STUDIO SOUND

MAY 1970 3s (15p)

and tape recorder

SURVEY OF PROFESSIONAL SOUND RECORDERS

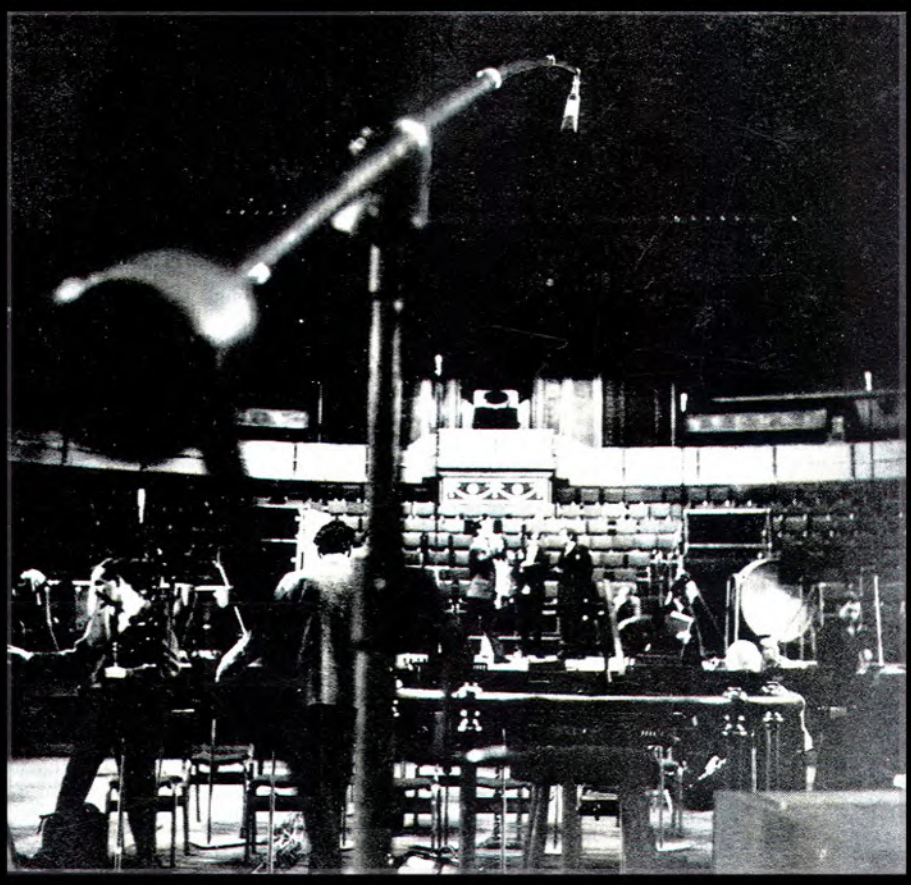
REMOTE CONTROL FOR A REVOX

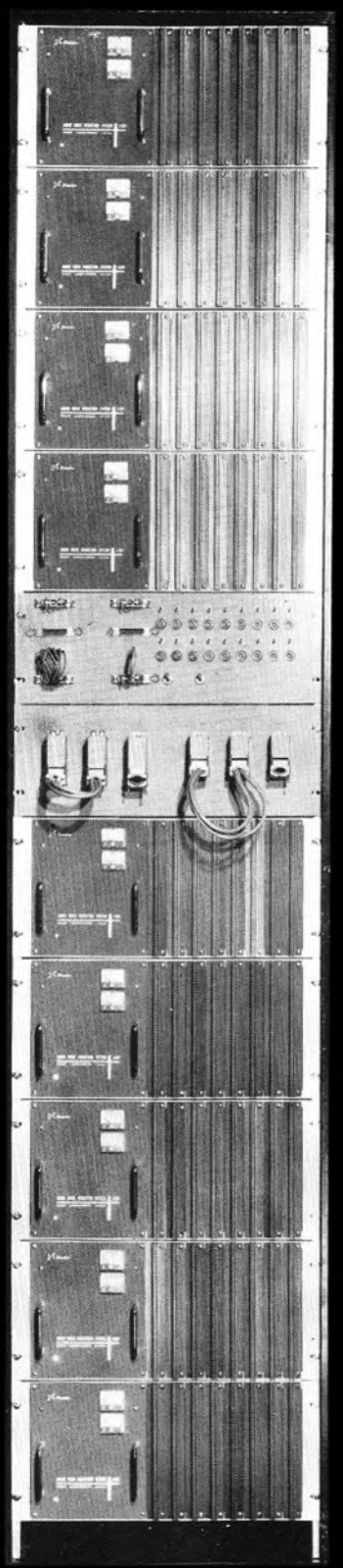
QUADRAVERDI

AROUND THE STUDIOS: ADVISION

PHILIPS PRO 12 AND FERROGRAPH 7 REVIEWS

RECORDING STUDIO TECHNIQUES: LINING UP





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OLYMPIC (installation shown)
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PYE
RCA
THE ROLLING STONES
SOUND TECHNIQUES
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Most tape recorders have at least one good feature. And they're sold with the emphasis on that one, to take your mind off the things they haven't got, or the things they'd rather not talk about.

Philips PRO 12 is different. It combines in one tape recorder all the features you can usually only find separately in others. And they're all up to the sort of standard that makes them leading selling points.

To start with, there's the frequency response. It betters DIN standard 45511, which gives the requirements for professional studio recorders. Even at its lowest tape speed of 3¾ ips, the PRO 12 is at least the equal of many large studio recorders currently in use at 15 ips. The sound quality of the PRO 12 is so good it could be used for immediate broadcast purposes.

The rest of the specifications are as you'd expect in a tape recorder of this quality: low harmonic distortion, good signal-to-noise ratio, minimum wow and flutter, excellent speed stability with the classic three-motor design.

In its standard version, the PRO 12 allows for twin-track stereo, twin-track mono and dual-track mono on ¼ inch tape; an alternative version allows for quarter-track stereo or mono.

It also has separate heads and separate amplifiers for both recording and playback at either of its speeds, 3¾ or 7½ ips, and provides before and after tape (A-B) monitoring either visually or aurally.

A stroboscope for checking tape speeds is built in, and there are individual correction filters at both speeds plus microphone, diode and line inputs for each channel.

Among the other things you can do with the PRO 12 are transcribe from one track to the other, fade in, fade out, pause, cue, dub, and get echo effects.

In fact the performance specification is so varied yet so exact that every machine is tested individually as it is assembled, and then certified by the engineer whose signature is on the test report that accompanies every PRO 12.

If you'd like the full information on the features of the PRO 12, plus a full set of performance figures, write for our brochure. No matter what you compare it with, you won't find anything like the PRO 12 at anything like the price.

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4" STD	300'	14/6	11/9
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7" ,,	1200'	36/7	29/-
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4½" ,,	600'	22/-	17/3
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5¾" ,,	1200'	26/4	28/9
7" ,,	1800'	51/6	41/-
4" D/P	600'	26/-	20/9
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TAPE RECORDERS

		Cash Price
Akai 1710W & L...	£109 0 0	£89 10 0
Akai 4000D ...	£92 3 0	£78 7 6
Akai M10 ...	£245 0 0	Prices
Akai X500W ...	£180 0 0	on
Akai X5000L ...	£180 0 0	Application
Aiwa 101V & Radio	£60 8 0	£50 8 0
Grundig TK120 ...	£39 5 0	£29 19 6
Grundig TK144 ...	£49 19 0	£42 5 0
Grundig TK124 ...	£44 18 0	£38 0 0
Grundig TK149 ...	£57 12 8	£48 15 0
Philips EL3302 Cassette ...	£28 7 6	£22 19 0
Philips EL3312 Stereo ...	£67 17 11	£61 10 0
Standard SR100 Cassette ...	£22 0 0	£15 15 0
Philips 4308 ...	£60 10 0	£61 18 0
Philips 4404 ...	£83 0 0	£71 4 6
Sanyo M26 Cassette	—	£20 19 6
Teleton T710 ...	£34 15 0	£29 19 6
Tandberg, Rotel, Ferrograph, Uher, Telefunken, Dual, Vortexion, Truvox	Send for Special List of CAVE'S Reduced Prices.	

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Eagle SE1 ...	—	£4 7 3
Shriro Secom 65Q	—	£3 12 6
Pioneer SE30 ...	£12 12 0	£11 0 0
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Eagle DM16HL ...	£6 12 4	£5 10 0
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Beyer M81HL ...	£11 5 0	£10 0 0
Beyer M81HL ...	£22 18 6	£20 5 6
Philips AKGD19C	£18 0 0	£16 4 0
Philips ADGD110HL	£7 15 0	£7 5 0
Shure 560 ...	£16 10 0	£15 10 0

AMPLIFIERS

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Leak 70 Chassis ...	£63 0 0	£52 0 0
Leak 70 Case ...	£69 10 0	£57 10 0
Leak 30 Plus Chassis	£53 0 0	£44 14 6
Leak 30 Plus Case	£59 10 0	£49 19 6
Armstrong 521 ...	£52 0 0	£43 10 0
Ravensbourne Case	£64 0 0	£54 0 0
Ravensbrook Case	£47 10 0	£41 7 0
Quad 33 & 303 ...	Prices on application	
Teleton 203E ...	£27 15 0	£20 15 0
Teleton SAQ 205E	£26 5 0	£22 5 0
Teleton GA101 Stereo	£37 10 0	£31 7 6
Goodmans Maxamp	£54 0 0	£43 10 0
Lux SQ 1220 ...	£124 10 0	£105 16 0
Lux SQ 77T ...	£67 7 6	£59 7 6
Lux SQ 505 ...	£97 10 0	£80 12 0
Rotel 100 Amp. ...	£45 10 0	£37 10 0
Rotel RA 840 ...	£75 0 0	£69 0 0
Sansui AU222 ...	£62 17 7	£55 0 0
Sansui AU555 ...	£80 8 7	£70 8 6
Sansui AU777 ...	£115 15 3	£101 6 0
Ferrograph F307...	£59 0 0	£54 0 0
Radon 404 ...	—	£18 19 0
Deccasound A600	£25 0 0	£22 0 0
Deccasound A1200	£35 0 0	£31 0 0

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		Cash Price
Wharfedale Dentons	£17 19 2	£15 0 0
Wharfedale S/ Lintons... ...	£21 9 0	£18 0 0
Wharfedale Melton	£29 10 0	£22 19 6
Wharfedale Unit 3	£10 19 0	£9 5 6
Leak Mini-Sandwich	£29 15 0	£22 19 6

TUNER-AMPLIFIERS

	Cash Price
Armstrong 526	£85 17 6
Armstrong 525	£76 10 0
Lux SQ HQ555	£148 0 0
Rotel FAX 330	£85 10 0
Rotel FAX 550	£107 2 6
Rotel FAX 660	£116 5 0
Sansui 350	£116 2 6
Sansui 400	£109 10 0
Sansui 2000	£145 17 0
Sansui 5000	£186 16 6
Wien 2312	£59 14 6
Teleton F2000	£59 17 0
Teleton 7AT...	£92 4 0
General R4200	£35 10 0
Goodmans 3000	£68 2 7
Pioneer SX 440	£101 0 0
Pioneer SX 770	£144 8 6
Pioneer SX 1500	£192 19 6

TUNERS

	Cash Price
Leak Stereofetic (case) ...	£65 7 0
Leak Stereofectic (chassis)...	£48 10 0
Quad FM ...	Prices on application
Armstrong 523	£43 12 0
Armstrong 524	£34 0 0
Goodmans Stereomax ...	£68 0 0
Armstrong 424	£29 10 0

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Stereo plus synchrotone
Mono: full track neopilot
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3.75 : 7.5 : 15 : 30ips
5" spools : 10.5 NAB
6 inputs (2 mic bal)
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10.5" x 8" x 2.5"

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hot tip

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Unitrack prototype 16 track
tape machine is
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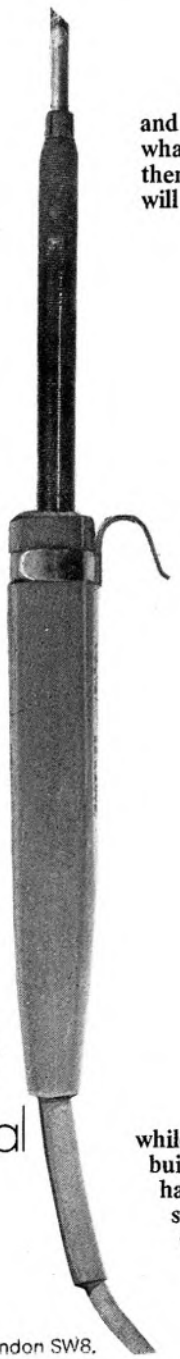
to go out on trial
to six great studios



and if they are looking for
what we think they are
then all the blood, sweat and tears
will have paid off.

unitrack

studio recording equipment
engineered for the professional

while we sweat over a hot iron
building these beauties, John S. Alcock, Esquire
has been talking his head off to all and
sundry, he can usually be heard on
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Unitrack Equipment Limited, 590 Wandsworth Road, London SW8. telephone 01-720-1124

Ferrograph
Series 7 tape recorder

Where a tape recorder must be good and reliable, you'll find Ferrographs. In a radio station, for example, tape recorders are in constant use. Technical performance is all-important; absolute dependability and split-second control are essential. So Radio Leeds uses Ferrograph recorders.

Ferrograph Series 7 tape recorders are British made, available in mono and stereo, with and without end amplifiers. All instruments are solid state, three speeds. All incorporate an unrivalled range of facilities, including two inputs per channel with independent mixing, independent tone controls on each channel, endless loop, signal-level meters for each channel on playback and record, re-record on stereo models, and many others. The output is 10 watts per channel. Ferrograph recorders are available in elegant hardwood or in a vinyl case to suit any decor and method of use.

Follow the professionals; choose the recorder you know will serve you best at home and in your work: Ferrograph. Your local Ferrograph specialist will be pleased to demonstrate it to you. Alternatively, please write or ring for details and address of nearest stockist. The Ferrograph Co Ltd, The Hyde, Edgware Road, Colindale, London NW9 Tel: 01-205 2241, Telex: 27774

International Distributors:
Leroya Industries Pty,
266 Hay Street, Subiaco,
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Hamburg 39, Sierichstrasse 43,
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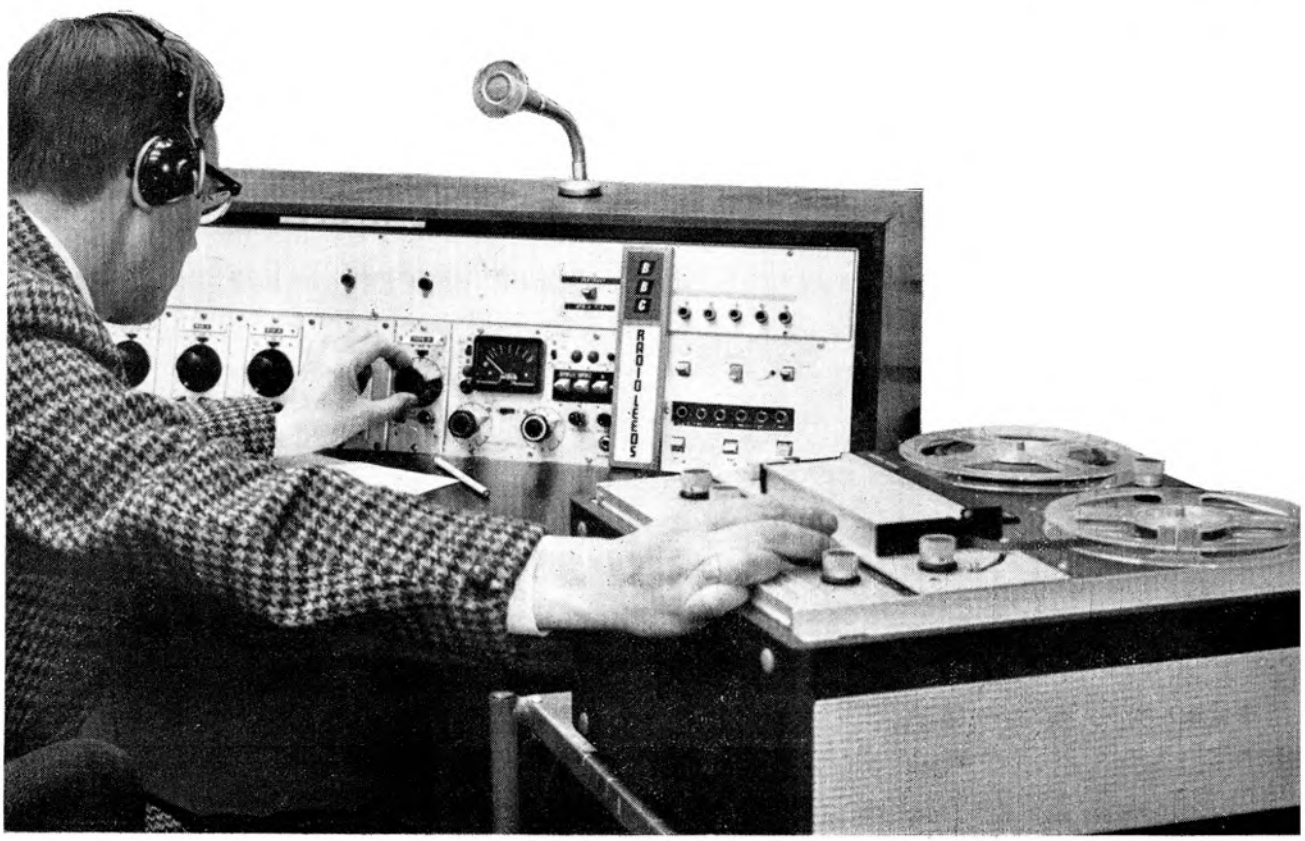
There are Ferrograph Distributors also in most other countries. Please obtain details from the London office.

Ferrograph



Studio Sound
& tape recorder

MAY 1970 VOLUME 12 NUMBER 5

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COVER PICTURE

In the foreground, a boom supporting the woodwind Neumann U87 microphone at the CBS Verdi Requiem session. Just visible in the background, our Deputy Editor and his wife making their debut on the Albert Hall stage.

SUBSCRIPTION RATES

Annual subscription rates to *Studio Sound* and its associated journal *Hi-Fi News* are 36s. ($5 or equivalent, overseas) and 44s. ($5.60) respectively. Six-month home subscriptions are 18s. *(Studio Sound)* and 22s. *(Hi-Fi News)*, from Link House Publications Ltd., Dingwall Avenue, Croydon CR9 2TA

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

IT SEEMS TO have started with the Moog. For two, three or four thousand pounds you can buy a small, medium or large rack of voltage-controlled oscillators, voltage-controlled amplifiers, white noise generators, voltage-controlled filters, envelope generator, and a piano-style keyboard. The inputs and outputs of each circuit unit are through standard jack sockets and, provided you have enough linking cables, you can connect anything to anything. Three oscillators might be tuned to a triad, for example, the entire chord being selected merely by pressing the root note on the keyboard. This signal may be fed through a mixer into a voltage-controlled amplifier and modulated by the amplitude of a low-frequency signal from a fourth oscillator —sine, square, sawtooth, or whatever you choose. The pulse/space ratio of all four oscillators may be altered at will and the amplitude of the modulating oscillator (lost yet?) varied by the amplitude of yet another LF oscillation. Then the whole caboodle can be fed into the envelope generator where attack, sustain, decay (and, if necessary, repeat) times can be adjusted to produce the most satisfying output from the external monitor.

The result, in the hands of an imaginative one-finger pianist, is an electronic musical instrument with an almost unlimited range of tone-colours: the instrument on which Walter Carlos produced the CBS discs *Switched-On Bach* and *The Well-Tempered Synthesizer*. It has two snags: firstly the cost prohibits it, as it prohibits new Steinways, to all but the wealthiest musicians. Secondly, being primarily a monophonic instrument (in the musical sense), it demands the connection of a multitrack tape recorder to reproduce polyphonic scores. This can be overcome to a limited extent by adding a second keyboard but the instrument's flexibility is then halved.

The cost barrier has recently been lowered by a London company, Electronic Music Studios Ltd., who are now manufacturing and marketing the *VCS3* (see page 185). Three oscillators, ring modulator, filter, envelope shaper, noise generator, filter and spring reveberation are combined in a portable unit selling at £330. The jack-patching arrangement is not used in this model; a 16 x 16 matrix connects the outputs in one plane with inputs in the other. Any output can be connected to any input through shorting plugs of panel-pin dimensions, the output of the second element being progressed to the input of a third, and so on. This provides all the flexibility of the Moog arrangement and is much more convenient to use and notate. Facilities for the insertion of external signals is made through jack sockets mounted at the rear. Once again the desirability of a multitrack recorder is evident.

A remarkable feature of both the Moog and *VCS3* devices is their ability to 'remember' and repeat very long sound sequences. This is achieved by interacting several control oscillators at very low frequencies.

The basic idea is extraordinarily appealing, particularly when compared with the monotonous output of electronic divider organs. It is also potentially cheaper than the latter—so much so that Robert Youngson's comment (*The Synthesis of Musical Instrument Tone*, November 1969) becomes almost believable: 'There is little doubt that, on economic grounds alone, the present conventional musical instruments will give way to electronic.' There is little doubt in our minds that, once the mass-production boys realise the simplicity of these electronic synthesisers, the market will be flooded with low-price mini-Moogs. The hegemony of the electric guitar might then be ended, and with it might go the tyranny of the piano keyboard. The *VCS3* doesn't have one.

SONY

Sound heart for your sound system . . . The Sony TA-1010 stereo amplifier provides a powerful and reliable hi-fi centre-piece at moderate cost.
This solid-state unit employs high quality transistors for trouble-free, reliable operation, and a rated output of 15 watts per channel ensures smooth amplification over a wide frequency range. A full selection of input/output facilities, including headphone output, provide complete freedom to create the sound system of your choice.
Model TA-1010 – the perfect choice for discerning listeners.

Recommended retail price £59.15.0

GENERAL
Circuit 20 transistors, 5 diodes.
Power requirements AC 100, 117, 220 or 240V, 50 or 60 Hz.
Power consumption Approximately 75 watts.
AC outlets Two switched, one unswitched, total 300 watts.
Dimensions $16\frac{9}{16}$ in. (w) x $4\frac{7}{8}$ in. (h) x $9\frac{11}{16}$ in. (d).
Weight 10 lb.

POWER AMPLIFIER SECTION
Power output Rated output, 15 watts per channel both channels operating.
Harmonic distortion Less than 0·5% at rated output (at 1 kHz).
Intermodulation distortion (60 Hz : 7 kHz = 4 : 1) Less than 1% at rated output.

PREAMPLIFIER SECTION
Frequency response Tuner, Aux-1, Aux-2, Tape: 20 – 60,000 Hz 0 dB;
Phono-1, Phono-2, RIAA equalization curve ± 1 dB.
Tone controls Bass 100 Hz ± 10 dB: Treble 10 kHz ± 10 dB.
Filter High filter 6 dB/oct. above 5 kHz.
Loudness control 100 Hz + 8 dB, 10 kHz + 4 dB (Att. —30 dB).
Signal-to-noise ratio Phono-1, Phono-2, better than 70 dB, 3 mV; Tuner, Aux-1, Aux-2, Tape, Rec/PB, better than 90 dB, 250 mV.
Supplied accessories Plug, polishing cloth.
Optional accessories Stereo headphones DR–4A, DR–5A (low impedance), DR–4C (high impedance), Rec/PB cord, connecting cord RK–74, RK–81.

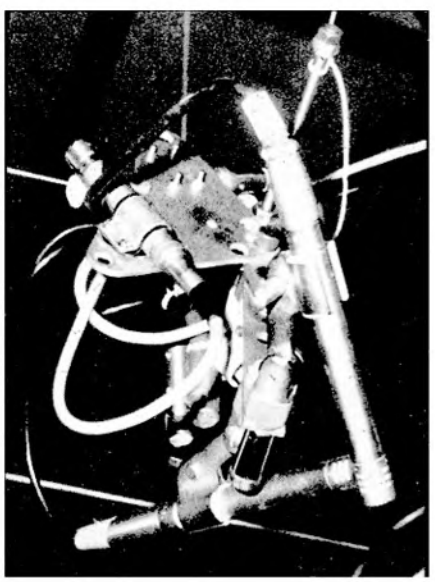
SONY®
RESEARCH MAKES THE DIFFERENCE Sony (UK) Ltd, Ascot Road, Bedfont, Feltham, Middlesex

studio diary

TA AT SU

TETRAHEDRAL AMBIOPHONY at Sussex University. On Sunday March 15, the first practical test of Granville Cooper's proposed four-channel sound reproduction system was made at the Institute of Educational Technology in Guildford. The Salomon Orchestra (playing Verdi, Bartok, Strauss and Ives—John Bauch on trombone) was relayed through four cardioid capacitor microphones some 4 m above and slightly behind the rostrum: a stereo pair pointing at a slight downwards angle to the orchestra plus a rear-facing vertical pair on the same mounting, pointing to the floor and roof at the back of the hall (Don't confuse the Cannon plugs in the photo.)

The microphone outputs were relayed to a distant room and monitored through two



Bowers & Wilkins loudspeakers (front left and right) plus floor- and ceiling-level speakers on the stereo centre line. A four-channel 12.5 mm TRD lent by Bob Woolford recorded the event for future comparison. A small panel of listeners, including Terence Long, Rex Baldock, Roderick Snell (Sussex University) and David Kirk, commuted between the main hall and the monitoring room. Impressions were noted on questionnaires prepared by Sid O-Connell (IET) and Granville Cooper. The aim of tetrahedral ambiophony is to capture the vertical dimension ignored in American four-channel systems. It will be described by G.C. in the June *Studio Sound*.

FESTIVAL DU SON

THE TWELFTH *Festival International du Son* took place in Paris from March 5 to 10. As in previous years, it was held in the Palais d'Orsay, a vast hotel-cum-disused-railway-station situated on the 'left bank' practically opposite the Louvre. It was almost certainly the last time for the Festival at this venue, which is due to be demolished shortly; a pity, as the many rooms and several large Salons have lent themselves admirably to a well balanced mixture of audio equipment demonstrations, displays of electronic musical instruments, technical lectures, concerts, recitals, diaporama shows, and live studio activities by l'ORTF.

The show encompassed about 100 exhibitors, with 15 British names (including Audix, Brenell and KEF), and offered on the equipment side a mixed bag of domestic reproducing gear for both disc and tape, with a fair selection of musical instruments and some items for studio use.

Demonstrations of four-channel stereo were given by Acoustic Research, an experience to be available again at the Sonex '70 show—see this page.

Various musical events, talks and discussions were miked (always in stereo, using crossed-pairs) by l'ORTF, either for live transmission or tape recording, and visitors were able to witness without hindrance the techniques employed. The French radio people are obviously *extremely keen* on stereo and the public reaction to it—BBC please note.

All-in-all, a lively and interesting show for all types of sound enthusiast. We wish the organisers equal success next year in fresh surroundings 'somewhere in Paris', and hope the style of their magnificently produced catalogue influences Cyril Rex-Hassan's autumn equivalent.

SONEX '70

AN EXHIBITION of radio, gramophone and tape reproduction equipment will open on Friday April 24 at the Skyway Hotel, Bath Road, Hayes, Middlesex. Entrance to 'Sonex 70' is by ticket, these being obtainable from dealers, by post from us (SAE please), or inside the current copy of *Hi-Fi News*. Fifty-one companies are participating, recording-equipment manufacturers comprising Akai, Brenell, Grampian, Pioneer, Quad, Revox and Vortexion.

Details of access to the Skyway Hotel are printed on the entry ticket (one ticket admits two persons). Bus services covering the area are 81b (Hounslow to Heathrow), 81 (Slough to Hounslow), 91 (Wandsworth to Hounslow West), 223 (Ruislip Station to Hounslow), 704/5 (Marble Arch to Heathrow Airport), Reading B (Victoria Coach Station to Heathrow), and a private service to the hotel from Hounslow West Tube Station. Car route: west along the M4 from London to Exit 4 (marked 'London Airport'). South to A4 and then east, the hotel being on the left.

MINIMOOG

A PORTABLE ELECTRONIC music synthesiser has been developed by Electronic Music Studios (London) Ltd., 49 Deodar Road, S.W.15, and is being marketed at £330. The *VCS3* ('Voltage Controlled Studio') comprises two 1 Hz to 10 kHz oscillators and a 0.025 to 500 Hz modulating oscillator. Oscillator 1 supplies sine and ramp waveforms, square and ramp being obtainable from Oscillator 2. An IC transformerless ring modulator, spring reverberation unit, manual or voltage controlled filter, envelope generator, noise generator, and mixing facilities may be grouped in series or parallel (using a 16 x 16 pegboard) to produce a very wide variety of sound effects and instrument syntheses. Other facilities include mixing, internal two-channel loudspeaker monitoring, meter indication of control voltage and signal level (calibrated in mA), and stereo panning. The unit is essentially L-shaped, with sloping front panels, and measures 438 x 444 x 419 mm.

BSI RECOMMEND METRIC RECORDING STANDARDS

THE 1970 EDITION of British Standard 1568/Part 1 entitled *Magnetic Tape Recording Equipment* has been produced in metric with Imperial equivalents in brackets. The next edition will be entirely metric. The standard relates to reel-to-reel studio, commercial and domestic systems, and makes little attempt to round off metric measurements in a fashion that would have encouraged everyday use. The four common tape speeds are referred to as 38.1, 19.05, 9.53 and 4.76 cm/s (all $\pm 0.5\%$ for professional and commercial purposes). Equivalents of 0.25, 0.5, 1 and 2 inch tape widths are specified as 6.25, 12.7, 25.4 and 50.8 mm. Tolerance on 6.25 mm is ± 0.05 mm and for greater widths is $+0$ -0.1 mm. Published by British Standards Institution, 2 Park Street, London, W17 4AA.

STUDIOS AT AUDIO FAIR?

PARTICIPATION OF musical-instrument manufacturers and recording studios is being sought for the October *International Audio and Music Fair*, to be held from Monday 19 (trade only) to Saturday 24. The exhibition remains at the Olympia but loses the Photo-Cine Fair with which it was joined last year. Lectures and some live music are expected. Admission will be 5s and opening times are 2 p.m. (Monday) and 10 a.m. for the rest of the week. Closing time is 9 p.m.

NEXT MONTH

ONE OF THE popular constructional features ever published in this journal was David Robinson's *Studio Quality Mixer* (1964). An updated version will be detailed in a series starting in the June issue. A. J. Waldron describes a loudspeaker suspension to combat Neighbour Effect, David Kirk looks at Metric, and Adrian Hope, in *Commercial Break*, covers TV advertising techniques.

Vortexion

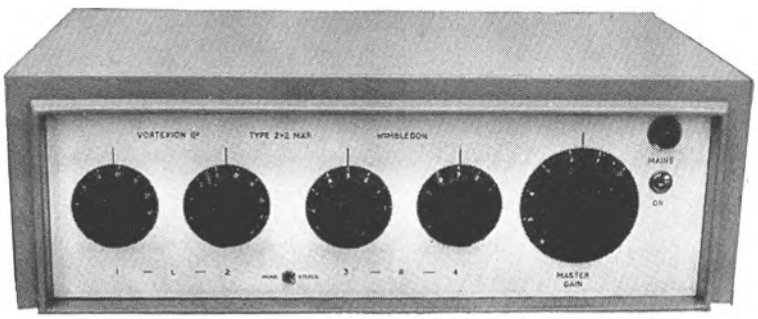
STEREO MIXERS

These electronic Stereo Mixers range from 2+2 to 5+5 input channels, with left and right outputs at 500 millivolts into 20K ohms up to infinity.

Separate control knobs are provided for L & R signals on each stereo channel so that a Mono/Stereo changeover switch provided can give from four to ten channels for monaural operation, in which state the L & R outputs provide identical signals.

A single knob ganged Master Volume control is fitted, plus a pilot indicator.

The units are mains powered and have the same overall dimensions as monaural mixers.



Also available Monaural Electronic Mixers:—

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

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David Kirk talks to Arthur Garratt, interviewer

interview

D.K. *Is all your interviewing done for the BBC?*

A.G. No. I interview for BBC, for ABC (Australian Broadcasting Commission), American radio, the Voice of Kenya and . . . well, you name it.

D.K. *On a freelance basis?*

A.G. Entirely.

D.K. *How did you start?*

A.G. The first programme I ever did was a recording on the site of what is now the Royal Festival Hall. I was a staff physicist at the Festival of Britain and I stood there in the pouring rain, up to my knees in mud, being interviewed in French for the BBC Belgian service. I had spent about 10 years designing armaments, for my sins. After the Festival of Britain I went to the National Physical Laboratory and stayed there until I found myself doing so much broadcasting that it was uneconomic to go into the office.

D.K. *Is it common for the BBC to recruit specialist interviewers from the relevant industries?*

A.G. I would say the BBC is always looking for people who are good broadcasters. What generally happens is that somebody goes on the air for one reason or another, you find he's rather good, you try him for something else, and bring him along in this way. Particularly on television, you can't possibly risk using someone who is going to let you down and this is why you tend to see the old stalwarts coming back.

D.K. *Working live must be extremely nerve-racking.*

A.G. In the old days everything was live. I suppose the first 150 television programmes I did were live—there was nothing else before the VTR came along. There's something about a live broadcast that gives you perhaps a greater kick than a recorded programme. I think the most interesting live ones are things like the Apollo, where you can have nothing prepared apart from general information. On the Apollo 11 sound broadcast we broke all BBC records. We were on the air for 12 hours continuously, from 9 o'clock at night to 9 the next morning. The devils walked early, as you know. You've just got to keep talking.

There's not really much distinction between doing television live and doing it on videotape because normally the videotape is not edited. It costs £50 to make a splice because you can't scrub the tape and use it again. If anything goes wrong it usually goes on the air that way, so you are effectively working live. If you make a fluff on sound, you just start again and edit it out, but we try not to fluff.

D.K. *If you fluffed while introducing a television programme, would the tape be stopped and rerecorded?*

A.G. This depends on the producer. An ordinary stumble would be allowed. I was doing a programme the other day and couldn't say high tensh—can't say it now—high tensile steel alloy. I fell over it on rehearsal and I fell over it on transmission but we didn't re-do it.

D.K. *Does the BBC provide formal training for an interviewer, once he's been selected?*

A.G. The only training a freelance is normally involved in is a course on using a portable tape recorder. I thought this was a screaming joke because I'd used recorders for ages but I went along, spent two hours on this course, and found it was jolly good. I learnt a lot. The man who teaches you most is your producer, though of course they vary. If you're lucky in the early days and get a good chap who is prepared to take a bit of trouble and teach you some of the tricks, this can be invaluable. There are a lot of tricks—you've got to ask, for one thing, the sort of question that doesn't have a 'yes' or 'no' answer. This is most important.

D.K. *You must also, I presume, avoid the thing that I am very tempted to do, namely grunting yes all the time.*

A.G. On television it doesn't matter, because the audience sees both of you. On sound it is diabolical so you grimace at the subject, make gesticulations, and nod your head feverishly.

D.K. *Are the majority of BBC interviewers freelance or salaried?*

A.G. Most of them are freelance, except for news people. The BBC encourage this. For one thing they can easily get rid of us!

D.K. *Is editing part of the interviewer's job or is this done by someone further along the chain?*

A.G. I would say that 90% of interviewers do a piece which is subsequently edited by the producer. I am rather different in that I supply a tape complete and ready for transmission, fully edited. Most interviewers have neither the experience nor the equipment needed for editing. They draw a Uher from the BBC and return with 19 minutes of tape from which you extract your three-minute interview.

D.K. *Are you ever accused of altering the emphasis of a tape by editing?*

A.G. The BBC has to be, and is, totally ethical on this. Obviously you can do anything with a tape. You can make the Archbishop of Canterbury say he doesn't believe in God by transposing question and answer. We do quite a lot of transposition, in the sense that we alter the *order* of an interview very often, but we *always* maintain the precise emphasis that the subject wanted to make. We don't cheat in the way theatre people do—'Splendid' said the Daily Mirror—when in fact the paper said 'Splendid for one minute, the rest was rubbish'. We are trusted in this completely.

D.K. *In broadcast interviews, the answers follow on very naturally from the questions. Are the questions rehearsed before the tape is made?*

A.G. This depends. My own method is to sit down with the chap I'm going to interview (having done some homework the night before) and say 'What is your story?'. Then I explain that I will have about four basic questions to give the interview a shape—What are you doing? What is its significance? What is its future?—and so on. But I put in all sorts of supplementary questions as it goes on. Just occasionally I will re-do a tape. Not usually, since the subject is normally best the first time. I might say afterwards—'You couldn't answer the question "How big is it?" because you didn't know—now look it up and I'll ask you again so we can edit it in'. One of the most complicated things in an interview is to avoid asking what we call the 'stopper question'. This is why you've got to know what the chap is doing—it particularly applies in science. One trick I always use when interviewing is to ask a couple of questions at the beginning which are relevant but not essential. These are cut from the tape. Almost every amateur starts slow and warms up. If you chop the first two questions, you have your subject in overdrive before you start.

(continued on page 189)

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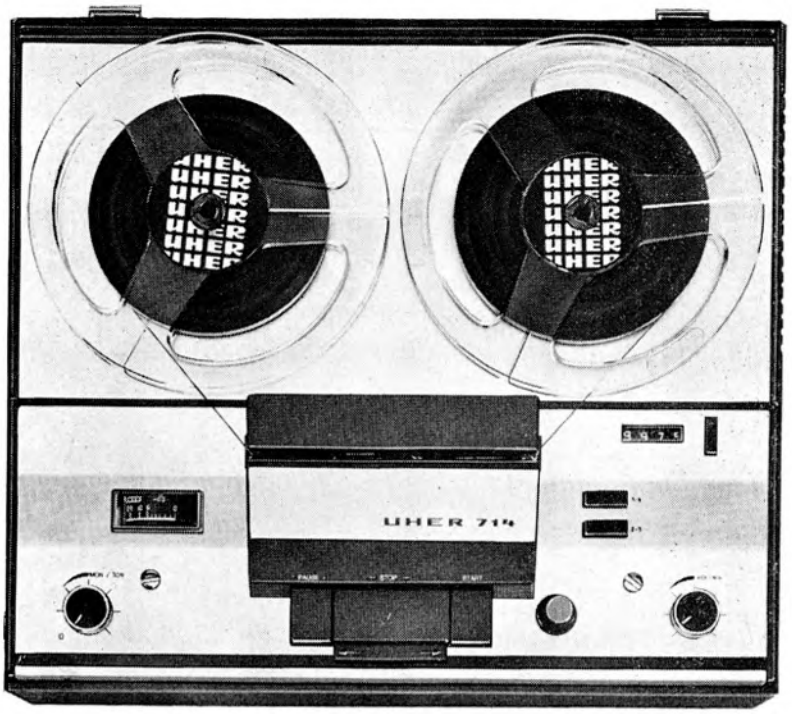

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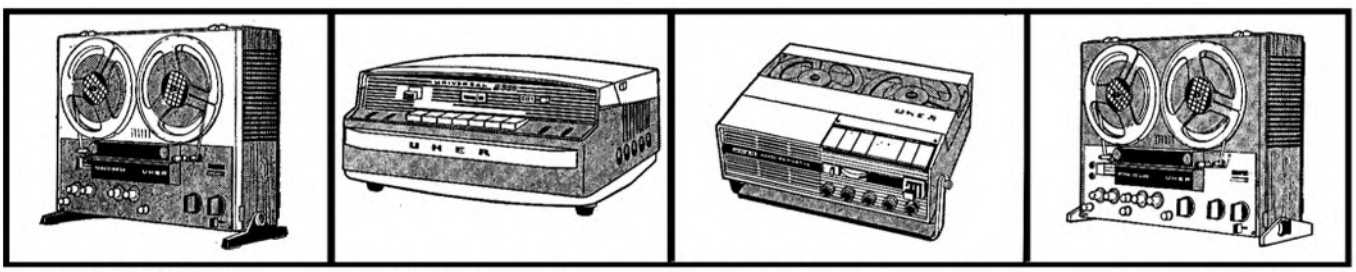

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D.K. (Staring down at notes) *Do you find it puts people off to stare down at notes during an interview?*

A.G. It can put a subject off a bit, if he's not used to it. One of the most important jobs an interviewer has is to provide a pair of eyes for the subject to talk to. It's not the questions you put so much as the rapport you establish that makes a good interview. By the way, don't let the subject keep his notes. Few amateurs can read into a microphone effectively.

D.K. *How does the BBC keep track of the many tapes produced by contributors and by its own staff?*

A.G. Anything destined for transmission goes into a library system. It is very efficient and in due course, when the programme is due to go on the air, the bit of tape arrives. I'll never know how they do it. There is necessarily a great deal of duplication. There is really no such thing as The BBC—there are a lot of producers, all of whom have almost complete control over their programmes. When a news item breaks, five different BBC services go along and interview the chap, much to his annoyance, but this is right because they all want a different slant.

D.K. *Your equipment?*

A.G. For ordinary location recordings I use a Uher *4000L* and an AKG *D19C* microphone. The AKG has variable bass-cut which is essential when working in reverberant rooms. I also have the *D19C* windshield which cuts wind and fingering noise to negligible proportions. The *D19C* is a bit peaky around 5 kHz though this is not necessarily a disadvantage for interviews. For my talks studio I use the *D25* cardioid—it's important to use a cardioid in a small studio because the reduced back-response suppresses room resonance. I also have a ribbon though I don't use it for broadcast purposes. Microphones have got to *sound* right. The specification tells you very little, apart from weeding out the rubbish. The only real test is to suck it and see—the good old scientific principle.

D.K. *Would you make a point of getting indoors on a blustery day or do you, in appropriate circumstances, take advantage of wind to provide the 'atmosphere' for an interview?*

A.G. No, I would never take advantage of wind as a sound-effect because it never sounds right. In those circumstances I would either shield the microphone from the wind with my body or put the chap in a doorway. The wind that you hear and the wind that comes out of a microphone are totally different. Unless you are in an acoustically-treated room, you want to be within about half a metre of a moving-coil microphone, to suppress reverberation and extraneous noise. With a ribbon, of course, you mustn't get close or you run into bass boost. Ribbons are not satisfactory for location interviews—they are also highly sensitive to wind and movement. The second thing, and most people are very bad on this, is that you must get a balance in level between the two speakers. You have to keep your eye on the record-level meter because many people go up about 6 dB when they get excited. Actually you get used to this and just move the microphone away when the subject gets louder.

D.K. *A classic mistake apparently made in the early days with the EMI portables was to monitor off tape on headphones while conducting an interview, reducing the interviewer to stutters.*

A.G. You get this effect rather badly if you wear cans while doing a trans-Atlantic broadcast. I've been in New York feeding back to BBC and, if I haven't got clean feed, my voice comes back on cable or satellite delay. You get used to it!

D.K. *Your editing is obviously not done on the Uher.*

A.G. No. I edit entirely on a Ferrograph. It's a very good machine for this purpose. You can hold the pinch wheel off with your thumb, rolling your tape into the desired position, marking with Chinagraph, then letting the wheel go. The tape speeds up immediately and you can ensure that the cut will be spot on.

D.K. *Have you tried felt pens? Chinagraph can get on to the heads.*

A.G. Keep your heads clean! The little Bib cleaner is very satisfactory. Clean your heads regularly and demagnetise them once a week. Felt pens rub off. And check your bias once a month or a machine will creep away from you.

D.K. *Your main recorder is a full-track 38 and 19 cm/s TR51. How does it behave?*

A.G. Good machine though it wows a bit if you get near the end of a reel. The replay monitor is diabolical—I've scrapped it, and feed the monitor head through a *TR52* pre-amplifier.

D.K. *Which speed do you work at?*

A.G. For domestic service sometimes 38. For World Service always 19. We are tending to standardise more and more at 19 because, on a decent machine, it is as good as the signal that comes out of the speaker at the receiver end.

D.K. *What machines do the BBC play on?*

A.G. A variety. It might be a *BTR2*. Probably nowadays a Leevers-Rich, a Philips, or on domestic services very often a Studer. There are also a lot of *TR90*'s. The BBC has hundreds of Ferrographs but never uses them for transmission—entirely for editing, monitoring, and so on. They have a bank of them, incidentally, which automatically record continuity announcements at 9.5 cm/s so that tapes are available if there is any comeback on announcers' remarks.

D.K. *Has a portable ever let you down?*

A.G. Oh yes. Let me tell you a horrifying story of one of the old EMI machines. I went to New York on the first flight out in a BOAC *707*. I did a live piece into *Today* as we left London, another piece over Belfast—they stooged around to go over there an hour later—and the same day I made a tape going through Idlewild customs. We had to record this twice because on the first occasion, since I was a special person in the circumstances, the blighter didn't open any bags. Anyway I took the final tape along to the BBC office to be sent out on the cable for the next morning's *Today*. I was castrated! The machine had been running at the wrong speed. So I spent the next two hours wrapping Scotch tape round an Ampex capstan until I got the speed right.

A friend of mine did something rather marvellous. He went down to the Mullard Laboratories, recorded a chap, parked his recorder, went off for a very good lunch, and came back to find nothing on the tape at all. He'd put it against one of the world's biggest magnets.

D.K. *You must occasionally get interference problems, particularly in scientific establishments.*

A.G. This is a real problem. The worst places are hospitals because they use induction-loop bleepers to call their surgeons. You come back and find a tape with bleeps on it. Another place I experienced this was on a diesel train, where they have electric heating at about 300 Hz. And another, believe it or not, is a London Airport studio, where they have a cable or transformer under the floor. If you stand at one point you are swamped with 50 Hz hum. It's easy enough to run a short tape to check.

D.K. *You have two editors on your Ferrograph—a Bib and an EMI block. Which do you prefer?*

A.G. I never use the Bib . . . the EMI block is very convenient, it is a standard editing block. I've mounted mine so that it pushes the pause control off as well. Edits should be totally undetectable. You are only beaten if you've got a plane coming over. If you cut over that, the background changes. I have incidentally recorded people who spoke as though they had been badly edited. You'd have to show the producer the original tape before he believed you!

D.K. *Have you ever made use of limiters?*

A.G. No, God forbid. The BBC have got them in, though I believe that on domestic services they are only to prevent you over-peaking and kicking the transmitter off the air. On the World Service, which goes out on short wave, they deliberately put compressors in to improve the signal-to-noise ratio. This is a creation of the devil. They are so efficient that they tend to eliminate any fades. A lot of the things you can do on domestic services are not possible on the World Service because of those damned compressors.

D.K. *You supply from your studio here music taped from disc using a Deram.*

A.G. Yes. It's not half as bad as people make out. I have found it an excellent pickup, providing you feed it into 2 M. If you try and be clever, making it behave as a magnetic, correcting it as one, it won't work. You get yourself involved in the most complicated circuitry for no reason at all. I use two of Mr Henry's matching modules—you have to select them carefully—built into the base of the Deccadec. On the EMI test record I am within 1.5 dB right up to 20 kHz and I can see no distortion feeding sine to the CRO.

D.K. *The quality of BBC news broadcasts is often criticised for being too chesty. I put this down to the use of ribbon microphones. Is this right?*

A.G. I would like to make the point that BBC engineering on the whole keeps to remarkably good standards. Remember their problems. They have studios where you book for half-an-hour, you go out, and someone else goes in with a different studio manager. Despite that, the quality is kept up to a very high standard indeed. The BBC has no control whatsoever over its lines; they are GPO lines and can be variable. Also, if you look at the Fletcher-Munsen or Robinson-Dadson curves, you will see that the bass and treble response of the human ear depends on the sound level. The BBC records flat which means you should play talks at natural level. Most people play

(continued on page 220)

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Operates on six flashlight batteries, or regular AC household current. 1,200 mW output power. Automatic level control (ALC) constantly keeps recording level adjusted for optimum recording quality, no manual adjustments required, especially useful for speech recordings. Three digit tape counter. Spindles accommodate 5 inch reels. Mixing while recording. Two signal sources (i.e. mike + radio, mike + record player) can be used simultaneously. Convenient for blending background music into narration. Continuous tone control. Battery condition indicator. Extension speaker and earphone outlet. Practically designed plastic cabinet designed for easy carrying.

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Recording system:
AC bias, 2 track
Erasing system:
DC erase
Tape speed & Recording time:
(With 5″ reel, 2 tracks, 50μ tape)
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$1\frac{7}{8}$ ips (4.8 cm/sec) 128 min
Frequency response:
(Record & Playback)
150-6000 cps at $3\frac{3}{4}$ ips
150-4000 cps at $1\frac{7}{8}$ ips
Output power:
Maximum 1.2W
Power requirement:
AC: 115/230V, 50-60 c/s
DC: Size D (UM-1) x 6
Output impedance:
EXT. SP: 8 ohm
Loudspeaker:
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Voice coil impedance 8 ohm
Power consumption:
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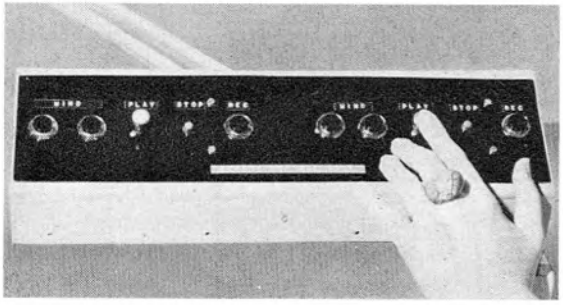


THE advantages of remote tape recorder control in a recording studio cannot be over-emphasized; it is almost a basic necessity. Indeed, even for the amateur it can be a great asset. The Revox *A77* recorder is supplied wired for remote control and the remote control connection appears at the rear of the chassis on a Hirschmann *Wist* 10-way socket. The plug is supplied with the machine with Pins 1 and 2 shorted together.

Our prototype was made on an aluminium chassis, screwed to a piece of 25 mm (1-inch) timber and, although the photograph shows a double control unit, the same sort of construction can be applied.

Mark out the metal as shown in **fig. 2a** and drill all the holes first. When these have been cleaned up, the chassis may be bent as required.

The switches required for the WIND LEFT, WIND RIGHT and RECORD are ordinary push to make switches.

The PLAY switch is a double pole 'push to make' and the STOP switch is a 'push to break' (see **fig. 3**).

Switches S.1, S.2 and S.5 are miniature bell pushes and can be mounted directly through a §in diameter hole.

S.3 is an ex-GPO biased keying switch having at least two 'make' circuits. This switch is mounted directly on to the chassis by 6 BA nuts and bolts. Care must be taken to give adequate clearance for S.3, if this is one of the old type switches as used in the prototype. S.4 is a 'press to break' switch, and the one used in the prototype was a Veto *6-250*.

A special mounting bracket had to be made as shown in **fig. 2c.**

Using the Hirschmann plug supplied with the machine, pins one and two must first be disconnected. When this is done, the 10-core coded cable can be connected to the plug as shown in **fig. 1.** The circuit diagram for the remote control unit is shown in **fig. 3.** The control unit end of the multicore cable (C)

(continued on page 195)

FIG. 1

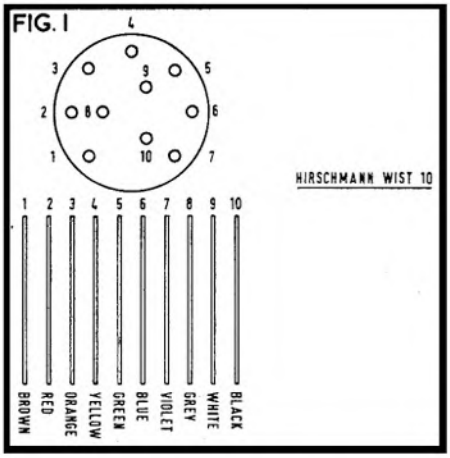


FIG. 2

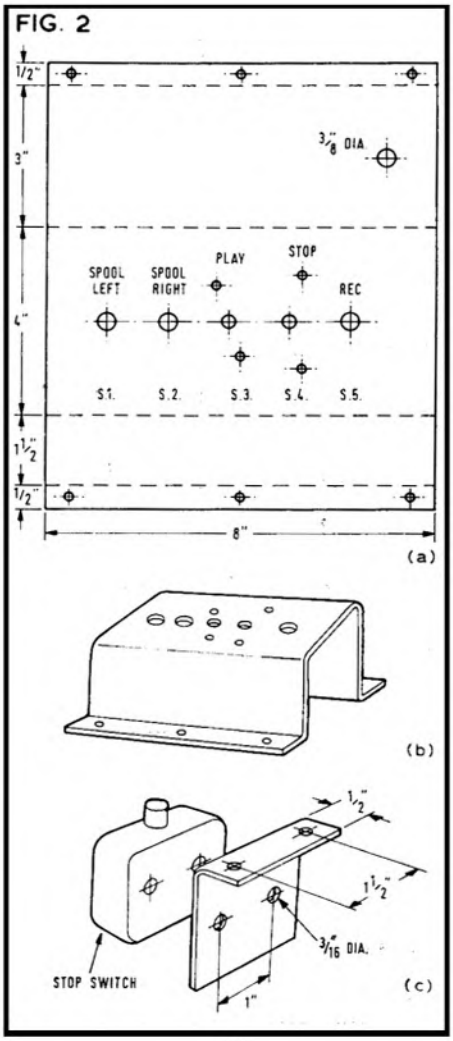


FIG. 3

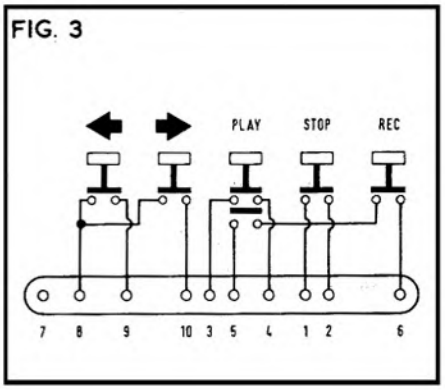
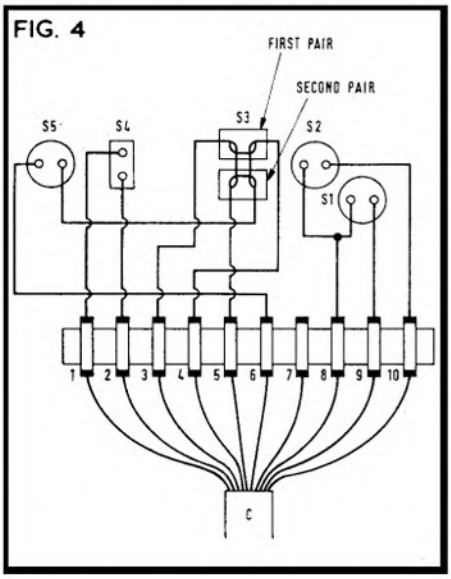


FIG. 4



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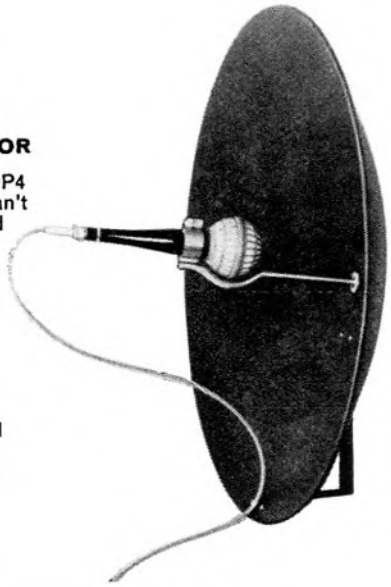

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RECORDING STUDIO TECHNIQUES

THE first tape recorders made, which ran at 1 m/s, and later at 76 cm/s, were aligned largely such that tapes recorded on them played back satisfactorily on the same machine, with preset controls juggled to give an over-all flat response. Not long after the beginning of classical music tape recording, however, it was realised that a standard replay characteristic should be nominated and all recording amplifiers adjusted so that a tape recorded on any one machine would play back equally well on another.

Some of the first test tapes produced in the world were made by EMI at Hayes, and by the middle fifties the time constants for professional speeds of 76, 38 and 19 cm/s were fixed, together with a standard peak recording level of 32 milliMaxwells per mm of trackwidth. The test tapes were recorded full track and these same tapes were used for many years for the alignment of half-track stereo machines in addition to full-track mono ones.

Fairly recently, however, BASF introduced a special stereo test tape having 1 kHz peak levels (at the beginning of the tape alternately on the upper and lower tracks) of 4 dB above 32 mM/mm such that, if this tape is played back on a mono full-track machine, the playback level would be the same as that on a full track mono test tape recorded at 32 mM/mm.

The next band on the tape consists of a 1 kHz recording at the same peak level, but recorded along the centre of the tape only, which should be inaudible, or almost inaudible, on both stereo replay tracks. This band is particularly useful for adjusting the height of the replay head. A useful trick for using this band, is to connect the record head into the replay circuit and again adjust the height for minimum output from both channels. The null on the record head will not usually be quite so good as on the replay head unless it records rather narrower tracks than usual.

The next band is white noise recorded on both channels. Here again the record head can be azimuthed very accurately on this band by using it as a replay head. If the record head is badly mismatched into the replay amplifier, the resultant loss, or perhaps boost, of top will not matter in this alignment and can be ignored. May I here refer readers to my article 'Azimuthing With White Noise' in the December 1969 issue? The azimuthing of a stereo tape recorder using this white noise band is best carried out by paralleling the outputs of the two tracks and azimuthing until a very pronounced peak in the high frequency end of the noise spectrum is obtained. Having adjusted the azimuth very carefully, the head alignment band should then be rechecked to make sure that the head is not now at an incorrect height.

After adjusting the azimuth and head heights, the replay heads and amplifiers should be set up using a mono full-track test tape.

I have assumed that, in setting up a tape recorder, the engineer will be working on an output of +8 dBm into 600 ohms from a recorded flux of 32 mM/mm. Should the studio be working to a peak tape level in excess of this figure, for example 6 dB above 32 mM/mm, which is the most common peak level used in studios today, then the replay amplifier chain should have its sensitivity reduced, of course, by 6 dB. It is important for a dBm meter to be used on the line output of the recorder, in addition to this output being aurally monitored. The peak level band on the test tape should first be adjusted to give the peak level required by the studio, for example +8 dBm. Having done this, the metering circuits in the recorder itself should be adjusted such that the meter reads 6 in the case of a PPM or +8 dBm in the case of other meters. If VU meters are in use, test tapes having a recorded level of 4 dB below 32 mM/mm will have to be employed, and in this instance the peak level tone should correspond to zero VU or +4 dBm, since +8 dBm is beyond full scale deflection of the meter.

The frequency response section of the test tape should then be played back and the response noted, the replay equalisers being adjusted to give the best compromise. Although professional specifications in general quote a response of ± 2 dB, most professional machines will replay a test tape at a considerably better tolerance throughout the frequency range 250 Hz to 15 kHz, this tolerance being often as good as ±0.75 dB, and sometimes even better. Although not necessarily true, if it is found that the response rises to +2 dB at 10 kHz with 15 kHz perhaps −1.5 or −2 dB, the replay head should be carefully examined for wear since any sign of a hump at 10 kHz well below the top frequency limit of the machine shows that the equaliser is having to be pushed hard to obtain a response within the specification at the HF limit of the recorder. With the replay amps adjusted for as flat a response as possible, the peak level band should be played again to ensure that it plays back at the correct level, since altering equalisers can in some machines alter the playback gains, although this should not happen on a good machine. Having set up the replay section at 38 cm/s, the same procedure should be adopted for 19 cm/s, but it should not be necessary to reazimuth the machine.

It will often be found that the azimuth on one test tape will not correspond to that on another ! The engineer must therefore decide which test tape he will regard as standard, and must then keep to this azimuth for all his machines.

Once the replay channels of the tape recorder have been adjusted they should not be touched again during the remainder of the setting up procedure, although it is advisable to check the replay response and level fairly often. A good studio may do this check once a day, although once a week may well be regarded as adequate, depending on the design.

I must here stress the importance of keeping the heads thoroughly clean. The best cleaning fluid that I have yet tried is industrial methylated spirit (IMS for short). Under no circumstances should ordinary meths or surgical spirit be used since both these contain additives leaving a solid or greasy deposit on the heads and guides, which will create havoc. A licence may well have to be obtained from Customs and Excise to get IMS. Some studios also use trichloroethylene which also evaporates without leaving a deposit. It is bad practice to use carbon tetrachloride since this can dissolve rubber or other substances used in the construction of transport mechanisms and heads.

The recording amplifier is not at all easy to set up accurately since an overall flat response can be obtained either by adjusting the bias or the equalisation or both. Many years ago most studios biased the machine on an audio input frequency of 1 kHz, increasing the bias from a low level so that the output from the replay amplifier reached a peak. Biasing is usually done at 20 dB below peak recording level and, having found the peak output point at 1 kHz, the bias was then advanced so that the output from the replay amplifier dropped by a dB or so at 38 cm/s, the amount by which the output dropped depending upon the type of tape used, and on the speed. In the case of 19 cm/s, the tape was biased so that the output just began to fall or perhaps fell back 0.5 dB. As explained in a previous article, however, many studios nowadays prefer to bias at 10 kHz and, in order to do this, it is necessary to have the tape tested in the laboratory first to decide exactly how many dB over the top is the best biasing point for the tape. This can be done using the 3 Hz biasing technique described in the March issue. With the bias set for minimum modulation noise, 10 kHz should be recorded and the output very carefully noted to an accuracy of 0.25 dB. The bias should then be decreased, no other controls being touched, until the output is at a peak; this level should then be measured. The first measurement relative to the second measurement is the amount by which the tape should then be biased over the top at 10 kHz on the machine under test with the particular brand of tape used. Only after the machine has been biased correctly should the recording equalisa-

(*continued on page 195*)

BY ANGUS McKENZIE (Roundabout Records)

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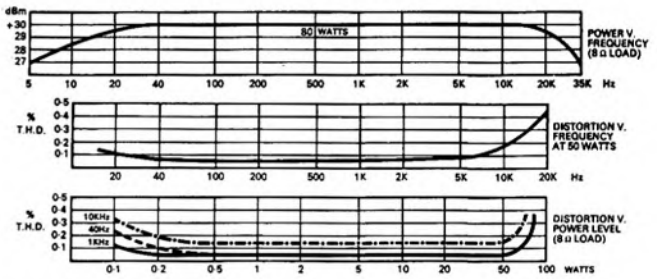

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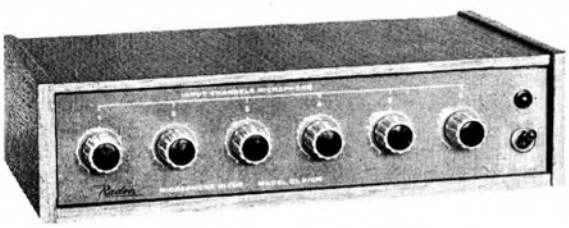

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tion be set for a flat response. Again, as with the replay amplifier, the professional tape recorder should give an overall response considerably better than specification at the high frequency end and, as before, if the response at 15 kHz is dropping badly compared with 10 kHz, the record head should be carefully examined for flats or other signs of wear. If the engineer knows the type of circuit used for equalisation in the recording amplifier, he will usually be able to tell from the response curve if the head is worn or if it is incorrectly biased, since the AF fall-off in the event of the machine being well over-biased is usually considerably more than 6 dB per octave, whereas most record equalisers at the high frequency end on modern machines never even reach 6 dB per octave at 38 cm/s, although at slower speeds a steeper slope can sometimes be encountered. It will be found, too, that a head having a wide record gap will need more treble pre-emphasis than one having a narrow gap because of the erasing effect of the bias field across the gap. Although these days a 12 μ record gap is becoming common, new machines having record gaps as narrow as 7 μ are being produced and perform very well.

Having adjusted bias and equalisation, the record preset gains should be adjusted so that the input level to the tape recorder not only gives peak playback level from the replay amplifier but also gives the same level when the line output amplifier of the tape recorder is switched to read direct rather than tape. Such gain controls are usually placed in the recording amplifier immediately after the monitoring point. In addition to this, the recording level meters should also be adjusted to read peak recording level when the tape reaches this point selected by the engineer. When aligning the recording amplifiers on some machines, a standing reading will often be noticed on the output meter and this is due either to ineffective bias traps in the replay amplifier, or a trap that has not been adjusted properly. It is most important that these traps are adjusted for a minimum reading with no audio modulation on the tape. Many machines also have bias traps in between the output of the recording amplifier and the recording head, stopping bias from feeding back to the recording amplifier, and in most cases therefore reducing the available output of this amplifier, and sometimes also causing distortion. The adjustment of this is best done by using an AF VVM with a high input impedance, or alternatively an oscilloscope, either of which should be attached to the record amplifier side of the trap, the trap thus being adjusted for a minimum bias signal at this point. This part of the setting up procedure is exceptionally important since one machine recently tested had a recording amplifier which started cracking at an output corresponding to only 32 mM/mm but, after adjusting this trap, the same distortion was reached at 6 dB higher, still not really sufficient, but considerably better.

Many machines will be found to have a hum-reducing potentiometer, and here I would like to give a word of warning. The lowest hum level as measured by meter is not always the lowest audible hum, and these 'humdingers' as they are called often have different null points for 50 Hz and 100 Hz. I feel this adjustment is best done by ear, even if by so doing the machine is not quite within specification, since after all it is the audible result which matters.

One final word should be said about machine alignment in connection with the position of heads, and that is the adjustment of heads horizontally, around their vertical axes. It is most important to have an equal wrap round the head either side of the gap for, if the gap is not central in the tape path across the head, no end of trouble will result. Also the importance of replacing tape guides should be noted, since a worn guide can scratch the surface of a tape quite badly, and cause oxide shedding. Many tape guides can be rotated and it is an idea to do this at regular intervals to spread wear evenly. The vertical alignment of these guides should also be carefully examined to ensure that the tape is moving in a straight path.

I have often been asked about the advantages of hyperbolic heads and also ferrite heads. A head with a spherical front tends to give what I call 'bass woodles'—a variation in output of as much as ± 2 dB from one bass frequency to another. This variation can be almost completely eliminated by the use of a head having a hyperbolically shaped front, which incidentally also gives a considerably more accurate LF output at all normal speeds and therefore does not require independent bass compensation. Although these heads are more expensive than normal ones, they are to be recommended, particularly where tapes are being copied.

Many high performance heads, as far as frequency response is concerned, are often accused by engineers of being 'made of lead' in that the performance is degraded at the HF end after only a few hundred hours of use. There is, of course, tremendous variation in the wear properties of ordinary heads, and largely because of this, Philips developed the ferrite head. Many recording engineers have told me they have not known a tape recorder fitted with ferrite heads to suffer head wear. I understand, however, that theoretically they should be replaced after a minimum of 5 000 hours of use. The head will outlast the life of the machine if treated with respect. Careless handling, however, involves some risk of shattering. Ferrites can cost two or three times the price of ordinary heads, but the considerable improvement in HF efficiency makes them an excellent investment.

'Magging up'

Different tape recorders show differing susceptibility to 'magging up', this effect being slight DC magnetisation of the record head, sometimes replay head, and occasionally the erase head. This can be caused in a number of ways, the main one being the bias oscillator being disconnected from the heads before the oscillations have completely died down. In such circumstances, if the bias waveform is at a positive or negative peak at the moment of disconnection the head will become slightly magnetised. This magnetisation can cancel or build up, so demagnetisation should be carried out at frequent intervals. Sometimes switching transients can also cause magging up. If any soldering is done to any part of the head wiring, it is important again to demagnetise thoroughly before using the recorder. Many a test tape has been ruined by an engineer forgetting to do this. It is also advisable to demagnetise after printed circuits are removed or replaced, since under certain circumstances capacitors can charge up and then discharge either through the head or their circuits, causing a transient.

Finally, to emphasise the importance of adjusting the recording amplifiers carefully to the type of tape in use, I recently measured many makes of tape for sensitivity at 1 kHz, 10 kHz and 15 kHz. Mr John Wooler of EMI kindly managed to produce from his attic two very early samples of EMI *H57* and *H60P* tape. To give an idea of how tape has advanced, the *H57* dated back to 1948 and to give the same output measured at 20 dB below peak, 14 dB more record gain was necessary than for the average present-day tape. In addition, when the tape had been correctly biased with the recording equaliser set again for present-day tapes, the response was 12 dB down at 10 kHz and 20 dB down at 15 kHz. It is even possible to see individual grains of oxide imbedded in the plastic. The *H60P* was considerably better. Sensitivity was approximately 12 dB below normal peak but the response was only 3 dB down at 10 kHz and 5 dB down at 15 kHz. Distortion started becoming very noticeable at a recorded level of 25 mM/mm. Tape noise, however, was lower than many modern tapes since the tape had quite a low coercivity. The only serious disadvantage of this tape at the time was the somewhat poor print-through. What an amazing difference, however, when one compares these tapes with EMI's latest *815*, the finest tape they have ever produced, or yet again BASF's *LR56*, an excellent tape that has been in use at least six years and yet is only just beginning to be bettered.

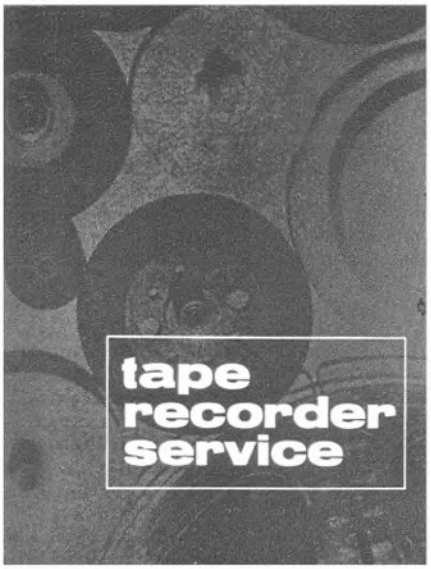
must be prepared and then pushed through the hole in the chassis. The colour coded wires are soldered on a tag strip, **fig. 4.**

Follow the wiring of the switches through with colour coded wires if possible. First wire S.4 taking a brown lead from Tag 1 to one of the switch contacts. Next take the return lead (red) back to Tag 2.

S.3 is the next to tackle. Take an orange lead from Tag 3 to one of the first pair of contacts. Follow through with a yellow lead back to Tag 4. Now green from Tag 5 to one of the second pair of contacts on S.3. With the same colour lead, wire the second connection to the RECORD switch S.5.

Complete the RECORD switch circuit by taking a blue lead from S.5 to Tag 6. Wire S.1 directly to Tags 8 and 9 using grey and white leads respectively. Then take one lead from S.2 to Tag 8 and the other, with a black lead, to Tag 10. Tag 7 is not used. Inspect wiring before plugging in. With the Hirschmann plug back in its socket, switch on and test the control unit. The length of the 10-core cable is not critical and the machine can be remotely operated from quite long distances.

On the prototype, Formica was used as an escutcheon plate.



FERROGRAPH SERIES 420

BY H. W. HELLYER

THE Ferrograph may have been advertised as 'incomparable' for many years, and certainly I would not wish to argue with its individual construction and design. But when I try to compare one Ferrograph model with another, so that prospective purchasers of second-hand 'battleships' may have some idea of what they may be getting, I find that comparisons are not just odious, they are overwhelming. This article was intended to be devoted to the deck, one fairly common factor of the range between the *3* and the completely restyled *7*. I have sorted out the range of *Series 4* machines that differed radically from that covered last month, but which have one common factor with the *Series 5*.

First a brief run down of differences, for which some readers have asked. Problem appears to be, so I am told, that an advertisement in a Classified column quotes only the briefest details and the seller may be miles from the hopeful buyer. Before wasting a stamp on a further enquiry, the buyer needs to know some basic facts about the offer. Some curious prefixes and suffixes have been used by Ferrograph to identify the various models. Staying with the *Series 4*, but with some reference also to later marques, the vital statistics of these 'lettered' types is as follows:

YD: Two-speed models for industrial use, with 600 ohms input and output. There is a high-gain stage tacked on as an afterthought, allowing that somebody might just possibly want to use a high-impedance microphone.

Digression—one does not usually think in terms of high-Z microphones. To do justice to the machine one uses low-Z microphones and matching transformers. For years, I employed Reslo and Film Industries ribbons and colleagues were equally happy with the Grampian *GR2*.

Suffix *A* denotes 'normal' record and play facilities, and tape speeds of 9.5 and 19 cm/s.

Suffix *L* after the *A* denotes low-speed, 4.75 and 9.5 cm/s.

Suffix *H* after the *A* means this is the high speed model, 19 and 38 cm/s.

Series *B* has similar speed ranges but with a different monitoring arrangement, with an output of 20 mV into 1 M, whereas the *A*, the normal facility, is 2.5 W into an external 15 ohms loudspeaker, plus a 600 ohm 5 mW balanced output. Monitoring during recording is an essential for live work, so the *B* range is a better bargain.

Most of these differences originated with the *Series 3*, so it may be possible to unearth an ex-government model with the *FN* suffix. These were *Series 3C*, dual-channel jobs with staggered heads. Although they were really intended for recording, the monitoring facility on them, with a small amplifier and speaker could easily be augmented. Playback is from either or both tracks so it takes very little ingenuity to convert this model to stereo operation, by modifying the three-way switch.

Suffix *S* denotes stacked head for normal stereo operation.

Suffix *CON* stands for the chassis-only version, suitable for rack mounting, lacking just the cabinet and the loudspeaker.

Coming on to the *Series 4* machines, and in particular the *Series 420* which is our main theme today, we find *U*, *A* and *E* employed for different purposes, a little confusingly. And the numbers, *422* and *424* identify quite different machines. To add to the bother, some of the previous sales brochures gave misleading information and an expensive conversion could well be required if one purchases a *Series 4* blindly. The problem is that of voltage and frequency changes. Series *U* is intended for 200/250 V, 50 Hz operation. Series *A* operates on 110 V, 60 Hz, and *E* is that strange hybrid, the 110 V 50 Hz version. According to the implication in some literature on the *Series 4*, all one needs to do to convert from *U* to *A* is change the motor pulley and the starter capacitor of the capstan motor.

Not true, I fear. The basic British machine has a 240 V capstan motor and the spooling motors are 150 V. 110 V Ferrographs need motors of half this rating, quite apart from the pulley to suit the frequency change. The start capacitor which increases from 0.75 μF to 2.5 μF and then to 3 μF for the *E* version. The mains transformer has to be changed to suit the voltage, although this is not so great a problem, being a more generally available item. The one thing often overlooked is that the high wattage deck resistor must also be changed, having a 250 ohm 27 W rating for 110 V models.

Add to all this another model, the *808*, which is really a stereo *Series 4* with the power amplifier and loudspeaker omitted. It has other differences, including a switched meter circuit, and did not appear in any great quantity. The *420* series took its place, so it is on this we shall concentrate.

Inputs 'for full depth recording', as the manual puts it, are 2 mV into 1 M and 35 mV into 500 K. This compares with the general *Series 4* input (the circuit of which was last month's **fig. 1**) of 3 mV into 1 M and 100 mV into 80 K.

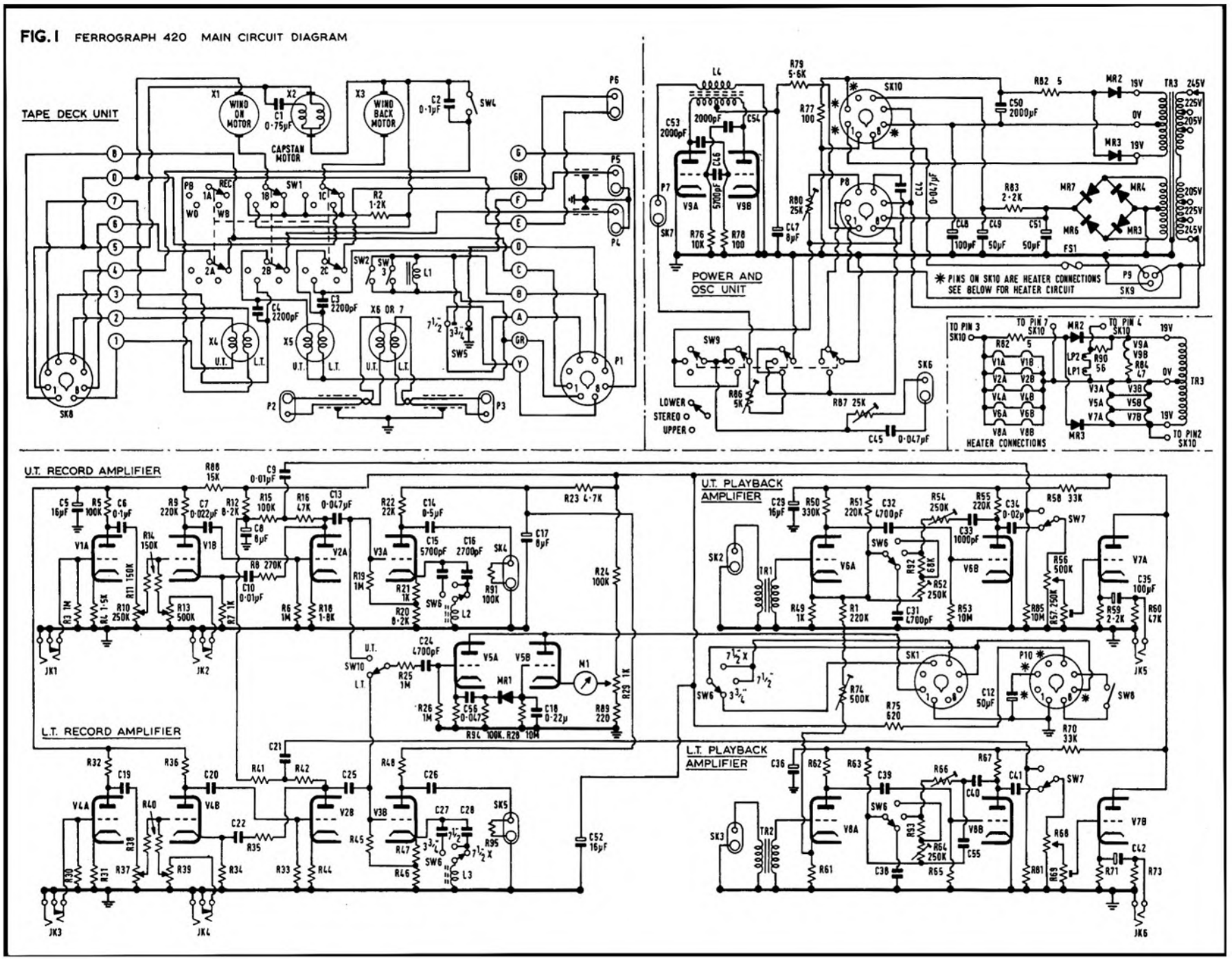
Some of the points to note about the main circuit, **fig. 1**, are (a) valve heater supply, (b) use of triodes throughout the amplifier, (c) auto-stop, (d) input isolation, (e) push-pull oscillator, (f) meter circuit, (g) added feedback—C55—lower track playback amplifier, and some special features of test procedure that are *not* obvious from the drawing. Taking these in order:

(a) Hum avoidance by DC heater supplies is a common practice, but is done here by a 19-0-19 V AC supply rectified by a couple of silicon diodes in a full-wave circuit, while the valves whose heaters are not so much a source of hum (meter and oscillator circuits for example) are powered from the AC winding. The full-wave circuit is based on the 19 V secondary but, after rectification and smoothing, there should be 12.6 V DC available for the heaters of the *ECC83* triodes.

(b) In contrast with the circuit shown last month, whose amplifier depended on pentodes, double-triode valves are employed in the *Series 420*, just as they are in the *Series 6*, whose circuit will be published next month. The *Series 5* uses pentodes and is similar to the circuit of last month, except that the oscillator, instead of being based on a pentode, uses a push-pull *ECC82* just as in this month's circuit. Why the changes? Well, one might receive all sorts of high-falutin' theories about valve efficiencies, etc., but my view is simply that Ferrograph used the valve-bases available in their basic amplifier chassis, and that was that!

(continued on page 199)

FIG. 1 FERROGRAPH 420 MAIN CIRCUIT DIAGRAM



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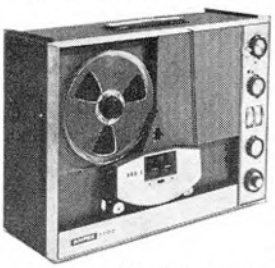

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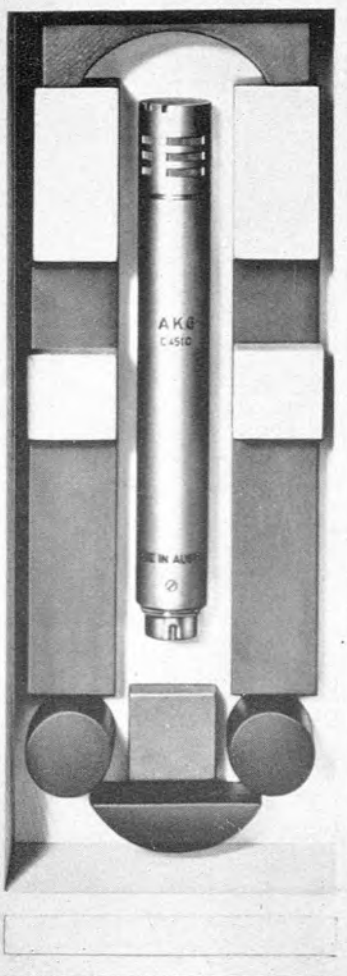
London, W.8.



(c) From valves it is not a far step to the auto stop because, on this model, it derives its power from the same supply. Note that the solenoid coil L1 is in series with a 100 ohm, 1 W resistor, and that the latter is in the DC supply return path when the stop button or the auto stop contacts short circuit the solenoid. This is, of course, a hold-in solenoid, energised while the deck is in the 'forward run' condition for play or record. Troubles in and around the rectified circuit, sometimes even the valves themselves which have been known to develop heater to cathode short-circuits and upset voltage conditions, can affect the mechanical operation of the deck. So the voltmeter is the first aid to service that one will need.

Auto-stop arm

Mechanically, the auto-stop switch is a pivoted arm with a short vertical rod at the end. The tape holds the arm in the 'switch-open' position with a light spring trying to return it to the 'switch-closed' position, as it would be with the tape absent, broken or slack. This autostop is not intended to work during fast running, and the sensor arm is held off during this operation. Auto-stop operation on this machine is 'complete', that is, the machine reverts to neutral and has to be reset to run.

(d) The recording amplifiers consist of two-stage preamplifiers from the high-sensitivity socket followed by further two-stage sections from the low-sensitivity input. The monitoring signal for A-B comparison is from the anode of the third stage and it will be noted that, whereas each channel has a single *ECC83* for its first two sections, the third section of each channel shares one valve, as does the fourth. This can be confusing for the chap who has to find his way around for the first time, and is defeating when one employs the subterfuge of gain testing, etc, by valve swapping.

Part of the reason for this device is hum-and-noise reduction by maintaining heater-cathode potentials of low-signal stages at the required level and balance. There should be very little bother with cross talk. Mixing, though rudimentary, is effective. Series 100 K and 82 K resistors prevent signal shunting, no matter what the position of the record gain potentiometers, even though both feed into the same grid.

(e) Mention has already been made of the push-pull oscillator and, as this circuit has some extra controls. Instead of the single preset potentiometer beside the output valve, we now find two controls on the top of the power/oseillator sub-chassis and one on the side between the plug and socket connectors. The latter is the bias control for the upper track, the one nearest the inside of the cabinet is for the lower track, while the one nearest the mains transformer is the 'bias equalise' control. Its function is to compensate for any bias imbalance due to circuit and head discrepancies when the stereo machine is used in the mono mode. So a switch section connects this variable resistor to chassis in either mono mode, but it is left floating during stereo.

There are one or two small points about the oscillator that need airing. Recording mono can cause some bother on a machine intended for stereo use. This calls for extra switching to put the unused sections of heads, and some parts of the circuits, totally out of the way so that they cannot interfere with the active section. In the *420*, the unused winding of the erase head is disconnected altogether to avoid cross-coupling (actually, a fault in this switch section produces an increase in noise level), but only one of the bias feed connections to the unused part of the recording head is disconnected. I would have been happier with the unused section short-circuited altogether, but this requires only a very small modification and, if you are going to be as fussy as that, you would probably go along with Tom Reps (see December 1969 issue) and not switch heads at all!

(f) Another double triode is called into action in the meter circuit, but this is an *ECC83*, not an *ECC82* as might have been expected. In fact, the other of the two *ECC82* valves in this circuit—the first being the oscillator—is the shared output cathode-follower of the playback amplifier. Having been led a pretty dance once by V7 and V5 having been swapped over, I speak with some feeling!

First half

The first half of the meter pair is a cathode follower and its job is to provide a charge circuit for the 0.22 μF polyester capacitor in the grid of the next stage. The rectified signal becomes a negative voltage for the grid of V5b and the meter is in the cathode circuit. When signal level is nil, a 1 mA backing-off current flows through the meter for full scale deflection, and increase in signal increases the bias to reduce anode current, and so meter deflection.

One adjustment of the meter circuit is for peak recording level for a given maximum distortion (3%). The grid resistor of the first half of the meter amplifier is selected to read 8 (nominal value is 1 M). The procedure is to begin by zeroing the meter, all controls turned to zero. Then an input signal of 50 mV at 1 kHz is applied to Input 2. Distortion is measured at the output of the channel under test and the input recording gain is advanced until the meter reads 8. The tape is run at 19 cm/s and distortion on play is measured. If it is not between 2.5 and 3%, the recording level is varied to obtain this figure. Then the meter reading will not be 8, so the grid resistor must be altered to obtain this magic figure. Sounds suspiciously like cooking the books, but it works. Of course, it argues that all other points are in order, including bias and that bias equalisation we have already spoken about, which is of great importance. It also argues that the bias trap is correctly set, as we mentioned in the last article.

(g) A small point this but, when a machine is completely stereo, any discrepancy between channels sticks out a mile. There is a capacitor in the lower track circuit that is absent in the upper track playback circuit. No prizes for finding it. This is C55, a 47 pF feedback component from the junction of the treble boost corrector preset and the 1500 pF section of the feedback loop (which may vary slightly from this norm) to the cathode of the first playback preamplifier. The idea is to compensate for wiring differences. Because the amplifiers have to be differently sited, and on the *420* the playback amplifiers are on another sub-chassis running along the left side of the cabinet, there will be some difference in screened leads, and the extra feedback is given to correct for this.

Between the cathodes of the two preamplifiers will be found a resistor network. This is variable to allow crosstalk reduction. In the mono mode, this crosstalk can be down around the noise level, and careful adjustment of the 'common' controls will be needed. The worse conditions for noise and crosstalk tests are with the deck opened up, so load a smaller reel, use a fresh spool of tape, prop the deck open, and make your noise, distortion and crosstalk adjustments that way in the sure knowledge that, when you batten down the hatches, your figures will be several dB better.

With the compensating capacitor in mind, watch the routing of those cables. The forms should loop down neatly in the spaces below their natural 'fall'. Many a hum problem has arisen because a cable got itself hitched.

One small factor not yet mentioned is the adjustable head on the *424* model. The play head can be raised by a lever to read off a normal ¼-track tape. This was necessary in the days when the *420* was spanking new and there were one or two odd track configurations to contend with. Trouble now is that ¼-track stereo tapes can give a right-hand channel loss on playback if you forget to bring the monitor head of the *424* down again.

Once again, we come to the end of a monthly article without having dealt with the subject which was originally projected. As the circuit of the *Series 6* needs very little discussion further to what we have said already about the *4* and *420* and, indirectly, the *5*, we can deal more explicitly with the deck in next month's article. Until then . . .

AB TAKEN OVER

AB AUDIO Electronic Equipment is now being manufactured by Allen & Heath Ltd., 203/209 Gower Street, London N.W.1. The former owner, Andy Bereza, has joined the Allen & Heath staff to manufacture compact studio mixers.

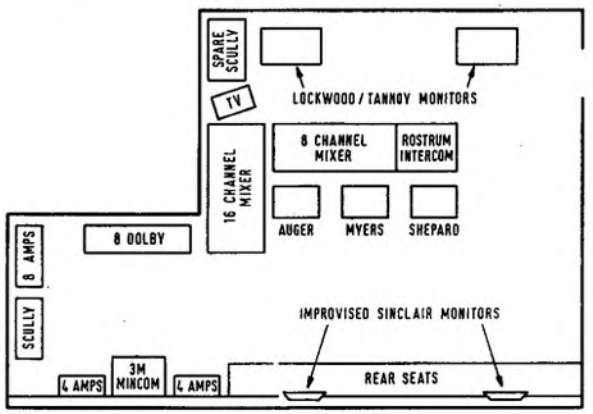
PYE TVT MOVE

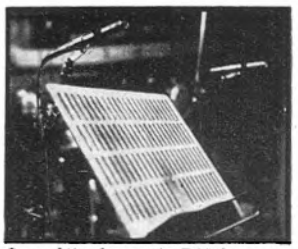
THE BROADCASTING Division of Pye TVT Ltd., handling Philips professional recording equipment, moves during April from Weybridge to Coldhams Lane, Cambridge. (Tel: 0223 45115).

E. J. MORLEY RETIRING

SALES DIRECTOR of Grampian Reproducers Ltd., Mr E. J. Morley, is retiring from the company. Mr Morley joined Grampian in 1940 as service manager, became sales manager in 1945 and joined the board of directors in 1966.

FIG. 1 CONTROL ROOM LAYOUT, CBS VERDI REQUIEM





One of the four solo D224's.

Front view of the woodwind *U87*, also visible in front-cover foreground.

'THE new *Quadraphonic* technique, employing eight tracks [said the news release] will be used by CBS Producer Tom Shepard (deputising for CBS Masterworks Director John McClure) when he records Leonard Bernstein conducting Verdi's epic *Requiem Mass* at the Royal Albert Hall.'

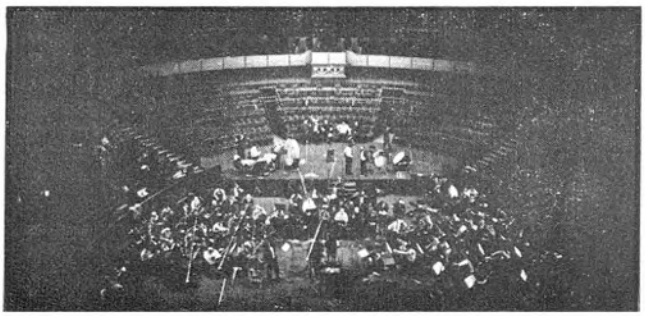
This month was February, the sessions in question occupying the afternoon and evening of Monday 23, Tuesday 24 and Thursday 26. Traditional CBS equipment—a multichannel mixer feeding two three-channel *A62* Studers in the hands of Hellmuth Kolbe or, more recently, facilities at EMI Studios—was replaced for the occasion by Granada Recordings' Bob Auger, eight Dolbys, two Neve mixing desks, and three eight-channel recorders —two Scully *284*'s and a 3M *C401*.

There were two aims to the exercise, one being the production of an LP disc album, the other a series of four-channel (hence *Quadraphonic*) tapes. Granada were the only UK company prepared to undertake a four-channel session.

Backstage RAH dressing rooms (it was actually an ex-buffet bar) do not lend themselves particularly well to Control Room roles. The absence of any visual link with the auditorium was overcome by a Rank TV camera aimed at the rostrum. This fed a display unit perched on a bank of Scully tape amplifiers. Room at the front for two Lockwood enclosures (Tannoy drive units of unknown identity) but only a narrow shelf at the rear. Two small Sinclair speakers, normally used for talkback, were placed on this shelf to avoid the clutter of additional studio speakers. These monitored the two ambience channels feeding from microphones A and B in fig. 2.

Why two mixers? The desk on the left (fig. 1) was connected to the sixteen microphones in the main hall: four Neumann *M49*'s on the stage, an AKG *D224* moving-coil on each of the four solo singers, and *U87* Neumanns covering the orchestra.

With the talkback Sinclairs otherwise engaged, speech communication from Tom Shepard to the performers was arranged through a third Lockwood. A telephone hooked on the red 'tape running' cue lamp was employed for longer conversations between Leonard Bernstein and the control room.



General view of the Promenade and stage.

More than half the Promenade ring was occupied by the London Symphony Orchestra, bass drums and timpani standing alone on the stage until the arrival of the choir. With the exception of the solo *D224*'s, which for most of the session were within one metre of their subjects, all the microphones were mounted between three and five metres above the floor. Highest were the ambience microphones, facing upwards at 40° from horizontal, towards the back of the hall. The latter pair occupied two of the eight tape channels and represented the only departure from two-channel stereo multi-mike techniques. It was not intended, Bob Auger explained, to mix any performers out from the front sound stage during the later reduction to four channels.

Even before the fibreglass sound diffusers were suspended from the roof, the RAH had too dry an acoustic for normal close-microphone technique. The ambiophony would therefore be mixed into the sound-stage of the resultant two-channel CBS discs.

Paul Myers (CBS London Division) agreed with my suspicion that some four-channel masters would be derived artificially from two by means of reverberation generators, though this seems unlikely to satisfy pop consumers once they have been subjected to 360° sound rotation effects. An American engineer, Auger reported, is building a small radar reflector motor into a mixer to drive a vector pan potentiometer.

Engineering problems were minor. On one occasion the tape ran out in the middle of a prolonged performance, to everyone's distress.

Bob Auger, Placido Domingo, Ruggero Raimondi and Leonard Bernstein in the Control Room.

CCTV monitor and Neve mixers.

String section.

Choir on stage.

David Kirk describes the CBS Quadraphonic recording of Verdi's Requiem Mass

QUADRAVERDI

corresponding replay but was assured that the balance would be sorted out during the final mix.

The real cause for anguish, which almost upset both the public performance (Sunday 22) and the recording sessions, was the last minute loss of the Italian tenor, Franco Corelli. He was unwell when rehearsals began in Bernstein's Savoy rooms and became worse as the public performance approached.

The British tenor, Robert Teare, agreed to take Corelli's part during the Sunday concert. This possibility was foreseen by CBS who, several months previously, had negotiated with RCA over the availability of their tenor, Placido Domingo. The CBS request was turned down as RCA were themselves planning to record the *Requiem* during 1970. Happily (for CBS) these plans were later cancelled and Domingo flew from New York for the Monday 23 morning rehearsal.

Other solo performers were Ruggiero Raimondi (baritone), Josephine Veasey (mezzo) and Martina Arroyo (soprano). It is a reflection on the unsuitability of close microphones for classical singing, perhaps, that difficulties were experienced in capturing the soloist tone that Shepard desired. This might account for his complaint over the talkback, on Thursday afternoon: 'We want a more open sound'. Bernstein, interpreting this as a comment on the performance, retorted with an understandable 'What do you mean?'.

'It sounded pinched.'

The soloist attempted to 'unpinch' his singing but became confused as to what was required. Bernstein promptly accused the Producer: 'Now you've given him a complex'. Only then did Shepard move the soloist back from his *D224*.

A similar problem occurred in the evening. Martina Arroya was moved further and further back from her microphone, without achieving the desired recorded tone. At Tom Shepard's suggestion, she was placed near one of the four *M49* microphones covering the choir. By virtue of its height, this provided precisely the required combination of voice and natural reverberation. Bernstein's reaction, when the tape was replayed in the Control Room, was to delight in the cathedral-like quality of the voice. Why, he asked, couldn't the entire work be recorded that way?

(*continued on page 220*)

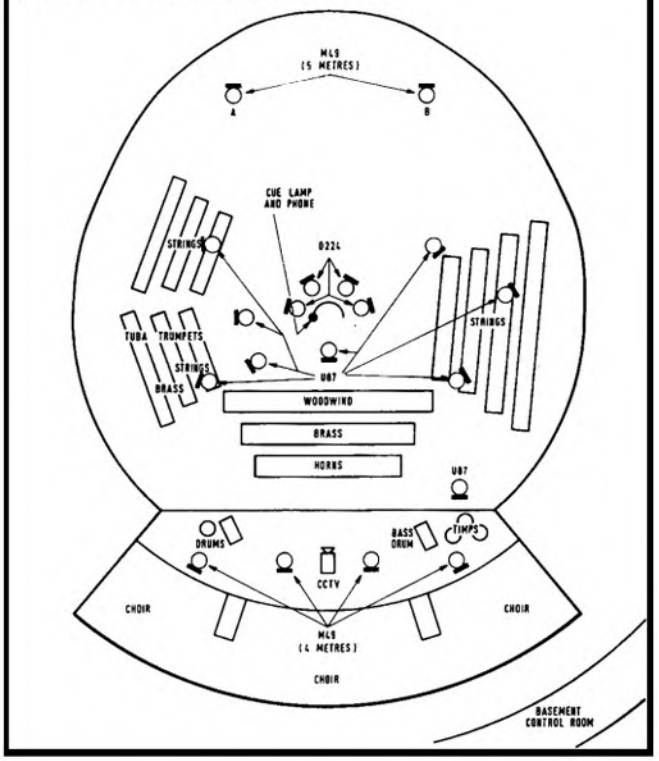
New reels of 25 mm tape (the Control Room was stacked with it), back a few bars, and off again. 'I should think *so*' Myers replied when I commented that I had heard the occasional splice in commercial recordings. 'Most discs contain quite a lot. If they didn't, and we allowed through a wrong note—which you will hear every time you play the disc, remember—we would go down in history as the company that issued so-and-so with a flat.'

Occasionally a microphone would lose itself, requiring a finger-snapping session to locate the appropriate fader.

During the afternoon of Thursday 26, the voice and piano of a warming-up solo singer floated into the hall. The rumble of ventilation fans was also audible to my stereo-pair ears. Neither interference source came through on the control room monitors, however, which presumably demonstrates an advantage of close-mike operation. A percussionist's attempt to close the stage door on his warming-up colleague was defeated by the mass of cable feeding through from the control room. After a few minutes, the orchestra was silenced by the conductor and the warmer-up put down.

Mezzo Josephine Veasey failed to satisfy the Producer at one point and, in anticipation of an unsatisfactory balance during a re-take, Bob Auger was instructed to ease up Miss Veasey's channel. He did, but the soloist also made an extra effort—moving forward slightly as she sang—with the result that her voice nearly drowned the orchestra. Josephine looked somewhat anguished during the

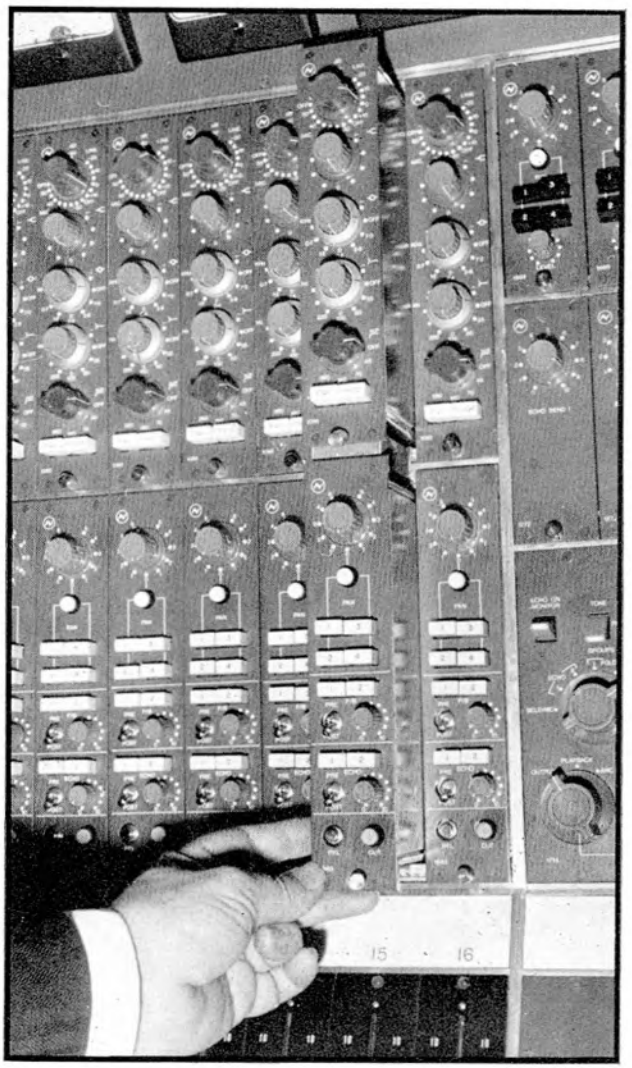
FIG. 2 MICROPHONE LAYOUT, CBS VERDI REQUIEM



SOUND balancing

PART TWO
MICROPHONES
AND MIXERS

BY BOB AUGER



Typical Neve channel modules showing (from top): Combined input switch and attenuator. Equaliser controls with on/off buttons. Group selectors with pan facilities. Echo and foldback selectors and gain controls. Channel faders are at the bottom of the switching modules.

THE first article in this series attempted to give a general picture of the recording engineer's responsibilities and we now turn to the items of equipment available to assist him in his work. The rate of technical development in the sound recording field is now approaching an almost frightening pace and scarcely a month goes by without some new inovation or trend appearing not only on the popular music side of the business, but recently on the classical music side also.

In my last article I mentioned that it was general practice to record classical music in straight stereo, occasionally the requirement being 4-track recording with the orchestra spread across three of the tracks and the fourth track retained for a solo instrument or voice. It is an indication of the times that, no sooner had I written that particular paragraph, I was asked if I was prepared to record the Verdi *Requiem* for CBS Records using 8-track tape recorders. The actual usage of the tracks for this particular session is reported by David Kirk elsewhere in this issue, so I do not need to dwell on the format here. Sufficient to say that it is only a matter of time before someone suggests recording classical music on 16-track equipment—the present custom with popular music.

However, the basic rules of the trade do not change quite so quickly, thank goodness, and I will now endeavour to go through the list of facilities which are now in common use throughout the recording industry today. The best place to start is in the recording studio, as distinct from the control room where the balance engineer is to be found. The set up of the studio and the planning and layout of the musicians, allocation of microphones, and so on, is the responsibility of the balance engineer and we should pause for the moment, to consider the various types of microphone available for professional use at the present time.

Capacitor Microphones

These are without question the most widely used by professional engineers. They have the merits of a very wide audio frequency response, together with extreme sensitivity and very low inherent noise. The vast majority to be found in the studios come from two major manufacturers, one being the Georg Neumann of West Berlin, and the other AKG of Vienna. It would be interesting to know the percentage of Neumann microphones in use in the recording studios of the world. If I were to hazard a guess, it would be somewhere around 75%. This figure would of course include different types of microphones from the same stable. In recent years AKG have produced many admirable microphones, especially in the *C12* range which is unbeatable for its extremely smooth frequency response and lack of 'fizziness' at the top end.

Probably the most common microphone in use today is the Neumann *U67* which uses the *EF86* valve in its head-mounted preamplifier. The later version is the *U87*, a transistorised version of the earlier model. One of the main advantages of the transistorised version is that the external power unit for the preamplifier and head capsule is very small, the current from the power unit to the head being fed along the audio lines, requiring only a simple three-way cable instead of the multi-core cable of the valve version. The U87 also has provision for housing two small batteries in its head, which may be used in place of the external power supply making the microphone a completely self-contained unit which is admirable for use with battery operated tape recorders, such as the ubiquitous Nagra.

Probably the most common microphone in the AKG capacitor range is the *C12A* which is widely favoured by the BBC. Common features of both types include a variable pick-up pattern. The microphone can be used as (a) an 'omni-directional' instrument allowing sound to be picked up evenly throughout 360° (b) 'cardioid' picking up sound from the front only with a sharp falling-off to the side (particularly of the high frequency notes of the spectrum) and (c) figure-of-8 whereby the sound is picked up at the front and back of the microphone but the sides are dead. A point to be remembered here is that any sound pick-up from the rear will be exactly 180° out of phase with that from the front, which may give considerable trouble when using a large number of microphones in one studio (but more of this at a later date!) The *U67* has the additional advantage of an inbuilt switchable attenuator allowing the sound level to be altered *between the capsule and the preamplifier* (which means that it is almost impossible to overload the instruments even when placed adjacent to the loudest of electric guitar loudspeakers) and a bass roll-off switch which, when needed, attenuates the bass by 3 dB below 200 Hz.

Stereo Capacitor Microphones

Only a limited number of stereo microphones are to be found in professional use and their application is generally restricted to the recording of classical music where they are useful for their pick-up of large orchestras or choirs. The number of occasions when the stereo microphone can be used in recording popular music are very few and far between, so consequently only two microphones are normally available. These are the Neumann *SM2c* and the AKG *C24*. These microphones are similar in that one capsule and the twin amplifiers are fixed in one plane, with a second capsule mounted directly above the first, adjustable about its axis over approximately 180°. This allows the two capsules to look in the same direction or to be adjusted until they are finally back-to-back. The angle most commonly used in stereo recording is with the two capsules operating on a 90° angle. Wider angles invoke a 'hole-in-the-middle'. Both microphones have variable pick-up patterns as found in the standard mono versions and many special applications can be made using the various angles of incidence of the capsules and through variable pick-up patterns. Special use of this microphone will be referred to in a later issue, particularly when covering church recordings.

Dynamic Microphones

Recently there has been an increase in the number of dynamic microphones used, particularly in popular music. This has come about mainly for two reasons.

(1) A number of excellent high quality dynamic microphones have appeared on the market.

(2) Much of the pop music being performed in the studios today produces a very high sound level which means that the low level output of the dynamic microphone (when compared with capacitor microphones) is more than compensated for by the volume of the music. Since the dynamic microphone often costs only one third of the price of the capacitor version, it can be seen that studio economics have some bearing on the situation, especially when microphones of the quality of the AKG *D224* are available. This has a very smooth frequency response with only a very gentle roll-off at the extreme treble end. It incorporates an LF attenuator which is very useful for reducing wind noise in the open air, it also allows the microphone to be used as a hand microphone in the light entertainment field, without producing the heavy bass rise at close proximity to the mouth. The cardioid pick-up pattern of the *224* is quite sharp, allowing excellent separation in difficult studio circumstances.

Ribbon Microphones

For many years the accepted standard in sound broadcasting and recording studios, the ribbon is now beginning to lose favour. The reason for this is two-fold. Because of the nature of the beast, the majority of ribbon microphones are only available with figure-of-8 pick-up pattern which can cause separation problems, particularly in the pop studio (the RCA *77DX* range being a notable exception, unfortunately very expensive in this country). Since the microphones have generally very low output levels, one is often troubled with noise problems when sufficient gain is applied at the microphone amplifier in the control room. Without doubt, the most successful ribbon microphone available in this country is the STC *4038* which is still widely used for brass instruments where it proves to have a beautifully smooth clean sound—sometimes difficult to obtain with a capacitor microphone. The balance engineer has to decide whether the open back of the ribbon is more than compensated for by the sound which is produced, compared with a capacitor microphone with its bright sound and cardioid pick-up pattern. This kind of decision is the essence of planning a session, and only experience can teach the engineer the right decision to make.

The Sound Control Room

The first item of equipment to be found in the sound control room is, of course, the sound mixing desk (or 'board' as it is called in the USA). Although now achieving fearsome proportions, with anything up to two or three thousand separate controls, these are remarkably self-contained. The facilities to be found on each channel of the mixer will probably consist of the following :

Microphone preamplifiers. Two switches are to be found on the microphone preamplifier, although on the latest Neve equipment these are put on to one control knob. The first sets the mixer channel to accept a microphone or line level input. This means that the channel can be used either to supply a feed from a microphone or from a tape recorder output, or indeed the line output from another mixing desk in the same building or at the end of a Post Office music line. Since the level of feed to the desk may vary considerably according to circumstances, from a string quartet through a ribbon to a screaming brass section via a capacitor), it is usual to have varying gain settings on the input switch allowing up to 30 dB variation on the line input and anything up to 80 dB variation on the microphone input. At one time it was customary to have this attenuator switching in another part of the control room, away from the desk, and this somewhat inflexible method meant that the engineer had to move from his seat in order to set up the sensitivity of the various mixer inputs. Happily this situation has been recently resolved and it is customary to put the attenuator at the top of the mixer channel.

Equaliser Network. The equalisation (or tone correction) to be found in the mixing channels differs between the various makes of desk. It is generally set to give three distinct areas of correction:

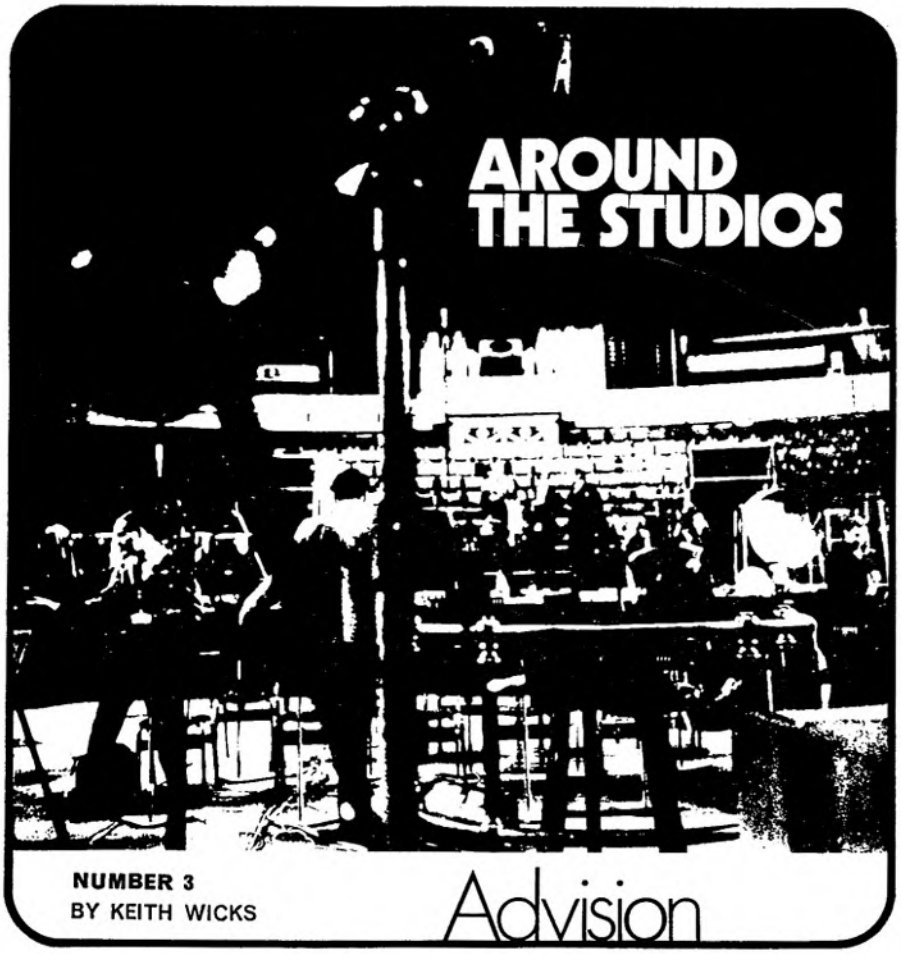
(a) HF correction which generally operates around 10 kHz. This is usually an infinitely variable boost or roll-off commencing at that frequency and allows the whole of the sound to be either 'brightened' or unwanted noise to be removed.

(b) Mid-frequency correction or 'presence'. This is usually a double control using concentric knobs, the outer control selecting the frequency while the inner selects the amount of correction at the chosen frequency. (Selected frequencies making one 'presence' range might be as follows: 1.2, 2.4, 3.8 kHz.) A point to remember is that the frequency selected becomes the apex of the frequency curve, the variable control selecting the height of the apex above the flat frequency level. Some 'presence' controls are fitted with a trough control which allows a dip to be put in the frequency response at this point.

(c) LF correction. This unit also is provided with two controls. One being the frequency selector governing, say, 35, 60, 100 and 220 Hz. The other control is similar to the HF selector in that it allows a smooth boost or roll-off at the chosen frequency. Some mixing desks also have an additional bass-cut control, which is in fact a sharp cut of 60 dB or so below the selected frequency. It will remove unwanted rumble through the channel which may be caused by wind noise, microphone suspension noise (as in television studios when the microphone is moved rapidly on an overhead boom) or from unsteady floor stands when recording in a large hall with the stands placed on a wooden floor.

Group or track selection. The incoming signal having been set at the right level, and the tone corrected, it is now routed to the appropriate fader on the mixer for recording on a specific track of a multitrack tape recorder. There are many ways of providing switching for this but, to my mind, the most effective system is a push button arrangement whereby the channel can be selected to any number of output groups, without matching problems occurring. The mixer module shown in the accompanying illustration is switchable to four group outputs without interaction and a further refinement is the stereo-pan control which, when selected by depressing a button, allows the channel to be panned across two stereo groups. It is now possible, when mixing two-track stereo, to inject any number of microphones which, when listened to on correctly balanced stereo speakers, will each appear to have a different point source. It is no longer necessary to put up with the dreaded ping-pong.

(To be continued)



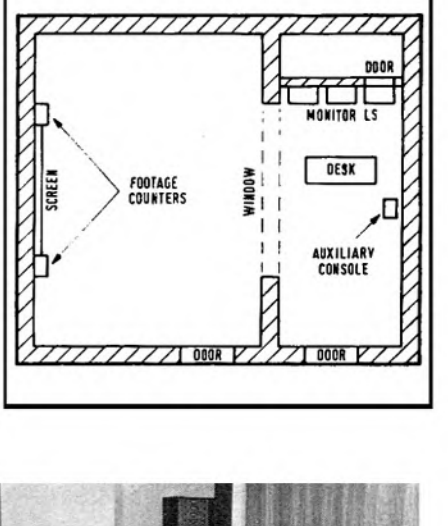
I HAD the pleasure of being present at Advision Studios recently during a multi-track pop session featuring The Move. Advision, having just moved into new premises at Gosfield Street (off Great Portland Street) were in rather an upheaval with major reconstruction going on almost everywhere. However, the parts that were finished indicated that, when the rest of the work has been done, the building will be magnificent. Conveniences include a top floor flat for the engineers' use, and a coffee lounge. (No bar, but there's a pub next door.) As for the extensive facilities, I hope to report on these when the installation has been completed.

I arrived at the studios one evening at about 7 pm and met Gerald Chevin (balancing engineer) who showed me around. The main studio and control room where the action took place were impressively modern in style, and a layout plan is shown in **fig. 1.** As you can see by the screen and footage counters, the premises are used for film dubbing as well as for straightforward recording. The microphones used are of 200 ohms impedance and, as is usual these days, they are fed into a relatively high impedance, in this case 1 K. Three panels are provided in the studio, each with 24 microphone sockets and 8 mains supplies for capacitor mikes. Also on these panels are low impedance feeds for studio loudspeakers, and sockets for 24 pairs of headphones. It was a pleasant change to see a control room as big as the one here. The tendency is for the studio to be as large as possible, at the expense of the control room, in order to accommodate a large number of performers. Such practice is brought about by economic considerations, and is most common where the total available space is small. In many cases the control room is reduced to something resembling the Black Hole of Calcutta. Not so at Advision, where it is large, well furnished, with comfortable seats for guests and a small coffee table.

The main advantage of having a large control room (besides allowing one to move without disturbing the engineer) is that the acoustic conditions for monitoring are so much better. As I explained in 'The Sound Studio' (May 1969), small rooms suffer from having widely spaced resonances at the LF end of the audio range. With large rooms, the widely spaced resonant frequencies are below the audio range, whilst the resonance spectrum inside the band is virtually continuous. This means that there is little coloration of sound by the room acoustics and the boomy quality associated with small rooms is avoided.

A rather unusual feature is the orientation of the control desk which is perpendicular to

FIG. 1 ADVISION
STUDIO AND CONTROL ROOM PLAN



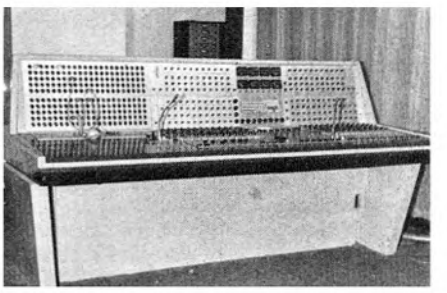


FIG. 2 (RIGHT): Control desk.

the observation window. The engineer has therefore to turn his head sideways to see the performers in the studio. This arrangement is perfectly satisfactory in practice and was probably adopted because the fairly high back of the desk obstructs the engineer's forward vision.

With the trend towards more and more tracks, control desks will inevitably increase in size. If they are extended horizontally, the engineer may have difficulty in reaching some of the controls. (Apparently, the *Todd-AO* desk is over 10 metres long, but five people are employed to operate it.) Another difficulty is that many control rooms lack the room for a very wide desk, so the upward trend seems likely over the next couple of years.

Whilst on the subject of space, it is worthwhile mentioning an alternative solution: an aircraft cockpit control position arrangement with most of the less frequently used controls placed above the observation window. There is some opposition to this idea but it may well prove to be the answer for some of the smaller studios contemplating the use of more tracks.

The Advision control desk is shown in **fig. 2.** It can handle up to 24 inputs, and provides eight outputs for multitrack recording. In accordance with current trends, the desk will soon be modified to 16 channel working, and in this case there is ample space in the room to allow an extension if necessary. A simplified diagram of the desk layout is shown in **fig. 3** and this should be studied in conjunction with the close-ups of the controls **(figs. 4, 5).**

The patchboard is in two sections each containing five rows of 22 sockets. Instead of more conventional jacks, 5-pin sockets are used in such a way that plugging operations are simplified. The input and output of each unit both go to the same socket and only one patching cord is required to insert an extra item into the circuit. The main part of the upright section of the desk contains the microphone amplifiers and the associated equalising units. At the top of each microphone amplifier is a group of foldback controls ; the signal can be fed from before or after the fader to one of two foldback groups. The equalisers are conventional, allowing treble and bass control and also peak boost at various frequencies. Directly below the equalisers, on the horizontal part of the desk, are a number of line amplifiers, and in front of these the MIX amps. These contain push buttons, allowing the sources to be routed to any number of the eight outputs and, if required, via group controls. Another feature on each MIX amplifier is a pan pot for stereo image positioning. Beneath these amplifiers are the corresponding channel faders, and the group and output controls are in the middle of the fader bank.

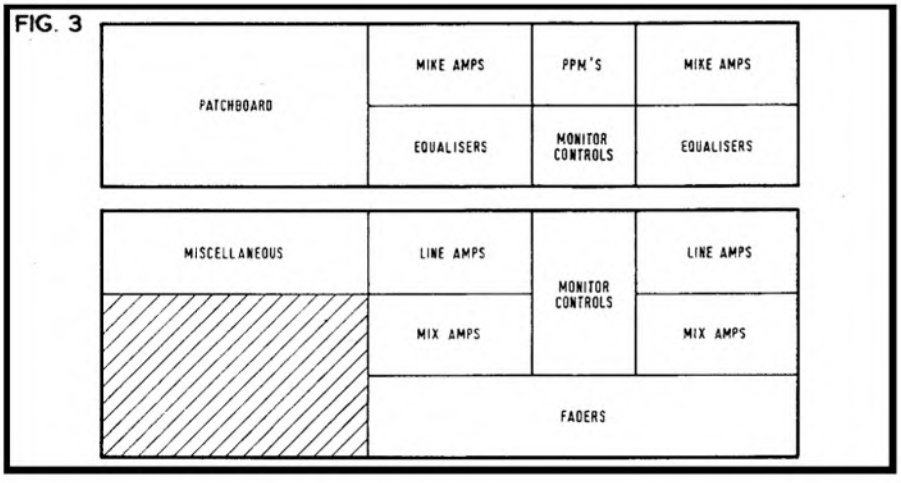
The PPM's, the monitoring amplifiers and selector buttons are arranged directly above the main faders. On the left hand side of the desk, the block labelled MISCELLANEOUS in the diagram contains a couple of limiters used for obtaining special effects, and a talkback amplifier. Other positions in the block are unused and covered by blank panels. Facilities not marked on the diagram include a test signal generator, echo-send amplifiers and equalisers, and reverberation plate remote control units. EMT plates are used and the input signals, which may be fed from before or after the channel faders, are monitored on small VU meters. The returned echo signals are controlled by faders on the extreme right of the desk.

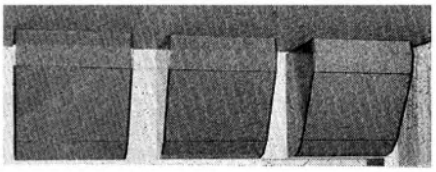
The 100 W loudspeaker monitoring amplifiers are the only part of the system which is not transistorised. They are situated well away from the desk, on the wall behind the

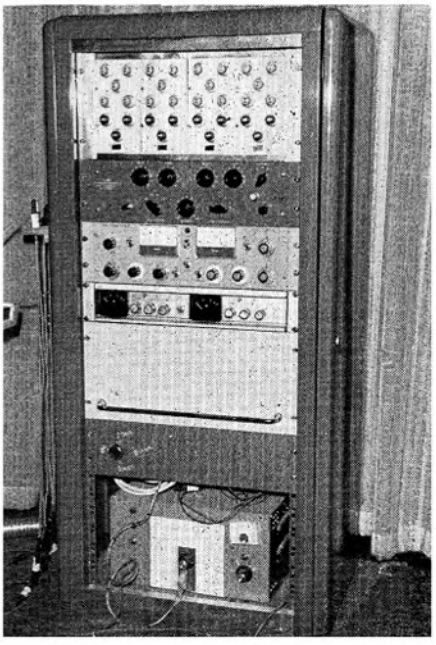
(*continued on page 207*)

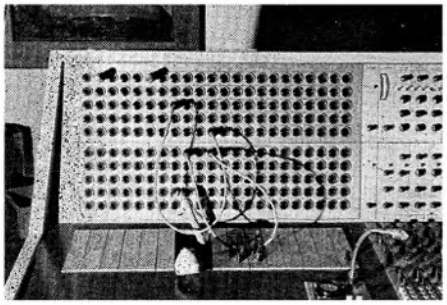
FIG. 4 (BOTTOM LEFT): Control desk patchboard.
FIG. 5 (BOTTOM CENTRE): Various desk modules.
FIG. 6 (TOP RIGHT): Altec Lansing monitor speakers.
FIG. 7 (BOTTOM RIGHT): Auxiliary console. Variable-Frequency supply at Floor-level.

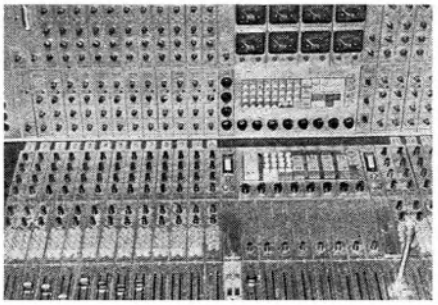
FIG. 3











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*Brenell ST400 4 Tr. Stereo
*Ferrograph 713
*Ferrograph 702/4
*Ferrograph 722/4
Fidelity Studio 4 Tr. Mono
Fidelity 'Braemar' 2 or 4 Tr. Mono
Grundig 124 2 Tr. Mono
Grundig 144 4 Tr. Mono
Grundig 149 4 Tr. Mono Auto
*Grundig TK320 3 sp. 2/4 Tr. Stereo
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three Altec Lancing speaker units shown in **fig. 6.** These were originally intended for use in cinemas, and replace the Tannoy Gold units previously used. ('They only handle 50 W—kept blowing the cones'.) Not surprising !

Why use three monitoring speakers for an 8-track desk ? Originally there were four speakers, but when the Altecs were installed there was only room for three, so that is what they use. The comprehensive monitoring controls allow the engineer to switch any output to any speaker as required ; for example, the outside units can be used for 2-track stereo.

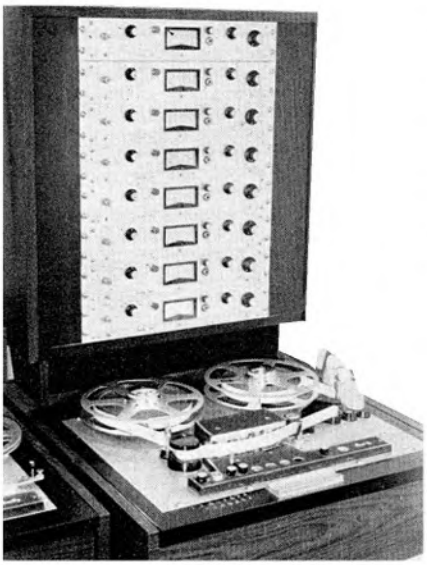
To put the total 300 W capacity of the monitoring system into perspective, it should be pointed out that this is less than 12 dB above the power available from a 10 W per-channel domestic stereo amplifier. This thought made 300 W seem much less extravagant although, when I heard the system working, I again began to wonder if so much power was really necessary. I was then told that customers tend to be more impressed if they hear their material at a very high level without noticeable distortion, and I must agree that the high level and quality really *are* impressive. The reason Advision use valve amplifiers for monitoring is that they have yet to find any suitable transistorised amplifiers to handle all this power with such little distortion. (Opportunity knocks for you amp manufacturers.)

Besides the equipment already mentioned, there is a console (**fig. 7**) to the right of the desk which contains auxiliary units. At the bottom is a Variable Frequency Oscillator, the output of which can be fed to a tape machine in order to drive it at non-standard speeds. In the middle of the console are two stereo limiters, one by Pye, and the other by Audio & Design. These are used in the production of master tapes and the channels are linked so that limiting on one side causes limiting to take place in the other channel. This prevents the stereo image position from changing whenever limiting takes place. Above the limiters is a Pultec equaliser, a versatile device with variable bandwidth controls. Finally, at the top of the console are four smaller equalisers similar in design to the Pultec.

At about 8 pm, The Move, or rather the singing three-quarters of it, arrived. Roy Wood, Carl (Charlie) Wayne, and Ric Price were to record vocal material for a new LP. The backing tracks had already been made, so Bev Bevin, their non-singing drummer, was not present. After a swift visit to the pub next door, we returned to the studio and the session commenced, using an 8-track Scully recorder employing 25mm tape. This is shown in **fig. 8,** and in **fig. 9** is a single track recorder used for producing 6.25 mm mono master tapes. The first number was *Fields of People*, and recording this turned out to be quite an eventful task. The object was to try to convey the impression of someone coming across a variety of people. Rather than invent the whole thing, it was decided to send Carl into Great Portland Street with a microphone and headphones on extension cables. The first vocal track was to consist of Carl's spontaneous chat to people he met in the street. Sitting in the control room, the rest of us listened as he made approaches to unsuspecting passers-by.

It is really quite incredible the variety of people that stroll along Great Portland Street on Friday evenings. There's the woman whose favourite pop star is Fenella Fielding, three men sounding like Peter Sellers, and another woman whose only knowledge of pop music is that most of them do *it* in the 'noode' (whatever *it* is). Finally there was the highly coloured gentleman who, when politely introduced by Carl as 'someone obviously from overseas', spent some time explaining

(*continued on page 220*)



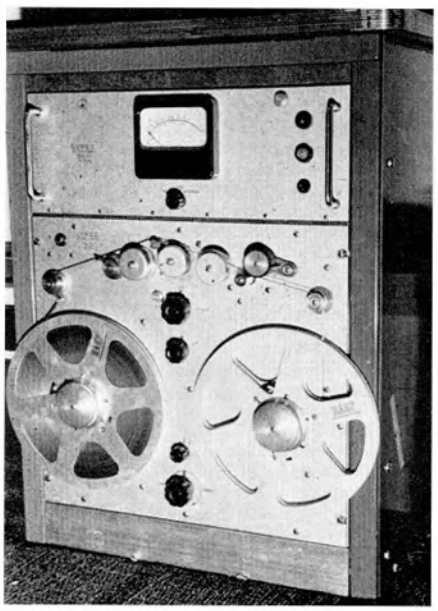


FIG. 8 (TOP LEFT): Eight-track Scully.

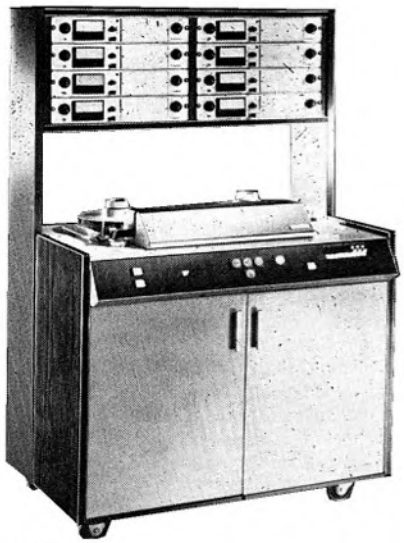
FIG. 9 (BOTTOM LEFT): Single-track Lyrec.

FIG. 10 (BOTTOM CENTRE): Carl Wayne singing in Great Portland Street.

FIG. 11 (TOP RIGHT): Roy, Ric and Carl (L to R) recording in undecorated back room.

FIG. 12 (BOTTOM RIGHT): Roy Wood listens to a recording. with engineer Gerald Chevin.

Professional Sound Recorders Surveyed



Ampex MM-1000

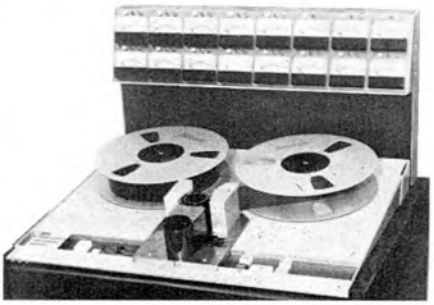
Unless otherwise stated, the following survey of professional reel-to-reel sound recorders specifies the following: Signal-to-noise ratio is referred to peak recording level, 1 kHz, in common with total harmonic distortion. Frequency response figures relate to—10 dBm level. Inputs are the minimum necessary to attain peak modulation, outputs being the maximum obtainable from a tape recorded to peak level. All specifications are record-replay at 38 cm/s, Tandberg and Uher excepted, including characteristics of the stated tapes.

AMPEX
AMPEX (GREAT BRITAIN) LTD., ACRE ROAD, READING, BERKSHIRE
(Tel. Reading 84411)
Model: AG-500
Channels: One (full-track mono). (Half-track mono, half and ¼-track stereo to order)
Tape width: 6.25 mm
Signal-to-noise ratio: 57 dB
Frequency response: 30 Hz to 18 kHz ±2 dB
Wow and flutter at end of reel: 0.15% RMS
Spool capacity: 18 cm **Type:** Cine
Level meter: VU
Inputs: 100 K unbalanced (two per channel), −18 dBm
Outputs: +4 dBm at 600 ohms balanced
BASIC PRICE: £650

Model: AG-440B
Channels: One, two, three or four (Specification relates to single-channel)
Tape width: 6.25 mm
Signal-to-noise ratio: 60 dB
Frequency response: 30 Hz to 18 kHz ±2 dB
Wow and flutter at end of reel: 0.08% RMS
Spool capacity: 36 cm **Type:** NAB or European
Level meters: VU
Inputs: 100 K unbalanced, 20 K balanced
Outputs: +8 dBm into 600 ohms, for +4 dBm output, balanced or unbalanced
BASIC PRICE: £1 054

Model: MM-1000
Channels: 8, 16 or 24 (Specification relates to 16-channel)
Tape width: 50 mm
Signal-to-noise ratio: 60 dB
Total harmonic distortion: 1.1%
Frequency response: 30 Hz to 18 kHz ±2 dB
Crosstalk (500 Hz): 50 dB
Wow and flutter at end of reel: 0.08% RMS
Spool capacity: 36 cm **Type:** NAB or European
Level meters: VU
Outputs: +8 dBm into 600 ohms, for +4 dBm output, balanced or unbalanced
BASIC PRICE: £12 500
Measured on Ampex 434 tape

3M Mincom



3M
3M COMPANY LTD., 3M HOUSE, WIGMORE STREET, LONDON W1A 1ET
(Tel. 01-486-5522)
Model: Mincom
Channels: 16 (one, two, three, four and eight channels to order)
Tape width: 50 mm
Bias frequency: 120 kHz
Signal-to-noise ratio: 62 dB
Frequency response: 40 Hz to 15 kHz ±1 dB
Wow and flutter at end of reel: 0.06% RMS
Spool capacity: 29 cm **Type:** NAB or European
Level meters: VU
Inputs: −10 dBm at 600 ohms, balanced or unbalanced
Outputs: +4 dBm balanced
BASIC PRICE: £15 475
Measured on Scotch 202 tape

KUDELSKI
HAYDEN LABORATORIES LTD., EAST HOUSE, CHILTERN AVENUE, AMERSHAM, BUCKS
(Tel. 0249-5-6565)
Model: Nagra 4D
Channels: One
Tape width: 6.25 mm
Erase track width: 6.25 mm (8 mm head)
Record track width: 6.25 mm (6.4 mm head)
Play track width: 6 mm
Record head gap: 7 μm
Play head gap: 3 μm
Bias frequency: 120 kHz
Signal-to-noise ratio: −73 dB (ASA A weighted)
Total harmonic distortion: 0.08%
Frequency response: 30 Hz to 20 kHz ±1.5 dB (30 Hz to 35 kHz ±1.5 dB to special order)
Tape flux at peak recording level: 50 mM/mm
Wow and flutter at end of reel: 0.1% peak-to-peak unweighted
Spool capacity: 18 cm **Type:** Cine
Level meter: PPM characteristic, dB calibrated
Inputs: Two balanced microphones: 50 μV at 50 ohms or 100 μV at 200 ohms
Line: 0.37 V at 100 K unbalanced
Mixer: 880 mV at 10 K unbalanced
Outputs: 9.6 V into 600 ohms, balanced
BASIC PRICE: £533
Measured on Scotch 202 tape

LEEVERS - RICH EQUIPMENT LTD., 319 TRINITY ROAD, WANDSWORTH, LONDON S.W.18
(Tel. 01-574-9054)
Model: E6R-1/1-M
Channels: One
Tape width: 6.25 mm
Erase track width: 6.25 mm
Record track width: 6.85 mm
Play track width: 6.35 mm
Record head gap: 25 μm
Play head gap: 4 μm
Bias frequency: 127 kHz
Signal-to-noise ratio: 62 dB
Total harmonic distortion: 2%
Frequency response: 40 Hz to 18 kHz ±2 dB
Tape flux at peak recording level: 32 mM/mm
Wow and flutter at end of reel: ±0.15%
Spool capacity: 29 cm **Type:** European
Level meter: VU (with isolating amplifier)
Input: −14 dBm
Output: +22 dBm
BASIC PRICE: £860*
Measured on Scotch 202 tape

Model: E6R-2/2-M
Channels: Two
Tape width: 6.25 mm
Erase track width: 3.25 mm
Record track width: 2.2 mm
Play track width: 2.2 mm
Record head gap: 25 μm
Play head gap: 4 μm
Bias frequency: 127 kHz
Signal-to-noise ratio: 60 dB
Total harmonic distortion: 2%
Frequency response: 40 Hz to 18 kHz ±2 dB
Crosstalk: 40 dB

Tape flux at peak recording level: 32 mM/mm
Wow and flutter at end of reel: ±0.15%
Spool capacity: 29 cm **Type:** European
Level meters: VU (each with isolating amplifier)
Inputs: −14 dBm balanced
Outputs: +22 dBm balanced
BASIC PRICE: £1 055*
Measured on Scotch 202 tape
(M type Broadcast console. Studio consoles, also available)

Model: G4S-8/8-S
Channels: Eight
Tape width: 25 mm
Erase track width: 2.2 mm
Record track width: 1.8 mm
Play track width: 1.8 mm
Record head gap: 12 μm
Play head gap: 4 μm
Bias frequency: 127 kHz
Signal-to-noise ratio: 60 dB
Total harmonic distortion: 2%
Frequency response: 40 Hz to 18 kHz ±2 dB
Crosstalk: 40 dB
Tape flux at peak recording level: 32 mM/mm
Wow and flutter at end of reel: ±0.15%
Spool capacity: 27 cm **Type:** NAB
Level meters: VU (each with isolating amplifier)
Inputs: −14 dBm balanced
Outputs: +22 dBm balanced
BASIC PRICE: £5 450
Measured on Scotch 202 tape

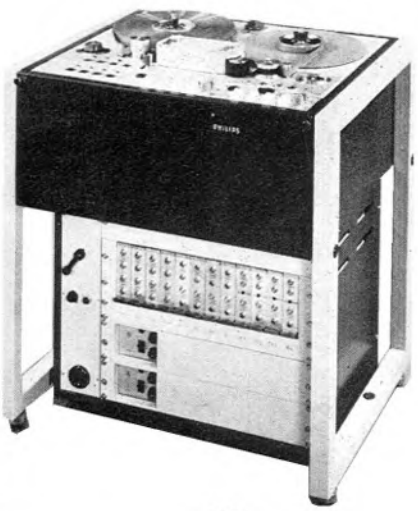
Leevers-Rich G4S-8/8-S

PHILIPS
PYE TVT LTD., BROADCASTING DIVISION, COLDHAMS LANE, CAMBRIDGE
(Tel. 0223-45115)
Model: PRO 51A
Channels: Two (full-track mono to order)
Tape width: 6.25 mm
Erase track width: 6.55 mm
Record track width: 2.9 mm
Guard band: 0.75 mm
Record head gap: 6 to 7 μm
Play head gap: 3 to 4 μm
Bias frequency: 94 kHz
Signal-to-noise ratio: 62 dB RMS, weighted
Total harmonic distortion: 1.5%
Frequency response: 40 Hz to 18 kHz ±2 dB
Crosstalk: 35 dB (0.75 mm track separation)
Wow and flutter at end of reel: 0.05% RMS
Spool capacity: 27 cm
Type: Cine, NAB or European
Level meters: None
Inputs: 500 mV at 8 K, balanced
Outputs: 7.75 V at 100 ohms
BASIC PRICE: £1 770 (Mono version £1 660)
Excl. auto editing

Model: Philips PRO 71
Channels: Four
Tape width: 12.5 mm
Erase track width: 2.102 mm
Record track width: 1.778 mm
Play track width: 1.778 mm
Record head gap: 6 to 7 μm
Play head gap: 3 to 4 μm
Bias frequency: 94 kHz
Signal-to-noise ratio: 56 dB RMS, weighted
Total harmonic distortion: 1.5%
Frequency response: 40 Hz to 15 kHz ±1 dB
Crosstalk: 46 dB
Wow and flutter at end of reel: 0.04% peak
Spool capacity: 27 cm **Type:** NAB or European
Level meters: None
Inputs: 500 mV at 200 or 600 ohms balanced
Outputs: 6.2 V at 600 ohms balanced
BASIC PRICE: £3 600
Measured on BASF LGR

REVOX
REVOX LTD., 90 HIGH STREET, ETON, WINDSOR, BERKSHIRE
(Tel. 95-63388)
Model: Revox HS NAB
Channels: Two
Tape width: 6.25 mm
Bias frequency: 120 kHz
Signal-to-noise ratio: 60 dB
Total harmonic distortion: 2%
Frequency response: 30 Hz to 20 kHz ±1.5 dB
Crosstalk: 45 dB
Tape flux at peak recording level: 32 mM/mm
Wow and flutter at end of reel: 0.04% peak-to-peak unweighted
Spool capacity: 27 cm **Type:** NAB
Level meters: VU
Inputs: 0.15 mV at 6 K; 2 mV at 100 K; 2 mV at 33 K; 40 mV at 1 M, unbalanced
Outputs: 2.5 V at 600 ohms, unbalanced
BASIC PRICE: £192
Measured on Agfa PE36 tape

Philips PRO 71



SCOPETRONICS
SCOPETRONICS LTD., CROWN WORKS, CHURCH ROAD, KINGSTON-ON-THAMES, SURREY
(Tel. 01-546 1275/4135)
Model: 1151
Channels: One
Tape width: 6.25 mm
Record head gap: 12.5 μm
Play head gap: 3.5 μm
Bias frequency: 100 kHz
Signal-to-noise ratio: 57 dB
Frequency response: 60 Hz to 15 kHz ±1 dB
Tape flux at peak recording level: 48mM/mm
Wow and flutter at end of reel: ±0.1% peak, weighted.
Spool capacity: 27 cm **Type:** NAB
Inputs: 45 mV at 600 ohms, floating.
Outputs: +8 dBm, floating.
Level meter: Single PPM
Basic price: To be announced
Measured on EMI H77 tape

SCULLY
FELDON RECORDING LTD., 126 GREAT PORTLAND STREET, LONDON W.1.
(Tel. 01-580-4314)
Model: 288/16
Channels: 16 (8-channel available to order)
Tape width: 50 mm
Erase track width: 2 mm
Record track width: 1.75 mm
Play track width: 1.75 mm
Record head gap: 12.5 μm
Play head gap: 5 μm
Bias frequency: 180 kHz
Erase frequency: 60 kHz
Signal-to-noise ratio: 64 dB
Total harmonic distortion: 0.5%
Frequency response: 30 Hz to 18 kHz +1 −1.5 dB
Crosstalk: 47 dB
Tape flux at peak recording level: 64 mM/mm
Wow and flutter at end of reel: 0.08% RMS
Spool capacity: 27 cm **Type:** NAB
Level meters: VU
Inputs: −10 dBm at 10 K, balanced (−40 dBm microphone)
Outputs: +24 dBm at 600 ohms, balanced
BASIC PRICE: £11 655 (Eight-channel: £6 190)
Measured on BASF LR56 tape

STELLAVOX
AUDIO ENGINEERING LTD., 33 ENDELL STREET, LONDON W.C.2.
(Tel. 01-836 0033)
Model: SP 7
Channels: Two (plus neopilot on mono headblock; syncrotone on stereo headblock—pilot and AF)
Tape width: 6.25 mm
Bias frequency: 61.44 kHz
Signal-to-noise ratio: 61 dB
Total harmonic distortion (+4 dB, 1 kHz): 1.2%
Frequency response: 20 Hz to 16 kHz ±2 dB
Tape flux at peak recording level: 50 mM/mm
Wow and flutter at end of reel: 0.12% peak-to-peak unweighted
Spool capacity: 13 cm
Type: Cine (27 cm NAB with adaptor)
Level meters: Modulometers
Inputs: 200 μV to 25 mV at 200 ohms
Outputs: +6 dBm unbalanced
BASIC PRICE: £500
Measured on Scotch 203 tape

STUDER
F. W. O. BAUCH LTD., 49 THEOBALD STREET, BOREHAM WOOD, HERTS.
(Tel. 01-953 0091)
Model: C37st

(continued on page 211)

Channels: Two (Single channel available to order)
Tape width: 6.25 mm
Bias frequency: 80 kHz
Signal-to-noise ratio (ref +6 dB, 1 kHz): 57 dB
Total harmonic distortion (200 mM, 1 kHz): 2%
Frequency response: 30 Hz to 15 kHz +1 −2 dB
Crosstalk: 40 dB
Wow and flutter at end of reel: 0.08% peak unweighted
Spool capacity: 30.5 cm
Type: European, NAB or Cine
Level meters: None
Inputs: 700 mV at 15 K, balanced
Outputs: 7 V into 200 ohms, balanced
BASIC PRICE: £1 423 (Version with 0.75 mm track separation: £1 444); C37m (single channel): £1 231

Model: A62z
Channels: Two (Single-channel available to order)
Tape width: 6.25 mm
Signal-to-noise ratio: 61 dB
Frequency response: 30 Hz to 15 kHz +1 −2 dB
Wow and flutter at end of reel: 0.05% RMS
Spool capacity: 27 cm **Type:** NAB
Level meters: None
Inputs: 200 mV at 20 K balanced or floating
Outputs (maximum, for peak modulation): 4.4 V (700 mV minimum) into 200 ohms
BASIC PRICE: £790; A62m (single-track): £632
Measured on Scotch 201 tape

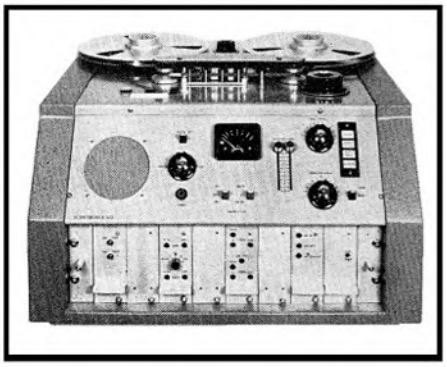
Model: A80-4-1
Channels: Four
Tape width: 25 mm
Basic Price: £3 140
Details as C37

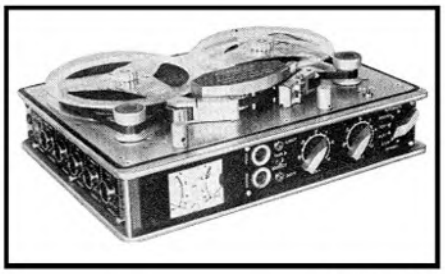
Model: A80-8-1
Channels: Eight
Tape width: 25 mm
Basic Price: £5 320
Details as C37

Model: A80-16-2
Channels: Sixteen
Tape width: 50 mm
Basic Price: £9 800
Details as C37

TAPE RECORDER DEVELOPMENTS LTD., 7 KING GEORGE'S AVENUE, BUSHEY HEATH, HERTS.
(Tel. Bushey Heath 2331)
Model: 622
Channels: Two (Four-channel to order)
Tape width: 6.25 mm
Bias frequency: 100 kHz

Scopetronics 1151





Stellavox SP7

Signal-to-noise ratio: 60 dB
Total harmonic distortion: 2%
Frequency response: 40 Hz to 20 kHz ±2 dB
Tape flux at peak recording level: 32 mM/mm
Wow and flutter at end of reel: 0.05% RMS
Spool capacity: 27 cm **Type:** NAB
Level meter: Single PPM
Inputs: −70 dBm 600 ohms (microphone); −20 dBm 10 K bridging (line)
Outputs: +10 dBm 600 ohms, balanced or unbalanced to order
BASIC PRICE: £250
Measured on Scotch 202 tape

TAPERITER
HARTLEY ELECTROMOTIVES LTD., TAPERITER DIVISION, MONKMOOR, SHREWSBURY, SHROPSHIRE
(Tel: 0743 6343)
Model: 4000
Channels: Two
Tape width: 6.25 mm (TRD transport mechanism)
Signal-to-noise ratio: 50 dB
Frequency response: 40Hz to 18kHz ±3 dB
Wow and flutter: 0.07% RMS (Gaumont Kalee 1740)
Spool capacity: 27 cm **Type:** NAB
Level meters: PPM
Basic price: £458

TANDBERG
FARNELL - TANDBERG LTD., HEREFORD HOUSE, NORTH COURT, VICAR LANE, LEEDS LS2 7NS
(Tel. Leeds 39834)
Model: 11-1 battery portable (19 cm/s maximum speed)
Channels: Full-track
Tape width: 6.25 mm
Bias frequency: 85.5 kHz
Signal-to-noise ratio: 59 dB (DIN 45/511)
Total harmonic distortion: 3%
Frequency response: 30 Hz to 18 kHz −5 dB
Wow and flutter at end of reel: 0.15% peak
Spool capacity: 18 cm **Type:** Cine
Level meter: VU
Inputs: 0.15 mV at 200 ohms balanced; 5 mV at 10 K and 125 mV at 200 K unbalanced
Outputs: 600 ohms balanced line
BASIC PRICE: £146; 11-P Pilot: £209
Measured on Scotch 202 tape

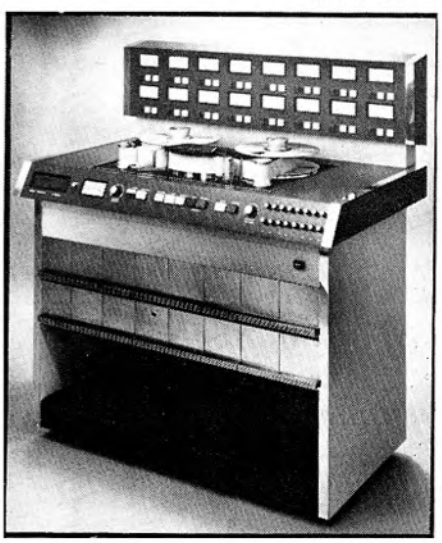
UHER
BOSCH LTD., RHODES WAY, RADLETT ROAD, WATFORD, HERTS.
(Tel. Watford 44233)
Model: Uher 1000 Pilot
Channels: Full-track sound plus pilot
Tape width: 6.25 mm
Signal-to-noise ratio: 52 dB
Total harmonic distortion: 2%
Tape flux at peak recording level: 32 mM/mm
Wow and flutter at end of reel: 0.15/p-p
Spool capacity: 13 cm **Type:** Cine
Level meter: VU

Nagra 4D

Inputs: 200 μV at 200 ohms balanced (microphone); 300 mV at 600 ohms unbalanced (line)
Outputs: 4.4 V at 600 ohms (balanced or floating)
BASIC PRICE: £331 15s. 4d.
Measured on BASF PES 40 tape

UNITRACK EQUIPMENT LTD., 590 WANDSWORTH ROAD, LONDON S.W.8.
(Tel. 01-622-8620)
Model: Uni 16
Channels: 16 (Single, two, four, eight and 24 channels to order)
Tape width: 50 mm
Bias frequency: 180 kHz
Erase frequency: 60 kHz
Signal-to-noise ratio: 62 dB
Total harmonic distortion: 0.5%
Frequency response: 35 Hz to 20 kHz ±2 dB
Crosstalk: 54 dB
Wow and flutter at end of reel: 0.06% RMS
Spool capacity: 27 cm **Type:** NAB
Level meters: VU
Inputs: 0 dBm at 600 ohms, balanced, unbalanced or floating
Outputs: 0 dBm at 600 ohms, balanced, unbalanced or floating
BASIC PRICE: £11 250; Uni 8 (8-track): £7 950; Uni 24 (24-track): £15 500

Unitrack Uni 16



OUR READERS write

. . . *about 'Column Speaker'*

From: Alan Green, Folk Heritage Recordings, 22 Longmeadow, Cheadle Hulme, Cheadle, Cheshire SK8 7ER.

Dear Sir: Having just read the 'Concluding Commentary' by Dropout, I was moved by the obvious sincerity of his article. I feel sure that, without his regular feature, many amateurs and would-be enthusiasts would not have gained the confidence needed to drive them forward. Although I now own a small recording company, I am still an amateur. When I first ventured into the world of tape some 10 years ago, I had an ancient Ferrograph and two second-hand cheap ribbon microphones. I had the old problem of who and what to record and satisfied myself with simple recordings of material which I happen to savour—traditional English folk music. There were, and still are, hundreds of folk clubs throughout the country, operating usually in a room over a pub, where weekly meetings take place to perform this kind of music. Many of these clubs run 'workshop nights' when 'amateur', yet highly talented singers work out song arrangements. These nights can provide enough recorded material to keep a dedicated enthusiast going for several weeks. I am sure that many other amateur organisations exist where musicians from the dedicated classical types to the would-be 'pop' groups must meet.

I quickly found that, once the recording has been made, this is *not* the end of the job. The tapes can be improved beyond recognition by playing around with simple techniques such as tape-echo and compression.

During the following two years, my enthusiasm got the better of me and, with other friends, I began to manufacture small issues of records of talented local folk-music artists. The hobby became a business and lost its main attraction—individuality. We split up and since that time my business has prospered. I now use two modified *Series 7* Ferrographs, four AKG *D202* and four *D707* microphones, together with a home-designed and built 8-channel mixer incorporating PPMs and compression facilities. More elaborate equipment is not necessary since the amateur has one great thing on his side—time. Time for editing, dubbing and experimenting with sounds and equipment. Time for preliminary tape balancing, unlike the 16-track fellows who slap a rough mix on tape at an expensive recording session and afterwards shut themselves up in a dubbing room to obtain the right sound.

I have my master acetates cut in the studios of one of these giants (CBS). The manager of this department once encouraged me by showing little regard for wow, flutter and measurable levels of noise and distortion. 'It's the sound that counts', he assured me. How right he was.

It's no use sitting around at the local tape club, talking about radiogram connecting leads and the perfect machine. The challenge is there to be taken up, not talked about.

By the way, I hope your Ferrograph *7* reviewer has found its outstanding fault: the pressure 'pads' are actually thick rubber and do not suffice. On my machine, and that of a friend, the replay level on the top track drops out occasionally. This causes dramatic effects on stereo recordings as the 'man in the middle' starts wandering. I have replaced the rubber with brass and the felt with foam-rubber. The foam surface is coated with billiard-table green felt which ensures intimate head contact with far less pressure.

Yours faithfully

. . . *about metric*

From: Richard Arbib, Multicore Solders Ltd., Hemel Hempstead, Hertfordshire.

Dear Sir: As Managing Director of a company which has received the Queen's Award to Industry for Export Achievement, and who is an audio enthusiast, may I express my complete agreement with Mr John Alcock and Mr Peter Bastin regarding their comments about metric measurements.

I consider it most irritating that your journals, and other electronic/audio ones, have adopted these measurements prematurely, or at least not had the foresight to quote Imperial measurements in brackets.

Any progressive firm which undertakes export business quotes metric measurements and weights in literature; and we as a company have been supplying solder for probably 20 years in kilogrammes if this has been required. Our literature has always quoted metric equivalents for solder and, more recently, for audio products where applicable, such as Bib tape splicers, etc. Perhaps it is significant that we export to more than 63 countries but not more than 10% of our solder is supplied on kg reels.

Possibly the best argument as to why technical journals should not at the present time use metric measurements is the fact that I have yet to see an advertisement in any of these UK journals quoting such measurements.

Yours faithfully

Look a little harder! We have published them occasionally. If any reader thinks we are bloody-minded on this subject, he might browse through the new British Standard 1568: Part 1: 1970 where dear old BSI advocates the use of 76.2, 38.1, 19.05, 9.53 and 4.76 cm/s equivalents. No attempt to round off within the accepted production tolerances of studio recorders. **Ed.**

PHILIPS PRO 12

MANUFACTURER'S SPECIFICATION (19 cm/s): Half-track stereo tape unit. **Tape speed deviation:** 0.8%. **Wow and flutter:** 0.08% (to DIN 45507, measured with EMT 420). **Starting time:** 1 second. **Equalisation:** 70 μS (CCIR). **Frequency response:** 60 Hz to 12 kHz within 1.5 dB, 40 Hz to 18 kHz within 2.5 dB, to DIN 45511. **Signal-to-noise ratio:** −56 dB weighted, to DIN 45405. **Total harmonic distortion** (+6 dB at full modulation : 0.5% (record amplifier); 0.5% (replay amplifier). **Crosstalk:** −52 dB (at 1 kHz to 3% third-harmonic distortion, full level on adjacent track, both tracks biased). **Tape speeds:** 19 and 9.5 cm/s. **Line input:** 100 mV at 100 K. **Microphone input:** 1 mV (unbalanced) from 50 ohms to 2 K. **Diode input:** 2 to 40 mV at 20 K. **Optional inputs:** 200 μV at 50 ohms balanced (microphone transformer); 400 μV at 200 and 500 ohms (taps); 0.775 V or 1.55 V at 600 ohms line input transformer available. **Line and monitor outputs:** 0.775 V to 4 V with 10 K load (600 ohm line transformer available). Internal monitor speaker. **Weight:** 23 kg. **Dimensions:** 520 x 340 x 240 mm. **Price: £249 10s.** (including £49 8s. 7d. purchase tax). **Distributor: Philips Electrical Ltd., Century House, Shaftesbury Avenue, London WC2.**

THE Philips *PRO 12* is the newest and smallest addition to the company's long line of highly successful professional audio recorders, thousands of which are in daily use in broadcasting and sound studios all over the world.

Excellent and expensive though it is, I hesitate to place it in any but the domestic bracket. Just one reason: no 38 cm/s speed is provided. The Chancellor of the Exchequer anticipated my feelings on this point by slapping £50 purchase tax on the machine.

The particular sample submitted must have gained entry by the back door unobserved because normally only heavy 'battle-ship' studio types are allowed into my test laboratory. However, it is here now and, bearing in mind that I am biased towards top professional gear, any praise forthcoming for this little fellow will be praise indeed.

Although small, it is quite heavy—23 kg—the reason for this being obvious when the machine is opened up. A massive deep-ribbed alloy casting supports the mechanics and the continuously running capstan is fitted with two pulleys and a heavy alloy boss, to which is affixed a solid copper disc 165 mm in diameter by 4.5 mm thick. The capstan is driven by a single-speed motor via a polyurethane belt, speed change being effected by a belt shift mechanism. (Why not a two-speed motor?) The copper disc runs between two pairs of adjustable eddy current brakes. A built-in stroboscope and neon lamp enable exact tape speeds to be correctly set.

Two substantial motors drive the tape spools. Rewind is very fast, albeit a little untidy: 110 seconds for 720 metres of tape! Controls on the deck are well laid out, although the push-buttons are rather heavy and the solenoids very noisy. At first I was quite alarmed by this noise and concerned for the safety of my valuable test tapes, but I need not have worried—the thinnest tapes were handled perfectly.

On the right-hand side of the recorder is the electronics panel, hinged at the back. When open this exposes controls for the bias, replay and record response on each channel at both speeds, modulation currents, and so on. There are no less than 16 adjusting screws in all, which will provide a field day for the enthusiast with the necessary test gear or many field days for those without.

A word of warning. Do not attempt to alter the speed change knob with the amplifier panel 'in the air' otherwise a lever will become disengaged and your equalisation goes up the creek. I made this mistake and had to start again. A mechanical modification needed here.

Comprehensive monitoring facilities by push-button switches, including AB check, are provided on the face of the panel which also houses the VU meters, meter switches, input switches and record and replay controls.

Mounted on the back of the recorder is a fine array of nine miniature DIN sockets for various inputs and outputs. I do not like the unbalanced microphone inputs but a balancing transformer is available as an extra.

An internal loudspeaker is fitted to the left-hand side panel. There is a DIN socket for headphone output on the tape deck, also cue and dubbing facilities with tape lifting device and pause button. Another good point, the machine can be operated in horizontal or vertical position, or rack mounted.

In the lid one will find various plastic bags containing mains socket and a collection of well-made right-angle DIN plugs. Also included is the *PRO 12* Operation and Service Manual, beautifully printed on art paper: 28 pages crammed with useful information, circuit diagrams, setting up and maintenance procedures. In the Manual are five loose sheets of works test reports of the individual recorder, all filled in by hand and signed by the various

(*continued on page 215*)

TEST REPORT

Model: Philips PRO 12

Tape: BASF LH (long play) CCIR

Characteristics: DIN 45511 (Professional standard)

FREQUENCY RESPONSE (9.5 cm/s) IN dB

	REPLAY		OVERALL	
	T	B	T	B
40 Hz	+0.5	+0.6	+1	+0.8
63	+0.2	+0.2	+1.3	+1
125	+0.5	+0.6	+1	+0.8
250	+0.5	+0.6	+1	+0.6
500	0	+0.3	+0.5	+0.3
1 kHz	0	0	0	0
2 k	−0.2	0	0	−0.2
4 k	−0.8	−0.8	−0.4	−0.4
6.3 k	−0.8	−0.8	−0.3	−0.3
8 k	−0.8	−0.8	−0.3	−0.3
10 k	−0.8	−0.8	0	−0.8
12.5 k	−0.6	−0.8	+0.2	0
14 k	−1.2	−1.2	−0.5	−0.4
16 k	−0.6	−0.4	−1	−0.8

FREQUENCY RESPONSE (19 cm/s) IN dB

	REPLAY		OVERALL	
	T	B	T	B
40 Hz	−0.3	−0.4	−2.5	−3
63	+1.2	+1	−0.6	−0.8
125	+0.7	+0.8	−0.4	−0.5
250	+0.5	+0.5	0	0
500	+0.2	+0.4	0	0
1 kHz	0	0	0	0
2 k	0	−0.2	+0.5	+0.8
4 k	−0.2	−0.4	+1.3	+1.5
6.3 k	+0.3	+0.4	+1.4	+1.5
8 k	+0.2	+0.2	+1.3	+1.7
10 k	+0.2	+0.2	+1.2	+1.8
12.5 k	+0.5	+0.5	+1.4	+1.6
14 k	+0.6	+0.6	+1.4	+1.6
16 k	+0.4	+0.5	+1.3	+1.4
18 k	+0.8	+0.5	+1.5	+1.4

WOW AND FLUTTER (18 cm reel)

	START	END (9.5 cm/s)
WOW	.025%	.075%
FLUTTER	.055%	.065%
TOTAL	.06%	.085%
	START	END (19 cm/s)
WOW	.017%	.05%
FLUTTER	.03%	.045%
TOTAL	.035%	.06%

SIGNAL TO NOISE RATIO (referred to 32 mM/mm RMS tape flux at 1 kHz): 52.5 dB (9.5 cm/s); 55 dB (19 cm/s)

HARMONIC DISTORTION (32 mM/mm RMS tape flux, unweighted): .8% (9.5 cm/s); .65% (19 cm/s)

CROSSTALK (ref 32 mM/mm, 1 kHz): 54 dB

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PRICE : £23.5.0

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Volume controls on each earpiece optional

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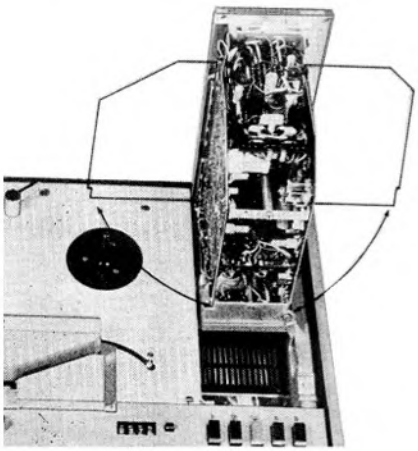
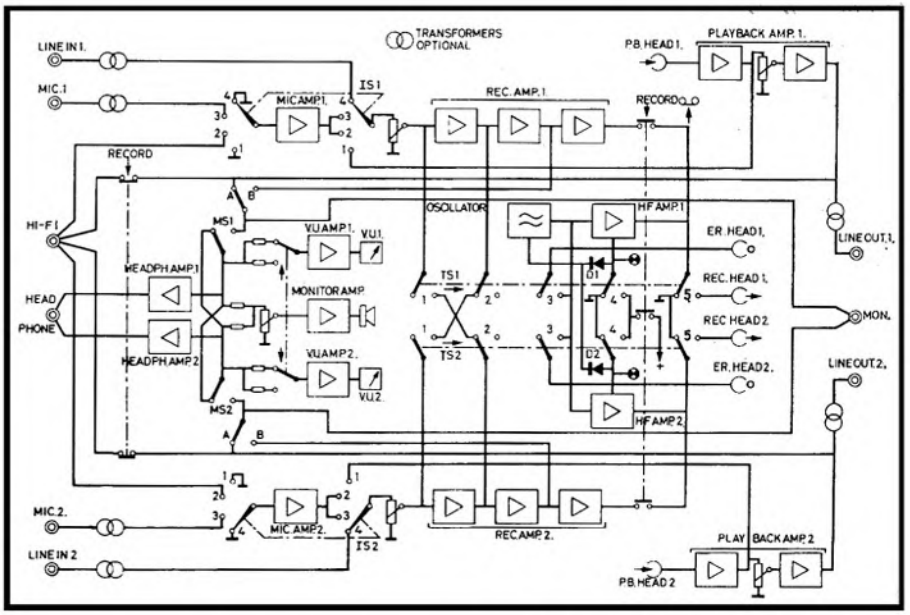


Hinging circuit unit



Inspectors. I will now compare these results with my own.

All frequency response measurements were carried out according to DIN 45 511. My test figures, which were almost identical with Philips, show that the DIN specification was easily met. The record responses were measured at 20 dB below 0 dB reference level (RMS tape flux of 32 mM/mm) after shorting the 19 kHz absorption circuit. Just as an experiment, I tested the record response at 10 dB below reference level which is my normal procedure for studio machines. At 19 cm/s the figures were practically identical with those of –20 dB but at 9.5 cm/s the response fell rapidly at 10 kHz and was 20 dB down at 16 kHz. This shows how 'amplitude conscious' the response is at this horrid speed. I would have liked to see ferrite heads fitted on this model.

Wow and flutter were well within specification. Because the integrated figure at 19 cm/s was no more than .05% RMS unweighted, except for the last few turns of tape, my ears were not unduly offended by piano recordings. Signal-to-noise ratio: here again good. An unweighted reading of .65% at 19 cm/s for harmonic distortion was much better than expected, but full marks must also go to BASF for their excellent new tape, type *LH* (low noise, high output), which contributed in no small measure to this result.

I made a copy of selected items from my 38 cm/s stereo masters on the *PRO 12* at both 19 and 9.5 cm/s speeds. These dubbings were taken to Holland. Shortly afterwards I received a telephone call from Philips in Eindhoven seeking permission to use the tapes for demonstration on the Continent. So *they* are not ashamed of their machine's performance!

To sum up—an excellent machine in every way, except the crashing solenoids which remind me of the 'snap, crackle and pop' variety of domestics. Surely a bit of felt and rubber here and there would do the trick.

What sort of sound? Well, not quite the same as a master on a large professional machine at 38 cm/s but good enough, provided you put the right signal in the front end and everything is carefully adjusted. Then the final tape will sound far better than a good LP disc.

I can recommend the *PRO 12* to any potential purchaser with an arm strong enough to carry it and a pocket deep enough to buy it.

Terence Long

FERROGRAPH SERIES 7

MANUFACTURER'S SPECIFICATION (38 cm/s). 6.25 mm two-channel recorder with internal power amplifiers and side-facing loudspeakers. **Wow and flutter:** 0.08%. **Replay characteristic:** 35 μS (50/3180 μS at 19 cm/s). **Frequency response:** 30 Hz to 20 kHz ±2 dB. **Signal-to-noise ratio:** 55 dB unweighted including hum. **Oscillator frequency:** 100 kHz. **Microphone input:** 150 μV to 15 mV at 10 K (250 ohm to 2 K source). **Line input:** 75 mV at 2 M. **Line output:** 2.4 V (unloaded) at 600 ohms. **Auxiliary output:** 300 mV into 10 K. **Loudspeaker output:** 10 W RMS into 8 to 16 ohms. **Amplifier distortion:** less than 0.25% RMS up to 10 W. **Stereo cross-talk:** 45 dB. **Lower track rejection:** 60 dB. **Tape speeds:** 38, 19 and 9.5 cm/s. **Weight:** 22.5 kg. **Dimensions:** 425 x 445 x 255 mm. **Price:** **£212 7s 6d** including purchase tax. **Manufacturer: The Ferrograph Co. Ltd., Mercury House, 195 Knightsbridge, London S.W.7.** Ferrograph Series 7 Manual with circuit diagram available separately at £1.

'BUILT like a battleship' generally describes the new range of Ferrograph tape recorders, as it described the old. The first Ferrograph tape recorders produced 20 years ago were designed for arduous Service conditions and the many thousands used by the broadcasting authorities in addition to the Services bear eloquent testimony to their reliability. It is obvious that the designers have used their wealth of experience obtained over two decades in the design of the Series Seven recorders. Inevitably, solidity means weight, and the *722H/P* submitted for review weighs a shade under 23 kg.

Mechanically, the unit is of box construction, made of heavy gauge steel and aluminium pressings. Because of the wide range of facilities provided, the underside view is at first sight awe-inspiring. The layout is logical and maintenance should present no difficulties. Should servicing become necessary, the extremely well prepared Handbook of 75 pages, with substantial cloth end boards, is well illustrated and in addition to detailed operating instructions devotes some 30 pages to technical description and service and maintenance notes.

The range covers both single channel and double channel, with various track configurations of full, half, and quarter track. Additionally, two different tape speed groups are available: 19, 9.5 and 4.5 cm/s and (suffix *H*), 38, 19 and 9.5 cm/s. The latter type (*722H/P*) with twin ½-track heads was submitted for review. The overall dimensions, including lid, are 425 x 445 x 255 mm, and the unit may be regarded either vertically or horizontally.

The *Series Seven* Ferrographs retain the

(*continued overleaf*)

basic three-motor drive system of the earlier models and, apart from this, the mechanical layout has been completely redesigned for solenoid operation. Thus, in addition to the normal controls, a tape may be started and stopped by remote switching, a DIN tape socket on the rear panel being provided for this purpose.

The main functions of the deck (FAST, STOP, PAUSE and RUN) are selected by a single knob with a separate press button for RECORD. On fast wind the direction and speed of wind are governed by a separate control. The four-digit turns counter is gear driven from the take-up spool. Up to 10 W are available from each output stage, with separate bass and treble boost and cut controls on each amplifier ; either external or internal loudspeakers may be used, and an alternative low-level high-impedance (10 K) output is provided. There is also a 600 ohm emitter follower output taken before the tone control circuits.

The tape can be monitored on fast wind, amplifier level being suitably lowered, enabling accurate editing to be performed. Mixing facilities are provided with separate gain controls for microphone input and line input. With the exception of the low level microphone input, all connections are on a panel at the rear of the instrument.

The top panel is conveniently divided into three sections : the upper portion, covered in black rexine, carries the two spools, power switch, tape speed switch, counter and record switch. It is impossible to operate the record or relay switch if the frequency compensation is not set to the correct speed. When operational errors occur, the red indicator light is extinguished. Because the record switch is completely separate from all the other controls, it seems almost an impossibility to operate it accidentally.

Spools up to 22 cm diameter can be accommodated, and are held in position with knurled screws. Two aluminium spools are provided with the machine, fitted with a spring loaded tape clip. To accommodate different spool thicknesses, a screwdriver adjustment is provided which aligns the tape exactly with the guides.

A centre panel contains the record, replay and erase heads, which are in line and covered by an aluminium casing. Threading is simplicity itself, a small lever disengages the pressure pads and the tape can be dropped directly into the groove. In line with the heads are the capstan with the pinch roller to the front. At this juncture I must mention my only design criticisms of this excellent recorder : I am surprised at the use of pressure pads because slight misadjustment or the inevitable accumulation of dirt will alter the loading and affect the wow and flutter ; and I would have liked some means of retracting the tape from the heads during fast-wind when the cue facility is not being used.

The lower panel contains the controls for the 'electronics' proper, and is divided into two portions : one, covered by a flap, contains the 'semi preset' controls, and the other the main controls and the signal level meters. Reading from left to right. these are : microphone input jack upper track, equalisation switch, microphone and line gain controls (concentric) and VU meter. These are mirrored on the right hand side for the lower track, whilst between the two meters is the recording mode switch. Under the flap are the loudspeaker output and meter switches, tape level control, bass and treble tone controls, and bias controls. It is thus possible within limits to equalise exactly both channels for optimum performance, taking into account the inevitable small variations of head characteristics, and the rather wider tape variations. With the exception of the microphone input, all the other connections are made on a panel at the rear of the cabinet. These are mains input plug, voltage selector, DIN auxiliary socket, mains input fuse, DC line fuses for both power amplifiers, loudspeaker output jacks, 600 ohm output jacks, low level output jacks and line input jacks. The lavish use of telephone jacks has obviously been dictated by the BBC and small recording companies' preference for this type of termination.

The main control has four positions : FAST, OFF, PAUSE and RUN. With the control in the FAST position, the tape speed and direction are controlled by a separate knob which governs the power fed to each reel motor. I found this feature of considerable assistance during editing. The control switch cannot be moved from the OFF position to the operating positions without release of an interlock.

All operations are controlled by solenoids, including the braking of the reel carriers. The amount of braking torque applied to each wheel is adjusted by sliding a locking screw in a slot, hence braking can be balanced for optimum performance.

The three heads are mounted on a block which may be removed from the deck as a complete unit. The erase head is fixed, but the record and replay head mountings are spring loaded on a central pivot with azimuth adjustment by a single screw.

The capstan motor is on resilient neoprene shock mounts and uses grease-packed ball races as the main bearings. It is a split-phase capacity type induction motor which, because of the small mechanical load imposed, runs synchronously. The speed change switch operates by cam action on three slider bars each carrying an idler wheel. These are spring loaded to maintain constant pressure, thus the absolute speed ratio should remain constant irrespective of operating conditions. The stepped flywheel is fitted to a stainless steel spindle, the top end of which is precision ground and then sand blasted to form the capstan. The lower bearing is a ball race ; the top bearing is self-lubricating sintered bronze. The whole capstan assembly and the pinch wheel bearings are adjusted to be precisely vertical and parallel to each other.

The tape tensioning arm between the capstan and the take-up wheel is differentially damped to prevent 'snatch' on starting the tape. It also functions as an automatic stop, switching off the tape drive at the end of a reel or should the tape break during running. A preset control is provided to optimise the tensioning, depending on whether vertical or horizontal operation is being used. Between the supply reel and the head assembly is the foil stop guide. When this is shorted to earth (through the tape tensioning guide) by a piece of foil spliced to the tape, it switches off the tape drive. Once any of the automatic stops has operated, the function knob must be returned to stop before the recorder will refunction.

Electrical

The input sensitivity on microphone is 300 μV to 15 mV with a load impedance of 10 K, the recommended source impedance being 250 ohms to 2 K. If a low impedance (30 to 50 ohms) microphone is used, a suitable matching transformer is necessary. Line input is 50 mV to 10 V at 2 M load impedance and can thus be fully modulated from crystal pickup cartridge in addition to the normal input levels from mixers, etc. Output is a maximum of 2 V into 600 ohms from a 600 ohm source ; the low level output is 300 mV into a minimum load impedance of 10 K, whilst 10 W RMS is available from the power amplifiers into a load impedance of 8 to 16 ohms.

The electronics are completely transistorised, mounted on a number of printed circuit boards, interconnections between the boards being by soldered connections. Silicon transistors are used throughout, and FET's are used where necessary. The replay pre-amplifier consists of a pair of *BC154*'s with overall feedback replay equalisation networks. The output is amplified and taken by a preset level control (under the flap of the control panel) to the meter and tone control circuit board, using the familiar Baxandall feedback type of tone control. The range is about ±15 dB for both bass and treble. The output from the board goes via the main gain control to the power amplifier. The power amplifier is quasi-complementary with a pair of *40312* output transistors driven by a *40360* and *40362* complementary pair. The overall feedback power amplifier is generous and, as is shown by the performance curves, crossover distortion is virtually negligible. Up to the rated output, the distortion was generally less than 0.1%.

The signal from the line input of the record amplifier is fed directly into an FET which is used as a source follower giving unity gain and an input impedance of 2 M with a very

low output impedance. The transistor is protected from damage by stray leakage voltages by a diode connected between gate and ground. The output passes through a line gain control to the main amplifier. The microphone input is taken by a two-stage amplifier, the gain being altered by variation of the negative feedback. The output then mixes with the line input and the combined signal is further amplified and equalised to give the correct recording characteristic.

The bias and erase oscillator consists of two *40317* transistors in push pull and operates at about 100 kHz. The waveform is excellent. The bias current is taken to the record head by preset resistors under the control of the operator.

The VU meter, which also doubles as a bias current meter, is fed from an isolating amplifier which is switched either to the record amplifier or to the output of the replay preamplifier. The power amplifier can be switched to either record or replay independently, thus enabling A-B switching or tape and source to be compared.

Performance

The claimed wow and flutter figures are realistic, being less than :

0.08% at 38 cm/s
0.08% at 19 cm/s
0.15% at 9.5 cm/s

Wow and flutter were tested at the three operating speeds using standard, long play, double play, and triple play tapes. BASF LH tapes were used for all tests. The results are summarised below :

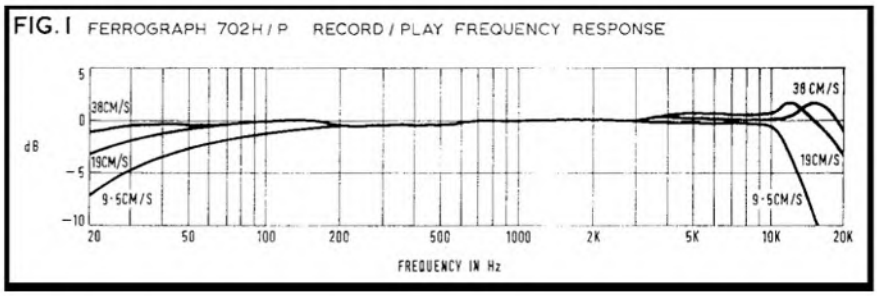
Tape	9.5 cm/s	19 cm/s	38 cm/s
Standard *35 SP52*	0.09%	0.06%	0.03%
LP (long play)	0.11%	0.07%	0.06%
DP26 (double play)	0.12%	0.08%	0.07%
TP18 (triple play)	0.2%	0.16%	—

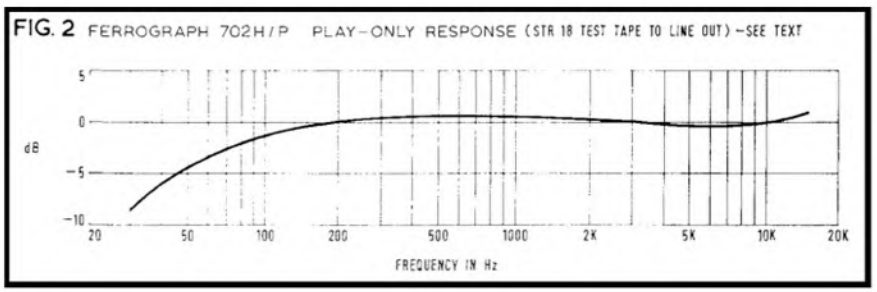
Tests on wow and flutter and tape speed showed no measurable difference with the *Series 7* in either vertical or horizontal positions.

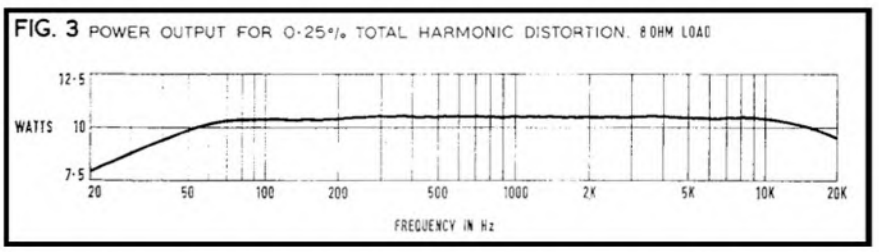
The wow and flutter figures were obtained on a Miniflux *ME 102* wow and flutter meter which measures half peak-to-peak wow and/or flutter through a weighting network in accordance with the DIN specifications *45507* and 45511. These specifications related wow and flutter much more nearly in accordance with subjective observations than the RMS method hitherto employed and are being promulgated as an IEC standard which will then be accepted by the BSI.

The wow and flutter figures were measured at the beginning, midway, and end of a 550 m (1800 ft) 18 cm diameter reel of tape, and the maximum difference in wow and flutter under all conditions was less than 0.01%, but the figures stated in the table above were worst cases.

Speed constancy is excellent. A 1 kHz tone was recorded, the tape was cut into three portions and spliced to the beginning, middle and end of a 550 m reel. The maximum variation was -2 Hz at the end of the tape, there being no measurable difference in frequency between the beginning and the middle. The overall performance figures were obtained using BASF *LH/LP35* tape on 18 cm spools.







The overall claimed frequency response (record and replay) using Ferrograph *Ferrotape B* is :

38 cm/s.	30 Hz to 20 kHz ±2 dB
19 cm/s.	20 Hz to 17 kHz ±2 dB
9.5 cm/s.	40 Hz to 14 kHz ±3 dB

The claimed frequency response specification is substantially met, as shown in **fig. 1.** In order to obtain these figures, the bias current was adjusted as set out in the Handbook at 19 cm/s, but was not modified for the other two speeds.

The replay response using EMI test tape *SRT18* is given in **fig. 2.** The recorder is adjusted for DIN/NAB characteristic, whereas the EMI tape is IEC, thus giving a variation of several decibels at the extreme ends of the scale. This variation can easily be accommodated (if necessary) by adjustment of the tone controls and is, in fact, covered by a note in the Handbook.

Input sensitivities (gain controls maximum) for 2% distortion on tape at 1 kHz were :
microphone (600 ohm source) 280 μV
line (600 ohm source) 40 mV

Crosstalks between channels was -62 dB at 1 kHz, -48 dB at 15 kHz, and -50 dB at 40 Hz, all measured with one track recorded to maximum level.

The signal-to-noise ratio with gain control at maximum and bass and treble controls flat, tape stopped, was 74 dB ; with virgin tape at 19 cm/s it was 59 dB, and with tape recorded at 1 kHz to overload level and then erased, was 56 dB. With virgin tape erased (that is, recorded, but no signal to record amplifier and with record amplifier gain controls to maximum, microphone input terminated 200 ohms, line input terminated 600 ohms) was 56 dB. These tests represent extreme cases and fully meet the manufacturer's claimed specification of 55 dB unweighted. Under normal operating conditions (using tape recorded with musical content to normal maximum levels and with the replay gain controls set to just overload point of the output amplifier at maximum modulation) the signal-to-noise ratio was 58 dB unweighted and was improved by a further 6 dB when measured through the CCIF weighting network.

Hum was negligible, being below the general noise level.

There was ample power in the record amplifier to overload all test tapes before the amplifier itself showed signs of distress, but all tests were performed with the test tapes running at an overload point of 2% total distortion. At a normal level of -12 dB reference to this point, the total distortion including record and replay amplifiers, power amplifier and tape, was 0.4% maximum over the frequency range of 50 Hz to 10 kHz.

The amplifier power output at rated distortion (0.25% total) is plotted in **fig. 3.** This is excellent by any standards. The 600 ohm output is taken from an emitter follower

(continued on page 219)

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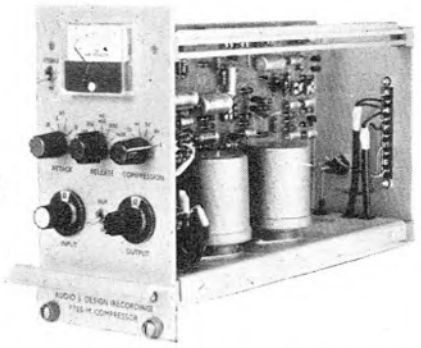

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5¾"	900'	... ...	7/6	5¾"	1200'	... ...	10/-
7"	1200'	... ...	9/-	7"	1800'	... ...	13/-
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which feeds the tone control circuit, and the distortion at zero level (0.775 V into 600 ohms) was less than 0.1%. Distortion from the high impedance output (taken from the amplifier following the tone controls) with tone controls set flat at an output of 150 mV into 47 K was 0.12%.

These distortion figures were taken using both the record and replay amplifiers in tandem, the input being from a 600 ohm source into the microphone terminals, and the output from either the loudspeaker terminals (8 ohm non-reactive load) or the low impedance or high impedance output.

Two 178 mm elliptical loudspeakers are fitted into the cabinet, presumably for monitoring purposes; they cannot be considered seriously with this class of equipment and their prime purpose during these tests was to indicate that the equipment was functioning. When the system was connected to a good pair of monitoring loudspeakers, however, the performance was impressive: background noise was almost totally absent, and the dynamic range excellent. The internal power amplifiers are more than adequate for location monitoring of recordings and the mobile recordist only requires the addition of first class microphones, a good mixer, and the aforementioned monitoring loudspeakers, to be completely independent of the studio.

The tape recorder was under test for a period of nearly four months and was in actual operation for about 150 hours, principally recording the efforts of a young pop group. At the end of this period the machine was re-checked and the difference in overall performance was not measurable, with the exception of the wow and flutter which had increased by about 30%. This was traced to an accumulation of dirt on the pressure pads and removal of this dirt restored the machine to its original performance.

The manufacturer's claimed specification is exacting but is fully met on all counts, and it is obvious that Messrs. Ferrograph have not attempted to skimp on either specification or manufacture. With the exception of the pressure pads, to which I am personally averse, I consider it a robust and reliable recorder and can confidently recommend it both to amateurs and to professionals who need a robust and portable recorder.

Stanley Kelly

by Peter Bastin

BRIAN DEAN, writing in the *Daily Mail*, tells us all about the Jacques De Lane Lea studios in London. Mr De Lane Lea is 36, the son of a French mother, and came to England as a refugee when he was ten. He took over the company in 1964 when it had a turnover of £76 000 a year. Last year the turnover was £400 000. His comments on the profession: 'I think the real answer is that British recording engineers are the best in the world. They have a natural instinct for knowing what kind of sound is wanted. Many of the engineers are long-haired youngsters in their early twenties, but they have supreme talent'. The studio is used largely for final re-recording of film sound tracks which have been dubbed into English—the type of dubbing which requires English words to synchronise with lip movements in other languages. Mr De Lane Lea says that dubbing has always fascinated him and finds that German, because of its similar lip movements to English, is easy to dub; French and Italian are tougher. Work has started on a new half-million pound music centre at Wembley which will offer Europe's most comprehensive recording facilities.

STILL TALKING about professional activities, Metrosound (Manufacturing), founded twelve years ago, have regained control of a company they had previously owned—Tempo Tapes—as well as obtaining University Recording, Bastinton Ltd. and Slot Stereo. Mr M. S. Myers has said that they hope to obtain a licence to manufacture Philips-type cassette tapes and, eventually, to enter the videotape field. At present, the Metrosound design team are finalizing details for a new 8-track car stereo cartridge player which will retail at about £42 including the speaker. Their Slot Stereo home-player, which was very successful at the Audio Fair, sells for £70.

A GENTLEMAN WITH the admirable name of Alfred Frankenstein writes in the American *High Fidelity* about Japanese classical (?) music discs. 'A new sound from the Japanese Bach Scene' is performed on two kotos, a shakuhachi, a guitar, a string bass and drums. Bach seems to be popular stuff for the experimenters. Witness the Swingle Singers and the CBS Moog Synthesizer 'Switched-on Bach'—which is very good.

EMI'S HMV record shop in Oxford Street, London, is being converted at a cost of £60 000 into what is hoped to be Europe's biggest record supermarket. The ground floor, which is already completed, carries 100 000 records and when the whole job is finally completed, the stock should be a quarter of a million records. There are 21 shops under the HMV name in the country, most of them in the Home Counties, and the company's aim is another fifty in the next four years. EMI fear that a decline in the number of retail record shops will threaten their business. This is probably based on the fact that the number of record shops has dropped from 5 500 to 4 500 in less than ten years.

MUSIC, SAID Dr Johnson (and *Office Equipment News*) is the only sensual pleasure without vice. OEN wonders whether he would have extended the accolade to background music, which today has become not only a part of our leisure time but also increasingly of our working lives. Automation has a nasty habit of creating boredom by eliminating the need for mental effort and a report published by HMSO found that music counteracts boredom—so long as the programmes are varied in content. The effectiveness of the system depends upon the extent to which the music can detract the mind from monotony without affecting efficiency. American research has proved increases in productivity ranging from 8.03% to 53.3% after the introduction of background music. One main objection to music while you work is the possible incidence of errors, although the Americans found by survey (of course) that typing errors dropped by 38.6% during a six-month period. Now who turned that radio off?

THE SOUTH African *World of Sound* claims that the tape recorder—and in particular the cassette recorder—has become the status symbol of the early teenager, superseding the bicycle, the horse and the transistor radio. It's amazing what they apparently get up to in South Africa. One girl recorded for posterity the first ardent protestations of undying love from her childhood sweetheart. He, pour soul, mistook the hum (hum?) of the recorder for heavy breathing!

THERE'S ONE thing about television which really gets me going, and that is to see people grimacing in front of the cameras to canned sound. It is known, gracefully, as miming and is, to my mind, about as low as you can get in entertainment. Pop groups are probably the very worst offenders, and if you don't believe me, watch the drummers. They are generally not with it at all, clouting cymbals where no cymbals ring on the tape. Apart from the more obvious clangers such as this, singers are rarely at their best when miming to the PA and more than once I have seen a raised hand or a bowed head covering up some bodged mouthwork. There are clearly cases where miming is necessary, where the original pop grew in a multitrack machine, but close-ups of nervous singers are really not necessary at all.

The paradox is that studio interviews are almost always done in front of microphones, where booms could easily be used. Miming is the reversal of cinema dubbing techniques and is a useful trick used in the right place, but I do object when pop groups coin large fortunes by clowning to one original recording which they may or may not have made by themselves. Many pop recordings are the triumph of the recording engineer and it is questionably ethical for his work to be performed ad nauseam as the group's own work. If miming really gets hold, we shall be subjected to the spectacle of Cyril Rex-Hassan introducing the Audio Fair to a canned recording by Orson Welles.

ARTHUR GARRATT INTERVIEW CONTINUED

at a higher level, giving bass boost and treble boost in their own ears. Listen at a natural level and, if it is still too chesty, there is something wrong with your loudspeaker. Ribbons give a flat response provided you are two-thirds of a metre away. A lot of news goes out from continuity studios where AKG *D202*'s are used.

D.K. *Do you harbour memories of a Biggest Blunder? I know I do.*

A.G. Blunders—I think we try to forget them. When I was doing Apollo 9 for the World Service, Christmas Day or Boxing Day in

QUADRAVERDI CONTINUED

The reason, Paul Myers assured me, is simply the high cost of orchestral time, which in the USA can reach £25 per minute. This is all very well for the performers but limits the time available for sound engineering experiments. The theory behind multitrack recording, borne out in practice, is that at least you are guaranteed *something*. A degree of frigging is possible at the reduction stage—and there's always the EMT plate.

Why Scullys and a 3M? Bob's reaction was not so much to praise their recording qualities, compared with Studer and Philips

AROUND THE STUDIOS CONTINUED

that he came from Britain and moreover was of British nationality. All very entertaining for us, but not quite what was required.

Next, with the aid of even more cable, Carl went into the adjoining pub with his 'roving microphone' but again with little success. When he informed people that he was recording an LP track they didn't really take it seriously, and made little comment. He told some other people that they were being televised which was apparently more acceptable to them in spite of the lack of cameras. However, the only thing they had to say was 'When will I be on?'.

After listening to the recordings, Carl returned to the street to try a new approach (**fig. 10**). Listening to the backing track on headphones, he called out to passers by at suitable points in the music, and their rather startled reactions began to inspire him, During part of the number Carl had to sing. which attracted more attention. He later gave an amusing impersonation of an old man who was hovering around with a puzzled expression on his face, and who caused Carl to remark 'There's a bloke down here looking for the band !'. This was kept on the tape, as well as the roar of a motor cycle which happened to pass by, and a comment about the 'fuzz' when they put in an appearance. If such methods of obtaining material are common, it is no wonder I have difficulty in understanding the significance of some of the words on records.

Having completed this track, the next thing to do was to make a second vocal track for

Bush House, we had a television set tuned in to BBC 2 which relayed the take-off. I was doing the commentary on the countdown. Forty-two minutes later I came back to cover the lunar injection. By then, the BBC 2 coverage had died, though the set was still on. I was interviewing Geoffrey Pardoe of Hawker-Siddeley Dynamics, looked at the screen, and found Sophia Loren taking all her clothes off—they were running *The Millionairess*. Made it very difficult to concentrate fully on the Apollo exercise.

I remember a schools television programme where we were talking about air pressure. We were doing the standard trick of putting paper over a glass of water and turning it upside down. Everything was fine on rehearsal but, for transmission, some blighter gave us a clean glass. I turned this over and the whole lot came out over me. The glass had a kink in it. It doesn't matter, provided you're not embarrassed, because people are more inclined to believe in you. About the *Lady Chatterley* time I was doing a thing about the old-fashioned shutter telegraph on live transmission and said 'Suppose we want to send a word—let's think of a four-letter word beginning with F. I was thinking of fire but nobody else was! Anyway, Mrs Whitehouse didn't write in so all was well.

D.K. *I think I shall end with the comment that, in addition to being a very good interviewer, Arthur Garratt is a very good interviewee.*

A.G. Thank you very much. This is the easy end!

---

designs, as to appreciate the ease with which a Scully could be lined up under cramped control room conditions if record-amplifier settings moved during road journeys. The implication that a Studer is necessarily more difficult merits separate treatment.

The CBS *Requiem* is due for release in the USA during autumn and in the UK early next year—it's a long pipeline. What medium the four-channel issue will be on is open to conjecture. Probably 4-track 19 cm/s tape, possibly 4-track Compact Cassettes, or even 4-channel (Scheiber system) discs. Scheiber coding has been employed in the USA on Compact Cassettes, which seem to offer the best compromise between cost, handling convenience, and quality. Quality at the end of the list—it may soon be rescued from its present hissy state by the domestic Dolby *B* system.

Finally a small point regarding the less-than-careful use of talkbacks. On two or three occasions this barked into the hall before the reverberation had died away. Perhaps it didn't sound like this on the tape. If it did, it will have to be edited out. A point the pro's should watch—the CBS *William Tell*, Leonard Bernstein conducting the New York Symphony Orchestra, ended with well recorded reverberation which gets the chop just before it dies. Talkback chipping in, or a noisy editing machine?

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the same number, this time all three of them singing. Instead of recording in the studio it was decided to try it in a room which was still under reconstruction, with bare walls, junk everywhere, and no heating. (It was a cold winter night.) The room was very live and the group thought that a rather unusual quality might be achieved using this room. A capacitor microphone with variable polar diagram was switched to omnidirectional, and Roy, Carl and Ric stood around it (**fig. 11**), a balance being achieved by Gerald telling them over the talkback who was too near or too far away. After a few attempts, a reasonable recording had been made, and this was 'double tracked' by listening to it and recording it again on another track. The technique is widely used in pop studios nowadays to give a 'bigger' and generally more interesting sound. In this case however, after listening to the tape a few times (**fig. 12**) the group were not very happy, and agreed to scrap these two tracks and start again. They used the same technique but this time recorded it in the studio proper. Having just spent some time in a very cold room, the group were starting to have a little trouble with their voices, finding it a strain to reach the higher notes. To get over this, the variable-speed unit was switched into circuit and adjusted to make the tape run slightly slow. The lower key thereby obtained was easier to accompany, and the tracks were soon remade, although one or two retakes had to be dropped in.

Finally, some additional rhythm was added using maracas. Once again, the variable speed unit was employed, but this time to speed up the tape during recording because, up to a point, the faster you have to marac the easier it is. Also, the 'crisper' sound quality obtained by recording the instrument in this way was preferred.

When all these tracks for *Fields of People* had at last been completed, some work was done on *Don't Make My Baby Blue*, and *Cherry Blossom Clinic*.

The session ended at about 2.45 am, most of the time having been spent on the vocal for one number. In addition some time had been spent at an earlier session in recording the backing track, and more time would be spent at a future session reducing the multi-track tape to produce a two-track 6.25 mm master, or more likely a number of possible masters with different balances, so that one of these could eventually be selected as the production master.

Now you may think that a group taking so long to produce a recording are wasting their time, especially as they seem to use the studio as a last resort. I must confess that if I had read about this particular session rather than attended it, I might have thought something similar. However, the truth is that The Move are willing to experiment with any technique that might give them a 'different' effect. They are perfectionists, and when work doesn't come up to their high standards, they scrap it and try again. With studio fees at about 25 guineas per hour, the fact that they are willing to take their time in order to get exactly what they want speaks for itself.

Having praised The Move, I must now praise Advision Limited for I have absolutely no adverse comments to make about the studio or control room, and I look forward to returning some time when their 16-track equipment is in use.

CLASSIFIED ADVERTISEMENTS

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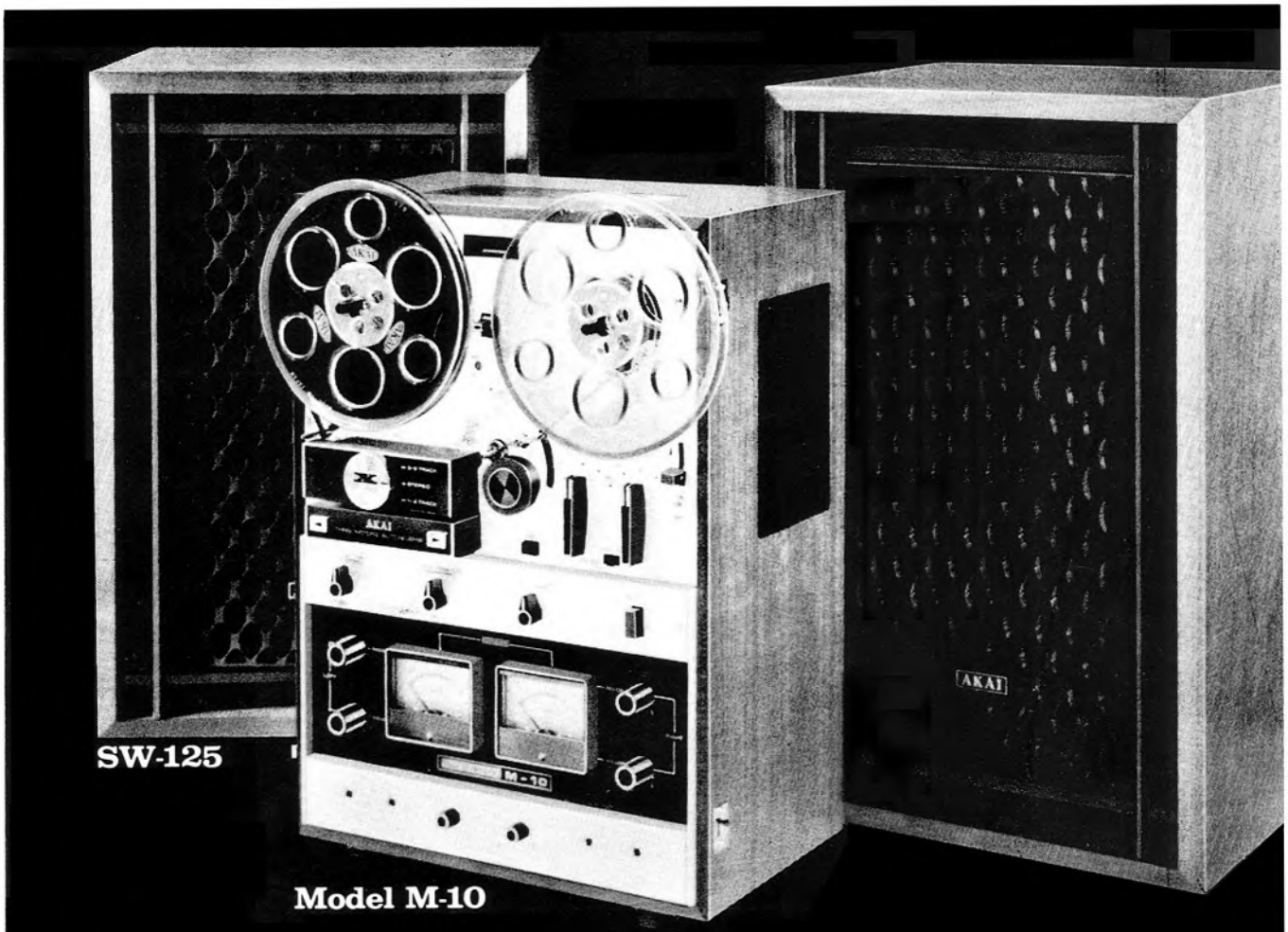

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