten inputs and 20 outputs. The required number of source/route switches are preset on a fixed time basis.

The exchange

The engineering manual exchange handles the engineering telephone control circuits which link all the main technical areas inside and outside the studio centres as well as the temporary telephone control circuits set up for outside broadcasts. The exchange, of the cordless auto-manual type, has 200 subscriber lines and 12 tie circuits which can be split into two groups of six. Each group goes to one of two positions which are manned in peak periods.

Once a source has been switched to a route, the subscriber line of the programme source will be extended automatically as the control line to the destination to which the source is being routed. This will be indicated on the EMX equipment which enables the communications centre to communicate with the source and the route as required. Recall facilities are also provided.

The studio control rooms

Ten to 20 circuits, over which the incoming programme contributions are routed, connect each control room with the communications centre. Rack-mounted jackfields in each studio control room enable these circuits to be routed to the appropriate control desk channels. All tape recorders, disc players and cartridge equipment can be remotely operated from the control desk by the operation of the channel fader to which they are connected. The channel gain is increased by moving the fader away from the operator.

To make sure that the sources and channels are completely interchangeable, a dc matrix switcher is mounted on the control room rack to enable the switching wires from any channel fader to be routed to the appropriate equipment.

In productions involving incoming contributions from distant points throughout the country, a programme circuit and control circuit is available to each contributor. Over these booked circuits he can have the following facilities:

Cue programme to contributor's headphones.

Contributor can call the destination over the programme circuit before transmission.

Two-way talkback between studio desk and contributor.

Telephone communication between contributor and desk over control circuit.

A multi-access talkback system is available between all studio control rooms, presentation control rooms, the communications and switching centre, and other points of interest. An exclusive talkback system is available between each studio control desk and the presentation control desk on which it has been selected.

A signal and cue system operates between the various studio control rooms and the presentation central source selection equipment. The signalling or red transmission light system is interlocked so that lights cannot operate unless the circuit from microphone channel fader to transmitter is complete.

The system works as follows. The control room desks can work in four modes: rehearsal, recording and transmission and 'off'. The selection of a programme source on the source selection equipment and the operation of the appropriate channel on the presentation console will light a red transmission signal lamp on the desk at the programme source, irrespective of the mode to which the desk has been switched. In the rehearsal and recording mode the studio red signal lights and machine controls are locally controlled. In the transmission mode the studio signalling lights and machine start controls cannot operate until a voltage is received from the presentation source selection equipment on to which the source has been selected. This indicates that the channel fader at the destination is open.

There are two types of cue: local cue and cue via the presentation source selection system. Local cues between studio and its control desk number between 12—in the most complex studio—to two—in a talks studio. A two-wire-plus-earth return circuit and controls enable two-way green light cueing between studio and control room. When a programme source is selected on the source selection equipment cueing may be done between studio control desks and the presentation consoles. When the presentation cue control switch is operated at the programme source the switch locks up a green light on the appropriate channel of the source selection equipment. A cue can also be given in the reverse direction.

In the studio the red signal and green cue lights are mounted on a single stand. The red light comes on when the microphone is live, but whoever is to speak remains silent until the green light comes on too.

The studios

Of the 13 studios only the largest, number One, is not constructed on the box within a box principle. The floor of studio One is over 5m below ground and, because of the dampness of the site, the foundations had to be anchored to stop the whole structure from rising.

Studio One will be used for live audience shows such as light entertainment shows and orchestral concerts. Like the other studios, its acoustics were worked out by computer. Christy Killeen, whose full title is senior engineer in charge, audio design department, told me as we went round the centre that he thought RTE were among the first to use computers for acoustics. They had used eight basic absorbers, each about 1m square. They fed the co-ordinates of the walls into the computer and the computer told them which absorber should go where. Did this give satisfactory acoustics? 'They were reasonably accurate. We needed to make some adjustments afterwards but they were mainly OK.'

Around the floor of the studio there are a number of mains supplies: 110V for guitar amplifiers, domestic sockets for the use of the cleaning staff; and safeblocks from a transformer-isolated supply for showbands. All the transformers for these supplies, the chokes and starters for the fluorescent lighting, and access to the plumbing are out in the corridor.

Behind the triple-glazed window of studio One's control room is a Neve 28 input mixer with eight outputs and a further sub-mixer which reduces the outputs to two. There are 20 input channels with wiring provided for four more. All the 20 channels have echo, public address and foldback facilities. There are two limiter compressors on the desk and Neve have put in wiring for another four. They have also put in remote controls for four Studer stereo tape machines and two cartridge machines. One of the Studers is a 16 track. The metering is on 11 ppms. This desk is identical to that in the pop studio, studio Eight.

Christy Killeen talked about monitoring and panning: 'The monitoring can be switched to the groups or to tape out. The pan control is set at the final stage; up to that it's all mixing.'

The pop studio

Like studio One, the pop studio has a 16 track Studer tape machine. The glass in the control room window is 19 mm thick, and I'm told that it took ten men to lift it when it was put in. Both studio One and the pop studio will have Lockwood Major speakers. RTE had tried various other speakers which I'd better not name and they kept burning out—a problem RTE share with some of the BBC's local

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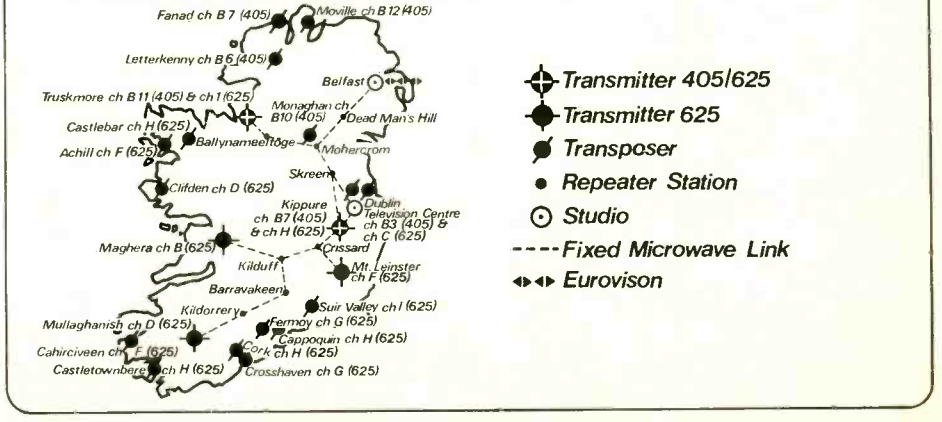
NATIONAL TELEVISION NETWORK FIG. 3



One of RTE's several Neve mixers.

radio stations. Christy said they would put Spendors in the speech studios.

All the microphones they use are Neumann. 'We have this gadget we bought in Germany, and we have space for two more: the stereo mic capsules are in one housing and you can change the characteristics by remote control. Each mic is separately adjustable.' Christy told me the pop studio would also be used for multitrack recording as well as for broadcasting. Instead of booking outside studios for multitrack recording they will be recorded here. 'This represents a direct saving,' Christy told me. I asked him if RTE could offer the same facilities as a commercial eight track studio: 'I don't think there's a single restriction in here, nothing we can't do.'

OB section

Neve's Les Lewis told me the most difficult part of the desk's design had been the outside broadcast section. This is fitted to all the consoles. As explained earlier, this will handle ten OB programmes simultaneously and has two-way talkback to each OB point. Two circuits are provided for each OB: one of the lines handles programme in and the other is a telephone control line.

If a particular OB key is pressed the operator can talk to the source of the outside broadcast. Return talkback is obtained via the programme circuit. The return talkback is disconnected as soon as the OB channel fader is opened to put the OB on air. As soon as the lines have been connected the person doing the outside broadcast hears all that is going on in the studio, including rehearsals. The talkback button interrupts this and those at the outside broadcast source then hear the studio talkback feed.

Another feature of this outside broadcast section of the desk is that it allows up to ten conference telephone calls at one time. Christy Killeen told me this was particularly useful during things like general elections when up to ten callers can converse with one another and with whoever is in the studio. Studio Ten, which is the most likely studio to be used for general elections, will take up to 20 conference calls. Christy also told me that no plugging was needed for the conference set-up. 'When this key is thrown, you can also send talkback out to all ten or all 20 at once.' Each console has a producer's desk next to it which also has all the talkback facilities mentioned above.

The dc matrix I mentioned earlier is a pin matrix which allows signals to be changed from one channel to another. There are two matrices: one high, one low level. The low level matrix is used in cases such as when a cue light associated with channel 12 has to be operated at microphone position 11. The switch is achieved by putting a pin into the appropriate position in the matrix. Christy Killeen told me this was the most flexible way of relating microphone positions and cues. If a microphone had to be changed from, say, channel four the engineer would change the XLR plug at the back of the console.

The line level matrix works on a similar principle but is used for programming the dc signals from the fader backstop contacts. If a tape machine has to be altered temporarily from one channel to another it is first jacked in and then its dc position is altered on the matrix.

The drama studio

The drama studio is about the same size as the pop studio but has two extra rooms opening off it at the opposite end from the control room. One of these rooms is acoustically live —very—and provided with running water. The other is dead. The control room has four EMT stereo turntables and some cartridge machines. 'We used to cut our own discs for effects but now we're substituting cartridge machines—if we can get them.'

In the drama studio there are six facility panels and there is also one in the live room and one in the dead room. Each of the panels has five microphone sockets, two cues, a mono speaker output, a talkback mic and key, signal. Talkback from the control room is fed on to A and B, and overrides the programme feed whether the studio is live or not. RTE use Astralite headsets.

The compere's headphone has selective talkback fed to it as opposed to the general information of the group phones: it would not be ideal for a guest speaker to hear the producer telling the compere his guest was talking too much, or maybe enquiring 'Just who *is* the chairman of this discussion?'.

The presentation and programme studios

There are two presentation studios and control rooms in the building. In each of the presentation control rooms the console has six high level channels and can be operated in mono or stereo. By access to the source selection system each desk can select any of 50 sources at 22 levels and another 30 sources at six levels on to any of six high level channels.

In each presentation studio the desk is self-operated, as is the case in each of the other production studios. For the kind of programme that will be made here up to six telephone conversations can be handled at once. On the desk is a button which cuts off the local control room immediately and switches through to the presentation control room. The button controls between 30 and 40 relays. All the units in the desk come out on a printed circuit card connector.

At this point Christy showed me some of the microphone cable they had installed throughout the building. It has a carbon screen, which provides high resistivity to interference signals and can be folded without making too much cable noise. It is also tougher and more flexible than ordinary screened wire. He estimated that they had used about 3 km of the cable, which is made in Paris by Filotex.

Having seen RTE's radio complex I could have understood it had they given way to feelings of superiority. In each of the small studios alone the self-operated desks cost £7,000 each, the four Studers cost £2,000 each, three turntables each cost £500 or £600, and there are three racks of equipment at £4,000 a rack. All this before the cables have been wired in and more panels added, which may put the cost up by another £4,000 or £5,000. The building itself cost £800,000 and the final cost of it may reach £1,000,000.

No such feelings showed, though those at RTE may, deep down, feel a little disappointed that the complex has not progressed a little quicker. A spokesman for RTE told me that

the building was being completed on schedule. The light music, drama and variety departments had already moved out to Donnybrook and the radio centre now produced four or five hour-long programmes a day. The features and presentation departments had yet to move. The newsroom is in the TV building and serves both radio and television so that that doesn't have to move. 'We have yet to move the gramophone library and archives,' the spokesman continued, 'and that involves moving some 18 tonnes of archive material'.

Nevertheless, the desks were ordered during the first week of July 1970 and were delivered no more than a year later.

Reflection of changes

Still, no matter. The fact that the Radio Centre is now nearly complete is a reflection of the changes that have occurred in a country that was once just a little left behind. As part of the effort to increase understanding between the North, the Republic and Great Britain, the British and Irish governments have been talking about introducing BBC and UTV into the Republic in return for broadcasting RTE throughout Northern Ireland.

I think this is trailing behind events a little, for the Irish have been erecting monster aerials for years in attempts to pick up BBC Wales, HTV, UTV and BBC Northern Ireland. There were 60.000 television owners in the republic before the republic had television. Not so much a question of introducing, therefore, as legalising.

As a result of these thousands of unofficial windows on the outside world Ireland now is a very different place from the Ireland of ten years ago. Those tall aerials introduced new ideas, new values. The television the Irish saw first was unofficial and uncensored, and the effect it had was the same as if Ireland had been picked up bodily and shaken.

Now the documentaries on RTE are as adventurous and outspoken as anything we have over here. Not only that, but the rest of Irish life has changed. The church is losing its influence. The Irish public are now a lot more critical of their leaders and expect to be told a great deal more about how their country is being run. The businessmen of Ireland are younger than those you used to meet.

I hope it's not too unflattering to say that the effect, when you see it, is that of a country waking up from a long sleep. I always liked the place. Now I like it more.

It would be impossible to list the sources from which I was able to compile the above without making it as long again. But I would like to mention the help of Mr Tim Murphy, Head of Technical Services at RTE, Mr Christy Killeen, the RTE press office, the Irish Ministry of Posts and Telegraphs, the Confederation of Irish Industries, Miss D. Coughlan, librarian of the Irish Embassy in London, innumerable people at our own Ministry of Posts and Telecommunications, and many others who have written valuable accounts of Irish life as it is now and as it was. Nor must I forget our own Heather White, who re-typed it all.

KUDELSKI NAGRA SN

By Hugh Ford

MANUFACTURERS' SPECIFICATION
(9.5 cm/s)
Magnetic Tape:
Nominal width and thickness: 3.81 mm x 8 μm.
Special metal reels: 68 mm diameter.
Length of normal tape: 160m.
Microphone input:
Current input, 200Ω inpedance: 3 μA rms.
Maximum level: 80 μA rms.
Line input (fixed level):
for nominal modulation, level from 100Ω maximum source): 160 mV rms.
Playback output:
Maximum load impedance: 1 kΩ.
1.7 mA DC will pass through the load. Nominal output level into 1 kΩ: 600 mV.
Playback standard: 50 and 3,180 μs.
Record and playback passband with high pass filter ±2 dB: 80 to 15k Hz.
Signal to noise ratio: measured with **ASA 'A'** filter, signal being at nominal level: 60 dB(A).
Distortion at 400 Hz at nominal level: 3 per cent.
Wow and flutter, peak value weighted as per DIN *45507* ±0.1 per cent.
Temperature range: —40°C to +70°C.
Average battery life on continuous run: (Ever Ready *E91*) greater than 5½ hours.
External power supply: +2 to +3V. Typical record and end of spool current 125 mA at 3V.
Dimensions: 147 x 100.5 x 26 mm.
Weight (with batteries and tape): 574 gm.
Price (less microphone: £506.
Nagrastatic microphone: £38.01.
Manufacturers: Kudelski SA, CH-1033 Chesaux-sur-Lausanne, Switzerland.
Distributors: Hayden Laboratories Ltd, 17 Chesham Road, Amersham, Bucks.

IN THE OLD days of the British Empire there was a saying 'getting a quart into a pint pot'. A simple 2:1 ratio. Since we joined the Common Market and encountered Mr Stefan Kudelski with his European (albeit Swiss) background of watchmaking, this old saying has become 'getting a litre into a centilitre pipette'. Comparing the overall performance of the Nagra *3* with the Nagra *SN*, this suggestion may be a slight exaggeration but the performance of the Nagra *3* at 19 cm/s may be reasonably equated to the performance of the Nagra *SN* at 9.5 cm/s and its bulk is only one 20th of the Nagra *3*.

The *SN* comes in two basic models: the *SNN* (as reviewed) which is a full track recorder running at either 9.5 or 4.75 cm/s, or the model *SNS* which is a slow speed version running at either 4.75 or 2.4 cm/s. Both models use 3.81 mm wide tape, the former embodying full track recording, and the latter half track recording because of the very severe problems of controlling azimuth at very low tape speeds. Mechanically the two types of *SN* are identical, both being pocket size recorders which can be readily secreted for location interviewing or, to put it bluntly, for bugging. In fact the model *SNS* is ideal for the latter purpose with its very low tape speed providing up to almost four hours continuous recording on a single reel of tape or 8 hours if the 'bugger' can retire to the gents to turn the reel over! This model is used by the Metropolitan Police as an *aide memoire* for detectives.

However, returning to more ethical uses of the *SN*, in its 4.75 cm/s version it offers a most remarkable performance both for its tape speed and for its pocket size. The standard of mechanical construction is more akin to an expensive watch than to a tape recorder, and military grade components and materials are used wherever possible in its construction. The main body of the recorder is milled from a solid lump of metal and supports all the mechanics and the three full track heads. The back cover is of drawn metal and is locked into position by three quick acting screw locks which make it easy to replace the two 1.5V batteries which are housed in the back of the recorder. The top cover is also mainly made of metal but incorporates three clear windows for inspecting the tape movement and internal meter without removing the cover which is secured by a very neat sliding latch.

The electronics, a block diagram of which is provided within the back cover, are contained on some seven miniature plug-in printed boards, the smallest of which measures only 25 x 15 mm and contains a microphone pre-amplifier or recording amplifier. Such miniaturisation would be outstanding for a domestic recorder but in the *SN* these electronics not only provide full record, erase and simultaneous playback facilities, but also full servo control of the motor, automatic level control, line output and voltage conversion circuits for raising the 3V battery voltage to 5V for the electronics and also to 50V for the Nagra capacitor microphone.

Inputs and outputs consist of a miniature jack socket for the line output or for feeding a headphone, and two multipole sockets. The first of these is the input socket which feeds the microphone input to the automatic level control. The latter socket also acts as the line input without any level control as well as giving a 50V dc supply for capacitor microphones and a linking facility which can automatically put the Nagra into record when the microphone plug is inserted. The remaining socket is the 'remote and pilot' which, as its name suggests, provides for remote start/stop, remote power supply and for a 10 Hz pilot tone input/output. The insertion of a plug into this socket automatically operates a switch to disconnect the internal power supply but the internal power can still be used if a link is inserted in the plug. Battery life with the internal batteries is stated to be six or seven hours, which is the result of ingenious voltage converter circuitry which optimises the use of the available energy.

The battery state can be checked by means of the internal meter when a small switch on the side of the recorder is operated, the meter normally indicating the degree of compression with which the automatic level control is operating.

Mechanically the Nagra *SN* is a reel-to-reel recorder using miniature spools. The basic or standard play tape is 18 μm thick and gives a running time of 27 minutes at 9.5 cm/s. The alternative tapes of 12 and 9 μm thickness offer running times of 40 or 54 minutes at 9.5 cm/s. As no pressure pads are used, threading the tape is delightfully simple, the tape path being printed on the surface of the tape transport together with a rough guide to running time at various spool diameters remaining on the takeup reel. The layout of the tape transport is as a conventional industrial reel-to-reel recorder, complete with tape tension control and the most delightful spool holders. Head mounting is really positive, the three heads being mounted really solidly on the main machined body. 50 ▶

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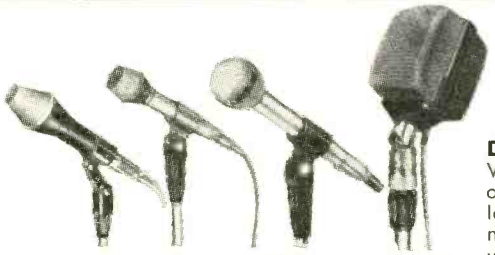

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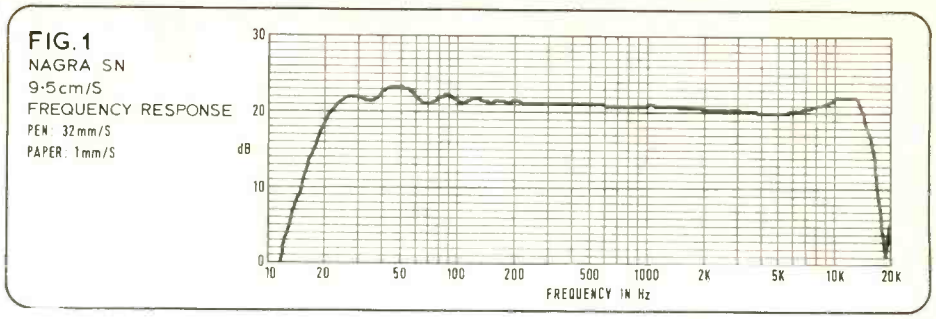


The tape drive is unusual in several respects. Firstly the capstan is an integral part of the motor shaft, the takeup spool being gear driven from the motor via a friction clutch. The change between tape speeds is achieved by altering the motor speed with a screwdriver operated switch on the main top plate. Perhaps unfortunately, this switch cannot be operated when the takeup spool is partly full. The motor speed is of course servo controlled from a capacitive tachometer disc as a magnetic pickup could not be used because of the essential proximity of the servo system to the heads. Otherwise the servo system is similar to that used in the large Nagras.

It may come as a surprise to find that the tape rewind is manual but this naturally saves motor power and is a perfectly satisfactory system in practice. A small folding crank handle is fitted for rewinding and with this it is possible to rewind a full reel of tape in a remarkably short time. The only thing I did not like about this system was the difficulty in unfolding the crank handle as this requires fairly long finger nails.

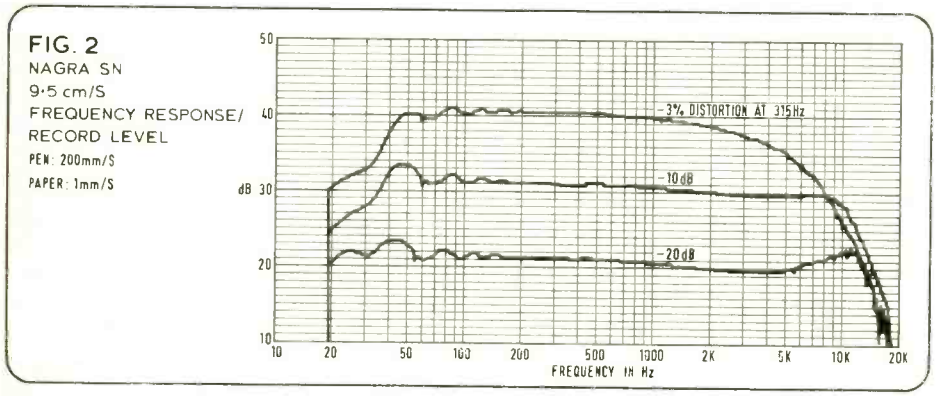
Operation of the normal transport functions is by means of a locking lever which is pushed into the machine to initiate the tape drive and engage the pinch roller, the record function being selected by inserting the microphone plug. In the released position of the operating lever, the pinch roller is withdrawn and both tape spools are positively locked so that the tape cannot spill off its correct path. For rewinding, the operating lever is withdrawn from the Nagra, when it releases the spool locks and also inserts two guides in the tape path so that the tape is out of contact with the heads. Within the machine there is one further control which locks the operating level in the neutral position so that the machine cannot be accidently started.

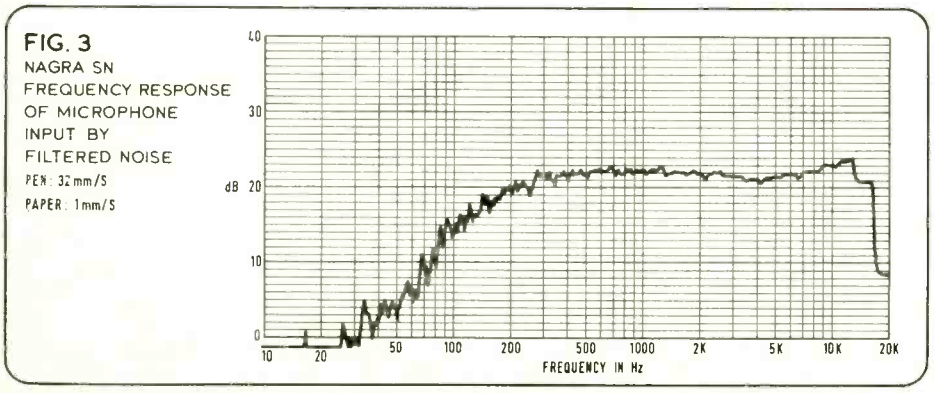
Measured performance

Initial investigation was directed at determining the maximum level that could be recorded without excessive distortion, so that noise could be referred to this level, as could other level sensitive parameters. Three per cent third harmonic distortion at mid frequencies is generally agreed to be the maximum recorded level for audio recorders, which I think is fair in this particular instance in spite of the low tape speeds involved. I have referred my measurements to 3 per cent third harmonic content at 315 Hz.

Using the line input, this level corresponded to 180 mV in at 9.5 cm/s tape speed, or 200 mV in at 4.75 cm/s tape speed. Under these conditions the output level into 1 kΩ was respectively 0 dBm or +0.4 dBm, corresponding fairly closely to the 'nominal level' in the manufacturer's specification. The following noise levels were then measured at the output in relation to 3 per cent third harmonic distortion:

Condition	Signal-to-noise ratio at 9.5 cm/s	4.75 cm/s
Machine replay noise without tape and in the replay mode:		
Wide band 2 to 200k Hz	53.5 dB	53.5 dB
Band limited 20 to 20k Hz	61.5 dB	59.2 dB
'A' weighted	72.0 dB(A)	70 1 dB(A)
With bulk erased 'standard play' tape:		
Band limited 20 to 20k Hz	60.4 dB	
'A' weighted	70.2 dB(A)	
Machine erased tape recorded without any input signal to the recorder, line input shunted with 470Ω:		
Band limited 20 to 20k Hz	59.5 dB	52.4 dB
'A' weighted	67.2 dB(A)	61.4 dB(A)





The noise performance at 9.5 cm/s is certainly really excellent and far better than the manufacturers' specification would suggest. However, while the performance at the lower speed of 4.75 cm/s is within specification it is marred by what would appear to be servo system noise at a level of −53 dB at 175 Hz. At the higher speed no servo noise is audible, the level being below −80 dB; it was also noted that operation of the switch for the battery level indicator was entirely click free.

Fig. 1 shows the frequency response at 9.5 cm/s, with the recorder fed by the line input, and clearly indicates a very good performance which has unusually good low frequency response with limits of ±2 dB from 20 to 15k Hz, or ±1 dB from 60 to 15k Hz. Furthermore **fig. 2** illustrates the great advantage obtained by using the 50 and 3,180 μs so far as tape saturation at high frequencies is concerned. However, I fail to see why the low frequency time constant of 3,180 μs was included (except for the paperwork exercise of complying with some standard i.e. NAB) as this clearly leads to low frequency saturation and distortion at high levels. This comment will not apply when the microphone input is used as this has a substantial low frequency

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cut (as shown in fig. 3) which is generally desirable for speech recording using the Nagrastatic lavalier microphone. In order to overcome any peculiarities of the automatic level control system, which operates only on the microphone input, pink noise was used for measurement on the microphone input response, the recorded signal being filtered in one third octaves.

In great contrast to the 9.5 cm/s frequency response, the performance at the lower speed of 4.75 cm/s is extremely disappointing as shown by the plotted response in fig. 4. While such performance is tolerable for speech recordings of rather low quality, I can only regard the low speed facility as an afterthought. I am informed by the Nagra distributors that the same bias and equalisation are used at the lower speed and this clearly accounts for the poor performance.

Inputs and output

Starting with the line input, this is a fixed level input with a measured sensitivity of 180 mV for 3 per cent third harmonic distortion at 315 Hz and an input impedance in the order of kΩ. The input is unbalanced, the connector being a special six pin connector which also includes the microphone input, the polarisation voltage output for capacitor microphones, and the record link connections.

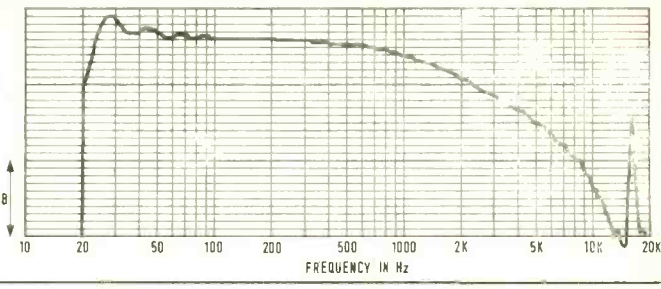
The microphone input is also unbalanced and is intended for either the Nagrastatic capacitor microphone, which uses the +50V measured +53.6V polarisation voltage supply, or for 200Ω dynamic microphones. This input is rather unusual in that it is a current driven input with a low impedance around 50Ω for a maximum input sensitivity in the order of 3 μA for full tape modulation. This is all very well for the Nagrastatic microphone, but I do not like low impedance inputs for dynamic microphones where all too often the microphone impedance changes dramatically with frequency, and consequently the frequency response is upset when feeding into low impedances.

The other matter which would have a substantial effect upon the choice of dynamic microphone is the range with which the automatic level control can cope without excessive distortion. In practice the input limit was found to be 80 μA at 315 Hz, a range of 28.5 dB, which is perfectly adequate if the right microphone is chosen.

Automatic level control

Operation of the automatic level control is by means of a dual time constant circuit as used in the large Nagra *4* recorders with a rapid attack time and a dual slope recovery (fig. 5) which shows the effect of a long term 15 dB increase in input level. The time for full recovery appeared to remain in the order of 1s for most conditions but the change in gain appeared to be less pronounced for short term increases in input. The audible effect of the automatic level control was found to be generally unobtrusive during the recording of continuous speech, even in the presence of transient noises, but as is only to be expected there was background noise 'pumping' during longer term breaks in speech.

FIG. 4
NAGRA SN
FREQUENCY RESPONSE
(LINE INPUT) AT 4·75cm/S
PEN: 200mm/S
PAPER: 3mm/S



On the output end there is the single unbalanced output at a fixed level of a measured 0 dBm corresponding to 3 per cent third harmonic distortion from tape, the level in terms of tape flux being omitted from this review as the Nagra reel-to-reel system is not compatible with other systems using 3.81 mm tape. The output is in fact a direct connection to the collector of the output transistor and must be loaded with a minimum of 1 kΩ through which about 1.7 mA of dc will pass. The actual output impedance is of course low, and was calculated as being 33Ω at 315 Hz. When in the record mode, the level of 60.7k Hz bias frequency in the output was 32 dB below the 3 per cent distortion level from tape at 315 Hz, the second and third harmonic of the bias oscillator being at substantially lower levels.

Wow and flutter

DIN weighted wow and flutter as measured by recording and subsequently replaying a tape was extremely good at both tape speeds and, more important, remained below ±0.1 per cent when the recorder was being carried around. Worse figures could of course be obtained by subjecting the recorder to violent motion, and rotational motion about the capstan axis was the most sensitive axis. However, such conditions are not to be found in normal use and the following static figures show how good the recorder is:

Tape speed	DIN wow and flutter		
	Beginning	Middle	End
9.5 cm/s	0.06%	0.06%	0.08%
4.75 cm/s	0.085%	0.09%	0.10%

Summary

The fact that the Nagra *SN* uses 3.81 mm wide tape may at first thought lead one to assume that its performance might be equated with a compact cassette system. As has been seen, this is far from the case when the Nagra is run at its higher speed of 9.5 cm/s where its performance easily surpasses the standard one would expect of 6.25 mm machines running at twice the tape speed a few years ago.

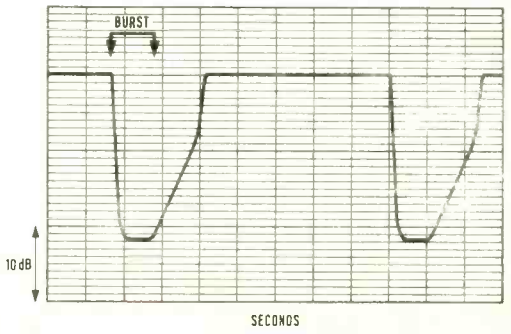
One of the major advantages built into the Nagra is the 50 μs treble pre-emphasis, which leads to the capability of recording high frequencies at high recording levels. In spite of this, the signal-to-noise ratio is very good as is the frequency response. As a recorder for interviews, the Nagra *SN* with the Nagrastatic microphone is absolutely first class at a 9.5 cm/s tape speed.

I have not mentioned in this review the capability of recording a pilot tone for synchronous film recording, as this requires an optional extra crystal sync unit for deriving an accurate 10 Hz timing signal. In fact, the Nagra *SN* operated at 9.5 cm/s is quite adequate for most forms of entertainment or industrial recording where a truly portable recorder is required.

Unfortunately the performance at the lower tape speed of 4.75 cm/s is distinctly disappointing, with a really poor frequency response. This speed hardly does justice to the expenditure of £500.

There are of course other shortcomings which I have mentioned in the body of this review but there is a limit to what one can reasonably expect from such a very small machine and overall the mechanical performance, the standard of construction, and the electro-acoustic performance at a tape speed of only 9.5 cm/s stand alone. **H. D. Ford**

FIG. 5
NAGRA SN
AGC PERFORMANCE WITH
1KHz PROBE TONE AND +15dB
BURST OF 315Hz
PEN: 200mm/S
PAPER: 10mm/S



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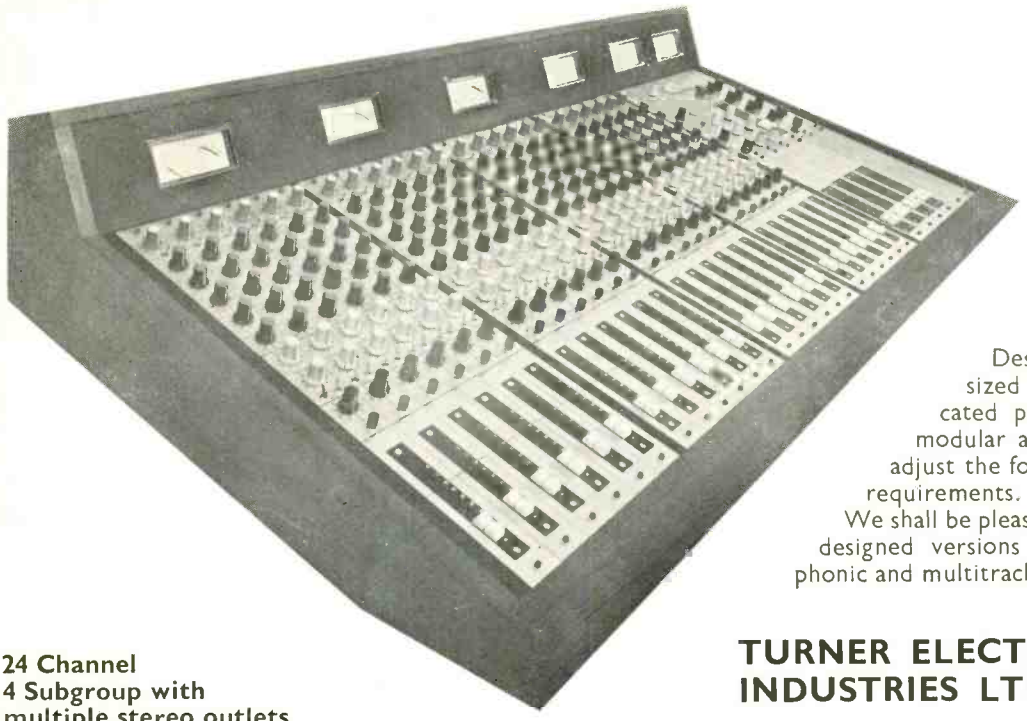

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STELLAVOX STELLAMASTER

By Hugh Ford

MANUFACTURER'S SPECIFICATION:

Format: 38 cm/s 6.25 mm stereo tape recorder.
Wow and flutter: ±0.05 per cent, DIN peak weighted.
Overall frequency response: 20 to 20k Hz within 2 dB.
Overall signal-to-noise ratio: 66 dB ref 800 nWb/m 64 dB DIN weighted).
Total distortion: 2 per cent ref 800 nWb/m.
Intermodulation distortion: 2 per cent.
Stereo separation: 55 dB at 1k Hz, 40 dB at 40 and 12k Hz.
Erase efficiency: 80 dB at 1k Hz.
Equalisation: 35 μs.
Track width: 2.6 mm.
Spool capacity: 13 cm 27 cm with adaptor).
Price: £1,200 (at 7.40 Swiss Francs per pound sterling).
Manufacturer: Georges Quellet, Engineer EPZ, 2068 Hauterive/Ne, Switzerland.
Agents: AV Distributors Ltd, 26 Park Road, Baker Street, London NW1.

ABOUT A YEAR ago I had the opportunity to review the Stellavox *Sp7* recorder, which is mechanically virtually identical to the *Stellamaster* being reviewed here and which also has much in common in the electronics department. My conclusion was 'without any doubt, the Stellavox *Sp7* has great potential. The sample reviewed had a number of 'bugs' which should not be difficult to get rid of".

Reference to the January 1973 edition of STUDIO SOUND, where the *Sp7* review appears, provides a full description of the machine and its accessories and I do not propose to repeat unnecessary material in this review. I shall endeavour only to show what improvements have been done and to describe new features. To start with, I am pleased to note that some attention has been brought to virtually all the aspects of the original review where I raised objection to the *Sp7* machine.

The mechanics

The mechanical construction of the *Sp7* and the *Stellamaster* is virtually identical with the one exception that the *Stellamaster* is fitted with a flutter roller in the place of the pilot head between the erase and record heads. The overall results of having some four roller guides in the tape path is that friction noise (scrape flutter) is quite incredibly low.

Editing remains rather difficult as, not only is the replay head inaccessible, there is still no support for the tape at the editing point one comes to by using the inbuilt system for winding the tape back a specific distance.

Wow and flutter showed a considerable improvement, being measured at a steady 0.045 per cent DIN peak weighted throughout a 13 cm reel of tape at the standard speed of 38 cm/s. The machine can be set to other tape speeds, as with the *Sp7* model, but these speeds are not actually intended for use in the *Stellamaster*. As previously, the equalisation components are fixed components within the head block, which means that a separate (expensive) headblock is required for each tape type to be used.

The only remaining mechanical change is that the microphone inputs on the review machine were standard *XLR* plugs in lieu of DIN sockets.

The replay performance

Investigation into the replay frequency response using the standard BASF DIN 38 calibration tape with a 35 μs characteristic showed that the response of both channels was to all intents and purposes identical, and within ±1 dB from 31.5 to 18k Hz relative to 1k Hz. Such a performance is really excellent as it is well within the tolerances of the available calibration tapes.

Replay noise was measured relative to 320 nWb/m at 1k Hz, to both the DIN measurement method and the conventional rms measurement with the machine running without tape moving and with machine erased tape which had been recorded with the level controls shut:

	REFERENCE LEVEL TO NOISE	
	Channel 1	Channel 2
Machine only, no tape		
Wide Band 2 Hz to 200k Hz*	—52 dB	—51 dB
20 Hz to 20k Hz*	—52.5 dB	—51.5 dB
'A' Weighted RMS	—74.5 dB(A)	—73.5 dB(A)
DIN quasi-peak weighted	—66 dB	—65 dB
Machine erased tape		
Bandwidth 20 Hz to 20k Hz*	—51.5 dB	—47.5 dB
'A' Weighted RMS	—66 dB(A)	—66.5 dB(A)
DIN quasi-peak weighted	—51.5 dB	—51 dB

*See text

The above table shows a very respectable performance with machine noise being satisfactorily below weighted tape noise; however, the unweighted figures indicate that all is not at its optimum. **Fig. 1** shows a third octave spectrum analysis of the machine noise and demonstrates that components at 50 Hz and 250 Hz are particularly predominant; these were traced to the machine's motor system and are clearly audible above tape noise. Use of the *APS* mains power supply produced a very odd effect which sounded as if one were listening to a ball bearing with a cracked ball! However, hum levels were good and this odd effect was not recorded on tape.

Subsequent investigation showed that the peculiar effect associated with the type *APS* power supply was the result of an earth loop being introduced by the power supply lead. This matter has now been rectified by the manufacturer. Furthermore, the manufacturer, in the form of Mr Quellet himself, was good enough to visit my laboratory with a second machine which demonstrated a very substantial improvement in unweighted noise performance. The reference level (320 pW/m) to unweighted noise level measured on this second machine was 64 dB, which is a perfectly acceptable standard. I am assured that great attention will be paid to this problem in the future; it is however my duty as a reviewer to report the facts found on the first machine presented for review.

Replaying the reference level of 320 nWb/m gives 1V rms at the two outputs which are capable of delivering up to +10 dB above reference level, thus catering for the replay of high output tapes without distorting and without having to use the level controls on the machine which only effect the output in the 'direct' position of the monitor switch.

Record/replay performance

Fig. 2 shows the record/replay frequency response at three different recording levels, while switching between the two channels. The complete lack of bumps in the bass response is particularly pleasing and the overall response of within virtually ±1 dB from 20 to 20k Hz is certainly impressive.

The noise introduced during the record process has also been improved upon, with now only 2 dB(A) increase over bulk erase noise being introduced on to tape by the erase and record processes. However, when using the line inputs the microphone inputs remain in circuit and this can introduce excessive noise in the record amplifiers if the record gain is set to a high level. Further problems were also apparent when the record gain was set to high levels on both channels as this provoked high frequency oscillation in the amplifiers and could not be removed by loading the inputs at either the line or microphone inputs. This fault subsequently disappeared, however, and all efforts to provoke its return failed to have any effect.

Microphone input noise levels were measure one channel at a time (with some care!) and found to offer noise figures of 5.5 dB when loaded with 200Ω. While this figure is not particularly bad, it is not good in comparison with modern mixers.

Harmonic distortion was low up to a recording level of +8 dB on the reference level of 320 nWb/m where it was in the order of 1 per cent but rose very rapidly to 3 per cent third harmonic at +8.5 dB as is to be expected with a machine including predistortion techniques. Intermodulation distortion to the SMPTE method was measured at 2 per cent for 1V equivalent sinewave output (reference level of 320 nWb/m) and increased to 2.3 per cent at +8 dB on this level. While this performance is in line with the specification, I have little experience of measuring intermodulation distortion of tape recorders but would consider this performance to be good. However, it must be pointed out that the SMPTE measurement of intermodulation distortion is very sensitive to fluctuations of replayed level with the result that the measured intermodulation distortion is the combined effect of intermodulation products and of the overall uniformity of record/replay level.

Fig. 3 shows the crosstalk performance between channels, which is now exceptionally good as a result of the use of butterfly heads and certainly far better than is required for normal stereo recording. Similarly, the erasure has been improved to a measured 83 dB at 1k Hz as a result of the use of a new high efficiency ferrite erase head.

Input sensitivities are also higher than those of the *Sp7*, without any loss in the overload margin providing for 150 μV to 84 mV from dynamic microphones or 210 μV to 120 mV from capacitor microphones for recording the reference level of 320 nWb/m at 1k Hz. For recording the same level, the line input sensitivity is 65 mV with an overload margin in excess of 12V.

Power supply *AP57*

This is a modified version of the previously reviewed *APS* power supply)and incorporates an improved integrated circuit stabiliser. As supplied, this unit was responsible for the 'faulty ball bearing noise' in the replay mode but this defect was subsequently cured. After modification of the lead between the recorder and the power supply, the performance was quite satisfactory but I remain unhappy about the electrical safety of the power supply because of the extremely small clearance distance between the mains fuse and the metal case, which most certainly would not meet the requirements of British Standard *415* which calls for a minimum 3 mm clearance between such parts. The simple modification of rotating the fuseholder would solve this problem. A further grumble about the power supply is that it takes 10 mm fuses (the value not being indicated on the power supply) while the recorder takes metric 20 mm fuses (also not identified on the recorder).

The manufacturer has assured me that not only will the type of fuseholder be changed to the standard 20 mm metric holder, but also that the potential safety hazard will be eliminated in the future. It is also anticipated that future production will have the fuse value and type identified on the power supply.

Microphone pre-amplifier *APA*

This is a small tubular microphone preamplifier about 20 mm diameter and 100 mm long which plugs into the microphone inputs and is powered from them when the recorder is switched for use with capacitor microphones by means of a lead equipped with an *XLR* socket and a DIN plug. The other end of the *APA* amplifier is equipped with a short lead converting its DIN output to an *XLR* plug.

The *APA* preamplifier has a fixed gain measured as 25 dB with a very flat frequency response. The input impedance was measured as 12 kΩ which is adequate for 200Ω microphones and the noise factor at around 2 dB is substantially better than that of the recorder's in-built amplifiers.

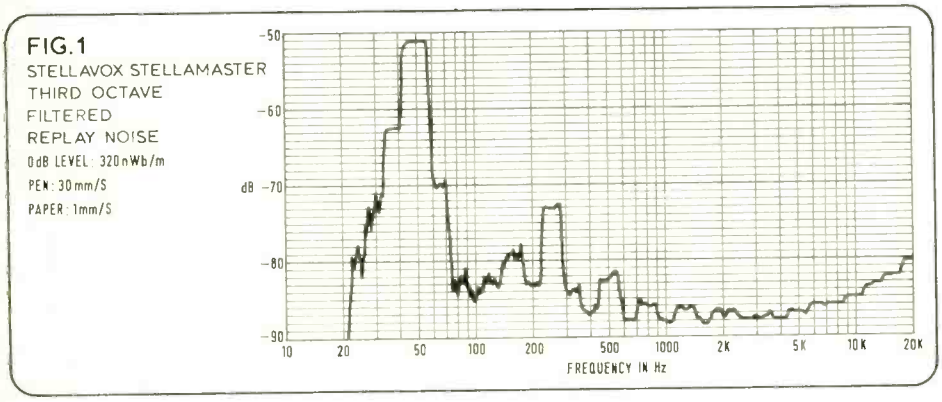
This extra 25 dB of gain provides an input sensitivity of a mere 12 μV but the input clipping level is somewhat low at 7 mV; this being controlled by the clipping input level of the *Stellamaster* recorder. It is my impression that a fixed 25 dB gain is more than is normally required and that it would have been better either to provide for a fixed 10 dB gain or to add switched gain in 5 dB steps to the preamplifier.

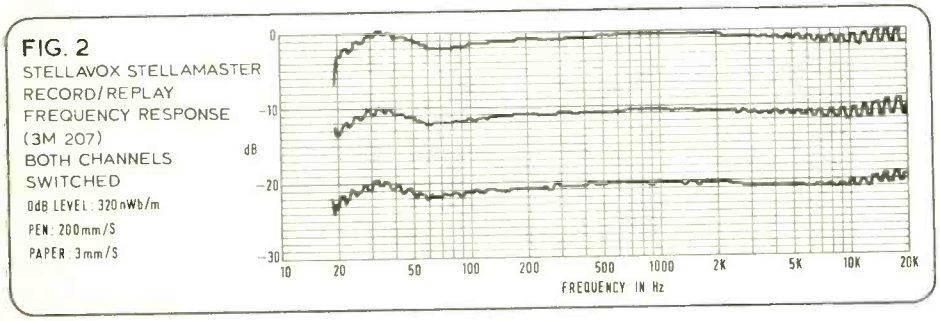
***ABR* reel extension unit**

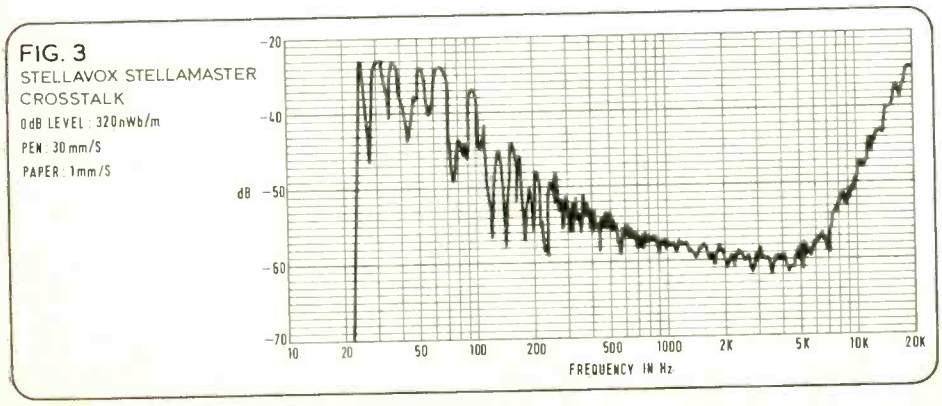
This unit, which permits the use of reels larger than 13 cm up to 27 cm NAB or European spools, was included in my earlier review of the *Sp7*. At the time I criticised this unit for providing an extremely loose wind but was informed that the wind could be improved by tightening the recorder's clutches. The *Stellamaster* reviewed here had its clutches tightened and did in fact provide a tighter wind on NAB spools such that a tape could be rewound on a mains driven machine without too much likelihood of damage.

However, I still do not consider the *ABR* adaptor to be satisfactory as it continued to provide a disastrously loose wind.

In spite of these comments, the *ABR* reel extension unit provides the ability to use 27 cm NAB spools with a very respectable wow and flutter performance which was measured at 0.06 per cent DIN weighted at both ends of a full NAB spool, furthermore the drift in speed from end to end of a full spool was only in the order of 0.03 per cent.







Summary

The first *Stellamaster* presented for review, together with its accessories, showed substantial improvements upon the *Sp7* but did not have all well in the electronics department.

During the course of this review I found every possible assistance offered by Bob Woolford of the local agents and indeed was impressed that Mr Quellet himself went to the length of bringing a second machine to the laboratory.

This second machine was by any standards a most excellent recorder and offered really serious opposition to the few competitors in the field of professional portable machines. If size and weight are at a premium and not all the comprehensive facilities of some competitive machines are really needed the *Stellamaster* becomes an outstanding machine for consideration, but at a price.

As for the accessories, the mains unit has been improved and I am assured will be further improved to overcome the possible safety hazard: the type *ABR* reel extension unit for NAB spools is basically the same as before, but behaves better with higher winding tensions: the *APA* microphone preamplifier gives no cause for complaint by itself, but is limited by the clipping input level of the recorder as a result of its high fixed gain.

Overall I am impressed by the rate at which the Stellavox organisation is solving its problems, and now consider the *Stellamaster* to be in the range of the very few top flight portable machines.

KUDELSKI NAGRA 4SL

By Hugh Ford

MANUFACTURERS' SPECIFICATION
(38 cm/s, 3M *206*)
Format: Half track stereo, 6.25 mm.
Tape speeds: 38 cm/s Nagramaster, 38 cm/s NAB or CCIR, 19 cm/s NAB or CCIR, 9.5 cm/s NAB or CCIR. NAB or CCIR equalisation can be switched on playback, but the record equalisation must be specified at the time of ordering.
Inputs:
(a) Two microphone inputs switchable for 50Ω dynamic, 200Ω dynamic, 48V, —12V or +12V phantom capacitor or T balanced capacitor microphones. A switch allows the phase of the left hand channel to be inverted.
(b) Two line inputs, 3.7 to 1200 μA (should be fed from a source greater than 20 kΩ).
(c) Two channels for a noise reduction system (Dolby).
Outputs: Line output: 1V 600Ω; Headphone: 1V into 200Ω; Two channels into a noise reduction system.
Switchable input filters: Six switch positions are provided as follows:
(1) Flat;
(2) Music: —3 dB at 25 Hz;
(3) M+LFA Music with a sharp low frequency roll off.
(4) Speech: —3 dB at 84 Hz then 12 dB per octave;
(5) S+LFA2: Faster attenuation rate than speech;
(6) Roll-off: Attenuation commencing at 500 Hz;
Overall frequency response: 30 to 20k Hz (±2 dB).
Nominal maximum record level with reference to 510 pWb/mm: +4 dB.
Third harmonic distortion at nominal maximum record level: 1 per cent
Overall weighted signal-to-noise ratio: 72 dB(A) (Nagramaster), —69 dB(A) (CCIR).
Amplifier chains: 30 to 20k Hz ±0.5 dB overall frequency response (from 200Ω microphone).
Modulometer (coaxial): 10 ms integration time for 1 dB, frequency response 40 to 20k Hz ±0.5 dB.
Approximate current consumptions: Test: 100 mA, Playback line: 190 mA, Playback loudspeaker: 270 mA, Record: 260 mA, Rapid rewind: 270 mA.
Pilot facilities: Carrier frequency: 13.5k Hz, deviation: +45 per cent, Frequency response: 0 to 2500 Hz ±3 dB, Sensitivity (pilot): ±2.8 V (2V rms) Sensitivity (cue): ±2V (1.4V rms), Playback (pilot): ±2.8V (2V rms), Playback level (cue): ±2V (1.4V rms).
Dimensions: Without carrying handle 330 x 241 x 114 mm.
Weight: 5.2 kg.
Power supply and batteries: Operating voltage range 12 to 30V dc. Number of cells: 12. (Ever Ready *HP2* or similar).
Approximate battery life: (based on 4 hours use per 24 hours continuous recording with rewinding): Carbon-zinc high capacity cells: 18 hours, manganese dioxide cells: 34 hours, rechargeable cells: 16 hours between chargings.
Loudspeaker (built-in): Electrical power output: 1.6W, frequency response (±6 dB): 200 to 15k Hz.
Spool capacity: 13 cm (lid closed), 18 cm (lid open).
Erase characteristics: Residue of 800 Hz signal recorded at maximum level and erased: —80 dB.
Wow and flutter: 0.05 per cent (DIN peak weighted).
Speed variation capability: Up to ±12 per cent can be achieved at each speed.
Temperature range: —20 to +71°C with internal manganese batteries.
Operating position: Any.
Price: £1,083.50
Manufacturers: Kudelski SA, CH-1003 Cheseaux-sur-Lausanne, Switzerland.
Distributors: Hayden Laboratories Ltd, 17 Chesham Road, Amersham, Bucks.

THE NAGRA *3* and its successor the *4* are probably the most respected portable tape recorders in the world. While other manufacturers have attempted to sell a competitive product I have not as yet come across a portable machine that really offers serious competition.

Not only are the mechanics of the *4* built like a battleship but the mechanical and electrical performance are both quite outstanding. The recorder also contains a quite amazing number of facilities in a very small space. The model *4SL* being reviewed here is a half track stereo machine with simultaneous record and playback as well as facilities for a pilot tone (or cue) channel which operates with a third track on the tape which is frequency modulated. This model is of course specifically intended for audio recording with or without synchronised film; the pilot track can however be used for speech recording or other purposes.

Mechanically the Nagra recorder is effectively two parts; the main case of the electronics and the tape transport which can be very easily detached from the remainder of the case. Loosening two screws enables the tape transport to be hinged away from the case for access to the electronics and the underneath of the tape transport. Removal of a further four screws and disconnecting the wiring from a 'block connector' enables the tape transport to be completely removed. This removable part is a light alloy casting in which is inserted a machined plate which accommodates the three fixed tape guides, the four heads (erase, record, pilot and replay) a damping roller with stroboscope and the capstan and pinch roller. Thus, all those parts which require accurate alignment are referenced to a precise surface. The mounting of the record, pilot and replay heads is really solid, with precision adjustment provided by means of recessed socket screws.

Spool capacity

Spools of up to 13 cm diameter can be used with the hinged plastic cover in place and shut, but 18 cm diameter spools may be used with the cover open; alternatively, the cover is very easy to remove as its hinges are of a cunning design so that they can be easily separated. The spool mounting is by the conventional Nagra knurled nut which may seem rather crude but is much more reliable than other more fancy methods. From the pay-off spool, the tape passes over a tension roller which controls the pay-off tension by means of a brake on the spool hub; it then passes over two fixed guides, intervened by the erase head, to the damping roller which is fitted with a stroboscope for the three speeds. This stroboscope was found to be 0.16 per cent inaccurate at a tape speed of 38 cm/s as a result of the damping roller being 33 μm too large in diameter. This error is of course insignificant for most purposes but I mention it because of the extremely tight specification that is quoted on speed stability.

The tape then passes the record head and the pilot and replay heads, the latter two being provided with a hinged hum screen which is only necessary in some circumstances. Then comes the large diameter capstan and pinch roller, followed by the take-up tension roller and the take-up spool. The design of the pinch roller system is particularly interesting as not only is the pinch roller tension removed when the recorder is switched off or in the test mode but, while the recorder is running, the pinch roller tension can be manually removed for editing. In fact the accessibility of the tape path makes the Nagra ideal for editing. The capstan is itself an integral part of the motor, directly driven, while the spools are belt driven from the motor shaft by large diameter belts of circular cross section, minimising the possibility of introducing wow and flutter. As with all other Nagra recorders the motor speed is servo controlled from a tachometer disc on the motor shaft.

Fast rewind is provided by operating a toggle switch on the tape transport and moving a large lever which brings the tape out of contact with the heads, provided that one remembers to fold down the hum screen which is all too easy to forget. The same toggle switch offers a fast forward function when the recorder is set to the replay mode with the internal speaker switched on; this of course provides some protection against accidental operation in the fast forward mode.

Preset controls

Replay equalisation is also switched by a screwdriver operated control on the tape transport so that either NAB or CCIR characteristics may be chosen in replay only. The tape speed selector or course corrects both replay and record equalisation for the tape speed chosen. Record equalisation trimmers are also mounted on the tape transport and are screwdriver operated controls which are recessed under a protective sliding plate that makes the transport proof against spilt tea and coffee. Similarly, a single bias control is available and this control is marked with a fairly rough and ready form of calibration.

So much for a description of the tape transport, the main electronics are mounted in the case body and are all mounted on fibreglass printed boards which in turn mount on a 'master board' occupying most of the base of the machine. As is only to be expected in a machine of this standing, all individual components are to a high standard and the layout and wiring are very neat.

A full description of the machine's facilities would be very lengthy, but the following give some idea of the many possibilities offered. The left hand side of the machine has three Tuchel seven pin sockets providing: (1) Line out and access to internal power supplies and remote control. (2) Connections for an external noise reduction system such as Dolby. (3) A current driven line input. There remain the two *XLR* microphone connectors and their individual switches to provide for either 50 or 200 Ω dynamic microphones, +12V, +48V or —12V phantom powered capacitor microphones, or T balanced capacitor microphones. In addition there is a switch for reversing the phase of one channel. It is therefore possible to use two different types of microphone at the same time and to correct phasing.

The right hand end of the recorder is occupied by the internal loudspeaker, two pairs of 3 mm banana sockets for line outputs and three Tuchel sockets providing for (1) External powering, speed correction and remote stop. (2) Cue. (3) Pilot, crystal and clapper.

All the main functions are arranged logically on the front of the recorder and are very clearly identified. Recessed toggle switches offer

microphone or line input, noise reduction socket in or out of circuit, internal or external power, line and cans from tape or direct, and a sprung toggle switch giving the possibility of metering from tape. Recessed rotary switches allow the headphone monitor socket to operate at five different levels or to monitor the pilot track for six different high and low frequency filters, for the twin coaxial modulometer to indicate level (stereo), battery state, pilot level, motor current, disc cutting depth and for pilot frequency with an optional extra unit. There are also facilities for operating the recorder or cans in either mono or stereo; indicators for correct motor speed and for presence of a pilot input, switches for meter illumination and for an internal reference oscillator and finally the level controls and the function selector. The latter is a six position rotary control providing for playback with or without the monitor loudspeaker, a stop position where the recorder is completely switched off and the pinch roller withdrawn, a test position for level setting with the pinch roller withdrawn, and record positions with or without a level limiter.

Level is controlled by two calibrated potentiometers which may be set independently but which are equipped with a clutch mechanism for ganging the two controls mechanically once level has been balanced, the record level of both channels being indicated on the twin coaxial modulometer.

While most of the recorder is proof against mechanical damage in rough handling and will probably stand being dropped on to a concrete floor without undue effect (I am loath to try this test!) I am rather surprised that two gain controls and the function selector are not recessed controls, as they were in the Nagra *3* series, as these are the only protruding parts liable to be damaged.

Operation

Operation of the recorder is really very good as the meter and all controls are to hand when the machine is either on the bench or being carried on a shoulder strap. Furthermore, threading the tape is simplicity itself, because the tape path literally becomes a straight line when the rewind arm is actuated and withdraws the pinch roller and other protrusions in the tape path—except the hum screen over the heads.

The Nagra as reviewed was tested with rechargeable batteries and the mains power supply (type *ATE*) together with the auxiliary battery charger (type *ATN-ATU*). While the latter is a small box that plugs into the Nagra and the mains unit, and has an indicator to show that the batteries are actually charging, the power supply itself deserves more attention. The *ATE* power unit operates at the following nominal mains voltages: 240, 220, 120 and 110 with specified tolerances of + 10 to 30 per cent. In practice the 240V mains supply could be almost halved before there were any symptoms of trouble from the Nagra! Another pleasing feature of the power supply is that it is fitted with two mains fuses of different values for 100V or 240V operation, the correct fuse rating being automatically selected by the coin operated mains voltage selector. In addition to providing power for the recorder, there is also a 1V rms pilot output for use in conjunction with mains powered cameras.

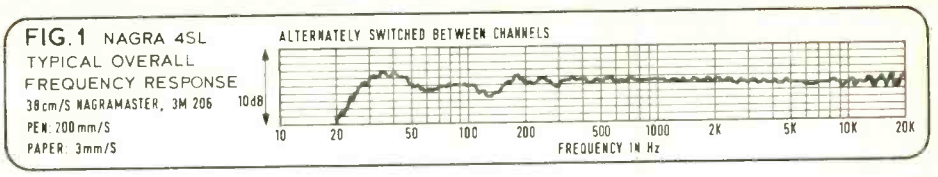


FIG. 1 NAGRA 4SL TYPICAL OVERALL FREQUENCY RESPONSE 38cm/S NAGRAMASTER, 3M 206 PEN: 200mm/S PAPER: 3mm/S

The overall mechanical performance of the Nagra was really first class, the measurements of tape speed being controlled by the accuracy of calibration tapes rather than the machine itself, the speed at all settings being well within 0.1 per cent and exhibiting no measurable drift either within a reel or throughout the evaluation of the machine. Likewise, the wow and flutter were to a very high standard, the following figures being measured to the DIN weighted standard:

DIN weighted peak wow and flutter

	38 cm/s	19 cm/s	9.5 cm/s
Beginning of reel	0.025%	0.04%	0.07%
Middle of reel	0.035%	0.045%	0.06%
End of reel	0.05%	0.07%	0.09%

The replay chains

The replay equalisation was checked by means of BASF standard calibration tapes at all three tape speeds with the following results which are themselves within the tolerances of the calibration tapes:

Frequency response ±1 dB

	CCIR	NAB
38 cm/s	31.5 to 18k Hz	63 to 18k Hz
19 cm/s	63 to 14k Hz	31.5 to 14k Hz

The replay characteristic in the 'Nagramaster' mode at 38 cm/s is of course not standard, and approximates to a 70 μs characteristic which gives some improvement in machine and tape noise at the expense of losing maximum recording level at high frequencies. In all modes of operation the difference in replay response between the left and right channels was too small to be of significance.

At all three tape speeds, line output was —2 dBm for a 320 nWb/m flux with the balance between the two channels being within 0.2 dB at 1k Hz. At this recorded level the modulometer registered —4 dB at all three speeds and with all replay characteristics.

The following table gives an idea how good the replay system noise performance is in terms of reference level to noise ratio—to obtain the effective signal-to-noise ratio with tape the maximum record level must be added to the following figures, and this addition will depend upon the tape type used.

Mains hum in the output was at a level less than —85 dB even when the Nagra was mains powered or the batteries were on charge from the mains charger unit. Using an induction coil to feed the replay head it was found that the replay amplifier did not exhibit excessive distortion until the output level was ±14 dB above a reference flux level of 320 nWb/m which is a more than adequate margin for replaying any known type of high output tape.

When the modulometer was switched to the 'tape' position it indicated —4 dB when a reference level of 320 pWb/mm was replayed at any of the three tape speeds and with either NAB or CCIR replay equalisation.

As received, the machine was adjusted for 3M *206* tape and this material was used for checking the record/replay performance without any adjustment of the machine. At a tape speed of 38 cm/s with either Nagramaster or CCIR equalisation, the overall frequency response was within ±1 dB from 25 to 20k Hz with less than 0.5 dB difference between the left and right channels. Reducing the tape speed to 19 cm/s also produced excellent results with the overall response within ±1 dB from 20 to 15k Hz or within ±2 dB from 20 to 20k Hz.

The performance at a tape speed of 9.5 cm/s was not so good due to a rising treble characteristic on both channels and an imbalance between channels of 2 dB above 7k Hz. however the response remained within ±2 dB from 40 to 10k Hz. I do, however, have the impression that a little adjustment could readily improve this performance.

Distortion was determined by the normal method of finding the 3 per cent third harmonic point at mid-frequencies which occurred at a leve lo f9.6 dB above 320 nWb/m at a tape speed of 38 cm/s with either CCIR or Nagramaster equalisation. This fell to +7.9 dB at 19 cm/s and to +11 dB above a reference level of 250 pWb/mm at 9.5 cm/s.

Adding these distortion levels to the noise

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REFERENCE LEVEL TO NOISE RATIO

Tape speed	Reference level	Left channel	Right
38 cm/s CCIR	320 pWb/mm		
Replay chain only—no tape		76.5 dB(A)	76.2 dB(A)
Bulk erased 3M *206*		70.6 dB(A)	70.2 dB(A)
Machine erased 3M *206*		65.6 dB(A)	64.5 dB(A)
38 cm/s Nagramaster	320 pWb/mm		
Replay chain only—no tape		78.6 dB(A)	78.2 dB(A)
Bulk erased 3M *206*		72.3 dB(A)	72.2 dB(A)
Machine erased 3M *206*		66.0 dB(A)	67.4 dB(A)
19 cm/s CCIR	320 pWb/mm		
Replay chain only—no tape		69.8 dB(A)	69.5 dB(A)
Bulk erased 3M *206*		67.0 dB(A)	66.2 dB(A)
Machine erased 3M *206*		63.8 dB(A)	62.0 dB(A)
9.5 cm/s CCIR	250 pWb/mm		
Replay chain only—no tape		58.8 dB(A)	58.6 dB(A)
Bulk erased 3M *206*		58.1 dB(A)	57.6 dB(A)
Machine erased 3M *206*		57.0 dB(A)	56.0 dB(A)

levels obtained when testing the replay chain determines the effective signal-to-noise ratio when using 3M *206*:

	Signal-to-noise ratio (3 per cent third harmonic to 'A' weighted noise)
38 cm/s Nagramaster	77 dB(A)
38 cm/s CCIR	75 dB(A)
19 cm/s CCIR	71 dB(A)
9.5 cm/s CCIR	68 dB(A)

Certainly this performance is excellent but, with the addition of a noise reduction system such as Dolby *A*, will give absolutely top quality mastering with a potential signal-to-noise ratio of 87 dB (A)

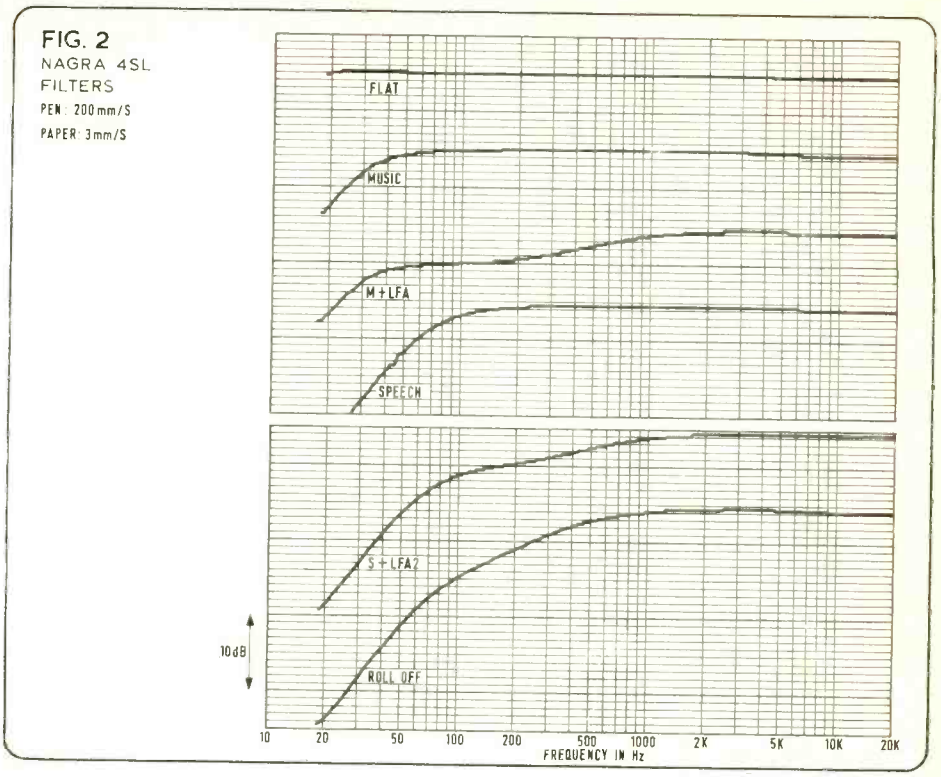
Third harmonic distortion at lower levels was also good, the distortion at zero indication on the modulometer (corresponding to about +4 dB on a reference level of 320 pWb/mm) was consistently below 1 per cent.

The limiter, which can be used in the record mode, should not be confused with the common type of automatic gain control as it has a very limited range of overload protection which limits any possibility of level 'pumping'. In practice the record level is set in the normal way and the limiter then switched into circuit when required: it then protects against overloads of up to 6 dB excessive level with a rapid attack time and giving full recovery of level within 300 ms. In spite of this rapid operating time, low frequency tone bursts did not produce any clicks or other defects which are common to fast operating limiters.

Operation of the meter is also rapid, and in fact a little faster in attack time than the standard ppm with a rise time to within 1 dB of the steady state level in the order of 15 ms; the fallback time is however considerably more rapid than the standard ppm occupying 1s to the–40 dB mark at the bottom end of the scale.

Crosstalk between the left and right channels was in excess of 55 dB at medium and high frequencies, falling to 40 dB at its worst around 50 Hz. Likewise, erasure was really good, a 1k Hz signal being erased to more than 80 dB which is well below noise level and completely inaudible.

Fig. 2 shows the six available filter characteristics on the record side, which give more than adequate selection of characteristics for any normal requirements.



Inputs and outputs

The two line outputs at the Tuchel socket offer an input impedance of 56 kΩ with the Nagra input adaptor which is supplied with the recorder, at a sensitivity of 140 mV for zero indication on the meter. Without the input adaptor, the line input is a current input with a sensitivity of 2.5 μA with an overload margin of around 50 dB which is of course ample by any standards. The line input did not contribute any measurable noise to the recorder, even at maximum gain.

Noise from the microphone inputs was also extremely low at all gain settings of the input control, the worst case giving a noise factor of 1 dB: that is, the noise introduced by the amplifier was only 1 dB above the theoretical minimum possible noise from the resistive source. The following table shows the measured input conditions for each of the switched input conditions:

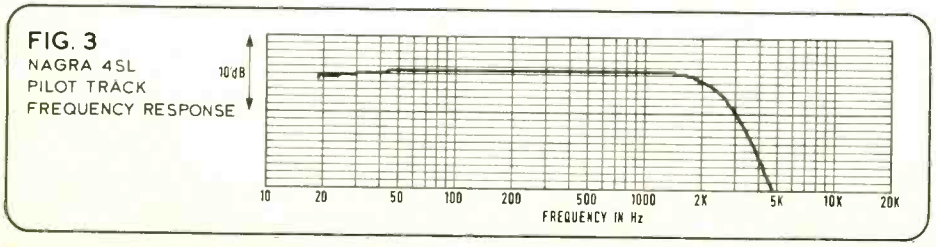
	Sensitivity for 0 dB on modulometer	Input impedance	Polarisation voltage
50Ω dynamic mic	130 μV	1.6 kΩ	Nil
200 dynamic mic	260 μV	6.2 kΩ	Nil
+12V capacitor	1.3 mV	1.3 kΩ	+12.02
+48V capacitor	1.3 mV	10 kΩ	+48.42
—12V capacitor	1.3 mV	930Ω	—10.05
T balanced capacitor	5.0 mV		+12.03

In all the above cases the input overload limit was +46 dB on the input sensitivity which is quite adequate for all common microphones but could in unusual circumstances be inadequate in the case of some capacitor microphones which are capable of delivering 0 dBm.

On the output end, the two line outputs for each channel are paralleled at the Tuchel socket and at the banana sockets and have an internal impedance around 5Ω suitable for driving unbalanced 600Ω lines. The output level is fixed such that a reference level of 320 pWb/mm on tape gives an output very close to —2 dBm at all three tape speeds, with the possibility of giving up to +14 dBm should a tape capable of recording such a high flux level be produced.

The remaining outputs are the headphone output which operates in conjunction with a switched attenuator and has a suitable range for most headphones, and the noise reduction system output. The latter is a slight peculiarity as it delivers 560 mV for zero modulometer reading into a recommended minimum load of 47 kΩ and operates in conjunction with the noise reduction system input which has the same sensitivity. These conditions are not compatible in level or impedance with the Dolby *360*.

A final point on the overall record/replay performance. The operation of any switches on the machine, such as the modulometer illumination switch and the meter switch, did not produce any audible effect upon the recording.



Pilot system

The pilot system of the Nagra *4SL* is a longitudinal track down the centre of the tape which carries a frequency modulated signal about a carrier frequency of 13.5k Hz. It was found that, provided that the headshield was in position, there was no audible crosstalk between the audio and pilot tracks or vice

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versa. However, if the headshield was not in position there was crosstalk between pilot record and audio replay although this crosstalk was not recorded on to tape.

This pilot track may also be used for recording other signals in the bandwidth dc to 2.5k Hz, the frequency response being shown in fig. 3, but the recorded quality is, as Nagra rightly say, mediocre.

When used in the direct input mode, the pilot signal switches in and is shown on the pilot indicator when the input signal is raised to 950 mV rms and while both recording or replaying the incoming pilot signal is available as a high level output at the 'cue' socket of the recorder. With the aid of the optional extra 'commentary microphone' it is possible to record commentary on the pilot track in either the record or replay modes of the audio tracks; a facility that can be extremely useful when the Nagra is used for sound or vibration recording.

Summary

The many facilities on the Nagra *4SL* make reviewing this machine a long and complex job, particularly in view of the very tight specification on its performance. I have not mentioned all the parameters and facilities but hope I have adequately covered the most important and interesting facilities to the majority of potential users.

In the body of this review I have mentioned a few peculiarities and potential shortcomings but it is really impossible to fault this machine which is completely outstanding in both its mechanical and electroacoustic performance as well as its standard of construction.

Overall, having regard to the price (which is far from cheap) and the overall standard of performance and facilities, the Nagra *4SL* offers better value than many studio machines.

FIELD TRIALS

NAGRA 4S

By Angus McKenzie

FOR OVER 20 years, Nagra recorders have had almost a legendary reputation. All the early models had a tape transport mechanism worked by a clockwork motor, and had very low wow and flutter. Up to comparatively recently it was necessary to wait months, or sometimes even more than a year, for delivery of a machine, such was the demand. Fortunately, in the last few years Nagra have expanded their manufacturing facilities, and their agents in this country can usually supply from stock.

It is quite obvious from using a Nagra for a few months for this field trial that the machine has not been designed to a price but for optimum performance. Although Nagras have more often been used by film recording engineers, and have been designed to enable accessories to be added to work with film equipment, I am only concentrating on the basic performance for recording stereo programmes without any special sync facilities.

The deck can accept up to 18 cm spools with the lid open but with the lid closed 12 cm spools are the maximum that can be accommodated.

The machine has very similar facilities to the Stellavox but, where the latter concentrates on the best performance for minimum weight and maximum portability, the Nagra concentrates on the maximum performance with the fullest possible facilities and the ability to record longer takes without spool changes.

The microphone inputs are normally supplied with common male sockets but fortunately female sockets can just be fitted into the same space. Facilities are provided for accepting outputs for 60 or 200 ohm dynamic microphones. Phantom powered capacitor microphones requiring either 9 or 48V can be energised, as can 12V powered models and also—12V phantom types. There is even a phase reversal switch on the microphone input. The performance of the circuitry was extremely good, although it was felt that not quite enough gain was available to record quiet sounds satisfactorily, a maximum input sensitivity of –69 dBm being available for 200 ohm dynamic microphones. All capacitor microphone input positions have 15 dB less sensitivity. All microphone input positions bridge the microphone with well over five times the likely source impedance, allowing the use of even 600 ohm types if necessary. The input clipping level for 200 ohm dynamic microphones is –25 dBm, whereas –10 dBm is the clipping level for capacitor types. This is more than adequate for all normal usage. Some types of capacitor microphone, such as the Calrec *1050* series, have much less output than average and the transformation ratio at the input is not really satisfactory for this type since there is insufficient gain in the overall system. I therefore modified the —12V phantom position to give 10 dB more gain, at the same time replacing the negative voltage with +48V by altering connections to the switch. The gain change between microphone types, incidentally, is given by a 10 dB voltage change through altering the microphone transformer's primary tap, and 5 dB by altering feedback around the microphone preamplifier.

The Nagra *4* is also equipped with an unbalanced line input and is supplied with an input lead in which a necessary series resistor is incorporated at the input plug. A switch on the front panel selects either microphone or line input, and a six-position selector switch allows different bass roll off characteristics to be chosen with both steep and gradual roll off positions. This was found very useful for reducing rumble when recording, as I have done, in locations such as churches and coal mines.

The facility of ganging or unganging the record level controls was found extremely useful since it was possible to obtain an excellent stereo gain balance and then adjust the level in the ganged position over quite a long range without any swinging of stereo positions.

The Nagra is provided with extensive metering facilities. A twin needle ppm enables left and right levels to be read simultaneously. An additional facility allows the metering on one needle of the highest channel while the other needle is showing the presence of out of phase information (difference channel). The out of phase position has a useful bass boost and treble cut permanently inserted to exaggerate the reading of low frequency out of phase components which would cause problems in disc cutting. The ppm can monitor the signal before it goes into the record amplifier, or off tape. Motor current and the state of the batteries can be monitored and a pushbutton illuminates the ppm. Although the audio metering is of a ppm type with a logarithmic scale, the attack time is not quite as fast as that on most meters designed to BBC specification. Some types of music metered approximately 3 dB less than they would on the best instrument and it appears that the metering circuit in the stereo model has only half wave rectification. This, in my opinion, might be improved on.

Overall response at both 38 and 19 cm/s is remarkably flat, and almost no difference in response or quality was heard when a programme before and after tape was compared. The machine tested was set up to record to the DIN curves, and the playback was very accurately set to obtain a flat response from test tapes. A switch allows NAB recordings to be replayed with the correct equalisation, and once again the curve was very accurately reproduced.

A further special equalisation position is available for 38 cm/s for record and playback, and this is designated 'Nagra master equalisation'. The replay curve for this approximates to 17.5 μs and therefore considerably more treble is recorded on the tape, with a subsequent reduction of hiss on playback. I can only recommend this characteristic for making recordings of programmes having a limited amount of power at high frequencies, since there is a considerable danger of high frequency compression. At 9.5 cm/s the overall response was curtailed on replay above 12 kHz, although recordings made on the machine, replayed on other machines with narrow gap replay heads

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with a response extending to over 15 kHz.

The Nagra has predistortion built into the record amplifier which can be preset to achieve very low distortion figures from almost any make of tape, normally used professionally at 38 cm/s. For example, a distortion level of only 0.25 per cent was noted at 510 nWb/m at 1 kHz on a tape which would normally have a distortion, without this technique, of approximately 1.5 per cent, at the same level. There is one snag with the use of this technique, however, and that is the severe and sudden increase of distortion above maximum recording level. This can be particularly serious when the tendency for the meters to under-read peak levels is not allowed for, by an inexperienced operator.

Unfortunately the stereo Nagra is at present only available with record and playback heads having very wide guard bands between tracks. For this reason it is not possible to obtain quite as good an overall signal-to-noise ratio as would be possible with narrow guardband heads. The electronics, however, are so well designed and the record head contour so carefully controlled in manufacture that the signal-to-noise ratio experienced in terms of recorded noise per mm of track width recorded is nevertheless very satisfactory. It is only fair to point out, however, that a minor fault developed on the machine during use which caused a high pitched tone to be recorded at a very low level on the tape. This was produced by the circuit which drove the capstan motor giving some leakage through to the audio circuits. Changing one of the printed circuit boards immediately corrected this.

The tape deck itself is provided with some very useful facilities. Although it is unfortunately only possible to spool forwards at two or three times normal playing speed, quite fast rewinding is possible. To rewind, one pulls out a clutch which removes a part of the tape transport mechanism from the vicinity of the tape path, thus giving less friction. The playback head is provided with a mumetal shield allowing the machine to replay tapes in the proximity of ac magnetic fields. The entire tape guidance and capstan assembly are so perfectly machined that wow and flutter are not noticeable on recordings made at either 38 or 19 cm/s, even when the machine is used on its internal batteries. At 9.5 cm/s, the wow and flutter performance compares very favourably with that of the finest professional machine recording at this speed.

Headphone monitoring

A stereo headphone jack socket is provided with a stepped attenuator for monitoring, and one of the many miniature toggle switches allows the user to hear before and after tape. The level available on this socket is more than adequate for 200 ohm headphones, which are normally recommended, but I found a slight lack of drive in some circumstances for headphones having a much higher impedance than this. A stepped attenuator varies the resistance in series with the headphones and makes very little audible level difference on high impedance models such as the Sennheiser *HD414*. The level changes were adequate, however, when used with the same manufacturer's *HD110*. A pushbutton allows headphones to monitor in mono, paralleling the outputs of the two channels. This allows phase to be checked without affecting the recording.

The Nagra is equipped with both a seven-pin line out socket and banana sockets, both giving unbalanced outputs where the output level is normally set at 1V rms equalling a tone level of 0 dB seen on the meter. This level is unfortunately a little low for many purposes but is limited by the available battery rail voltage. External output transformers are available to give a balanced output at a high voltage, but unfortunately the line output stage does not like being loaded with too low an impedance, distortion occurring if this is done.

Of the many other facilities, one particularly interesting one is the provision of a socket to introduce an external noise reduction unit. Nagra are at present working in association with Dolby Laboratories to provide a built-in Dolby A system. In the meantime, however,

an external one having a sensitivity of approximately 200 mV for a recorded flux of 185 nWb/m will work extremely well. Any external equipment introduced at this point can be switched in and out at will. There are also built-in limiters which can be switched in and out of the recording chain if required. Although they worked very well, some types of material, and in particular speech, sometimes sounded clipped on transients.

A further switch allows the machine to be set to mono, in which case the two inputs can be mixed with the combined output being fed to both recorded channels. A 6 dB gain position for stereo, designated 'high sensitivity', is also provided but unfortunately still gives inadequate gain for recording quiet sounds.

Up to recently Nagras have had non-detachable lids, but the manufacturers now supply new hinges which allow the lid to be removed.

I have used the Nagra for some months to make safety extra masters on several recording sessions, and on some occasions where speed of setting up and simplification of equipment has been essential. It was possible to make a very fine stereo recording of an amateur dramatic production using two AKG *412* microphones straight into the machine, and without even headphone monitoring. An organ recording of a public recital by Ralph Davier was made at 38 cm/s with a stereo Neumann *SM69* fet. The microphone, including its phantom power supply/polar diagram box, was once again powered from the Nagra. Only ten minutes were required to set up completely, and only five minutes to vacate the church. When the tapes were replayed on my Philips *Pro 36*, the reproduced quality was indistinguishable from that which could have been obtained under proper session conditions, with the exception that some slight hiss was noticed in quiet passages as no noise reduction was used.

I was also asked to go to Hove to record for posterity the first performance of the late Havergal Brian's *23rd Psalm* for chorus, soloist and full symphony orchestra. Time made it impossible to take my complete equipment but, despite monitoring with headphones and working off batteries, the results achieved with the Nagra and the Neumann stereo microphone were quite astonishing.

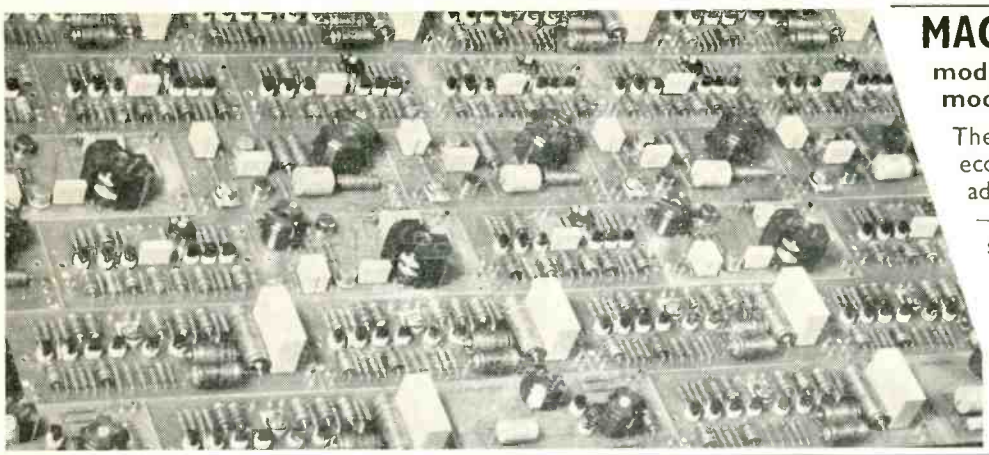
Further use

I further used the machine under portable conditions on recent visit to the BASF factories at Willstät and Ludwigshaven where I was doing some recording for Radio London. The Nagra was additionally taken on a visit to a coal mine to record sound effects. Under these circumstances, the only snag was the rather excessive weight, as compared with the Stellavox *SP7*. However, this should be considered a very small disadvantage in a machine which even includes monitor loudspeakers for playing back recordings in mono. One charge of the nickel cadmium batteries in more than enough to allow a full day's recording under quite arduous conditions. A mains unit is available which can allow the machine to work directly off mains, or can trickle charge it with an extra accessory unit.

In conclusion, I recommend the Nagra *4* very strongly indeed. The machine can be operated in any position without apparent loss of performance. The internal circuitry is so neatly designed and constructed that setting up and servicing are extremely simple, although some of the circuitry is very advanced in design to reduce battery consumption without deterioration of performance.

Although the Nagra is now rather expensive, I anticipate that many studios will find that, once they have one, they will regard it as indispensable. It is so easily portable and adaptable that it is even useful for making quick copies off other machines.

BASF have now developed a new tape to allow the long playing time of 28 minutes at at 38 cm/sec at studio quality. Designated *DPR26/LH*, this backed to allow easy editing, but has identical characteristics to their type *LPR35LH* on the latest sample, under one per cent distortion is reached on the Nagra when recording at a level of 7 dB above 320 nWb/m. I must congratulate Mr. Kudelski, the designer, for producing what I regard as the most remarkable tape recorder available in the world, irrespective of size or cost.



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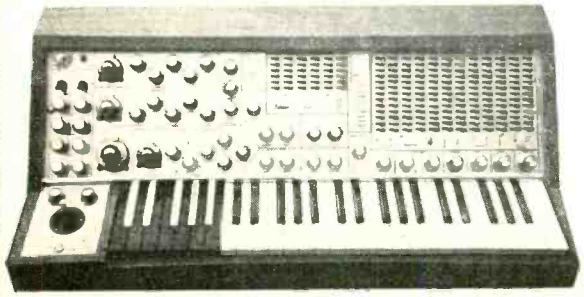

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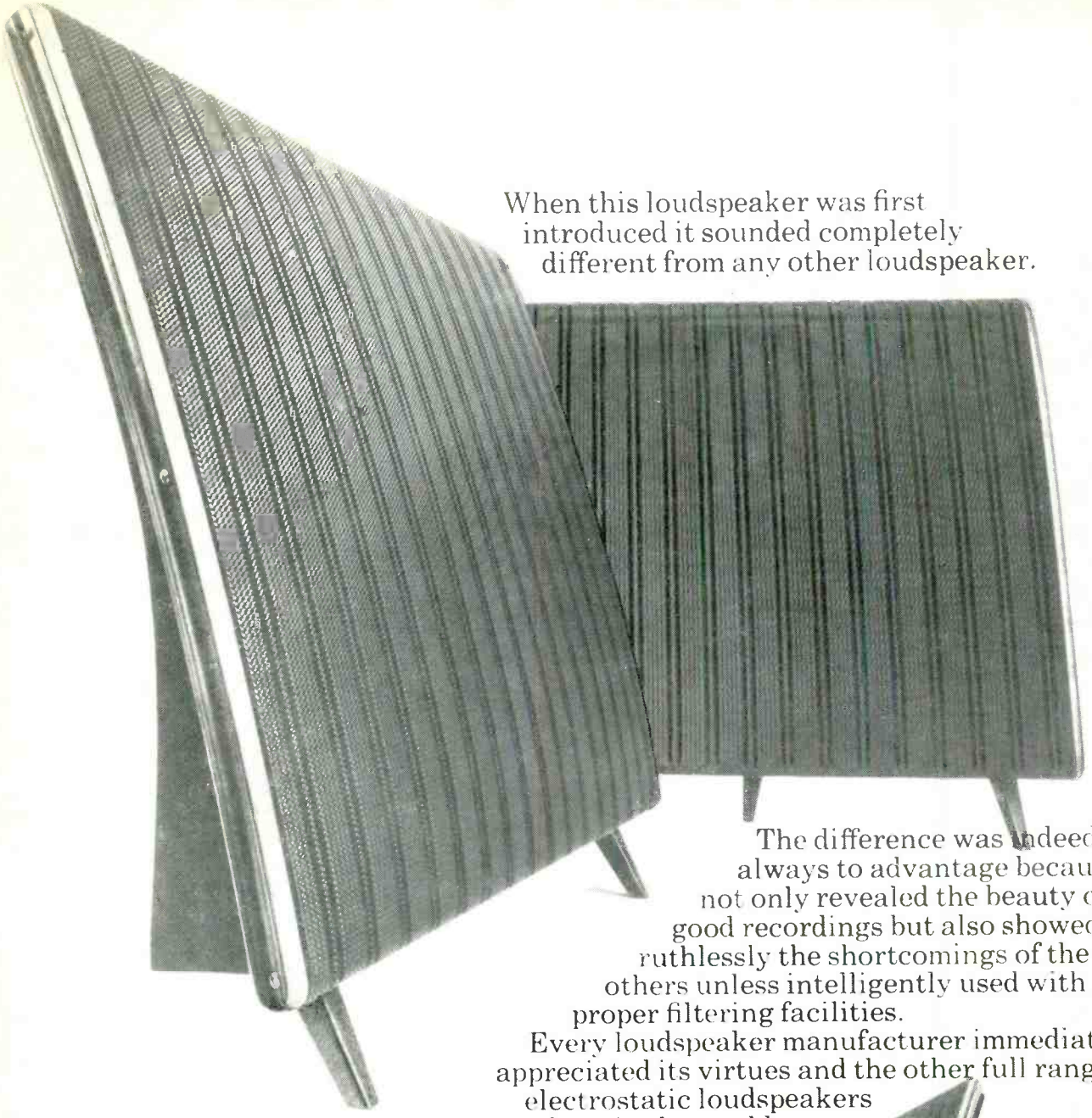

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