STUDIO SOUND & tape recorder

FEBRUARY 1970 2s 6d (12½p)

says Jac Holzman, President of Elektra Records.
"Since early 1967, we have used Dolby units on most of our recordings of The Doors, Judy Collins, Tim Buckley, Tom Paxton, The Incredible String Band, Roxy, and many others. The New Music can have a surprising dynamic range, and we find that the Dolby System not only gives a really low-noise background during quiet passages, but it helps to preserve the clarity and definition of complex musical textures. A related advantage is that the mixdown is faster and less tedious. In working out the final mix, we no longer have to resort to intricate equalization schemes to retain crucial nuances and subtleties of the performance."

"Elektra was first in recognizing the value of the Dolby System for multi-track rock recording,"

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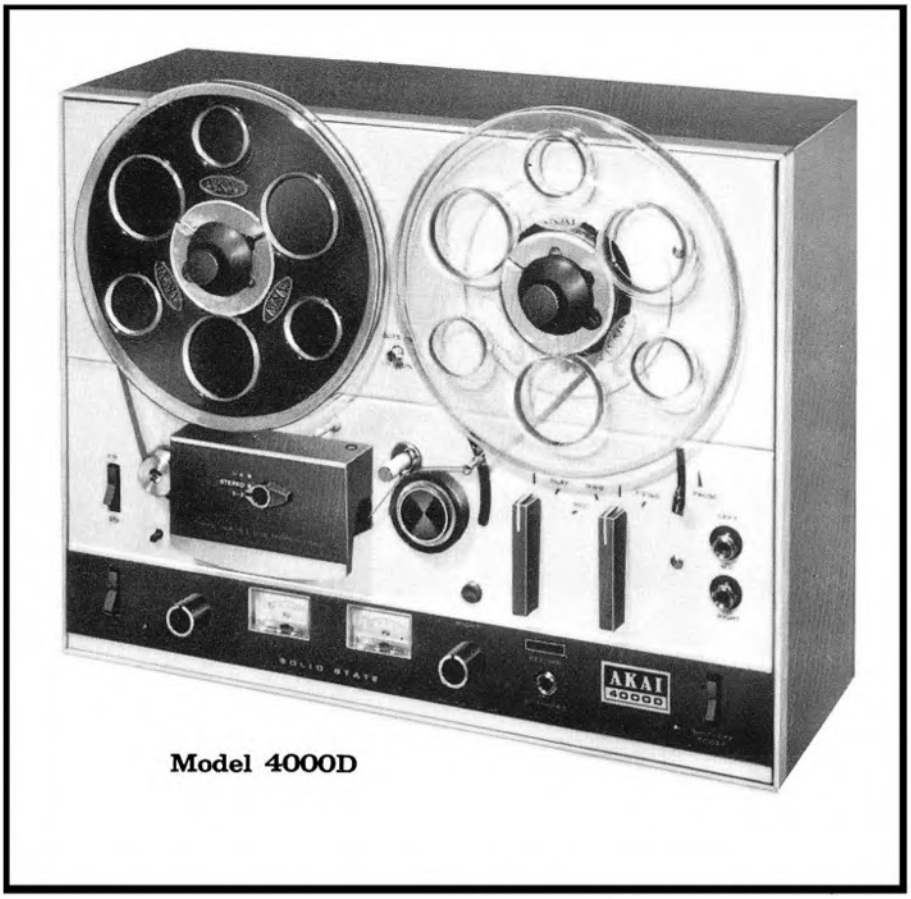
telephone (212) 243-2525 cables Dolbylabs New York
for international inquiries contact UK address:
346 Clapham Road London S W 9 England
telephone 01-720 1111 cables Dolbylabs London

S. Calif.	**Audio Industries Corp.** 1419 N. LaBrea Ave., Hollywood, Calif. 90028 Tel. 213-HO 5-4111
N. Calif.	**Audio-Video Systems Engineering** 1525 Tennessee Street, San Francisco, Calif. 94107 Tel. 415-647-2420
Midwest	**Expert Electronics, Inc.** 7201 S. Western Avenue, Chicago, Illinois 60636 Tel. 312-HE 6-2700
Canada	**J-Mar Electronics, Ltd.** 6 Banigan Drive, Toronto 17, Ontario, Canada Tel. 416-421-9080



Model 4000D

ONE MICRON GAP HEAD

AKAI's one-micron gap head is responsible for an amazing, important difference in tape recording.

It's the difference between every day, ordinary, performance and highest possible quality perfection—AKAI perfection.

Just what is a one micron gap head? It's a head whose width is one-micron—one astounding micron, to be precise.

Up to now, 2-micron heads or 4-micron heads have been the standards for comparing tape recorders.

But AKAI has pushed forward and narrowed the head-gap—narrowed the distance between tape recording results and actual sound. The result is AKAI perfection. One micron heads have these distinctive advantages over heads with wider gaps:

(A) They have excellent frequency characteristics even at low tape speed. (This means extremely high intense recording and playback is achieved)

(B) Clear high pitched tone can be regenerated as a high frequency tone and recorded smoothly. (A high frequency tone is recorded with a low distortion rate.)

The frequency characteristics resulting from one micron heads are amazing in recording, but certainly more noticeable during playback.

The frequency which can be regenerated is determined—theoretically—by the width of the head-gap (λH). Generally, it is conceded that head output comes to zero when the record pattern wavelength (λs) of the recorded frequency is equal to the head-gap length (λH).

Actually, the frequency ($f\frac{1}{2}$) whose record pattern wave length is twice the head-gap length (λH) can be used for the actual frequency band.

The relationship of the frequency and the head-gap to the tape speed is given in these quotations:

$f=V\sqrt{\lambda S}$ ··· General formula for tape speed frequency and record pattern relationship.

$fo=V\sqrt{\lambda H}$ ··· Frequency at which head output comes to zero.

$f\frac{1}{2}=V/2\times(\lambda H)$ ··· Actual frequency band.

These equations prove what more and more satisfied AKAI users know—that the narrower the head-gap the higher are the tones that can be regenerated.

Using these equations, let's calculate for a moment.

When tape speed is 9.5cm/s, the actual frequency bands ($f\frac{1}{2}$) will be:

$f\frac{1}{2}$=47.5kHz For one-micron heads

$f\frac{1}{2}$=12kHz For four-micron heads

Let's suppose that a 20kHz tone is to be regenerated. The frequency will be out of the actual frequency band whenever a 4 micron head is used. However, whenever AKAI's one-micron head is used the tone can be regenerated.

Why—you may ask—can only AKAI make one micron heads?

In answering, let's list some of the problems that must be overcome in narrowing head-gaps. First, there is regeneration power degradation, then there is s/n degradation and recording performance deterioration—to mention a few.

These and many other obstacles have been surmounted by AKAI's diversified experience in this and related fields.

From this experience has blossomed AKAI's own, unique technique—technique that leaves absolutely nothing to chance.

Special adhesives and precision plus correct alloy materials for the head-gap have also been distinguished results of AKAI research to successfully narrow wide-gap heads with no defects.

This is all another step-by-step success story in what tape recorder users call "AKAI PERFECTION."

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*4 track stereo/monaural recording and playback *2 speeds, 3 heads *All silicon transistorized pre-amplifier *Automatic shut off, Instant stop control *Tape cleaner *ONE MICRON GAP HEAD *Magnificent oil-finished wooden cabinet *For increased stereo enjoyment, use the matching AA-6000, 120 watt solid state amplifier and the matching speaker SW130 (2 way, 25 watt input).

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- **3 tape speeds**
- **2 recording level meters**
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4-TRACK STEREO

	Cash Price	Deposit	12 Monthly Payments
	£ s. d.	£ s. d.	£ s. d.
Philips N4404 ...	80 0 0	26 13 4	4 8 11
Ferguson 3232 ...	93 5 0	33 5 0	5 1 10
Sanyo MR929 ...	97 4 9	33 4 9	5 6 10
Sony TC 252 ...	99 15 0	33 5 0	5 10 10
Philips N4407 ...	103 15 4	35 15 10	5 13 4
Akai 1710L ...	109 0 0	36 6 8	6 1 2
Sanyo MR939 ...	112 0 2	38 13 6	6 2 3
Grundig TK247 ...	112 10 0	37 10 0	6 5 0
Sony TC 230 ...	121 11 9	40 11 9	6 15 0
Philips N4408 ...	136 3 10	46 19 5	7 8 9
Telefunken 204TS	124 19 0	41 19 0	6 13 4
Sanyo MR990 ...	131 18 1	44 18 0	7 2 4
Philips N4408 ...	136 3 10	46 19 5	7 8 9
Tandberg 1241X ...	149 0 0	49 0 0	8 6 8
Beocord 2000K ...	159 12 0	53 4 0	8 17 4
Beocord 2000T ...	165 18 0	57 18 0	9 0 0
Ferrograph 722/4	204 16 9	68 16 9	11 6 8
Akai 1800SD ...	199 0 0	66 6 8	11 1 2
Philips Pro 12 ...	239 0 7	79 13 7	13 5 7
Revox 1122/24 ...	236 5 0	78 15 0	13 2 6

4-TRACK MONAURAL

Fidelity Braemar	34 4 8	11 12 8	1 17 4
Fidelity Studio ...	46 0 10	15 17 10	2 10 2
Grundig TK149 ...	47 13 1	16 10 1	2 11 11
Philips 4307 ...	48 11 11	16 15 3	2 13 1
Ferguson 3228 ...	48 16 0	16 16 8	2 13 4
Telefunken 201 ...	51 9 0	17 3 0	2 17 2
Ferguson 3238 ...	59 12 0	20 12 0	3 5 0
Philips 4308 ...	60 0 10	20 14 2	3 5 7
Ferguson 3216 ...	66 2 0	22 16 0	3 12 2
Tandberg 1541 ...	82 0 0	28 0 0	4 10 0

STEREO TAPE UNITS

	Cash Price	Deposit	12 Monthly Payments
	£ s. d.	£ s. d.	£ s. d.
Sanyo MR801 ...	72 9 0	24 3 0	4 0 6
Sony TC252 ...	72 15 0	24 9 0	4 0 6
Sony TC355 ...	100 2 6	34 2 6	5 10 0
Tandberg 1641 X...	89 10 0	30 0 0	4 19 2
Akai 4000D ...	87 10 0	29 10 0	4 16 8
Tandberg 62/64 X	157 0 0	52 6 8	8 14 6
Ferrograph 702/4	194 15 8	64 15 8	10 16 8

MAINS TWIN TRACK

Fidelity Braemar	31 0 0	10 14 0	1 13 10
Ferguson 3224 ...	33 14 0	11 12 8	1 16 10
Grundig TK120 ...	39 5 0	13 5 0	2 3 4
Tandberg 1521 ...	77 0 0	27 0 0	4 3 4
Beocord 1100 ...	82 19 0	27 13 0	4 12 2
Ferrograph 713 ...	174 13 6	58 13 6	9 13 4

BATTERY OPERATED

Philips RF290 ...	31 10 0	10 10 0	1 15 0
Grundig C200 ...	37 17 6	12 7 6	2 0 10
Philips RF482 ...	54 12 0	18 4 0	3 0 8
Telefunken 300 TS	57 15 0	19 5 0	3 4 2
Telefunken 302 TS	68 5 0	22 15 0	3 15 10
Uher 4000L ...	133 13 2	44 13 1	7 8 4
Uher 4200/4400 ...	162 10 7	54 10 7	9 0 0

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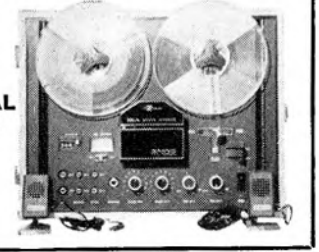

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1200′ on 5″ reel Double Play (Polyester) ...	43/1	27/9	81/-	157/6
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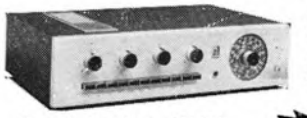
BARGAINS OF THE MONTH



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1800′ L/P on 7″ reel ...	51/-	41/6	123/-	243 -
1200′ D/P on 5″ reel ...	43/-	34/6	102/3	202/-
1800′ D/P on 5¾″ reel ...	56/6	45/6	135/-	266/9
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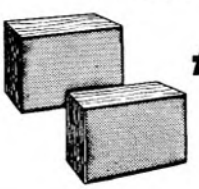

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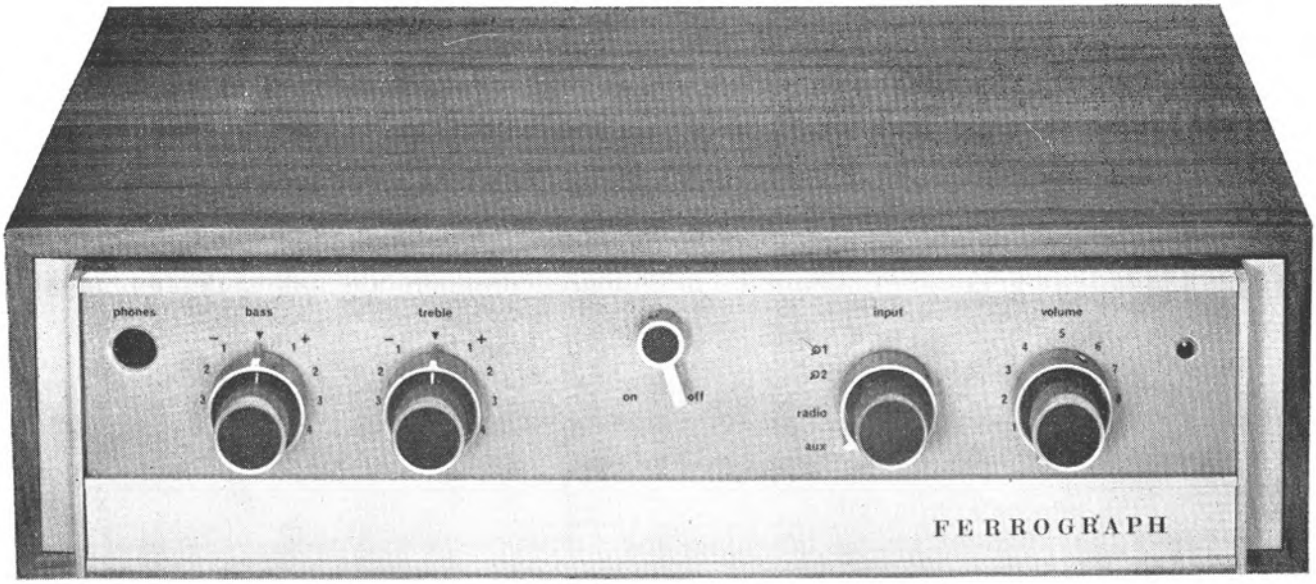

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F307 is an integrated Stereo Amplifier, built in a tradition of excellence and extremely versatile in its capabilities.

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F307 delivers power output of 20 watts RMS per channel into a load of 8 ohms and has a total harmonic distortion of less than 0.25% at 1kHz at all levels up to its rated output.

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TR

Studio Sound
& tape recorder

FEBRUARY 1970 VOLUME 12 NUMBER 2

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COVER PICTURE

The most expensive broadcasting station on or off the earth, Apollo 12 carried a Sony *TC50* miniature tape recorder which was used to relay a mock attack by Red Indians (according to the newspapers). Uses *C60* cassettes and costs £83 15s.

SUBSCRIPTION RATES

Annual subscription rates to *Tape Recorder* and its associated journal *Hi-Fi News* are 30s. (36s. overseas) and 47s. respectively, U.S.A. $4.30 & $5.60. Six-month home subscriptions are 15s. (*Tape Recorder*) and 24s. (*Hi-Fi News*), from Link House Publications Ltd., Dingwall Avenue, Croydon, CR9 2TA.

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

ANCIENT SAYINGS are of doubtful value at the best of times, and when only half remembered ought not to be used as Editorial lead-ins. That doesn't stop *us*, however. We half remember someone somewhere saying that if the petrol engine had been invented before the steam engine, the latter would have been accepted as a great step forward. Much the same thing has been said of the transistor ('why didn't Marconi put a couple of cat's whiskers back to back instead of playing with the "new" thermionic valve?') and is going to be said, here and now, of signal level meters and the cathode ray indicator.

We have never really understood the objection to developing the grotty little magic-eye into a larger calibrated alternative to the crude electromechanical indicator called a 'meter'. Cost, perhaps, though decent PPM movements are indecently expensive. Whatever the reason, Altec Lansing in the USA have taken great pains to avoid the issue by producing a seven-step peak level indicator which, crude or not, should simplify the balance engineer's task of controlling 20 channel levels simultaneously. The device comprises an 82 mm column of 10 mm coloured squares marked in percentage modulation and triggered by a transistor circuit. Overload (+4 dBm) is registered when the uppermost (red) square is illuminated, the downward graduations being 0, −4, −8, −12, −16 and −24 dBm (marked as 100, 63, 40, 25, 16 and 6%). Colour scheme is yellow down to −12 dBm, green at −16 and blue at −24 dBm. A similar device has been introduced by Electrodyne, nine increments from +6 to −20 dB. Anyone interested in standardising?

Turning from visual indicators to video recording, we have been inclined to be doubtful about fresh announcements of 'domestic VTR' systems since the demise of Telcan. However, when Sony and Philips lend their names to such activities there seems some probability of the promises being fulfilled. Unperturbed by the prospect of EVR, Sony are planning to produce a Videocassette system with recording and erase facilities ('Studio Diary,' page 53 — perhaps we need a 'Video Diary'). Not mentioned in that report is the fact that clock mechanisms can be sealed inside Videocassettes to count (and charge for) each playback of a hired programme. This sounds like becoming an expensive game.

Talking of expense, the BBC engineer who wiped out the *Messiah* ('Studio Diary') has not been sacked, in case you wondered. Fair enough; it brings to mind the occasion when a BBC radio man dropped a single-flange reel of tape due for imminent broadcast and had the nightmare of unravelling the tangle as the clock ticked towards zero. Twin-flange NAB spools overcome the latter risk, provided the screws stay tight, and the record interlock is a fairly common device even if incorrectly applied in some solenoid-controlled machines.

There is room for greater application of accident-prevention devices to protect increasingly expensive master tapes. Only a few studio recorders can claim to incorporate foolproof mode selection—Scully, Studer and Unitrack models employ a latching circuit which stores a premature mode change until the reels have nominally halted. The majority of so-called 'foolproof' transports create spillage and (particularly on high-tension studio models) snapping when *stop* and *forward* are pressed in quick succession from *fastwind*. The momentum of a full NAB spool does not help matters.

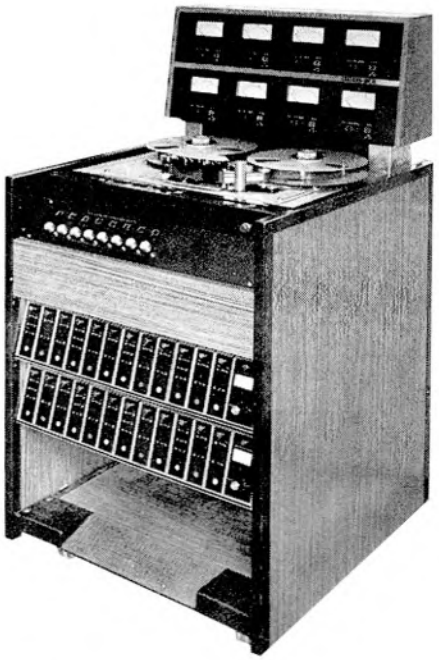
Day-dreaming in the presence of a bulk eraser must be the commonest cause of accidents in the recording world. We recently conducted some experiments with a powerful 27 cm model and found that, whatever else it did, it could *not* be persuaded to produce a silent tape. We have long assumed that rotating the reel by hand as it is slowly withdrawn from the eraser's field overcomes the once-per-revolution 'bonk'. It doesn't. More disturbing is the fact that this residual noise is almost impossible to erase on a conventional 38 cm/s recorder. At least one studio feeds its eraser from a high-frequency power supply, which apparently improves matters. Perhaps a Variac would be cheaper.

Henry Maxwell is ill

8-track

LEEVERS-RICH

studio tape recorders



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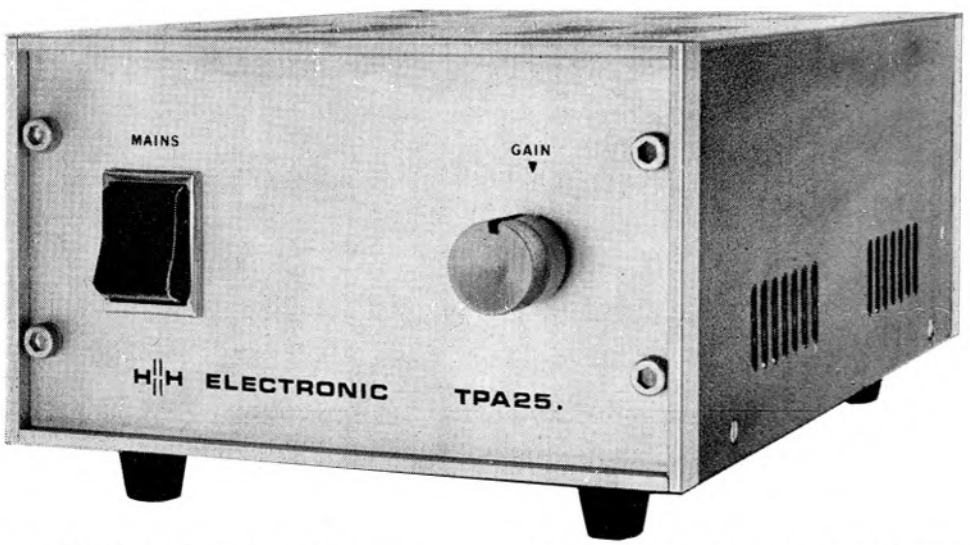

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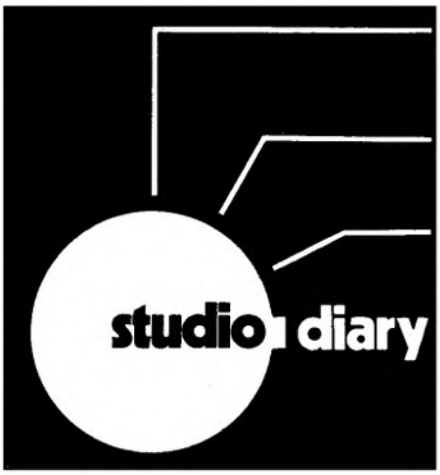


PYE MIXERS ORDERED FOR LOCAL RADIO

ELEVEN-CHANNEL AND five-channel mixing systems have been ordered from Pye TVT for the recently announced new local broadcasting stations. These will be situated at Birmingham, Blackburn, Bristol, Chatham, Derby, Hull, London, Manchester, Middlesbrough, Newcastle, Oxford and Southampton, bringing the total number of local stations to 20. A further 20 stations are expected by 1975, according to the Minister of Posts and Telecommunications, Mr. John Stonehouse.

£640,000 STUDIO TO OPEN IN 1970

THREE STUDIO INSTALLATIONS handling 24-track, 16-track and eight-track operations respectively, reduction, editing and film-dubbing facilities, will be incorporated in Quiver Records to be built off Shaftesbury Avenue by a US/German consortium. The project is in the hands of Werner Schwartz, formerly with Ariola and Odeon. John Alcock (Unitrack) has been appointed studio consultant.

EMI APPOINTMENTS

MR. R. F. L. ZEIDLER, who joined EMI Central Research Laboratories in 1954, has been appointed Export Marketing Manager for EMI Electronics and Industrial Operations. He will be responsible to the recently appointed Marketing Director, P. J. N. Collaro, for development of overseas markets. Mr. A. F. Elliott, formerly of the EMI Commercial Division, is appointed Market Research Manager.

BBC 'MESSIAH' ACCIDENTALLY ERASED

A COLOUR VIDEOTAPE recording of Handel's *Messiah*, produced for BBC 2 and screened Christmas 1968, was not repeated as planned on BBC 1 in 1969. The recording was accidentally erased while being prepared for broadcasting. It was replaced by repeats of a discussion programme and 'Songs of Praise'.

SONY ANNOUNCE HOME VIDEOCASSETTES

'THE MOST PRACTICAL, economical and realisable system yet'—Sony's claim for their newly announced helical-scan Videocassette. This is the heart of a Colour Videoplayer system which will be offered on the Japanese market in late 1970 at a price around £150. The Videocassette measures 205 x 125 x 30 mm, and carries up to 90 minutes television and stereo sound (or bi-lingual mono). Horizontal resolution is 300 lines (monochrome) and 250 lines (colour). Audio frequency response is 50 Hz to 12 kHz +1.5 −3.5 dB with 40 dB signal-to-noise ratio. The Videoplayer connects to any standard TV monitor or receiver and will record and reproduce in the manner of a normal VTR. Unlike the latter, however, a Sony tape may be removed in mid-programme and reloaded later at the same point without fast-winding. The price of a virgin Videocassette is expected to be around £7. A tuner to receive TV broadcasts can be added to the Videoplayer and may ultimately sell for about £40. None of the predicted prices assume any tax.

Sony are negotiating with Philips and Grundig on a standard format for videotape recording. The largest motion picture producer in Japan, Toho, is planning to make its cinema programmes available through Videocassette libraries and Sony hope to extend this facility to the rest of the motion picture industry, TV networks, educational institutions and music recording companies. Further details from Sony VTR Division, 11 Ascot Road, Bedfont, Feltham, Middlesex (Tel. 69-50021).

MORGAN EXPAND TO 16-TRACK

A £70,000 ADDITION to their eight-track studio in High Road, N.W.10, has been made by Morgan Recording Studios. Up to 45 performers can be accommodated in the 100 sq. m. extension which is equipped for 16-track recording and Dolby noise reduction.

MM-1000 INSTALLED AT MARQUEE

LONDON'S FIRST AMPEX *MM-1000* was recently installed at Marquee Recording Studios in Dean Street, W.1. The Studio Director, Gerry Collins, considers its selsync quality good enough to permit mixing down from several tracks to a single track, freeing the original tracks for further material. Orders for 27 units have been received outside the US. The *MM-1000* is marketed in Britain and Scandinavia by Ampex (GB) Ltd., Acre Road, Reading (Tel. Reading 55341).

Assembly area of the enlarged Elcom plant at Weedon Road, Northampton.

The Grundig TK149 gives you the complete sound.

A tape recorder is only as good as it sounds. You know that and so do we. That's why we developed the Automatic TK149—to take the guesswork out of tape recording, to give you that distinct, clear sound for which a GRUNDIG is so justly famous. There's a lot of sophisticated engineering in the TK149 to bring it right up to Hi-Fi standards and, of course, it comes with more than £10 worth of quality accessories. But first things first.

The Features . . . Switchable automatic level setting without increase in distortion and using the unique GRUNDIG delay system. Illuminated recording level meter. Automatic stop at end of tape. Facilities for dual play and trick recordings. Heavy gauge plated steel chassis provides robust construction and perfect mechanical alignment. Handle unclips. GRUNDIG 'Easy-G' single dial control. Head cover unclips for easy access to heads and sound channel. Optional accessories available to give added facilities.

...and the Facts...Recording System: 4-track mono with dual-play facilities.
Level Adjustment: Automatic with the ingenious distortion-free Grundig delay system or manual override.
Tape Speed: 3¾ i.p.s. (9.5 cm/s).
Wow and Flutter: 0.2% r.m.s.
Maximum Playing Time: 6 hrs. (4 hrs. with the 1200 ft. of L.P. tape supplied).
Frequency Response: 40—12,500 Hz +3—5dB
Signal to Noise Ratio: 45dB
Output Power: 2.5 Watts/5 Ohm
Input: Microphone/Universal 2mV/1.5MOhm
Outputs: High impedance 500mV/15kOhm, Earphone 11V/220kOhm, Ext. Loudspeaker 2.5W/5 Ohm. Monitor Output for synchronised recordings.
Loudspeaker: 6" x 4" high flux density unit.
Position Indicator: 4-figure digital with press button re-set.
Accessories Supplied: Moving coil stick microphone GDM 312, 1200' L.P. tape in library container, spare spool, connecting lead.

Grundig TK149. For the complete sound. Recommended Retail Price **£57.12.8.** One of the incomparable range of Grundig Tape Recorders— ask your dealer for a demonstration soon.

Hear it all on

GRUNDIG

Grundig (Great Britain) Ltd., London, S.E.26.

. . . about azimuth alignment

From: John Shuttleworth, School House, Eltham College, Mottingham, London S.E.9.

Dear Sir, Following on from Angus McKenzie's article on azimuth adjustment in the December issue, readers may be interested in the following method which does not require the use of a test tape.

Connect a tone generator to the input of the recorder and a valve millivoltmeter to the line output. Adjust the record head azimuth for maximum output while recording a 10 kHz tone.

Next record a 2 kHz tone at the same level, then rewind and play this recording with the tape inside out (plastic base against the heads), assuming ¼-track stereo or full-track mono operation.

Adjust the playback head azimuth for maximum output, carefully noting the number of screw turns required. Now set the playback head halfway between its original position and its new position. Record a 10 kHz tone with the tape the correct way round and adjust the record head for maximum line output.

The entire process is repeated until it is found that no increase in signal is produced when adjusting the playback head.

This method has the advantage that the final result depends only on the patience of the operator and not on the unknown merits of a test tape.

Yours faithfully

. . . about metric

From: John Alcock, Unitrack Equipment Ltd., 590 Wandsworth Road, London, S.W.8.

Dear Sir, I feel that I really must protest at the constant use of metric units throughout your magazine.

Whilst I would agree that we have to convert sooner or later to the metric system I feel that, in the early stages of the changeover period, it would be of great benefit to include both standards so that people such as myself, unequipped at all times with a slide rule, could readily convert one standard to another. Furthermore, in some instances I fail to see how you will persuade this industry to convert accepted terminology such as ¼", ½", 1" and 2" tape into 6.25 mm, 12.5 mm, 25 mm and 50 mm.

In your December issue I was most perturbed to discover that our machine was 1270 x 1144 x 673 mm. I would think that, at a rough guess, 95% of the people who read that extract would have no idea whatever how large the object was. However I am pleased to note that there is one sane member of your staff, Peter Bastin, who outlined similar objections in his 'Talkback' page of the same issue.

No doubt you will wish to tear me into little metric pieces and prove that I am a staid, short-sighted individual; I look forward to any excuses you may care to put forward in reply. Happy Christmas!

Yours faithfully,

(*Ever tried exporting ?*—**Ed.**)

. . . about 'Talkback'

From: Robert Morgan, Hotel Stewart, Richmond, Surrey.

Dear Sir, Your plans for the future of *Studio Sound*, née *Tape Recorder*, sound very promising. But if you expect this reader to buy and read it you will have to begin by excluding or radically transforming Peter Bastin's so-called column, 'Talkback'. This contribution is so prejudiced, inaccurate, uninformative and unnecessary that it is quite incompatible with the rest of your excellent magazine. You don't see what I mean? Consider the following comments, arranged in parallel with his column:

METRICATION: This sort of criticism of the metric system is a stale re-hash of what has been better said elsewhere, and it offers no new insight or solution. The dedicated boozer need not 'guzzle 800 centilitres of brown ale', of course; he will guzzle 8 litres only, which is the beauty of a decimal system. (Let Peter Bastin consider the present 'pint' as so many ounces or as a fraction of a gallon! Can he even do it without looking up the equivalents?) And the chippy's mate, after metrication, would never think of ordering '76.2 mm by 50.8 mm pine'. Does Peter Bastin think that today's 'two by four' measures 2.00 by 4.00 inches? Those are nominal measurements and in metric days there will be nominal metric measurements, too. Clearly, the author of this paragraph hasn't even tried to 'consider the ramifications', as he asks us to do.

PRICES: Two outright errors here: Sony and Tandberg both give *exact* prices in their advertisements. (Sony: Model *TC-630*, recommended retail price £199 15s, Tandberg: £89 10s.) Ferrograph, Film Industries, and Telefunken are advertising a *range* of products where any single price would be misleading. But the most important point is clearly stated in the B & O ad, and it is incredible that Peter Bastin is unaware of it: '. . . for those who consider design and quality before price.' It is a well-known convention, not limited to audio products, that lack of a price in an advertisement means that the item is relatively expensive and that other qualities are more important. You don't buy a Ferrograph because it fits your budget; you buy it because it is good. If you have to ask how much it costs, Peter, you can't afford it.

LOCAL RADIO: Not surprising that local radio turned down Mr Bastin's tapes, if they were anything like his column. But local radio is *supposed* to be an amplified parish pump—a very necessary institution—and if it were not immediate and topical it would be failing in its function. This paragraph positively reeks of sour grapes. The professional knows that he must tailor his product to the market requirements if he wants to sell it; Mr Bastin, militant amateur, wants the market to come to him.

PHILIPS VTR: The most amazing thing about this paragraph is the price differential between the *LDL1002* at £198 and the *LDL 1002* at £188.

ITALIANS: It is news to Mr Bastin, but not to other people, that English is very widely known in countries where the mother tongue is not an international language. The English and the French get by nicely on their native tongues, and can spare themselves the bother of learning those silly foreign languages; but nobody but Italians speaks Italian, so they have to know some English.

DISCOURTESY: On the evidence of his column, Mr Bastin can find discourtesy anywhere, so it is not surprising that Philips' labour-saving device affronts him. If he really wants a personal reply he will of course have to wait even longer. And by the way, doesn't he know yet how to order spare parts from large manufacturers? When he buys his cassette recorder—not later, when it needs repair—he should write to Philips for a (free) service manual. Each part is shown in exploded diagram with its code number. He then can ask for the part by number when he needs it and the response will be very rapid. He can even phone CES in Croydon after business hours and tell their recording machine what he wants. Why doesn't he give the reader *that* sort of information in his column, instead of mindless gripes?

TAPES: The metric gripe again! Does Mr Bastin think that ¼-inch tape is actually 0.250000 inches wide? A little research would indicate that it isn't.

WHARFEDALE: 'Tell me, Wharfedale, how does an item *suddenly* increase in cost by 12.5%?' Well, Mr Bastin there is one way: the manufacturer holds the price constant in the face of increased costs until his margin of profit is too small to continue. *Then* he ups the price. He could increase it by small amounts whenever a resistor goes up in price by .01d, but that would make the complainers complain even louder.

CODE NUMBERS: Another pointless complaint; Mr Bastin hasn't filled his word quota yet and he is scraping the bottom of the barrel. So equipment is designated by a combination of numbers and letters (rather like an *English* car registration plate?)—so what? An equally loud and meaningless case could be made against using 'recognisable and logical names'. How about *Maxim*, *Marimba*, *Mezzo*, *Magnum*, and *Magister*? One can hear Mr Bastin's outraged voice: impossible to remember the difference . . . emotional associations . . .

I suppose that next month Peter Bastin will again spend ten minutes leafing through a few audio magazines and come up with another 'column'. If, sir, you are really 8 feet three inches tall, can you not stop him before it is too late? Perhaps by writing that nasty letter he referred to? Your readers would appreciate a well-written, informative column on tape-related topics. It could even be lively and opinionated, if there were a solid background of knowledge and journalistic spadework behind it. But 'Talkback', in its present form, is not such a column, Please do the decent thing.

Yours faithfully

Reader reaction to the "Talkback" column has

(*continued overleaf*)

been generally favourable and suggests that a light-hearted column is not out of place in an otherwise fairly technical journal—**Ed.**

. . . about green stickers

From: J. V. Herbert Cookson, Hugh Barn, New Longton, Preston PR4 4SQ.

Dear Sir, Re 'Talkback' in the December issue and Peter Bastin's reference to the green sticker of Philips Electrical, I do not think he has any cause for complaint. He was informed of the price required for the article and could decide whether to buy or not.

On two occasions after I have asked the price of an item, I have been puzzled to be confronted with the postman holding a COD parcel. In both cases all charges were added. In one case, after parting with my cash, I found the parcel contained the item whose price I had requested plus an item never mentioned. After correspondence, the last mentioned was accepted back and, after some weeks, I received a refund. I had to bear the annoyance, the packing and COD charges, and postage on letters and return parcel. Apart from this, I considered the price of the item left far too high.

In future, please do not ask the price of anything without having first placed a wad of pound notes handy beside the door.

Yours faithfully

. . . about rising costs

From: J. Hone, 130 Old Oak Road, London W.3.

Dear Sir I feel that I must comment on a point raised by Peter Bastin ('Talkback', December), in which he refers to a piece of equipment seemingly increasing in cost by 12.5% almost overnight. Being a retail business man (not connected with audio) I can understand Mr Bastin's attitude but can also point out that I purchased certain lines of goods a few months ago and, when the last of these articles has been sold, the next batch will be at least 30% dearer.

As I write this letter, three national publications have increased 20% overnight and my business rates have increased £100 a year. I could go on forever and would add that Mr Bastin's remark about inflated profits is nothing to do with the matter at all. Also, SET *does* lead to increased prices. Next time you buy something, it is *more than likely* to be up in price.

Yours faithfully

. . . about measuring distortion

From: W. H. Myall, 35 Villiers Road, Watford WD1 4AL.

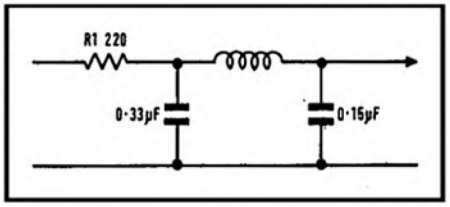
Dear Sir, Feeling rather pleased with the success of the following circuit, I thought you might agree it is worth passing on.

Anyone who has become stumped in measuring small distortion products due to the distortion content of his test oscillator (mine is 0.1%) will find the following circuit very efficient and easy to knock up. It attenuates the second harmonic of a 1 kHz test tone by something like 20 dB.

The inductance is the primary of a standard pentode output transformer, the type once used in domestic radio sets for matching a *6V6* to a 3 ohm loudspeaker. The laminations are removed and the secondary winding ignored. The primary resistance of the one in use is 550 ohms.

If the generator has an output impedance greater than 200 ohms, R1 should not be necessary. The filter should not be loaded with less than about 5 K or the attenuation falls off. There is no loss of signal amplitude at the test frequency.

Yours faithfully



A NEW CUSTOM

THINKING OF BUILDING a 24-channel mixer into the dash-board of your car? Then you are obviously the type who prefers his transport to have an individual look—tuned for optimum performance like a good tape recorder.

Seriously, though, if you are a car tinkerer—or you know any young men that way inclined—then look out for *Custom Car*, a new motoring magazine from the Link House Group to be launched in February. *Custom Car* will be youthful, colourful and full of know-how on making cars look like something else—tape recorders for instance. Price 2s 6d from any newsagent, first issue February 6.

around the studios

number 1 - studio G

by KEITH WICKS

THE idea of this series is to take a look at various sound studios and see the facilities they provide and the techniques used. Studio G, in London's Wardour Street, is a good place to start as the firm's main business is that of advising the film, television, radio and advertising industries in matters concerned with sound recording and music in general. Customers have included Twentieth Century Fox, Anglia TV Radio Luxemburg, Rank Advertising, and numerous other big and small names in all fields.

Studio G was founded by John Gale, who is the Musical Director and Conductor of the London Concert Orchestra, and has been involved in music in many different ways including the composition of beat music and music for TV commercials, for which he has won many awards. The studio can advise on all aspects of the business—copyright clearance, choosing composers and musicians, negotiating fees, etc. They have a sound effects library and a voice library which enables producers to choose a voice suitable for the purpose they have in mind, without having to audition scores of people. Technical facilities on the premises include a film transfer suite containing two RCA Sunbury machines an EMI *BTR4* recorder, an editing desk, and a Lockwood Speaker for monitoring. The RCA film transport can deal with 35 mm or 17.5 mm whilst the second machine handles 16 mm, all at 24 or 25 f/s, depending whether the work is for cinema or TV.

I was shown around the studio by Bob Cort, one of their composers and arrangers (and well known for his part in the skiffle movement of the 'fifties). I found that the recording facilities provided on the premises were somewhat limited but, as B.C. was quick to point out, besides using their own studios, they make use of various other London studios, which have been inspected by their own consultants and engineers. Thus, whatever facilities are needed, Studio G are able to choose the best place for the job. Their own two studios deal with single-track recordings only, the smaller one being a very basic affair for recording speech. This is about 3 x 4 m in size. The mixer provides for one microphone channel and two auxiliary inputs (spring echo is used) and there are two desk mounted *BTR4*s. When I arrived, Frank Weintrop of Walt Disney Productions was just finishing an editing session on some tapes for a new series of children's records to be brought out soon.

The larger studio is about 5 x 6 m, and there are six microphone channels, four auxiliary inputs, and two high level inputs. The control desk, which was built by Post Electronics of Ashford, Middlesex, is shown in **fig. 4**. There are two group faders to which the various channels may be switched as required, and six response selection amplifiers are provided for modification of the signals when desired. Spring echo is used here, as in the smaller studio. To the left of the desk can be seen an EMI *TR52* which is used only for editing. the *BTR4*s being used for recording. **Fig. 5** shows one of a pair of desk-mounted *BTR4* decks, and the associated recording amplifiers.

As far as microphones are concerned, Studio G have four by AKG—two *C61*s, a *C28*, and a *D19*, a Sony *C38*, an STC *4038*, and an MKH *405*. Unfortunately I was unable to see the studio in action as the booking with which my visit had been scheduled to coincide had been cancelled.

The overall impression I gained during the visit was simply of being among people who know the music business inside out, and provide a much needed and unique service in this field.

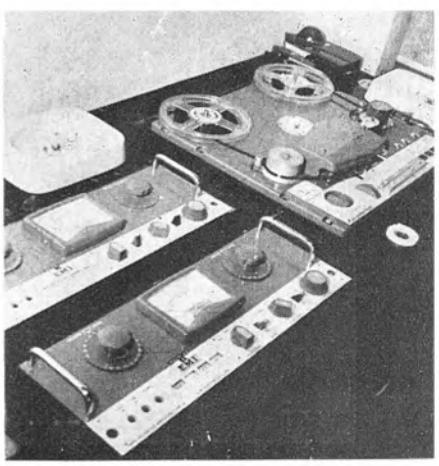


FIG. 1 (top left): Acoustic separation screens.
FIG. 2 (top centre): Small studio, single STC 4038 ribbon
FIG. 3 (top right): Tape editing on BTR4 for Radio Luxemburg.
FIG. 4 (lower left): Post Electronics mixer and EMI TR52.
FIG 5 (lower right): One of two BTR4 transports.

EMITAPE *Afonic*

low-noise recording tape

quiet as a mouse!

don't buy any tape – buy EMITAPE

THE RANGE OF EMITAPE AFONIC LOW-NOISE TAPE

88
STANDARD PLAY
The best general purpose tape, giving maximum durability at all professional speeds. Pre-stretched polyester base film of super strength.

99
LONG PLAY
50% longer recording time – specially designed for multi-track recorders – pre-stretched polyester base film of super strength.

100
DOUBLE PLAY
Twice the recording time for a given size of spool – the perfect film for low speed, multi-track recorders – superflex polyester base film.

300
TRIPLE PLAY
Maximum playing time on spools up to 5″ dia. – extended dynamic range – specially suitable for battery operated recorders – extra tensile polyester base.

EMITAPE IS AN EMI GROUP PRODUCT EMI

RECORDING STUDIO TECHNIQUES

PART 2
STEREO MICROPHONE PLACEMENT

BY ANGUS McKENZIE (Roundabout Records)

THIS month I am going to deal with the different techniques for obtaining a stereo sound picture on tape from the various types of sound source, and in particular comment in detail about early techniques with which I myself experimented. As we are primarily concerned with present day techniques, I am not going to go into detail about how Blumlein arrived at his system of using crossed bi-directional microphones, a technique which many people consider still the best today.

I wish to stress that the choice of any particular technique tends to be personal, in that one engineer may well prefer spaced mikes with extra mikes added, whilst another prefers to follow Blumlein. Because of this I will write about my own experiences and preferences, whilst at the same time explaining why I dislike many others, in addition to accepting certain techniques which are combinations of the ones already outlined.

In the summer of 1955 I was fortunate enough to have the opportunity of purchasing almost all the equipment of the old Mercury Sound Studios located in Hornsey and amongst the items bought were four Neumann *U47* capacitors. These were initially switchable to cardioid or omnidirectional directivity patterns. In 1958 with the help of a friend all these mikes were modified to give any pattern between omnidirectional through cardioid to bi-directional, with a control on the power supply unit. In the same year I purchased my first professional stereo tape recorder, namely an *EMR TR90* which had stereo record and replay amplifiers together with a 10 W monitor amplifier switchable to either channel in one cabinet, whilst the tape deck, capable of taking NAB spools, was in a second cabinet, which also contained the erase oscillator, bias supplies and tape replay preamps. I can well remember the very first stereo recordings I made with two *U47* mikes on the pavement outside my little studio in North End Parade, Fulham. I spent literally hours comparing the merits of spaced mikes placed between two and five metres apart, and a coincidental pair in which one mike was suspended downwards from a boom with the other mike pointing upwards on a mike stand. The most obvious difference was that in the case of the spaced mikes, depending upon the spacing, the effect of a sound arriving at one loudspeaker and then tending to disappear and later reappear at the other speaker was very marked, particularly when the sound source included a large proportion of high frequencies, for example ordinary footsteps or a clanking bicycle. If a similar sound source was recorded and played back using the coincidental technique, whether the characteristic was set at cardioid or bi-directional, the directional accuracy of the sound was much greater. I well remember a particular bicycle with rattling chain and mudguards vibrating, traversing slowly and accurately without any change in frequency balance from extreme right to extreme left.

I was not prepared to accept anyone else's word that a particular technique was best since one engineer at the time told me that a spaced mike technique was to be preferred and deprecated the use of coincidental mikes, whilst another gave the opposite advice.

After these somewhat crude experiments I was fortunate in having the help of a church organist, Brian Cole, who allowed me and helped me to record his performances on the organ of St. James's Church, Alperton. In this church I was able to confirm that the coincidental technique gave by far the best approximation to the original sound, provided that I sat at a position mid-way between the two loudspeakers and a metre or two away from them, but that the spaced mike technique sounded slightly preferable, although not so realistic, if I was well away from the centre line of the loudspeakers. I played these comparison tests to many friends at the time and it is interesting that without exception everyone preferred the coincidental technique, and the slight improvement of the spaced mike when the listener was off axis was considered by all to be of little significance at the time.

Some months later I was asked by the Royal School of Church Music to record in mono their festival at the Royal Albert Hall, in which there was not only a choir of about eight hundred, but an audience of several thousand joining in the hymns. Just before the event I was introduced to George Pontzen of Lustraphone who asked me if it was possible to tape some of the rehearsal using two of his *VR53* ribbon mikes situated as near together as possible. I decided also to record the entire ceremony in stereo using two of my *U47's* about 23 cm apart with a hypercardioid directivity pattern. Such a directivity pattern causes the mike to have its main sensitivity lobe in a forward direction and a small lobe in a backward direction, and two almost dead lobes facing approximately 45° either side of this backward direction. This characteristic was selected in order to control the amount of reverberation pick-up in the hall whilst at the same time receiving a sufficient amount of sound from the congregation singing in the hymns.

Some readers may remember hearing the tapes played back in the Lustraphone room at the Earls Court Radio Show in 1958, and it is remarkable how well the inexpensive Lustraphone ribbon reproduced the sound of the huge choir in stereo, although of course the tapes made with the capacitor mikes at the actual performance were far superior.

Around this time I also experimented with filling in the gap between the two loudspeakers when two spaced mikes were used by adding a third mike in the centre and feeding this equally to both channels, but slightly down in gain with respect to the gain of the spaced mikes. My reaction to this technique then was the same as now, namely instead of getting two distinct sound sources from the left and right speakers respectively, one heard three positions of sound, which was only a fractional advantage.

With a spaced technique the two mikes are situated from two to five metres apart, a metre or so behind the conductor and to each side. This tends to give undue prominence to the front desks of the orchestra whilst the sound from the centre of the orchestra appears to recede into the background. Much early American stereo was recorded in this way, with rather unsatisfactory results. A modification to this technique consists of facing the two mikes to the opposite sides of the orchestra to those on which the mikes are placed, but although this partially overcomes the hole in the middle effect, it has the dangerous consequence of picking up the front desks of the first violins and cellos and causing them to appear from the wrong side. It is amazing that I have seen sessions costing thousands of pounds using this technique, although I would admit that I have not heard it used after 1959.

Some defects in the use of coincidental mike techniques will now be discussed together with the modifications which can in certain circumstances correct its deficiencies. In a concert hall, a large orchestra will be seen to stretch from extreme left to extreme right and, although there are several different layout plans available to the conductor, a typical layout is violins from extreme left to just left of centre, cellos from right of centre to extreme right, violas in the centre but some distance back, and other instruments tending to be positioned from left to right behind the string section. It will be seen, therefore, that for a member of the audience half-way back in the hall, the stereo sound picture will be totally different to that heard at the average place where the coincidental mike might be positioned. In this latter case the back desks of violins, for instance, will be largely behind the front desks, whereas the member of the audience referred to will hear the back desks largely to the left of the front desks. To overcome this, some early stereo was made using two coincidental pairs with one mike close to the orchestra and the additional mike nearly half-way back in the hall. When the outputs of these two stereo pairs were mixed, the sound tended to be broader from the strings, but the centre of the orchestra became very muddy, in addition to low frequencies reaching the two mikes at different times and subsequently being mixed together partially out of phase causing bass cancellations at some frequencies and bass additions at others.

Recordings made with this technique therefore tended to be rather boomy in the bass and lacked definition in the centre and back

(continued on page 63)

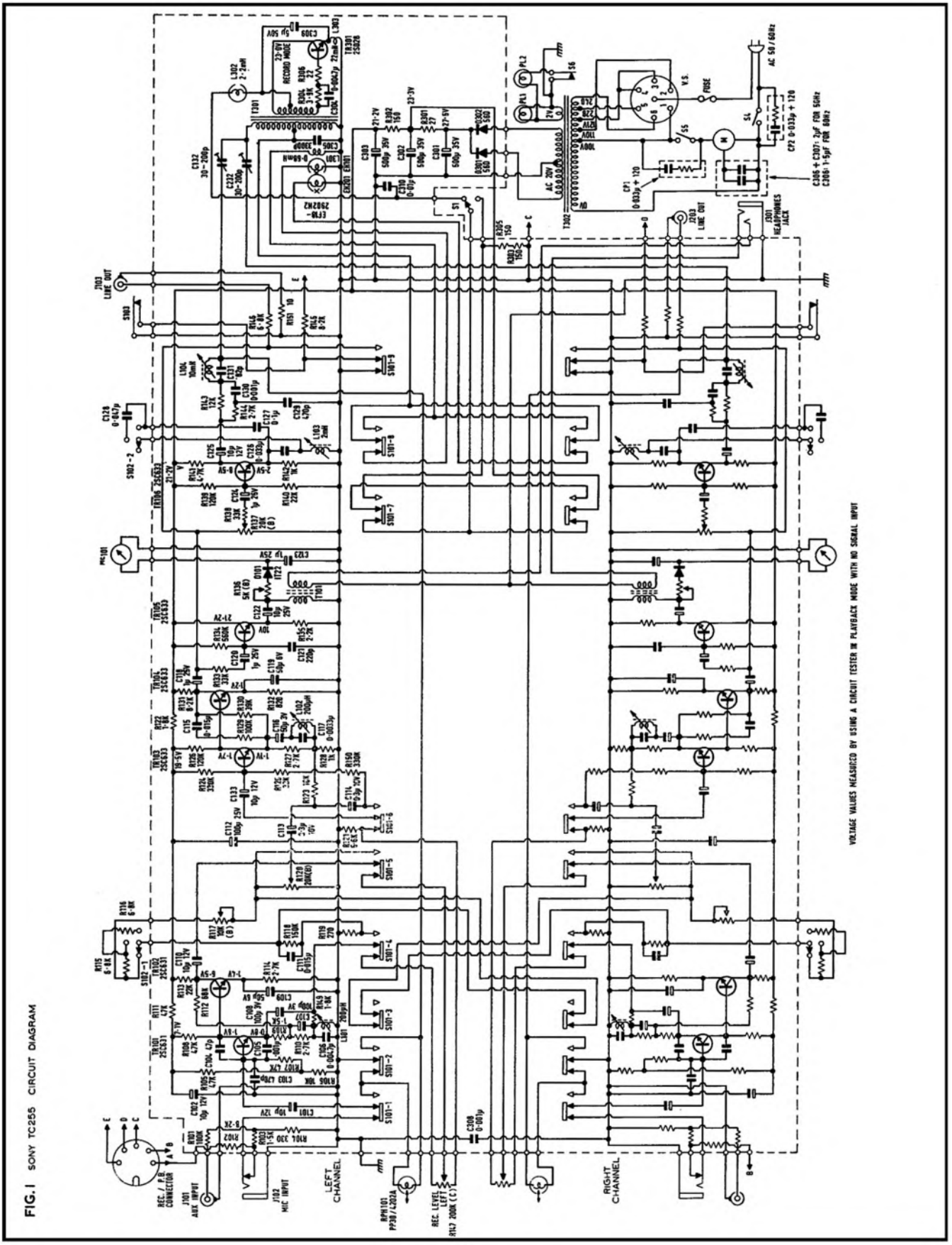
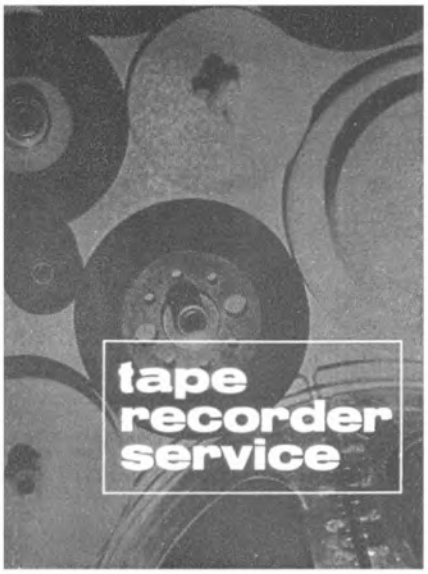


FIG. 1 SONY TC255 CIRCUIT DIAGRAM



SONY TC255

BY H. W. HELLYER

SQUEEZING an extra dB of performance out of a circuit at the lower end of the scale, where signals are minute and even the system noise caused by a slight difference in voltage is significant, presents a real problem. Sony have gone a fair way toward solving it in the *TC 255* by using a high oscillator frequency (150 kHz or more) and by a silicon-transistor input section using the now-familiar direct-coupled pair of silicon planar transistors, with a carefully engineered feedback circuit consisting of three separate negative feedback loops, incorporating correction, and adding the required trapping quite early, in series with two of the loop lines. From there, the signal goes on to another direct-coupled pair which drives an emitter-follower output stage. Correction and trapping again come into operation. A close study of **fig. 1** reveals a number of interesting details.

In particular, one will note a good deal of switching, not obvious from a swift appraisal of the actual machine. The present adjustments are quite detailed, too. A few remarks on the method of setting them may give guidance to a few of our correspondents who ask to be told 'the right way' to check amplifiers, oscillators and the like. But first, the switching.

Equalisation is carried out by a rotary wafer switch on the extension of the speed change spindle (speed changing being mechanical, as on previous Sony machines we have studied). A capstan idler on a ramp is spring-loaded and engages with a stepped motor pulley. The trouble we may get with this assembly is slight rattle because the short spindle of the idler itself is on a fairly long extension of its bracket, which is not as robust as one could have wished, and which can be too easily bent to present the idler to the capstan on an angle instead of directly in line. Both the fault and its cure are obvious.

Electrically, the equalisation consists of changing the resistive element of the feedback loop between the collector of the second stage and the emitter of the first on play, and is also made to modify the emitter bypass capacity of the output stage. The layout lends itself to experimentation if one is so inclined.

Unusual switches, for Sony machines, are the muting and the oscillator on/off. Muting simply short-circuits to chassis the signal applied to the line output connection. Note that this comes from the collector of the fourth transistor: the fifth is a meter amplifier and the last a recording amplifier to feed the head. The meter amplifier also provides an 8 ohm headphone output. 30 mV is available at this point.

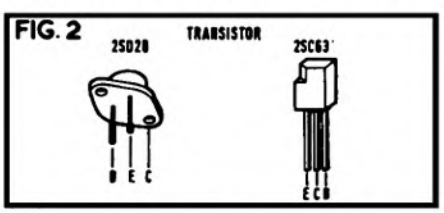
At the line output (phono) socket, the full 0 dB level is obtainable at an impedance of 7 K. It should be pointed out here that the output of the DIN socket is not the same as from the line out: a further 8.2 K is inserted in series, reducing the output to −1.2 dB (680 mV) and making the impedance a more suitable match, a nominal 50 K.

A similar choice of sensitivities and impedances occurs at the input, where the method of connecting the line and DIN inputs to the microphone input via an attenuating network is not the best way of providing a true match. If care is not exercised. it can spoil that very good noise figure. But the method does lend itself to some adaptation —providing one avoids like the plague the least chance of overloading. If we forget ourselves and treat the inputs of Sony tape recorders as if they were Radford amplifiers, we are going to suffer distortion. Looking at the input network, it is easier to visualise what is happening by regarding it as two resistors across the base-chassis line, with the auxiliary input tapped to the junction between the two with its individual series attenuator, and then the DIN connector coming to the same position as the microphone, via its own series attenuator. This gives us the following input impedances and sensitivities:

Microphone: 600 ohms, 200 μV.
Line: 100 K, 60 mV.
DIN: 80 K, 30 mV.

The muting switch mentioned above is not the usual manually operated switch by the output sockets, but a spring-set mounted near the inner edge of the meter, actuated by the pinch roller arm and muting when the machine is in the fast winding mode. The purpose is fairly obvious, because the *TC 255* has no replay manual level controls, and the chatter of rewind can be annoying. I would prefer the choice of a manual switch, or, even better, a pair of output potentiometers to mute if need be. or help with output matching. Tandberg have a better idea, I can't help feeling.

Bias killers are nowadays fairly common, and where there is a likelihood that machines will be used for language teaching, etc, it is a great help to have the channels completely separate. The *TC 255* does have the two-key system, so that one channel can be left on play while the other records, but one will also find the Sony habit of making the record level gain control do a bit of extra work by an 'off' switch that kills bias oscillators incorporated in the more expensive machines. Unfortunately, the *TC 255* does not do this, and a quick glance at the circuit shows that this switch is indeed tied up with the record/play selector system, and can limit one's use of the machine. It is a small microswitch with a lever action pressing its button, and can very easily cause trouble if not correctly aligned.



Mention of alignment brings us to adjustments. First thing to note is that readings are taken at the line output socket, using a *VVM* and across a 100 K resistor to preserve adequate loading. The 0 dB reading of 775 mV from a fully modulated tape is the first thing to establish here. Test tapes such as the Sony *N-19-F2* can be used to make spot checks, and head alignment can be made at the same time for maximum output.

Setting the meter is another vexing point about these machines: it is done while replaying a standard test tape, the adjustment being for the needle to sit on the boundary between red and white zones for an 0 dB output.

Having set the meter, one can go on to check playback—crazy, isn't it? But Sony are no fools, and this method of leaving the meter loading the circuit has some real advantages to the operator. Playback adjustments include the equalisation setting, and this is again done to the tune of a test tape. The series resistor networks have a variable component, easily accessible, and the adjustment is for the correct curve. There is no need for the table of detailed adjustments here, but they are available if any *255* owner needs to know them. The overall playback level is also preset and, from the 700 Hz band on the test tape, an 0 dB reading should be obtained.

After this we go to record and adjust the traps. This machine is liberally supplied with protective traps. In each case, the adjustment of the traps, in the record mode, is for minimum reading on the VVM. Test for crosstalk trapping must be made, with one channel on record while the other is on replay, and some care should be taken over this test. Detail of the preset and trap coil positions is only of interest to owners, and, as before, is available on demand.

Bias adjustment on this machine is done by recording a signal of 1 kHz at an input of −60 dB (780 μV) at the microphone socket with correct loading, setting the record level controls for an 0 dB reading, then checking its output on playback. Then to go back over the process, altering the setting of the 30 to 200 pF trimmers for each channel until the output readings are at a maximum. This sounds tedious, but unless some clever fellow has been twiddling, the actual resetting process takes very little time.

Recording curves are set by the coil in the emitter of the head driver stage, and this is set for 0 dB reading—or as near as you can get it in practice, when a high frequency is being recorded. 18 kHz in at −80 dB (78 μV

(continued on page 63)

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	Spool	Length	Suggested Retail Price	Our Price
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	5"	600'	22/2	16/11
	5½"	900'	29/5	22/5
	7"	1200'	36/7	27/10
LONG PLAY	4"	450'	15/6	11/10
	4½"	600'	22/-	16/9
	5"	900'	29/2	22/2
	5½"	1200'	26/4	27/7
	7"	1800'	51/6	39/-
DOUBLE PLAY	4"	600'	26/-	19/9
	4½"	900'	31/-	23/6
	5"	1200'	43/2	32/8
	5½"	1800'	56/11	43/1
	7"	2400'	79/1	59/9
TRIPLE PLAY	4"	900'	40/-	30/3
	4½"	1200'	50/-	37/9
	5"	1800'	67/1	50/7
	5½"	2400'	91/4	68/10
	7"	3600'	116/8	88/5
B.A.S.F. 'ROUND PACK'	7" STD	1200'	OUR PRICE	21/6
	5" L/P	1200'	OUR PRICE	21/6
	7" L/P	1800'	OUR PRICE	31/9
	5½" D/P	1800'	OUR PRICE	32/6
	7" D/P	2400'	OUR PRICE	45/-

CASSETTES PHILIPS/B.A.S.F.

	Suggested Retail Price	Our Price
C-60 (Std.)	18/-	13/6
C-90 (L/P.)	25/6	19/6
C-120 (D/P.)	34/-	25/6

MAXELL CASSETTES (Philips Type)

	Our Price
C-60	9/6
C-90	13/9
C-120	18/6

HEADPHONES

Sansui SS2	£7 14 0	£6 15 6
Beyer	£32 18 0	£29 0 0
Akai ASE95	£6 10 0	£5 19 6
Eagle SEI		£4 15 0
Shriro Secom 650		£3 12 6
Pioneer SE30	£12 12 0	£11 0 0
Pioneer SE2P	£6 15 0	£5 18 6
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	Suggested Retail Price	Our Price
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Eagle DM16HL	£6 12 4	£5 15 10
Eagle DM58HL	£10 0 6	£9 13 0
Eagle UD50HL	£8 7 6	£7 6 7
Beyer M81HL	£11 5 0	£10 0 0
Beyer M818HL	£22 18 6	£20 5 6
Philips AKGD19C	£18 0 0	£16 4 0
Philips AKGD110HL	£7 15 0	£7 5 0
Shure 560	£16 10 0	£15 10 0
TAPE RECORDERS		
Akai 1710W	£109 0 0	£89 10 0
Akai M9	£195 0 0	£165 0 0
Akai 1710L	£109 0 0	£89 10 0
Sanyo MR801	£78 0 0	£69 10 0
Sanyo MR800		£79 0 0
Sanyo M26 Cassette		£21 19 6
Philips EL3302 Cassette	£28 7 6	£21 19 0
Aiwa TP730 Stereo	£41 9 6	£34 4 8
Aiwa TP1;1 and Radio	£60 18 0	£50 8 6
Aiwa 728 Cassette	£36 4 6	£29 17 6
Teleton T710	£34 15 0	£29 19 6
Grundig TK120	£39 17 6	£34 10 6
Grundig TK144	£47 13 1	£41 18 10
Grundig TK124	£41 18 6	£36 17 6
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7" 1200'	36/7	25/6
LONG PLAY		
3" 210'	9/6	6/9
4" 450'	15/7	10/9
5" 900'	29/3	20/6
5½" 1200'	36/5	25/6
7" 1800'	51/7	36/-
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C.60	17/7	12/3
C.90	25/1	17/6
C.120	33/7	23/6

DOUBLE PLAY	List Price	Our Price
3" 300'	15/-	10/6
4" 600'	26/1	18/3
5" 1200'	43/3	30/3
5½" 1800'	56/5	39/6
7" 2400'	79/7	55/6
TRIPLE PLAY		
3" 450'	23/-	16/-
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5" 1800'	67/3	47/3
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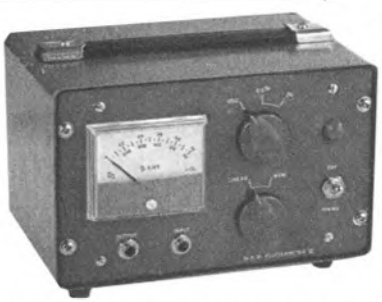

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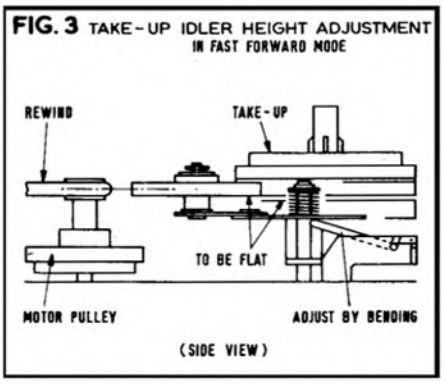

FIG. 3 TAKE-UP IDLER HEIGHT ADJUSTMENT IN FAST FORWARD MODE

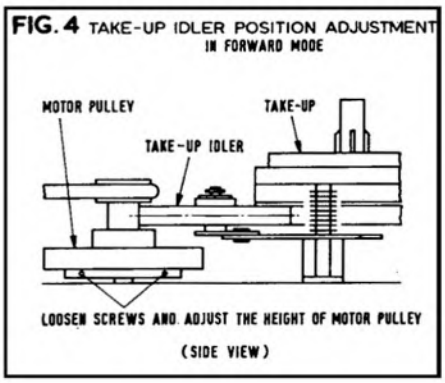

FIG. 4 TAKE-UP IDLER POSITION ADJUSTMENT IN FORWARD MODE

and a reading across the head winding with the valve-voltmeter, adjusting for maximum, should do the trick. It always seems very difficult when doing this test to get the channels exactly the same and time can be wasted. Do not worry too much; after adjusting for maximum, the overall performance will be found quite within tolerance unless there is some serious fault such as head wear.

One or two things to be remembered: the bias frequency is very high compared with other machines in the range. More than 150 kHz can be read, so any discrepancy in measuring methods can affect readings. Similarly, the bias voltages read across the heads can be misleading and require not only a good VVM but also a good probe. Between 60 and 70 V can be measured across the record play head, with 80 to 90 erase voltage.

Before closing, I should explain the need for the further three figures. **Fig. 2** shows the connections of the main transistors that give trouble. In particular, the silicon planar transistors used by Sony, such as the *2SC401* and *402*, and these *2SC63* jobs, are small and have maker's identification marks on them that may be a bit misleading. The clue to configuration is always the cutaway on the casing, as shown, and the base is never in the expected central position with these transistors. There are, in fact, one or two simple meter tests one can apply to any transistor to identify it and I shall run through these next time.

Finally, the two drawings which underline some of the remarks made in previous articles about the Sony method of throwing an idler into contact with the take-up spool or the fast-driven drum. It can be seen that there are two main adjustments, the first for height of the idler and the second for its position relative to the motor pulley and turntable. It is the motor pulley that is adjusted for the matter of fine movement, not the idler bracket. Wrong adjustment causes an angled throw and eventually noisy drive—not always the easiest fault to cure on these machines.

RECORDING STUDIO TECHNIQUES CONTINUED

of the orchestra. The reverberation pick-up also is rather excessive. This technique was only partially successful when a very large hall was used for the recording and, if it was attempted in a small hall or studio, the distant mike reproduced much too much hall or studio acoustic. Again the basic coincidental mike technique is not easily usable for orchestras in other than a large concert hall since a single stereo coincidental mike is often placed at a considerable distance back from the orchestra to give the correct perspective, but unfortunately in such a position that it would then pick up a considerable amount of indirect sound, reducing the clarity which this system can give in a large hall. Most record companies, therefore, use a compromise between the coincidental and spaced techniques by using a stereo mike fairly close to the orchestra and mono mikes at the sides and front of the orchestra, and additional mikes spotlighting various sections such as basses, woodwinds, percussion and brass.

A further reason for the adoption of extra mikes is to obtain a better compatibility with mono reproduction so that a stereo tape or disc played back on a mono system still sounds acceptable. There are many other modifications to these techniques used throughout the world, and probably the most interesting of these is the German system in which a large number of stereo mikes are in use set to different directivity patterns, and the outputs from all these are mixed in a complicated control desk in which their outputs can be electronically positioned so that the ear imagines every sound coming between any two points from extreme left to extreme right. The simplest example might be a stereo mike on the entire orchestra and an additional stereo mike facing the back of the studio with soloists singing towards the orchestra, the soloists' mike outputs being arranged so that the voices appear to come from half left to half right. The German recording companies often use a system known as the 'M and S system' in which the directivity patterns of the stereo mike are chosen in such a way as to necessitate the outputs from the mike being electronically sum and differenced to give the left and right outputs.

A brief explanation of this sum and difference may be useful, and the simplest example is the combination of a bidirectional characteristic and an omnidirectional one. If a stereo mike is placed in front of the orchestra with one capsule side on to the centre (i.e. with its axes pointing to the left and right studio walls each side of the orchestra, and the omnidirectional capsule immediately above) it will be seen that the sum and difference of this pair of capsules, when the gain from them is carefully adjusted, will give two back to back cardioids. With each cardioid facing the side wall of the studio, the output after sum and differencing will therefore be stereo and essentially identical to a mike having back-to-back cardioids. The advantage of the M and S system, therefore, is that by reducing the difference channel, i.e. the output from the bidirectional mike, the total stereo width of the reproduced sound will become less, and with no difference channel at all of course, sound will come from the centre. By altering the directivity pattern of the omni-directional capsule towards that of a cardioid capsule it should be noted that after sum and differencing the effective characteristic will be that of two hypercardioids with their main axes pointing towards the left and right sides of the orchestra, whilst at the same time reducing the reverberation pick up, i.e. indirect sound pick up from the hall or studio. It is also possible to apply frequency correction to both sum and difference channels, and with this correction it is possible to increase or decrease the stereo information artificially to any band of frequencies. Most companies prefer to reduce the difference channel information at low frequencies thus reducing the vertical amplitude of the stereo disc cutting equipment. Such a technique has been said to improve the tracking of records produced from tapes made in this way, although I personally am not convinced of the necessity of doing this unless there is an undue amount of out of phase components in the bass frequencies resulting from a poor balance.

Another important consideration for the engineers to bear in mind is that the producer in charge of the recording session may well not want the listener to hear the programme as it sounds in the studio or hall, but may on the other hand want to produce an effect when the recording is heard. Frequently friends have remarked that a gramophone record, or recording of a broadcast, sounds clearer in texture than the music did at its performance. With many of today's complicated orchestral scorings, a lot of detail can be lost in the concert hall, which comes out more clearly on a record. It is not the producer's job to say to the composer that his writing is at fault, it is his job to take the music as it stands and cause it to give the greatest satisfaction to the maximum number of listeners to the record.

There are many examples of recordings which, on my own equipment, seem to have a huge hole in the centre, or sometimes are artificially boosted in the centre with the output of a third microphone channel, which sound well on small stereograms in which the two loudspeakers may only be a metre apart. The exaggerated stereo of these records on

(continued on page 68)

Model MR 939

Solid-state, 4-track, 3-speed stereo tape recorder

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SPECIFICATIONS

Recording system AC bias 4 track
Erasing system AC erase 4 track
Tape speeds
7½ ips (19cm/sec)
3¾ ips (9.5 cm/sec)
1⅞ ips (4.8 cm/sec)
Wow & Flutter
7½ ips : 0.15% R.M.S.
3¾ ips : 0.20% R.M.S.
1⅞ ips : 0.30% R.M.S.
Recording time
64 min at 7½ ips (Stereo 1200 ft. tape)
128 min at 3¾ ips (Stereo 1200 ft. tape)
256 min at 1⅞ ips (Stereo 1200 ft. tape)
Level indication VU meter x 2
Output power
Music power 7W x 2
Undistorted 4W x 2
Frequency response
7½ ips 20-20,000 c/s (30—15Kc ± 3db)
3¾ ips 30-13,000 c/s
1⅞ ips 30- 8,000 c/s
Signal-to-noise ratio 45 db
Crosstalk
50 db (channel-channel)
65 db (track-track)
Output impedance
Line out : 2 Kohm
Speaker out : 8 ohm
Headphone : 10 Kohm
Input impedance
Microphone : 50 Kohm
Aux : 100 Kohm
Record/play DIN connector
Input : 10 Kohm
Output : 2 Kohm
Microphones
Two dynamic microphones
Speakers
Two 4″ free edge permanent dynamic speakers
Voice coil impedance 8 ohm
Power source
AC 100V, 117V, 125V, 220V, 240V
50-60 c/s
Dimensions
Main unit : 18½ x 6″ x 13¾″ (470 x 150 x 350 mm)
Speaker boxes : 9″ x 5″ x 13¾″ (230 x 130 x 350 mm)
Weight 36.3 lbs (16.5 kg)

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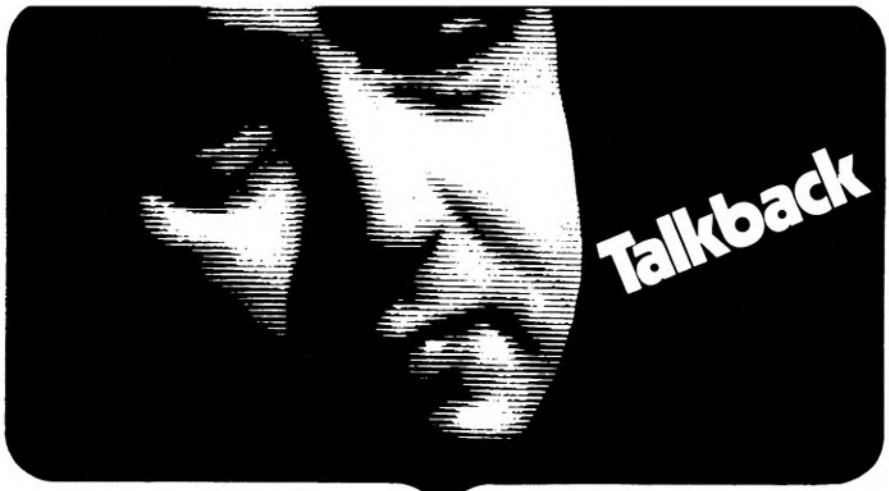


by Peter Bastin

I HAVE always had a Thing about half-a-story reporting in the daily Press. For example, not so long ago, my paper devoted half the front page to reporting the hi-jacking of an aeroplane from an American airfield. The report was padded out with irrelevant facts about what everyone had had for dinner, what they wore and how old they were. There was a detailed description of how the plane had been pinched etc., *but not a word about where it was or what was happening to it*. This sort of thing is common in the popular press and now, it seems, columnist David Lewin of the *Daily Mail* has succumbed. In the November 5 copy, he describes how British tourists in Spain this summer and next winter will be the first to see films projected via cassettes on a television set. His article is rich in description of the films to be canned, why Spain has been chosen for this experiment and so on. He also says, somewhat out of context, that the estimated price for buying an hour's cassette showing at home would be between £14 and £20. Unfortunately, he does not say *how* these mythical cassettes are going to be played through a television set—Spanish or otherwise, and the average reader would almost certainly forget all about the idea and go and have a bath. The idea of being able to buy a videotaped film or copy of a BBC series for replay through your own television set is very remarkable but, of course, not very new and readers of the technical press will have read all about the equipment necessary to do this. It is, however, debatable whether the electrician, the stockbroker or the housewife who reads the *Daily Mail* will have had access to this information and it seems to me that David Lewin would have been doing both the trade and the public a service if he had spent a few of the 500 words in his article on a very brief mention of the type of equipment involved in operating this miracle, and its probable cost. But perhaps he doesn't know. The *Radio Times* on the other hand, in their issue of November 6, explained the situation a little better. They described the 'device' as a home video machine which will be 'an attachment added to your television receiver' costing at least £100.

[*see page* 53—Ed.]

THE ASSOCIATION of Public Address Engineers have introduced a 45 RPM test record for equipment-testing. The first side consists of male and female speech with 30-seconds off-mike speech to illustrate the importance of correct microphone technique. The reverse side of the record comprises intelligibility phrases for phonetic balance, a 1 kHz tone, warble tone and other choice noises. The record is available for 'bona fide professional use' and can be obtained for 15s from APAE, Sales Office, 394 Northolt Road, South Harrow, Middlesex.

PRACTICAL ELECTRONICS for June 1969 contains an article by R. Spathaky BA., called 'An International Technical Language'. Esperanto has been struggling for decades with no apparent results, so I think it very debatable that Mr. Spathaky's technical athletics will get anywhere. English, we are told, is the hot favourite for the science world-language, with sturdy competitors in the shape of Russian and Chinese. Chinese? An example of the sort of thing envisaged by the inventor (?), Dr. Eugen Wuster of Austria: 'quando le commutator es clause le diodo a neon operara al momento quando le voltage instantanee del conductor a currente alternante attingers le voltage liminal del diodo empleate'. One might imagine this to be a sign in a Rome tram meaning 'Do not spit on the conductor's shoe because the driver has been struck by lightning'.

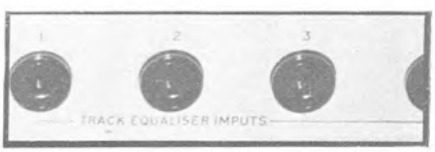
ELECTRONICS (CROYDON) Ltd. advertise 'repairable radios'. What a good idea.

AUDIO RECORD REVIEW for November contains an interesting article called 'What is good Recorded Sound?' It deals with the recording of pianos of various vintages, sizes and persuasions. The emphasis is, however, more on pianos than good recorded sound. It is nevertheless an article worth reading and quotes an example of piano levitation. It seems that if you place a piano between two speakers relaying a mono piano recording, the effect is of a piano floating in space. The article also suggests that stereo very often seems to give little service to piano music and advocates the use of this technique only in cases where two pianos are used. This I can understand, for, to me, stereo is very much a sales gimmick and I really cannot see myself concentrating like mad on a stereo recording which could be heard very much better in mono—without having to concentrate and take bets with myself where the next instrument is coming from. [*You don't know what you're talking about*—Ed.]

LOOKING BACK at countless editions of this noble journal, I am struck by the enormous value offered in the shape of technical articles. The conscientious dedication which goes into articles by such contributors as H. W. Hellyer, Alec Tutchings, K. R. Wicks and others, plus the excellent circuit diagrams and drawings, makes me wonder how much one would pay for this sort of information if these writers set themselves up in the sort of consultancy operated by the medical, legal and architectural professions. For example, you can learn all about the workings and the construction of a line-up unit from John Fisher, get a complete run-down on new equipment from Alec Tutchings, and a whole lot of invaluable information about servicing your machine from H. W. Hellyer. I'm not plugging the magazine: it just occurs to me that for the modest sum of 2s 6d a month we are operating the biggest brain-picking swindle going. [*All is forgiven*—Ed.]

HARKING BACK to my bete noir, metrication, I see that J. T. Harold of Oxford, writing in Wireless World, has even more to say on the subject than I have. One interesting point he makes is that he understands that certain organisations on the Continent have reverted to *Fahrenheit* measurement of temperatures for cold storage plants, as this is a more sensible calibration. I wonder just how much value is placed on this metrication business by the government—or is it just another of these repulsive *moves*? For years now, we have been subjected to violent changes and moves 'for the better'. Railway lines have been closed, coinage has been changed and redesigned, colour-coding for wiring has lost its logic, Americanised-trading is replacing well-tried British methods, and so on. I have the distinct conviction that somewhere in Whitehall there is a room full of dropouts whose job it is to invent new nuisances, fashionable words and gross inconvenience. I'm sure of it.

MAGAZINES THAT make occasional typographical errors (which, believe it or not, includes even us) should not make fun of studio engineers who can't spell. Anybody recognise it?



INSIDE DOLBY

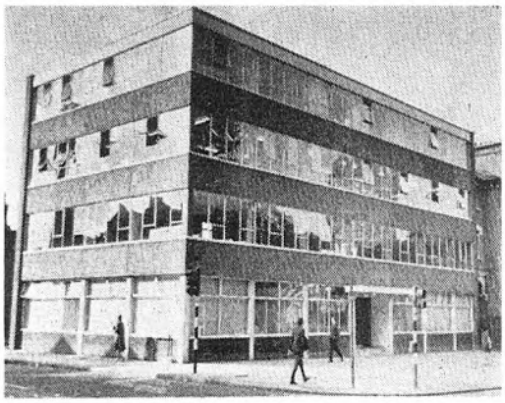
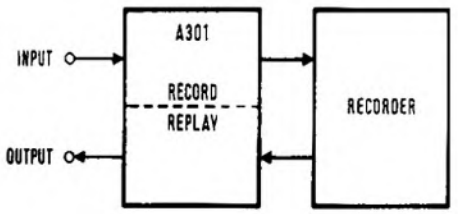


FIG. 1 PERMANENT CONNECTION OF AN A301 UNIT TO A SINGLE-CHANNEL RECORDER



Keith Wicks describes the Dolby Noise Reduction System–PART ONE

THE major limiting factor in high quality sound recording or transmission systems has been the noise level, especially in the case of tape recording. On orchestral music, if the recording level were set so as to prevent excessive distortion on the highest peaks, then the quiet parts would be lost among the tape hiss. In other words, the system cannot cover the wide dynamic range with which it is presented. To get over this, the engineer controls the level of the signal to the recorder and, with the aid of a musical score, increases the gain for quiet passages, reducing the gain just prior to the loud parts. In such a case, the *difference* in levels of the two passages is maintained at the junction between them, and tends to give an illusion of a wider dynamic range than the system really provides, but the fact remains that for most of the time, the quiet parts are substantially louder than in the original live performance, and tape hiss can still be heard. Assuming that the tape is to be used as a master to make a disc, the original dynamic range of the performance can be partially restored, again by skilful gain control manipulation on the part of the engineer. This is possible because the LP disc has a low noise level and can consequently handle a wider dynamic range than standard tape, but the extent to which the process is successful depends among other things on the skill of the engineer and the complexity of the music. If another disc was cut from the master tape at a later date, it would inevitably differ from the original disc as it would be impossible for even the same engineer to control the piece in exactly the same way twice.

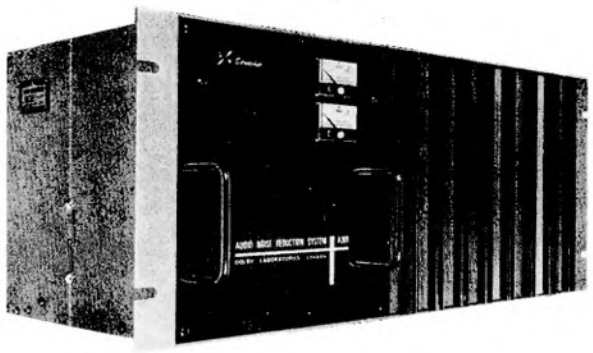
Clearly there is a need for a device which will improve the signal-to-noise ratio by automatically controlling the recording and playback levels in a standardised manner to produce identical results every time. Such a device does exist and is known as the Dolby *A301* Audio Noise Reduction System, the Dolby S-N Stretcher, or simply, the Dolby.

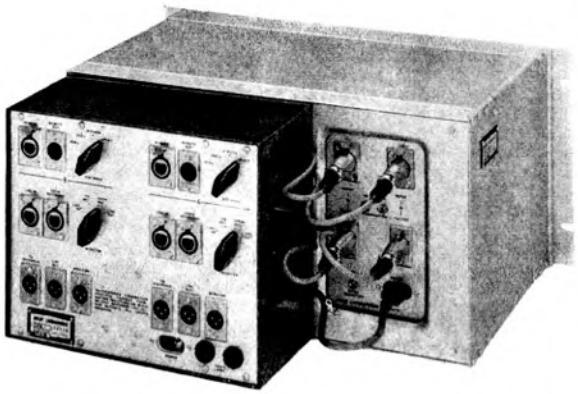
You may think this is just another of those 'compandors', compressing the input to the recorder, and expanding the replayed output. Many attempts have been made to use this idea for the suppression of noise in high quality systems, but a number of difficulties exist which have severely limited the usefulness of these units, the main ones being:

1. Poor tracking between recording and replaying units; and high sensitivity to gain errors.
2. Excessive overshooting on transients.
3. 'Swishing' and 'breathing' noises arising from the sudden raising and lowering of background noises.

The *A301* has overcome these difficulties and, when in use, the immediately noticeable effect is the reduction of tape hiss by 10 to 15 dB without any noticeable defects. In addition the system reduces LF noise produced by irregularities in the tape surface, hiss, rumble, crosstalk, print-through, and modulation noise. In fact *all* unwanted noise produced by the tape recording system.

Conventional compandors increase the overall signal level and compress (limit) high levels before recording and, on reproduction,





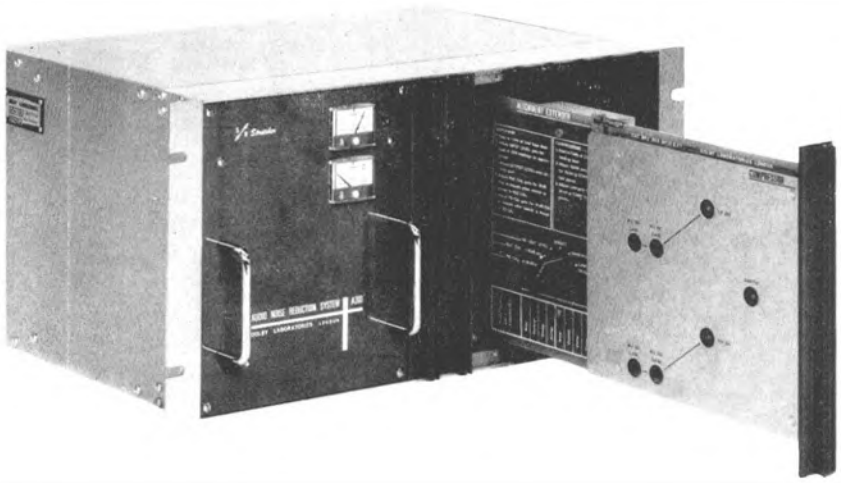


FIG. 2 (top left): *A301* front panel.

FIG. 3 (top right): Automatic switching unit.

FIG. 4 (left): Alignment extender board.

the loud parts are expanded to complement the compression. The Dolby system differs firstly in that it deals only with the low level signals, leaving the high level signals completely unaffected. This immediately guarantees that if any adverse effects were to be caused by the unit, they would occur at low levels only, avoiding the problems of distortion and accuracy usually associated with compandors.

The basic method is to connect the unit between the studio desk and the recorder input. The low level signals are boosted before recording to produce a 'processed' or 'Dolbyised' tape with virtually no *wanted* signal recorded near the hiss level. On replay, the signal is passed through the *A301* (replay mode), and again, the high level signals are unaffected, but the low level signals are now attenuated to complement the boost introduced during recording. Thus the dynamic range is restored, and all the *unwanted* low level noises produced by the tape system are reduced at the same time.

Besides operating on the low level signals only, there is another important difference with the Dolby system; the masking effect of the ear is taken into account, and as Dolby says, 'exploited fully'. A relatively quiet noise may be masked partially or totally by another louder noise provided that it is in the same frequency band. For example, on a tape containing low level hiss and hum, a single loud LF organ note could mask the hum but not the hiss. Such a sound processed and deprocessed by a simple compandor would give rise to an *overall* increase in gain on reproduction for the duration of the note. The result would be that the noise level in this period would increase, and although the hum would be masked, the increase in the hiss level would be noticeable. In the Dolby System, the signal is split into four frequency bands, and each one is treated separately so that a high level signal in one band will not affect the amount of compression or expansion in another band.

If the low organ note were recorded and replayed via a Dolby unit, the tape hiss (lying in the medium and high frequency bands) would be suppressed by the low level expansion arrangement on playback, whilst in the LF band the gain would be normal, but the hum and any other noises of similar frequency would be masked by the LF note. Before and after the note, *all* noise would, of course, be suppressed, so the overall effect is to produce an extremely low background noise which never varies. This is important as changes in the background noise level are disturbing to the listener and can draw attention to a general noise level which might otherwise have been tolerated. The 'swishing' and 'breathing' noises which, as previously mentioned, are associated with the sudden simultaneous raising and lowering of all the background noise components, are eliminated by this 4-band treatment.

Before taking a more detailed look at the system, I should mention that recently I visited Dolby Laboratories in South West London in order to see and hear the *A301*,

(*continued overleaf*)

and to take a look at the production line. Unless you are one of those people who consider that the more knobs to twiddle the better, you could not help but be impressed, as I was, by the fact that the *A301* is just a 'black box'—there are no operating controls to adjust at all. Each unit contains two separate and independent signal processors, so that for a single-channel recorder, it could be permanently connected as in **fig. 1**, and then forgotten (if that is possible with such a great improvement in quality), one processor being preset to record and the other to playback, by means of switches on the back of the unit. For a two-channel stereo system, two *A301* units would be needed if the facility of simultaneous playback were required. Often it is preferable, or at least acceptable, to monitor 'line in' whilst recording, and to check the tape later. In such a case, one *A301* would suffice, using both processors in the record mode, during recording, then switching to the other mode for correct reproduction. I use the term 'correct' reproduction, as it is in fact possible to monitor the Dolbyised tape as it stands (without deprocessing), this having a 'larger than life' effect, quiet sounds being much louder than they should be. Most recording faults can be checked in this way (and may even show up better in this processed form) but the advantage of immediate A-B checking is, of course, lost. Using a single *A301* with a two-channel recorder would not only involve the frequent mode switching of the two processors but also moving the system between the input and output circuits of the recorder. These operations could be carried out manually with the basic unit or, if desired, using the Dolby automatic changeover unit (**fig. 3**) which fits to the back of the *A301*. By connecting the record switch circuitry of the tape machine to the changeover unit, the processors are automatically connected as required. This would save a great deal of time and trouble, particularly on eight and sixteen channel recorders.

The *A301* system is built on fibreglass plug-in printed circuit modules with gold-plated edge contacts. There are eight of these boards, each with separate processors consisting of one amplifier module, two compressor modules (each containing two compressors), and a control module. The large unit on the left-hand side of the *A301* is the plug-in mains unit which gives a stabilised supply of 18 V at a very low impedance. This unit contains also the input and output transformers, two meters on the front for recorder alignment and, on the back, the input and output sockets.

For alignment and servicing purposes, an extender board is available (**fig. 4**) which enables the compressors and amplifiers to be adjusted and tested, although it should be noted that the system is extremely stable and does not require *routine* alignment; a great point in its favour. The extender incorporates a switch which selects various calibration and test functions, allowing fault finding and calibration to be carried out quickly.

This description of the physical appearance of the *A301* would not be complete without mention of the excellent workmanship which has resulted in an extremely reliable unit. More about this when I deal with the Dolby production line.

Now we know what the unit looks like, and what it does in terms of decibels, it is time to see what it does in practical terms. When the system was demonstrated to me, I heard music which had been recorded with and without the *A301* unit. The tape was replayed on a Studer *C37* feeding a pair of Leak speakers. For the Dolbyised parts of the tape, a processor was switched into circuit and, by alternating between normal and processed recordings, the effect of the unit was demonstrated.

Knowing in advance that the set-up was to demonstrate noise reduction, I naturally tended to listen to the noise rather than the music. The hiss was easily heard at first. Then the *A301* was switched into circuit for the processed part of the tape. The immediate impression was not that something had been switched on, but rather that a noise generator had been switched off. It was simply not possible to hear the tape hiss using the *A301* system and listening at a fairly high level.

It is very easy to get used to the hiss level experienced with standard recordings, and to the rather restricted dynamic range that this implies, and so the extended range obtainable with the Dolby system comes as something of a surprise when listening to a recording made in this way. By this I mean that, when playing normal tapes, the listener is conditioned to such an extent that he can adjust the gain setting whilst listening to tape hiss alone at the start of a tape, and he can be fairly certain that the loudest parts of the tape will be replayed at a reasonably acceptable level. At a gain setting low enough to render the hiss of a normal tape inaudible, the loudest parts are reproduced at only a moderate level. This is where the Dolby system produces the surprises, because hiss is inaudible at normal listening levels, and when suddenly the full orchestra plays loudly after a soft passage, the volume is very much higher than anticipated. The extended dynamic range and overall improvement has to be heard to be fully appreciated and has brought many favourable comments from the record-buyer press: ' . . . a big stride forward in technical quality . . . ' (John Borwick, *The Gramophone*) ' . . . astonishing forte explosions . . . ' (Edward Tatnall Canby, *Audio*) ' . . . adds a new dimension to recorded music . . . ' (Bert Whyte, *Audiofan*).

Users of the Dolby System include Decca, CBS, IBC, Pye, and numerous other recording studios, broadcasting organisations, and film companies. The production of an LP disc can involve several generations of tape copying before arriving at the master, and hiss is added at each stage. Dolbyised recordings can be copied and edited in the processed state, finally being deprocessed when fed to the disc-cutter, to obtain a standard record with very low background noise. It should be mentioned at this stage that, to end up with a theoretically correct disc, the signal should not be operated on by the normal studio facilities such as reverberation devices and response selection amplifiers whilst in the processed condition. Ideally these operations should be carried out prior to the processing, or after it by replaying the tape through the *A301*, and then re-recording the altered signal. In practice it may be convenient to doctor the processed tape, and it has been shown that perfectly acceptable results *can* be obtained in this way. Nevertheless, procedures along these lines should be treated as experimental because errors in frequency response and signal dynamics may creep in.

As far as the recording industry is concerned, the main improvements offered by the Dolby system are:

1. Recording is virtually noise free, and copying adds a negligible amount of extra hiss (theoretically a 0.4 dB increase)
2. Precious master tapes can be made using the system to eliminate the possibility of degradation by print-through.

The record buyer's bonus is the extremely quiet background noise and wide dynamic range available on the Dolbyised discs (which are being made in ever increasing numbers). Why, you might ask, isn't the processed signal put onto the disc so that noises introduced by the disc and turntable can be reduced as well? The answer is that the *A301* is not within the price range of the average record buyer so deprocessing Dolbyised discs at home is really out of the question. (The price for the standard *A301* unit incorporating two processors is £560, although a single processor is available at £340.) Significant price reduction seems unlikely considering the cost of labour and the number of man hours spent in inspecting and testing the units.

For domestic tape recording, KLH hold exclusive rights in the USA to incorporate a simplified single-band Dolby System in their *Model 41* recorders, so that 9.5 cm/s can be used without the usual high background noise. Whether or not this is a fair trade for the usual problems of single band compansion I would not like to say without hearing the system, but I do have doubts.

It may well be that machines incorporating this simple system will appear on the British market some time in the future, but whether the main use will be for improving high quality recording, or to make extreme slow speeds tolerable for low quality systems is anyone's guess.

Next month, a more detailed study of the principles of the *A301*, and a look at the Dolby production line.

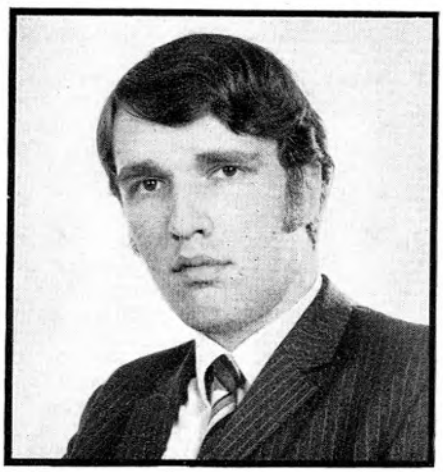
RECORDING STUDIO TECHNIQUES CONTINUED

capsules is ideal, in practice, especially when preferable to coincidental mike stereo, but I personally feel that these companies are wrong to degrade their recordings so that they sound better when reproduced on small instruments.

To sum up then, the most important matter is what the listener himself hears, and what the recording engineer wants him to hear. How this stereo sound is achieved is entirely a matter for the engineer and producer, and engineers would not keep their jobs unless they continually kept up a high standard in the opinion of their Company. There is probably no more contested point in the recording industry than that of the stereo mike technique used for recording, and in showing my own preference for the coincidental mike technique, I am not prepared to decry all others, but only in general say that I still prefer one stereo mike if conditions allow.

Interview

David Kirk talks to John Alcock, Sales Director, Unitrack Equipment Ltd.



D.K. *At the present time, all the London pop studios appear to be going over furiously to* 8, 16 *and even 24-channel multitrack recorders. When did this revolution begin?*

J.A. Very recently. People got the idea that they needed more and more tracks, they wanted better quality, more flexibility. Everyone who counts has been on 8-track for about two years and in the past year they have decided they need 16.

D.K. *Has the change been for technical reasons or to keep up with the studio down the road?*

J.A. You should bear in mind that a lot of studios cater for specialised markets and do not necessarily compete with each other. One studio will be geared to the bubblegum young teenager type, another may be interested in modern jazz, progressive pop, and so on. There is an increasing trend for artists and producers to frequent studios specialising in their particular kind of music rather than look down the London Classified and go to the first on the list.

D.K. *I gather there is a certain amount of hard feeling against producers ringing around to find who has the largest number of channels.*

J.A. This is true. In my view it is quite unnecessary. There are some types of music where you just don't need more than about four channels, two stereo pairs. For other types of music, you must have 16 tracks or more. I can see 32-track coming within 18 months.

D.K. *What kind of programme would need that?*

J.A. The sort of big-band progressive pop material where you have a big brass section, you want to do double-tracking, phasing, repeat, variable-speed effects, and you want to ping-pong, which is track jumping a mix from the sync channel on one track, plus an incoming signal, recording on another track and building up your master in layers. I have a couple of contacts in the USA who are already very interested in 32-channel and it may come over here. What can't continue is the trend to pack more tracks on a given width of tape because with 24-track you are down to 1 mm track widths, signal-to-noise and crosstalk are not very good. You have to stop somewhere.

D.K. *What was wrong with the old idea of multi-miking through a mixer straight to 2-track?*

J.A. A lot of time has to be taken on a session to fix it up. Few artists are versatile enough to work with this system and the idea of multi track is that you get down as many tracks as you can, get the musicians (the session boys in particular) out of the studio, and then the main task starts—the reduction.

D.K. *Is the cost of multitrack recorders really compensated for by the saving in performers' time?*

J.A. I agree the equipment is expensive—not the recorder but the mixing desks. You can pay £25 000 to £30 000 for a desk quite easily nowadays. You can spend up to about £15 000 on a 16-track recorder but the most important thing about a studio installation in my opinion is that it must be flexible and reasonably free from operator-error. Multitrack will come increasingly into the large studios and a lot of today's small studios who are thinking of going multitrack I'm afraid are going to catch cold. They just haven't the money. Within two years I think we will see a major twelve-or-so studios with full multitrack facilities, plus some twenty around the country with two and possibly four

(continued overleaf)

tracks, very limited equipment, very small, handling local group demo's to send off to the major companies. The small people certainly won't be doing any mastering and they are going to have a hard time. The studios who will really be up against the wall are today's middle men, those who are 4-track and 8-track, who can't afford to go 16, who are not getting the right bookings. I can see a time when we shall have major studios, small studios, and nothing in the middle.

D.K. *And are you selling on this basis ?*

J.A. And we are selling on this basis.

D.K. *Has the move to multitrack been confined to pop studios?*

J.A. Yes. The orchestral boys are getting interested but I can't see big orchestras recording 16-track. There again, four years ago orchestral people were saying they wouldn't go 4-track or 8-track, but they are. The most important thing happening in recording music, any type of music, is the four-channel playback system being pioneered by Vanguard in the USA. I think this is going to be very big indeed. Like colour television, it's not going to catch on immediately, but it will come.

D.K. *Will British recording companies have the gumption to follow this up or, like stereo tapes, will they leave the market mainly to American firms?*

J.A. There are not many British recording companies.

D.K. *No, I never know what's American these days. I thought STC were British until the other day.*

J.A. British companies are aware of the Vanguard developments. I am quite sure that EMI and Decca are making plans though when they are likely to come about I don't know. I would hope that, when it does, it will be on Fidelipack cartridges.

D.K. *This is the endless loop; do they not wow?*

J.A. That depends on the transport. Provided you nurse the cartridge you can get extremely good results.

D.K. *For how long?*

J.A. Good point. It's lubricated tape. The lubrication wears off and you start to get sticking.

D.K. *Say no more!*

J.A. It may eventually be on the Philips system. Whatever happens, there will always be a market for the stereo disc. People buy these in thousands, people who will not appreciate the four-channel stereo system.

D.K. *A lot of people didn't appreciate two-channel stereo when it first came out but today you can buy stereo pop singles.*

J.A. The average member of the public thinks next door and over the road and all my best friends have got stereo so I must have stereo. They rush out with their cheque books and HP agreements to the local dealer and buy a stereo radiogram; the speakers are four feet apart and don't give a stereo effect. The result sounds awful.

D.K. *You're a few years behind the times in this respect (we don't have to record that) because the people with their stereograms are now going in for 'hi-fi'. This is why Hi-Fi News is so fat at the moment.*

J.A. True, and you *can* record this. Many people with radiograms are saying this isn't good enough, rushing out to their friendly hi-fi dealer and fixing up a package deal. This is a very good trend and eventually these people will go over to four-channel stereo, in the same way as colour TV and, in its early days, two-channel stereo.

D.K. *You have referred in the past to a possible move from multitrack recording on wide tape to coded multichannel, pulse code modulation.*

J.A. There is a limit to the expansion of multitrack techniques, set by the cost of 50, 75 and 100 mm tape. Running costs will go up so fantastically when you start talking about 100 and 125 mm, and the machines will rise in at least equal proportion, that we shall have to adopt a completely new audio recording technique.

D.K. *But you would still require at least the same area of tape for a given number of channels, whatever the tape width.*

J.A. Yes but 6.25 mm tape is an easier medium to use, easier to store, there are no delivery problems.

D.K. *And editing?*

J.A. This presents problems but people will get over them. They are now worrying about editing wide tape, which is really not editing at all; it is just splicing in leaders. The real editing is done by over-recording. The only thing that worries me about digital recording is that there are so many standards, every manufacturer's system has its own peculiarities, that somebody somewhere has got to form a committee or association and decide what is going to be the standard for digital recording in sound studios. The APRS hasn't the authority. We need a committee composed of influential recording engineers, manufacturers, and perhaps musicians. I had my own ideas of trying to start this but unfortunately, because of the vast amount of paperwork and organisation involved, it is just not possible. It has to be done as a joint venture and it's got to be done soon because there is already a lot of disagreement about recording techniques, modulation level, and equalisation standards. There is an increasing tendency to follow NAB standards.

D.K. *Presumably because most of the studio recorders used today are American? Multitrack models at least.*

J.A. Yes, you can get American recorders with IEC or CCIR characteristics but people are going over to NAB simply because they have got to decide on something. It's not the right way of running things. Someone ought to have decided long ago which is the best standard to use, which offers the most advantages.

D.K. *Is Unitrack doing any development of PCM systems?*

J.A. Yes, we are working very hard! We had to get out our first range of machines. Once those are out and have proved to be successful, then we will concentrate research and development on alternative methods of recording.

D.K. *The new Unitrack machines; when did you commence production?*

J.A. Early October. We will be producing our first batches of equipment around March. The recorder has been designed initially for the British market. If we want to export the equipment, then possibly there will be changes.

D.K. *You are using an oscillator-controlled capstan drive system which presumably overcomes 60 Hz mains problems?*

J.A. Yes, though that is not such a problem nowadays because one can buy synchronous motors for various line frequencies. The reasons we have gone to a servo drive system are stability and flexibility. We are governing our servo drive system by a crystal clock, which is the most accurate readily obtainable device known.

D.K. *Not the cheapest.*

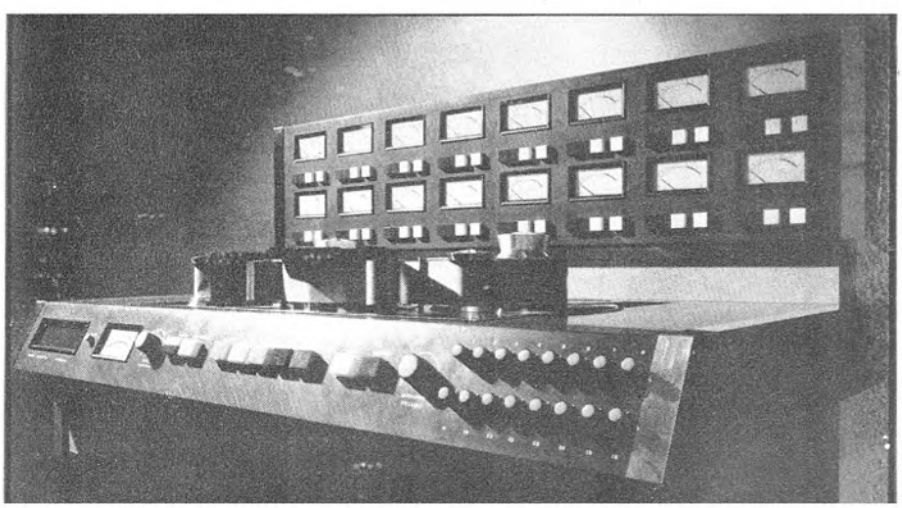
J.A. No, but when we say the capstan is running at 38 cm/s it *is*, plus or minus virtually nothing. In fact we deliberately leave off a strobe because we would otherwise get endless telephone calls saying the machine is running fast or slow when in fact the lighting frequency is going up and down. From the flexibility point of view, it is very easy to break into the capstan supply with a high-stability oscillator and give variable speed. If somebody wants to use one of, say, 16 tracks as a sync track, this is no problem at all.

D.K. *Might this allow you to tie two 16-track machines together?*

J.A. If anybody wants this, I hope their studio manager will phone me up and ask for a 32-track.

D.K. *How does the recording industry of this*

Uni 16



country compare, in your view, with those of Europe and America? Whenever I have been abroad, I have found that English records seem to predominate.

J.A. My own opinion is that British studios are the best, full stop. They are creative, the balance engineers, they have an ear for the end product, they are original but they are to some extent hampered by the economic condition of the country. They could be very much bigger and better if the rein on small companies and on entertainments was less tight. You can walk into the average American studio and it is packed with equipment, far more than in a British studio, but American engineers seem less creative—they follow a trend rather more than our people. The best European studios are in Germany. They are very interested technically in what they do, they strive for perfection, the lowest possible distortion, the best frequency response, the highest signal-to-noise ratio. They are so worried about this that they forget the musical content. They don't like nasty unpleasant sounds, even though these may be very appropriate to the material that they are recording. This is reflected in German and Swiss equipment. Telefunken and Studer recorders, Neumann disc-cutters, mixers and microphones, they are made to last and technically excellent.

If you look down a list of the British records that appear in the Hit Parade, you will find with monotonous regularity that they all seem to come from the same four or five studios. These are the studios with the most original balancing engineers. There are certain studios that spend thousands, even hundreds of thousands, of pounds on equipment, who have very clever engineers, but who get nowhere at all.

D.K. *Are you using ferrite heads in the Unitrack machines?*

J.A. No. We want to use ferrite heads but we can't. Philips and Mullard make certain heads but are not interested in producing specials; they quote ridiculously long delivery dates for 50 and 25 mm heads to audio configurations. If you want data heads to IRIG standards you can have them tomorrow. It's understandable, they are very busy producing thousands of data heads and wouldn't want to break into this in order to make a few audio heads. It is very awkward because the whole concept of Unitrack is to hell with the price, let's produce really good machines. I object most strongly to the patent situation in this country, where one man can have a brilliant idea that would prove useful to all sorts of companies and industries, go into manufacture and, lacking capital, narrow his field down to one industry, completely ignoring everybody else. This is very irritating because it is stunting progress. Our whole system could go over to multitrack ferrite heads if they were obtainable, but they're not.

D.K. *Have you made allowance for the possible introduction of less sensitive tape? I am thinking of Crolyn.*

J.A. Yes, We have worked with some of this and, if it becomes commercially available, are geared to go over to it.

D.K. *In the Unitrack specification, the bias frequency is stated as being 180 kHz while the erase current is at 60 kHz. Why the difference?*

J.A. To get good erasure without overheating the erase head (and causing total erasure by melting the tape!), you have to keep the frequency down. We are using comparatively narrow-gap record heads for good selsync quality and so have to use a high bias frequency to give good penetration. Consequently we have a 60 kHz master oscillator with a frequency tripler. Scully do exactly the same thing and a lot of companies are adopting it, for multitrack at least.

D.K. *Do you use the same gap dimensions for record and play heads?*

J.A. No. The replay head is 25 μm and the record head 75 μm. We would like to get the record gap down further but you run into all sorts of problems, bias and that sort of thing.

D.K. *You seem very concerned about the quality of the selsync. Surely it isn't very important.*

J.A. It is vital. There is a trend in the USA for the replay head to become redundant. You may be horrified by this and so also is Robin Bransbury, our electronics designer. Every time I mention this to him he throws up his hands. Until two or three years ago, people used the sync signal purely as a cueing or monitoring device; something for the vocalist or instrumentalist to sing or play to. It is now being used as a processible signal. You replay a vocal off Track 1, mixing with another vocal, adding different equalisation, and recording the combination on, say Track 3 or 4. The quality of that has got to be good. We have now reached the point where there is virtually no audible difference between the replay signal and the sync signal.

D.K. *Do you find any tendency for the erase field to spread between segments of a 16-track head?*

J.A. Yes but we have found a way of getting round it which may be the subject of a patent.

D.K. *Are you grooving between the segments?*

J.A. No, it's purely the structure of the screen, and its composition. The low erase frequency helps since we need less power. We can get away with erasure which is 2 dB above threshold, in other words 2 dB above the noise level of a bulk-erased virgin tape. This, I maintain, is the difference between professional and semi-professional equipment. Semi-professional equipment works, it's adequate. With professional equipment it is not so much the final performance as the way in which it is achieved. If you record a tape in January and rerecord the same session in September for some reason, you expect the same results.

D.K. *Another big difference between professional and non-professional equipment is the accessibility of line-up presets. How often is setting up done? Every morning?*

J.A. Depends on the studio. Some will religiously line up their machines almost every day, others once a week, other not at all. We have to design machines for idiots because there are a lot of young inexperienced tape-ops who hope to become balance engineers and studio managers in later life but, because of their outlook on life, are irresponsible and don't particularly care whether a recorder is worth £10 or £10 000. They are ham-fisted. We have to make our machines to cater for an uneducated gorilla. Consequently you have to make the equipment very easy to line up, and supply monosyllabic instructions. Few studios shift the bias much as they stick to a preferred tape. They tweak to −2 dB over peak and check occasionally to make sure it hasn't drifted.

D.K. *Do you chrome the capstan to prevent wear?*

J.A. No, It is a hardened steel shaft. It may sound boastful but our transport, like a lot of others, is so designed that you don't get capstan wear to any appreciable extent. You get wear on the pinch wheel, which is much easier to replace. The capstan is centreless ground, not turned as on some cheaper machines. It doesn't bend, it snaps off if anything ghastly happens. How are you going to know that a chromed capstan has an equal coating of chrome all round it?

D.K. *You machine it after coating.*

J.A. Yes I know, but you get into awful complications. We are talking about a 25 μm tolerance on a 75 mm length of capstan shaft. Chrome is hard, it needs special grinding material. If you start off with a very accurate hardened shaft on a recorder which is designed to be kind to its components, remember the capstan diameter is 12.5 mm, you won't get this sort of problem.

D.K. *A number of people, and by a number of people I mean Terence Long, claim that they can hear something, which they can't measure, that betrays the presence of a servo system on certain recorders.*

J.A. There are servo systems and servo systems. The Nagra uses a phonic wheel, so does the Revox. Now if you use something which is in effect a gear, you necessarily have relatively few on/off signals per revolution so you could get a form of modulation coming back on to the capstan. This is a mechanical thing and I agree that you might hear it. It is flutter, nothing else. The way we are doing it, without any exaggeration five or six times more expensive, is to use a glass disc with perhaps 700, 1 000 or 1 500 lines marked on it, plus a lamp and a photocell. Because the graduations are so much greater in number than on a phonic wheel, any consequent flutter should be lost in the drive momentum. It may be there but who has equipment to measure it? We are talking about several thousand pulses per second. The servo system and the printed circuit motor (we are the first audio manufacturer to adopt it) give, to all intents and purposes, a constant speed drive. What is imperative is that no combination of button pressing must damage the tape. A multitrack master can be worth the price of a recorder hundreds of times over.

D.K. *Do you have any commercial liability for this sort of thing?*

J.A. No. In law we are not responsible for anything after the machine has been delivered. We will provide maintainence and honour our guarantee but, if the machine breaks down at the start of a three-week Beatles session, we are not responsible for the loss of booking time. What we hope to do, though is ensure ourselves against this loss, build it into the selling price, and say to the studios that anything up to say £2 500 we will stand, I think this will be unique. It shows good faith, even if nobody holds us to it. I hope we'll get a healthy no-claims bonus.

D.K. *Why 'Unitrack'?*

J.A. We first of all picked 'Multitrack', which as a name is self-explanatory. Unfortunately a hi-fi dealer down in Southampton had just pipped us to the post and we were deprived of the trademark. Unitrack may be very appropriate in perhaps two years time when we are talking about digital recording.

THE SYNTHESIS OF MUSICAL INSTRUMENT TONE

FIG. 49 FLUTE. SIMPLE TT-SECTION, LOW-PASS RC FILTER

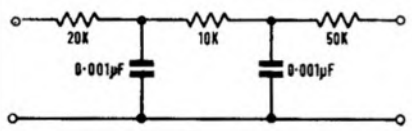


FIG. 50 OBOE. HIGH-PASS RC L-SECTION WITH PARALLEL LC BANDPASS COMBINATION RESONATING AROUND 1·5KHz

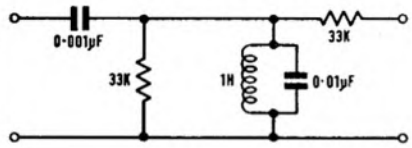


FIG. 51 CLARINET. A LOW-PASS RC SECTION WITH THE EFFECT OF THE CAPACITOR REDUCED BY SHUNT RESISTANCE, THE EFFECT OF THE L-SECTION BEING FURTHER MODIFIED BY THE INCLUSION OF A DAMPED BAND-PASS FILTER RESONATING AROUND 1KHz

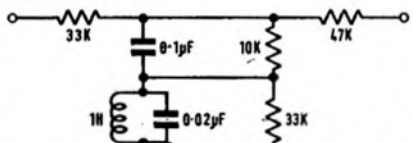


FIG. 52 BASSOON. A VOLTAGE DIVIDER, OF WHICH THE SHUNT ARM CONSISTS OF A DOUBLE RESONANT FILTER, BOTH SECTIONS BEING DAMPED BY THE 33K RESISTOR. THE SECTIONS RESONATE AT 500Hz AND 1·2KHz

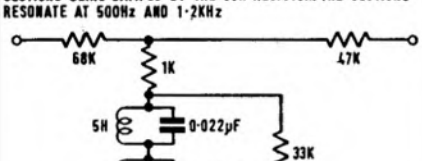


FIG. 53 BASS CLARINET. BASED ON FIG. 51

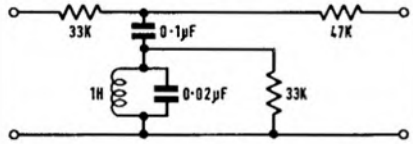


FIG. 54 HORN. A SIMPLE LIGHTLY-DAMPED RESONANT FILTER. F_r AROUND 350Hz

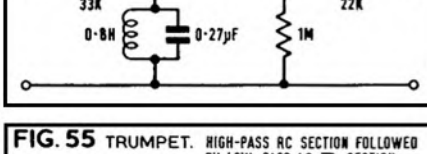


FIG. 55 TRUMPET. HIGH-PASS RC SECTION FOLLOWED BY LOW-PASS LC TT-SECTION

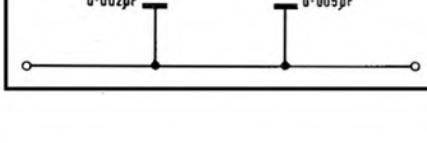


FIG. 56 TROMBONE. A BRIDGED-T-NETWORK. THE BRIDGING LC COMBINATION OFFERS ITS HIGHEST IMPEDANCE (LEAST EFFECT) AT ITS RESONANT FREQUENCY, ALLOWING MAXIMUM SIGNAL VOLTAGE TO BE DEVELOPED ACROSS SHUNT COMBINATION, SIMULATING PRONOUNCED FORMANT.

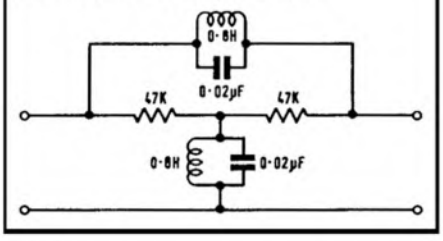


FIG. 57 SAXOPHONE. HIGH-PASS LR T-SECTION BRIDGED BY A CAPACITOR

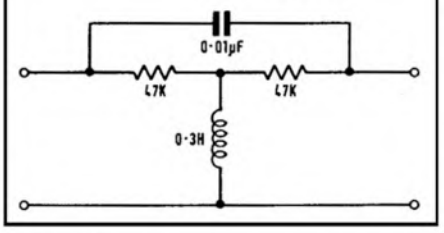


FIG. 58 TUBA. BASICALLY A BAND-BASS 450Hz LC FILTER FED BY A COMBINATION OF TWO OUTPUTS FROM A FREQUENCY-SENSITIVE VOLTAGE-DIVIDER WITH CLIPPING PROPERTIES.

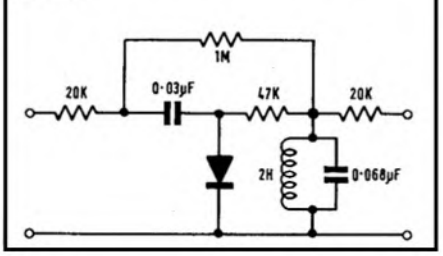


FIG. 59 VIOLIN. A HIGH-PASS FILTER WITH A LOW TURN-OVER FREQUENCY, FOLLOWED BY A LOW-PASS FILTER WITH A HIGH TURN-OVER FREQUENCY.

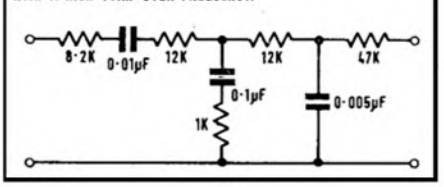


FIG. 60 VIOLA. SIMILAR TO FIG. 59

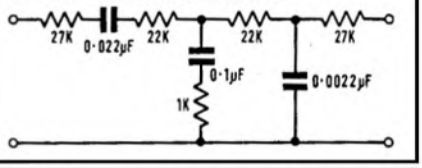


FIG. 61 CELLO. SIMILAR TO FIG. 55 BUT FEED AT MUCH LOWER SIGNAL LEVEL

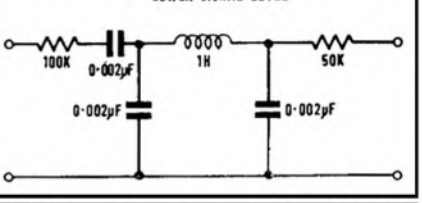


FIG. 62 SHOWING HOW A SAWTOOTH WAVEFORM MAY BE OBTAINED BY THE SUMMATION OF SQUARE WAVES OF APPROPRIATE FREQUENCY AND AMPLITUDE.

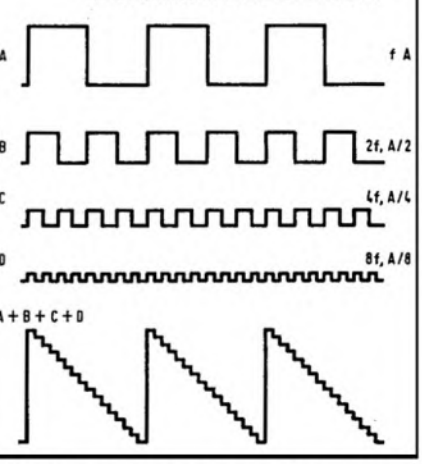
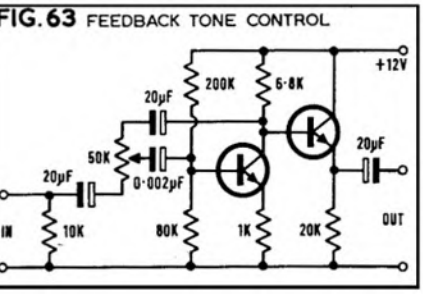


FIG. 63 FEEDBACK TONE CONTROL



Part five by R. M. Youngson

A SELECTION of simple resonant and other filters which can be used as a basis for experimental work is given in **figs. 49** to **61**. Since empirical trials are essential it is an advantage to construct a multi-terminal junction box with flying leads at input and output, in which can be inserted various combinations and values of capacitors, resistors and inductors. The number of permutations is very high however, and empirical trials must always have a basis in a knowledge of reactances, resonant frequencies, and filter properties.

The most rigorous approach to tonal synthesis is the additive system using sine waves (Fourier analysis in reverse). In this method a full harmonic series of, ideally, phase-related sine waves is required, and these are combined at appropriate amplitudes. It is necessary to use pure sine waves to avoid the undesirable effects of beating between the harmonic components of different pitches, if these are not phase-related. If the sines are to remain in phase with each other, some form of phase-locking arrangement is necessary and this is difficult to arrange for a full harmonic series. An alternative is to provide twelve sets of very high stability crystal-controlled oscillators, each set consisting of thirty or so oscillators, one for each harmonic. Such a system is capable of excellent tonal synthesis but is very expensive and restricted to equal temperament tuning. A more practical method is to start with a set of twelve master oscillators tuned an octave above the highest harmonic frequency required (i.e. covering the octave around 20 to 40 kHz) and each having its chain of square wave frequency dividers taking the pitch down to the lowest frequency required. As already mentioned square waves provide only the odd-numbered harmonics. Taking the lowest pitch of one divider chain as the fundamental it will therefore have the harmonics f, 3f, 5f, 7f, 9f, 11f, 13f, 15f and so on. If now, we add, appropriately attenuated, some tone from the second divider from the bottom of the chain, we can fill the gaps 2f, 6f, 10f, 14f, 16f and so on. Tone from the third bottom divider gives 4f. 12f (16f), 20f and from the fourth 8f, 24f etc. and so on. In this way, although not using sine waves, we can obtain the whole required harmonic series, exactly in phase with each other and, moreover, we can vary the amplitude of groups of harmonics at will. If you draw the process graphically, adding algebraically, and scaling the added harmonics in inverse proportion to their number, you will find that the graph rapidly approximates to a sawtooth and that the more harmonics you add, the smaller becomes the steps on the 'staircase' until these become negligible (see **fig. 62**). It is important to ensure that the divider stages produce good, 50 : 50 mark-space ratio, square waves with very short rise times, but this is easily achieved with modern transistors designed for high-speed switching.

For the purposes of practical musical instrument design, this system has some special advantages but one or two major drawbacks. One important advantage is that, since groups of harmonics are available for separate treatment, adjustments may be made, by suitable delaying circuits, in the order in which the harmonics sound at the opening of the note (in some instruments the attack is characterised, among other things, by the momentary sounding of some of the harmonics *before* the fundamental sounds). This characteristic can, however, be achieved in other ways. (See below.)

An unfortunate disadvantage of the method is that unless you are willing to include a double set of switches, one to switch on the master oscillator and dividers and another to select the appropriate pitch, each divider chain must be operating, in toto, before any single note can be sounded. The continuously running arrangement can be used fairly satisfactorily, so far as keying the signal is concerned, by using transistor gates of one of the types shown in **figs. 70** to **72** (see next section), but you still have the disadvantage that octave-related pitches are too precisely in tune and in phase with each other. It is therefore desirable that, as each note is played, the master and all its dividers, down to *the pitch being keyed*, should be switched on. This will preserve phase-freedom, but at the cost of somewhat complicated switching. By this method, however, you can incorporate variable attack rates by varying the time-constant at the master oscillator power switch and are spared the problems of keying into a signal current.

It is a matter of common observation that the timbre of certain instruments is, to some extent, under the control of the player, even within a small dynamic or pitch range. This is especially true in the case of the bowed string instruments, as there is considerable possible variation in the manner and exact position of bowing. By altering the speed, pressure and angle of incidence of the bow hair and by varying the distance between the bridge of the instrument and the point of bow contact, the player is able to obtain considerable control over the harmonic content of the sound produced.

Manifestly, if we are to succeed in effectively synthesising the tone of such instruments, we must provide the means of altering the timbre, at will, in the course of performance. The range of control provided must not, of course, be so great as to pass outside the limits of what is characteristic for the instrument. The matter is facilitated by the fact that fixed tone filters readily produce a characteristic variation of timbre with changes in pitch (e.g. harmonic simplification at the upper end of the frequency range) and by the ease with which loudness and controls can be tone compensated. These are the built-in safety mechanisms against harmonic 'howlers'.

The phrase 'purity of tone' is a sample of evocative semantics beloved by critics and is more impressive than meaningful. The purest of all tones is, of course, the sine wave : I need not labour the fact that music of this degree of purity of the tone would not satisfy

(continued on page 83)

FIG. 64 PERCUSSION GATE. MONOSTABLE MULTIVIBRATOR CONTROLS BIAS TO PUSH-PULL PAIR. TONE CEASES WHEN MONOSTABLE REVERTS TO ITS ORIGINAL STATE (JENNINGS MUSICAL INDUSTRIES)

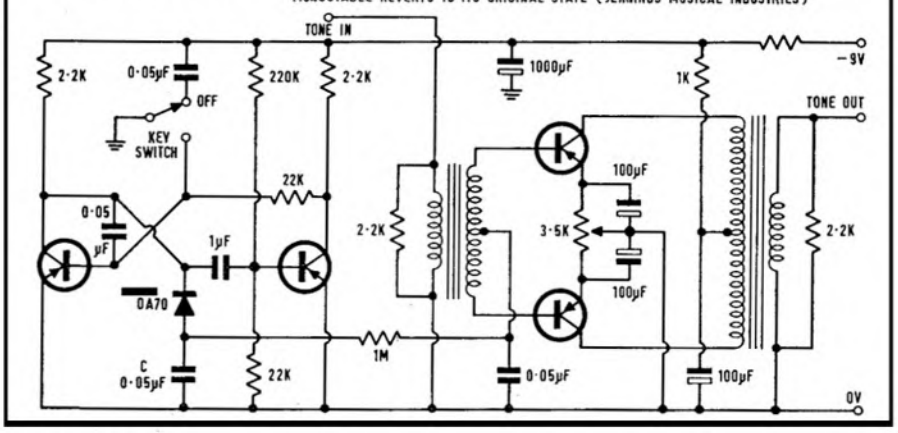
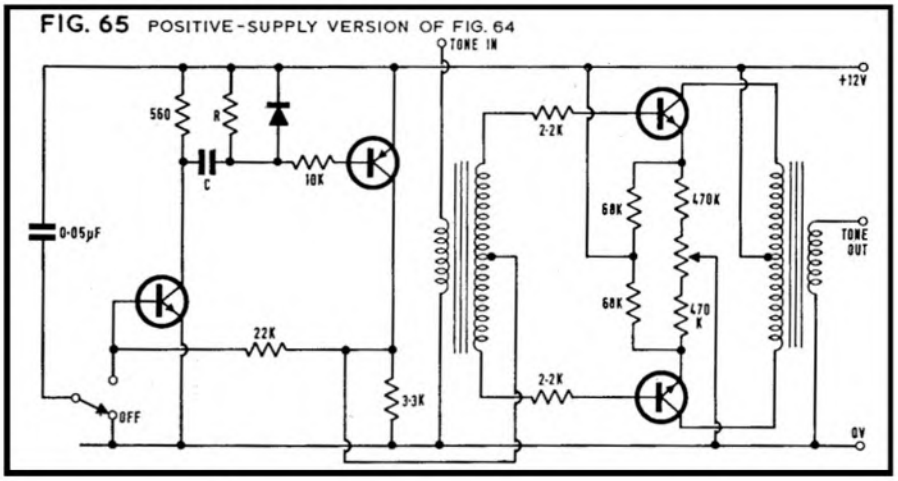


FIG. 65 POSITIVE-SUPPLY VERSION OF FIG. 64



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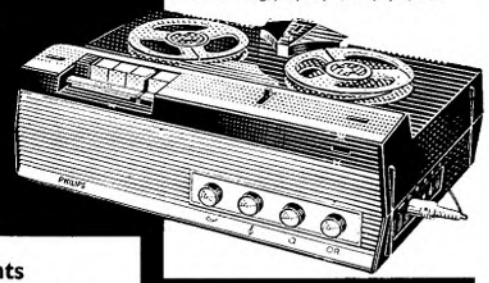

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a hypercardioid capacitor microphone

Part 2 Application

by Trevor Attewell

READERS who built one, or a stereo pair, of the capacitor microphones described in last month's issue will scarcely have waited until now to test them, and will have worked out some sort of fixing device, however temporary, for themselves. The prototypes spent several weeks in test-tube clamps on a retort stand, a device frequently pressed into service for all kinds of three-handed jobs, but not really suitable for use at a public concert. This month, therefore, we consider a possible microphone mounting, a cable suspension, the provision of windgags, and some subjective effects of microphone placement. The emphasis will be on stereo recordings, using a Blumlein pair of microphones, but the arrangements described are readily adaptable for single units.

The disposition of a Blumlein pair is shown in **fig. 1.** Two microphones are placed at an angle to one another of about 90 to 130°, with their capsules as nearly coincident as possible (they are often referred to as a coincident pair) so that the right-hand microphone receives sound mainly from the left-hand area of the source, and vice versa. This arrangement is the only one for which a theoretical justification is generally practicable. Occasionally, circumstances arise which make it impractical to use a Blumlein pair, and a spaced technique must be used in which different microphones each receive sound from one area of source, their various outputs being mixed as necessary to give the final left and right channels. This technique can also give an accurate spatial picture, but it is full of pitfalls for the amateur (and the professional, judging by some recordings) and will not be dealt with further in this article.

We shall see later that it is desirable to allow some choice of the angle between microphones in a Blumlein pair, and the mounting should provide this, preferably by a single adjustment which automatically maintains the capsules on the same vertical axis. In practice, too, it is always necessary to be able to tilt and swivel the whole assembly so that the combined axis of the pair (see **fig. 1**) can be moved at will. Other requirements include the need to keep the mountings as small and as far from the capsules as possible to avoid obstructing the sound field or provoking disturbing reflections at particular frequencies, and the ability to use the mounting either on a floor stand or on a cable suspension.

The mounting finally adopted is shown in **fig. 2,** and the parts are detailed in **fig. 3.** Each microphone sits in a ring, by which it is clamped against the top of a tube by the tension in a length of studding passing down the tube and through a hole in the mounting bar, the clamping 'nut' taking the form of a small knob. Both mountings for the stereo pair are similar, differing only in the lengths of the tubes. In the prototype, the tubes were bits of scrap waveguide, but the exact size is not important, and this item can be fabricated out of sheet, soldered down one edge, or could quite well be of circular section. It could also be solid (e.g. of wood) with a hole bored through it for the studding, and opened out at the top to take the clamping ring boss.

Each tube is located on its bar by two small screw heads to stop it rotating. It was a requirement that the prototype should dismantle to pack into a small space, but, if this is not a consideration, the tube can be permanently fixed to the bar.

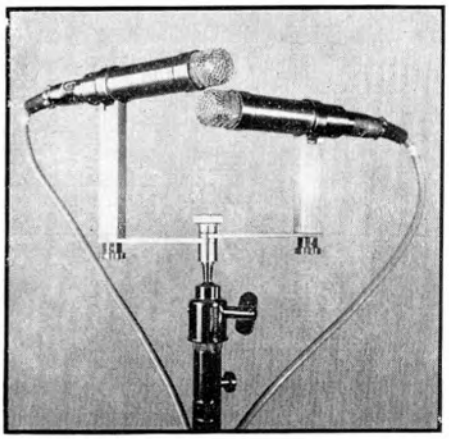


Fig. 2

Making this mounting presents no particular difficulty—the main point to watch is that the tube must be cut squarely at the bottom. It is difficult to face a rectangular tube in a lathe, so, failing an end-mill, it will have to be filed. The ring can be either parted off from a suitable piece of tube, or formed out of strip. Any finish can be used, and should preferably match that of the microphones. The thin fibre lining protects the microphones from possible scratching, and can be fixed inside the ring with Araldite.

To obtain the required movements of the common axis, an ordinary photographic ball-and-socket head, as used to mount cameras on tripods, is employed. This will usually have a hole in the bottom tapped ¼" Whitworth: if this does not suit the stand to be used it can be drilled out and re-tapped. Before buying it, ensure that sufficient depth is available for this operation. The upper end will have a disc to

(continued overleaf)

Table 1

Image position relative to amplitude ratio of loudspeaker outputs.

IMAGE ANGLE (o)	LEFT SPEAKER 30	25	20	15	10	5	CENTRE 0	5	10	15	20	25	RIGHT SPEAKER 30
RATIO LEFT O/P / RIGHT O/P (dB)	∞	20	13	9	5½	2½	0	−2½	−5½	−9	−13	−20	−∞

support the camera, with a $\frac{1}{4}$" Whitworth screw protruding in its centre. As a rule the disc simply unscrews off the centre thread; if not, it will have to be turned off. If the centre screw is not long enough to pass through both mounting bars, leaving enough protruding to take the clamping terminal, then the easily made extension of **fig. 4** can be added. Any additions should be plated to match the ball-and-socket. It pays, by the way, to have all plating jobs done together, since many firms have minimum handling charges.

There are many situations where a floor stand cannot be used, and this is frequently the case at public concerts, when a stand would obtrude in the line of people's view. Suspension from an overhead cable is sometimes the answer, and a device is needed which will allow the microphones to be lined up directionally before being hoisted into place. The ball-and-socket has been found less useful in this situation, and the device adopted is shown in **fig. 5** and detailed in **fig. 6.** This is straightforward, and uncritical in dimensions. It works as follows: by adjusting the position at which the long bar is clamped in the wood cross-piece, the centre of gravity of the whole assembly is shifted correspondingly. Since the arrangement will always hang with its centre of gravity vertically below the suspending cable, it follows that the elevation angle of the microphone axis will vary accordingly. It will be found that, if the required angle is set with the microphones lifted just clear of the floor by holding the suspending cable between the hands, it will remain virtually undisturbed when the whole thing is hoisted into place, provided the microphone cables are supported along the suspending cable.

The angle between microphones, and the angle between their common axis and the normal to the sound source, are set by the positions in which the microphone mounting bars are locked. A screw is fitted to one of several holes along the sliding bar, and serve two functions. First, if, by some oversight, the sliding bar has not been firmly locked, the screw will prevent it from sliding out of the cross-piece. This may sound over-fussy, but you can't be too careful when hanging heavy objects over people's heads. Second, the screw can be used to attach one of the rubber straps designed to fix bowden cables to bicycle frames —this makes a handy fastener for the microphone cables.

The brass 'terminals' on the cross-piece merely allow the suspending cables to be looped and slipped on or off without the need to struggle with tight knots. If this facility is not wanted the cables can be threaded through the holes in the cross-piece. The cable used is 200 lb. breaking strain nylon cord, obtainable from many hardware stores. This is adequately strong in most cases, but should be doubled where there is little headroom, so that considerable tension becomes necessary to keep the microphones high enough.

At first sight, it might seem that the falling off of OA in **fig. 9** as the source moves towards the centre would also constitute a perspective

FIG. 1 A BLUMLEIN PAIR

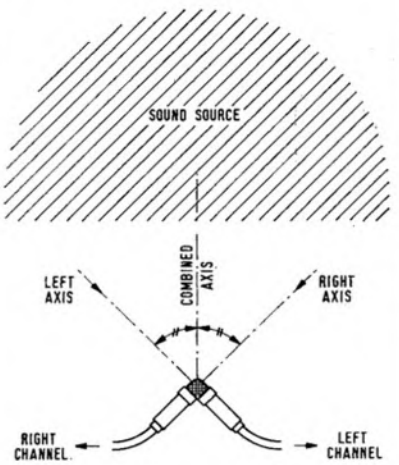


FIG. 3 MOUNTING DETAIL

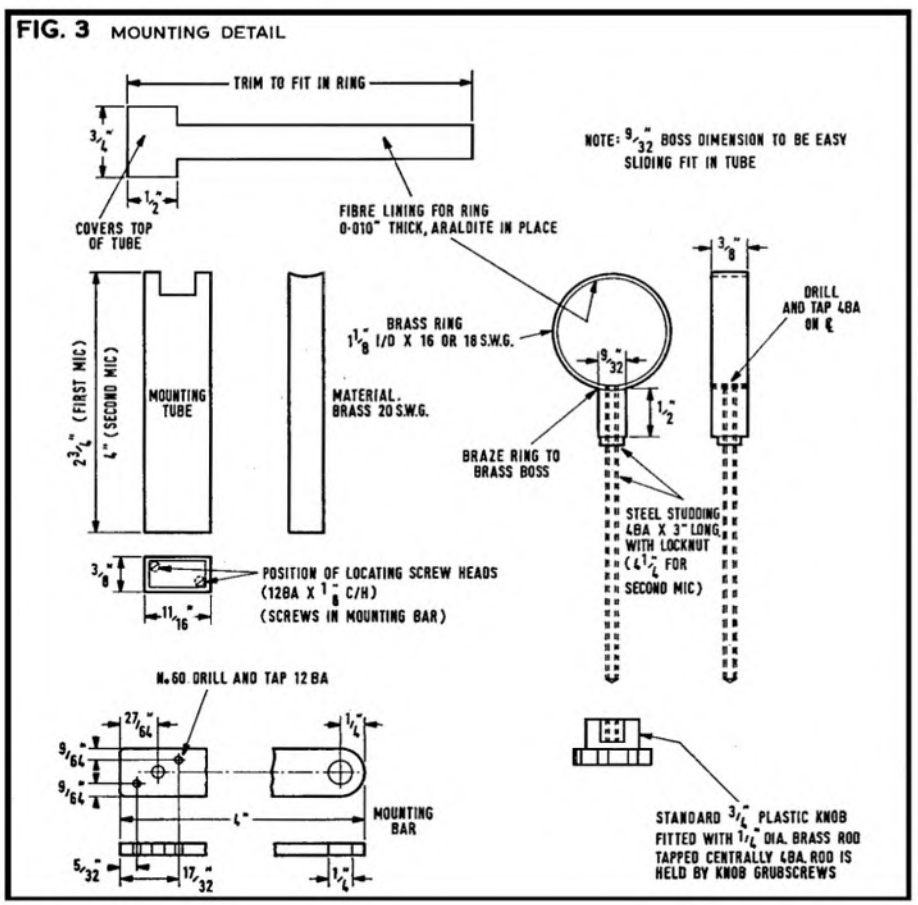
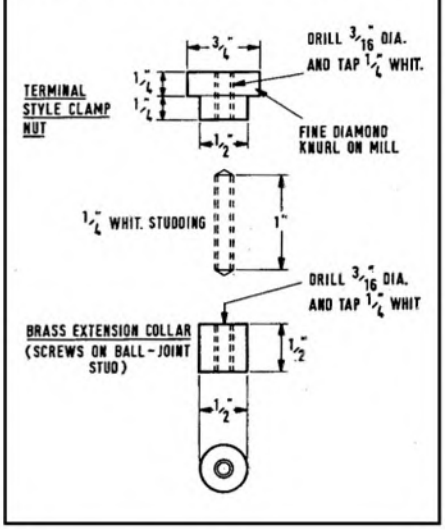


FIG. 4 BALL-JOINT EXTENSION



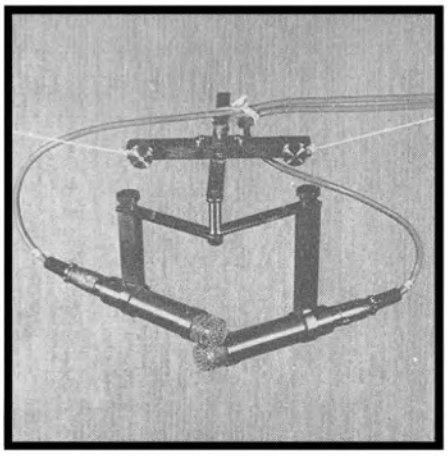


FIG. 5

shift. Reference to **fig. 8** shows that the output from the left speaker must fall as the source moves away from it towards the centre if the image is to remain on a line parallel with that joining the two speakers. The cardioid characteristic ensures that the fall in OA gives the required compensation, and a fairly true perspective is obtained over the central regions if the angle M is not too far from 90°.

In general a sound image will have some degree of angular distortion—in other words, the angular relation between individual points in the image will not be a linear function of the angular relation between corresponding points in the original source. The angular distortion can be estimated from **fig. 10** for any particular case.

How important are all these considerations in practice? To start with, we should remember, in using **fig. 10**, that the microphones are nearer the source than most of the listeners. The total angle subtended by the original source at our ears obviously depends upon where we sit, and the 60° maximum image angle of the conventional stereo system is merely a compromise—at a concert we are often perfectly satisfied with much smaller (or larger) angles. This factor, plus the latitude inherent in the various approximations made, is very fortunate, since the curves show how difficult it is, theoretically, to attain the wider image angles. (Separating the loudspeakers does not help, since this soon results in the famous hole in the middle.) Certainly, we must not become too obsessed with the theory—too many approximations are involved—and who really cares if the angle between the oboe and the trumpet appears to be only 10° when it should be 15°?

How, then, can microphone angle and position be determined in practice? First, the distance between source and microphones should be decided on the basis of the source strength, the degree of reverberation wanted, and the likelihood of interfering sources (every concert hall these days seems to be a hotbed of bronchial catarrh). The angle M is then adjusted as necessary, using **fig. 10** as a guide, but regarding it as slightly pessimistic as far as image angular spread is concerned. Since large sources tend, naturally, to be more potent than small ones, the angles M and S turn out to be surprisingly constant. With these microphones it has been found that M=S=120° is a good starting point, the image spread (theoretically 38° for cardioids) being nearer 50° in practice, partly because of the hypercardioid characteristics, and partly for the subjective reasons already mentioned. Excessive variations in M nearly always lead to unrealistic results, some of which are doubtless due to perspective troubles, and the adjustment of apparent source width by this method is useful mainly when the microphone position is dictated by circum-

(continued overleaf)

FIG. 6 SUSPENSION DETAIL

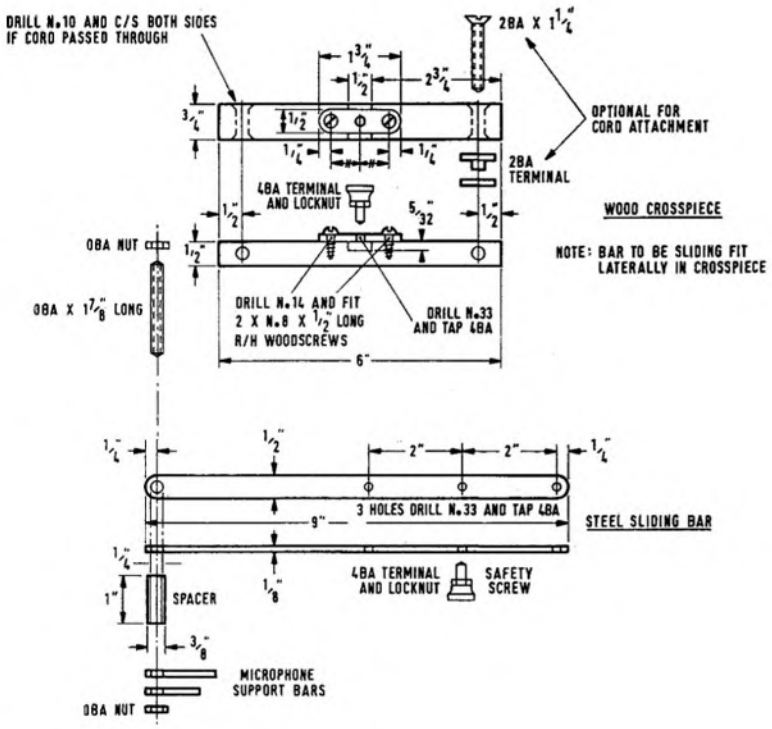


FIG. 8 APPARENT IMAGE DIRECTION

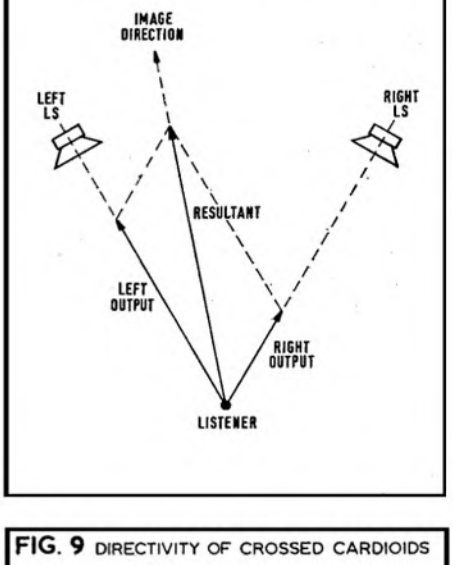


FIG. 7 SOURCE, MICROPHONE AND IMAGE ANGLES

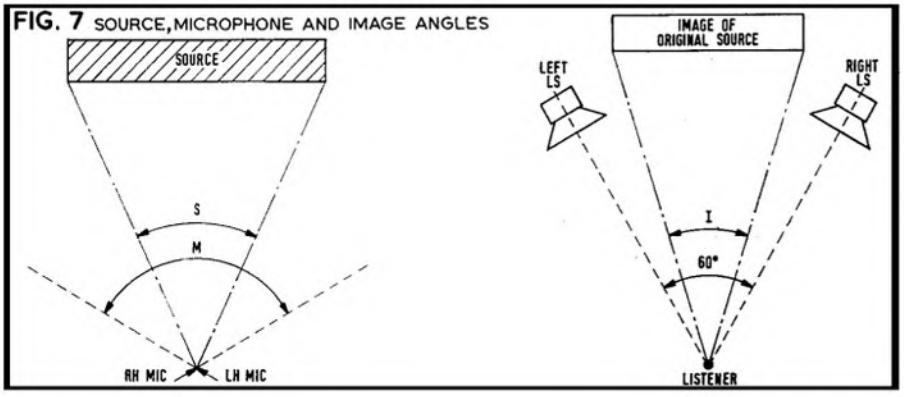
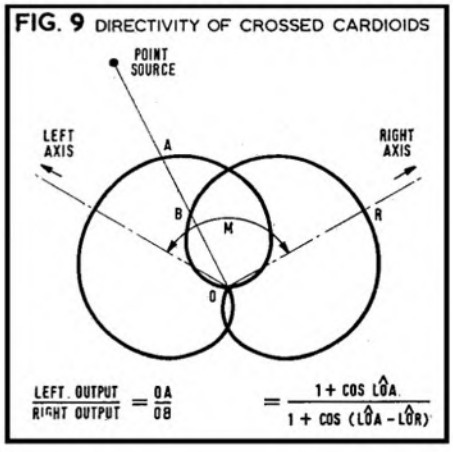


FIG. 9 DIRECTIVITY OF CROSSED CARDIOIDS



stances, so that the desired position cannot be used. When it is necessary to open up the microphone angle, however, it is worth bearing in mind that a cardioid microphone always discriminates against sounds which are random in direction, in favour of those at which it is pointed. Therefore, when it is turned away from the source, the pick-up of unwanted reverberation and audience noise will be increased at the expense of the wanted sound.

Capacitor microphones must be kept dry at all times if their high insulation resistance is to be maintained and the noise output minimised. When not in use, they should be stored in dry plastic bags, and a favourite storage place is a warm airing cupboard. Should they have to be transported through wintry conditions into a warm hall, condensation can be a real headache. A simple trick in such a case is to slip one microphone into each trouser side pocket as you enter the hall (take out odd coins and bits of fluff first, of course!). In about five minutes, if you are moderately healthy, they will be nicely warmed, and can safely be brought out to face the music.

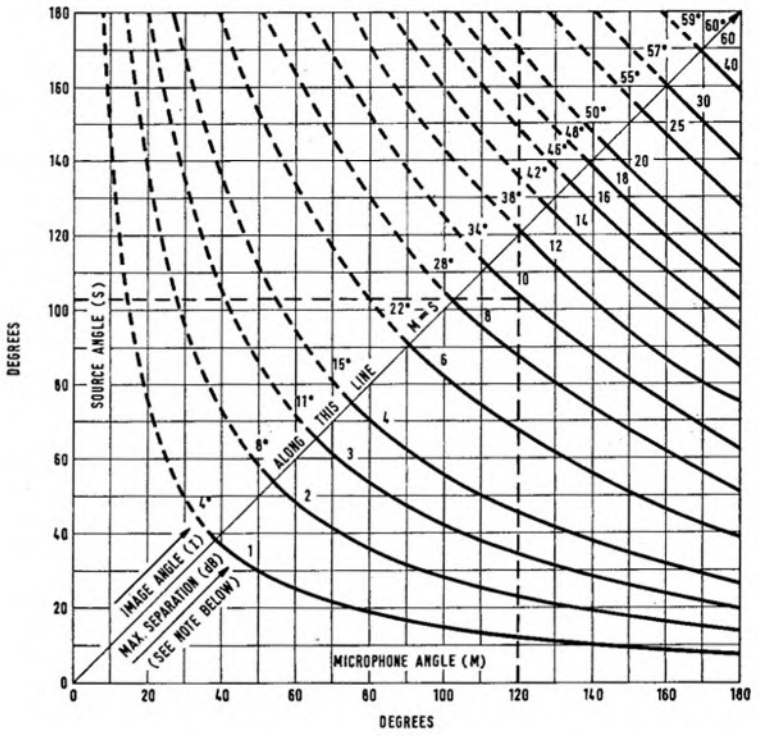
Blowing into the microphone as a continuity test, thoroughly reprehensible with any type, is a crime with capacitors which carries the automatic sentence of two days confined-to-airing-cupboard. If you wish to record pop-singers, you are in real trouble (even ignoring the risk of premature deafness). One answer is to cover the shield with a single thickness of thin plastic, kept in place by the windgag slipped over it. The thermoplastic type used by some supermarkets to cover food is useful, since it can be shrunk into place with *gentle* heat. The exact frequency response cannot be vouched for, but there is no pronounced effect, not to my prejudiced ears at least.

It was said in the first part of this article that the subjective results obtained from a stereo pair of these microphones, now in use for about a year, have been very gratifying. This is certainly not to say that all recordings have been good ones, indeed, there have been one or two absolute shockers. There will always be occasions when microphones cannot be placed where they should be, and one then has either to forget the whole thing, or do the best one can and put up with the results. There are also occasions when a Blumlein pair simply will not do. This anomaly arises particularly when there are soloists, especially vocalists, with large choirs and/or orchestras. Such soloists are often rather weak in comparison with the forces surrounding them and, when you are present as a listener, you unconsciously make allowances. After all, you can actually *see* all those red-faced brass players about a metre behind the soprano, and it does not seem unrealistic that their output should be so much greater than hers. But replay the tape at home, especially some time later, when all the visual information is lacking, and the soprano simply seems weak. The solution is to provide separate microphones for soloists, and pan-pot them into the correct spot in the stereo image at judiciously increased amplitude.

Similar considerations can also arise with small groups unless you are able to arrange the players to best advantage—the difficulty is in achieving a good replay balance between instruments of differing 'penetration', from any one microphone position. Again, there can be a credibility gap between what one accepts in the concert hall and finds uncomfortable when transferred to a different environment with no visual clues.

Naturally, many of these problems and challenges in making a good tape recording arise regardless of the type of microphones used but the possession of some basically good units does at least allow concentration on these problems without the distractions of poor frequency response or other defects.

FIG. 10 ANGULAR SOURCE-IMAGE RELATIONSHIPS

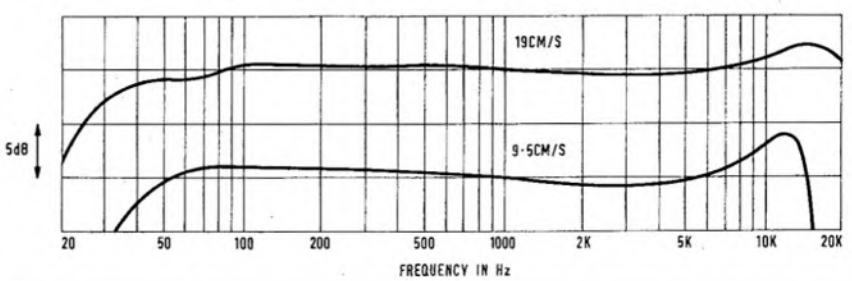


MAXIMUM SEPARATION: THIS FIGURE IS THE RATIO REQUIRED BETWEEN THE L.S. OUTPUTS IN ORDER TO GIVE AN IMAGE AT ONE EXTREME EDGE OF THE SOURCE E.G. IF LEFT/RIGHT RATIO IS 10dB, IMAGE IS ON LEFT-HAND END OF SOURCE SUBTENDING 34° AT LISTENER - I.E. IMAGE IS 17° OFF CENTRE TO LEFT

TELEFUNKEN M250 REVIEW (POSTSCRIPT)

FOR REASONS we have yet to ascertain, record/play curves relating to an Eagle **TC450** found their way into last month's review of the Telefunken **M250.** The correct **fig. 3** is printed below with our apologies.

FIG. 3 TELEFUNKEN M250 RECORD-PLAY FREQUENCY RESPONSE (LINE IN, BASF LGS 35, LINE OUT)



an attic studio

by Robert Rowe

HAVE you ever looked back and asked yourself, 'Why on earth did I do such and such a thing at such and such a time?' Well the other day I did just this and tried to work out what motivated me, after being married for only a couple of weeks, to turn a small irregularly shaped attic into a fully equipped recording studio.

I suppose I started on the road to financial ruin about seven years ago when, at the age of fourteen, I saved up enough money to purchase a Grundig *TK20* recorder. From my first attempts at recording sound effects of birds twittering and the like, I was hooked.

My first go at 'multitracking' (to use the term very loosely), involved recording bass guitar on a Fidelity machine, piano on a borrowed *TK20* and finally, after starting these two recorders in sync (more by luck than judgement), recording the combination plus live drums on to my own machine. Believe it or not, the recorders kept more or less together throughout the whole two minutes rendering of *Swing Low Sweet Chariot*.

The *TK20* continued to give good service over the following years, but eventually the time came for it to go where all the good tape recorders go, to meet its maker. Grundig replaced various worn parts but, after receiving a good offer for the machine from a friend, the recorder and I reluctantly parted company.

In due course I married and on discovering the spare room at the top of the house, decided that, God and wife willing, I would endeavour to turn the attic into as good a sound studio as my pocket would permit. It seemed, at the time, that the cards were stacked against me. I had virtually no wood-working skill; an almost impossible soundproofing task in that, as the room was two floors up, it would be difficult to stop low frequencies being carried down through the floor; and least of all the fact that, at that time, I had no tape recorder.

The first step was to persuade the wife into agreeing that it was a good idea to spend a high percentage of our savings on a good recording machine. I had in my favour the fact that one of my other hobbies was song-writing so this, together with reminders of an imminent birthday, was used to crowbar the wife into submission. (I'm not really as bad as I sound.)

So early in 1968, we equipped ourselves with a new Revox *736HS*. I tried to explain to the wife about the machine's high signal-to-noise ratio, low wow and flutter figures, and cathode follower outputs, but was met with typical wifely remarks: 'I like the funny little dials that light up'.

Meanwhile, back in the attic, I had found a friend in Paul Birtles who was more than willing to help with the wood-work and soundproofing, so at last I was able to make positive moves towards my goal.

First job, was to draw a floor plan to scale and try and work out how best to divide up the odd shaped room to give me a control room and an acoustically separate enclosure in which to place the drum kit.

From an attic which measured only 4 x 5 m at its widest points, this was some problem. The design finally decided upon is reproduced in **fig. 1.**

The next step was to look thoroughly into the problems of sound-proofing. I found several books written by Gilbert Briggs very enlightening, in particular *Audio and Acoustics*. It soon became obvious that the best I could hope for, without going to great expense, was to kill most of the reverberation in the multi-sided room and try and reduce home-to-neighbour leakage to a tolerable level. Luckily I am blessed with very understanding neighbours. In fact, one of them asked for a loud-speaker feed from the studio to his house so that, as he put it, 'the music could be enjoyed with more clarity'. Fine man!

It was found, after experiment, that one of the best and cheapest sound absorbers were, of all things, fibre egg cartons. Each carton covered about 300 x 300 mm so all I needed was a grocer who would supply me with about two hundred of the things. Unfortunately such a man was not to be found, so in the end I had to make a weekly round of several shops, getting a dozen or so cartons from each.

Each wall was battened with pieces of 50 x 25 mm wood, the egg cartons being stuck and pinned directly on to the wall. Over these were hung 25 mm thick fibreglass blankets and a membrane of polythene stretched across the lot. To finish the job, the above was compressed by peg-board, the polythene preventing the fibreglass from flaking through the holes in the Peg-board, getting beneath one's skin and causing days of irritation.

The floor was merely covered with old carpeting and underfelt purchased from a local church jumble sale.

As we were only working on the studio about one night a week, the sound-proofing process took the best part of nine months to complete. During this time, a mutual friend of Paul and myself, Ivan Huddlestone, gave great assistance. He became so interested, that he put his own Revox *736* at my disposal. Things were looking up.

Like most people, I suppose, my musical life started with five or so years of piano lessons, after which my tutor emigrated. Nevertheless, this knowledge of the piano gave me a good grounding and from there I became interested in the guitar, bass organ and drums.

After a while, I joined up with three friends similarly interested and formed a pop group, calling ourselves the Globetrotters. I would point out that we are not and never were one of the long haired thousand Watt brigade; we concentrated on the sound rather than the pretty clothes. *(continued overleaf)*

You may be wondering what this waffle about groups and things has to do with the building of the studio. Well, the very fact of being in a group solved another of my equipment problems, that of microphones. Overnight, as it were I had access to no less than seven good mikes: four Beyer *M260*'s, one *AKG D12*, one *AKG D24B* and a Reslo *RB* ribbon.

The remaining piece of equipment needed was a mixer. As I intended to use the studio mainly for the production of pop music demonstration tapes I decided to invest in a mixer unit incorporating monitor and reverberation facilities. Eventually I purchased an *Audiomaster* by Watkins of London. Really for a piece of equipment in its price range. the *Audiomaster* is amazingly flexible. It has five channels, each one having the following controls: gain, reverberation gain, bass and treble. The tone control circuits are of the Baxandall design. Over all channels is a master gain control. There are two inputs per channel, one high impedance and the other switchable to 60 or 200 ohms, balanced.

In addition the *Audiomaster* boasts comprehensive facilities for signal monitoring by meter and/or headphones, the whole being quite a useful item.

The various pieces of equipment were duly assembled in the now acoustically 'dead' studio and test recordings made. One of the first things noticed after switching on the equipment, was a tone of about 100 Hz being emitted from the loudspeaker of the Revox. The tone seemed to persist irrespective of the inputs being used. After proving that the tone was present on both recorders, it became apparent that it was mains interference. The first step taken to reduce this was to provide a separate earth connection for the studio equipment, the latter being previously earthed at the mains socket. This reduced the noise somewhat, but it was finally stopped entirely by the inclusion of an ex war-department low-pass filter unit in the incoming mains lead.

Another point noticed on the early test recordings was the fact that the deadness of the drum enclosure tended to make the drums sound lifeless and flat. The booth was made more acoustically bright by a lining of heavy gauge aluminium foil.

When these minor details had been ironed out, the studio was stripped of equipment and I got down to the task of wiring up the control room. I decided that a switching panel was required to permit the easy connection of the various inputs and outputs of the Revox's, monitor ampifiers, studio loudspeakers, headphone bus, etc. The headphone bus consisted of a feed to the drum enclosure and one to the main jack panel, which was placed, just above ground level, on the studio facing, front 'wall' of the control room. The recordist's phones were fed from a jack positioned on the switching panels, switchable independently of the main studio headphone feed.

Also on the main jack panel were five input jacks, wired to the mixer inputs, and two auxiliary input sockets. These were wired to the switch panel and were switchable to any input on the system. Another facility afforded by the switching panel was the ability to route the output of, say, Track 1, Revox 1, through the mixer and back on to Track 2 of the same recorder. Thus enabling 'flat' signals recorded on Track 1, to be reverberated or equalized at will. These few nights of wiring up were followed by weeks of my crawling up the wall trying to work out exactly what facilities I had given myself!

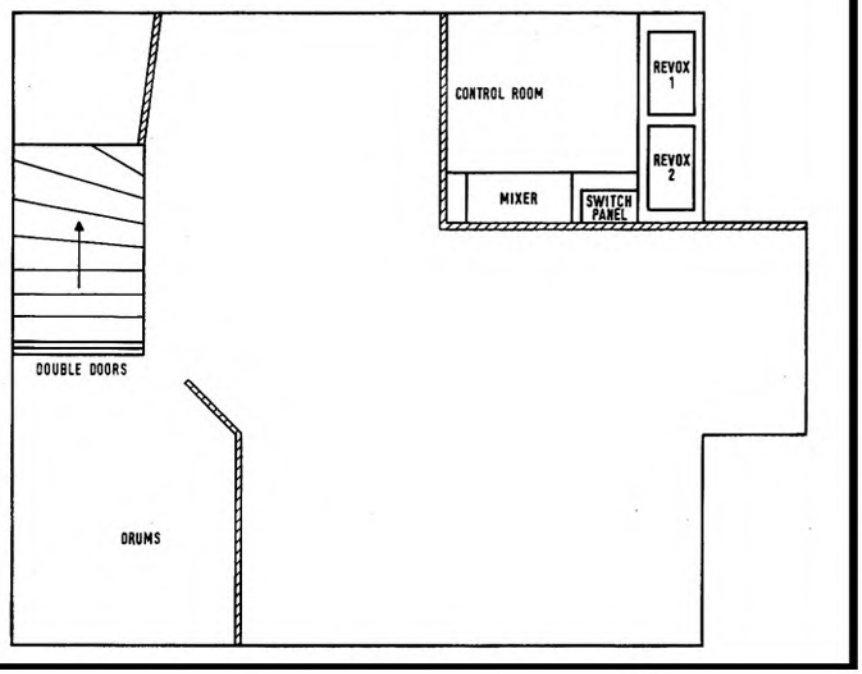
Revox *736* machines have a solenoid-operated deck mechanism, so it was an easy job to rig up a remote control circuit, with switches in strategic points around the studio. This has proved a boon when 'multitracking' on my own, alleviating the need, after starting the recorder, to dash across the studio, knocking over microphone stands and the like, arriving at the drum stool just as previously recorded tracks start to play back.

My group, The Globetrotters, had been working for some time on a song written by rhythm guitarist Mel Oates and myself entitled *Walk a Little Closer*, so this was the number chosen for our first recording attempt. The signal from the bass guitar was fed, via a split lead, simultaneously to the bass amplifier and directly into the mixer. The tone controls on the bass amp were set to give the maximum treble boost available. This lessened the amount of 'boomy' bass being fed into the studio, while at the same time, giving the bass player easy monitoring of his playing. Two mikes were used for the drums, one placed about 15 cm in front of the bass drum and one overall. At first I experienced a little trouble from mikes being out of phase, but this was overcome by revising the microphone positions relative to each other. As I had no means of electronically compressing the input signals to the tape recorder, I anticipated a little trouble from overloading. However, keeping amplifier outputs down to a sensible level, this proved no problem.

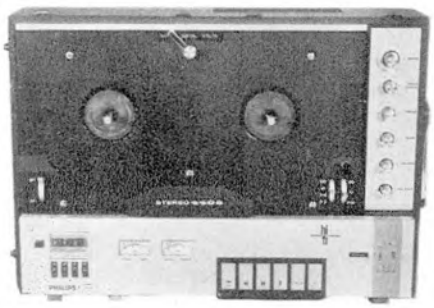
Everybody agreed that, for a first try, the results were excellent. Perhaps you can imagine my feeling of intense pride when, after nearly two years of hard work, I found myself sitting back listening to a tape produced by my own group in my own studio!

Since that early session my luck has held out. I have had a series of tapes played on local radio and, a few weeks ago, one of my song was released by a major record company.

FIG. 1



equipment reviews



PHILIPS N4408

MANUFACTURER'S SPECIFICATION (19 cm/s). Quarter-track stereo tape recorder with detachable loudspeakers. **Wow and flutter:** + 0.15% (Din, EMT 450). **Frequency response:** 40 Hz - 18 kHz within 6 dB. **Signal-to-noise ratio:** 45 dB. **Bias frequency:** 61 kHz. **Equalisation:** 40, 1 590 μS (CCIN). **Inputs:** .02 mV at 2 K (microphone); 2 mV at 2 K (diode); 150 mV at 1 M (PU). **Outputs:** 1 V at 20 K (auxiliary); 0 to 2 V at 1.5K (headphones); 6 W unspecified at 8 ohms. **Dimensions:** 508 x 343 x 229 mm including lid speakers. **Weight:** 13 kg. **Price:** £110 5s. (plus £23 11s. 8d. PT). **Distributor: Philips Electrical Ltd., Century House, Shaftesbury Avenue, London W.C.2.**

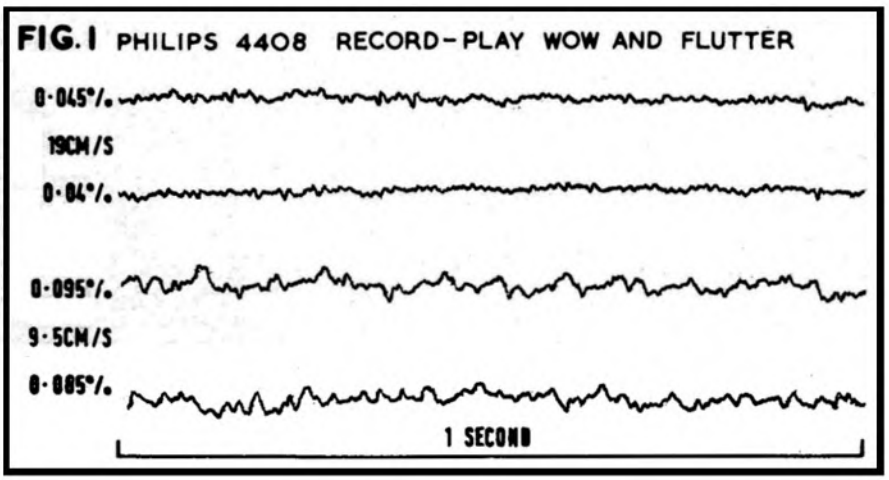
THIS is a nicely styled machine that can be used in the horizontal or vertical position. Piano-key controls are placed just right of centre and are, from left to right, pause, rewind, wind, play, stop and record. To the left we find two VU meters scaled in dB from −20 to +4 dB. On the extreme left of the bottom panel is a combined tape position counter and auto stop. The four digit counter is driven from the supply reel and clocks up 9 digits for every 10 revolutions of the reel; it can be set to zero by the usual push button. The auto stop is a completely new feature and an absolute joy to use. The lower set of digits can be preset by knurled wheels to any desired reading; when the programme indicator reaches the same reading the tape is stopped, whether on wind, rewind or play. This is a very efficient programme selector and is much more accurate than anything we have tested so far.

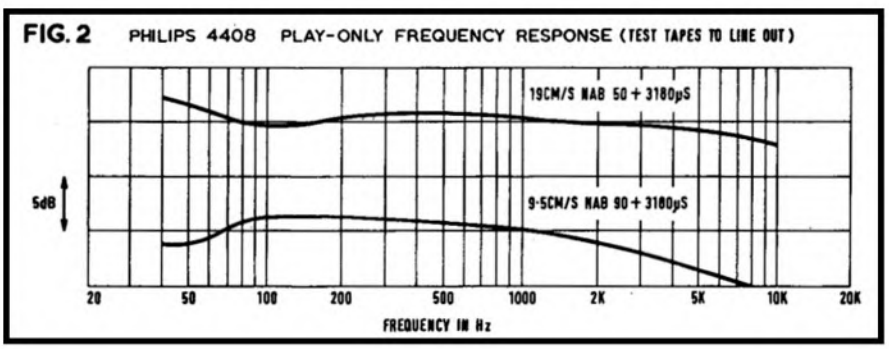
Wind or rewind of an 18 cm reel of LP tape was accomplished in 2¼ minutes which is quite fast for a single motor machine.

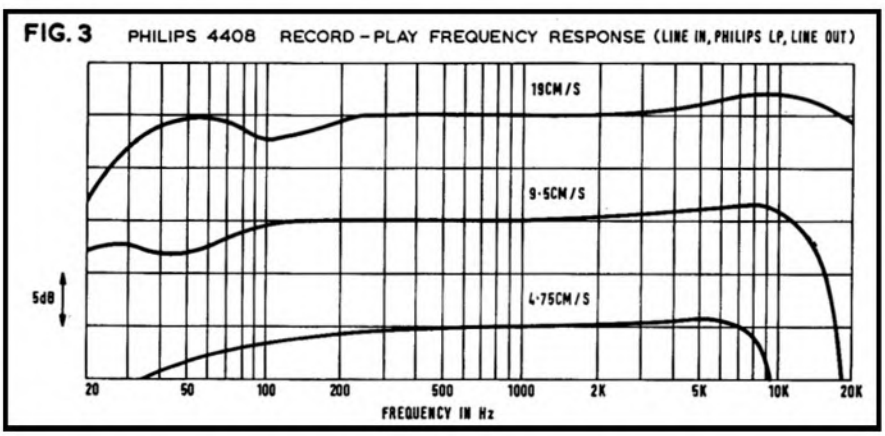
Tape speeds were accurate to within 1% when tested with a tape driven strobe wheel.

Short-term speed fluctuations were very low at 19 cm/s, 0.04% to 0.045% RMS cumulative wow and flutter. At 9.5 cm/s the readings were still under 0.1% at 0.085% to 0.095% RMS. At the lowest speed of 4.75 cm/s the first signs of a capstan wow appeared at about 4 Hz; see the fluttergram pen recordings of **fig. 1.**

Fig. 2 shows the play-only responses to line output when playing standard NAB 50 and 90 μS test tapes. The 19 cm/s response is within 2 dB limits from 40 Hz to 10 kHz but the 9.5 cm/s response falls by 6 dB at 10 kHz.







This should be borne in mind when playing prerecorded tapes at 9.5 cm/s into wide-range external amplifiers and speakers. A slight touch of top lift will be required at this speed. If the tapes are played on the machine's own speakers, the treble tone control can be left near the mid setting.

System noise with no tape passing the heads was 55 dB below peak recording level when weighted to the IEC 'A' response.

The record-play responses of **fig. 3** extend well beyond the limits of the test tapes and show evidence of 'wavelength wobbles' at low frequencies where the pole face length of the head is comparable to the wavelength recorded on the tape. High frequencies have been carefully pre-emphasised to maintain a level response to 20 kHz at 19 cm/s, 15 kHz at 9.5 cm/s and 8 kHz at 4.75 cm/s to meet the manufacturers specification exactly.

Harmonic distortion tests indicate that this extended response is obtained by slight underbiasing, as the third harmonic dis-

(continued on page 83)

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*Philips 4408 Prof. 3 sp. 3 Tr. Stereo
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*Telefunken M207 2 sp. 4 Tr. Stereo
Telefunken 501 4 Tr.
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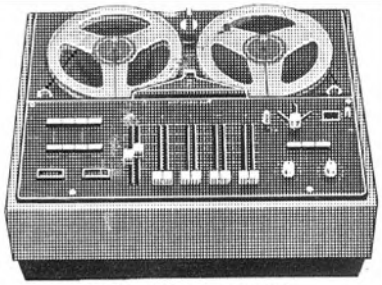

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tortion at 1 kHz, 19 cm/s 32 mM/mm, is 2.5%. It was interesting to note that the distortion level on playback from the DIN 32 mM/mm test tape was only 0.8% at line output.

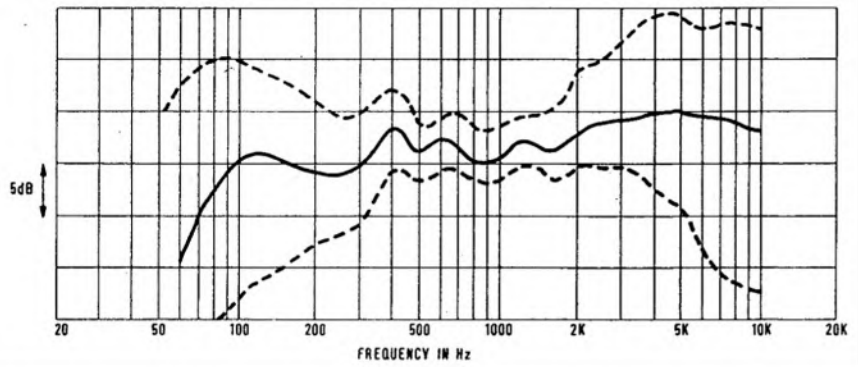
Peak recording level of 32 mM/mm was recorded on Philips tape at −1 dB on the VU meter. After erasure on the machine the weighted tape noise was −52 dB. Bulk-erased tape was −53 dB which indicates that the bias and erase waveform is extremely good.

Regular readers will know that I have become rather disillusioned by so-called stereo recorders with built-in speakers. Some have practically no stereo effect at all; some are reasonable if you are prepared to sit no farther than arm's length from the machine; a very few manage under certain conditions to produce a stereo image rather larger than the cabinet dimensions. The Philips *4408* avoids all these pitfalls by providing detachable speakers which can be placed in the optimum positions for the room in which the recorder is to be used. These speakers are relatively small and light in weight, but they manage to produce a solid stereo image with very pleasant sound quality indeed.

A well recorded stereo demonstration tape containing both popular and classical music is provided with the *4408* and is so outstandingly better than that provided by any other domestic stereo tape system that I recommend it to any readers who listen to the *music* and not the frequency response of the recorder.

Fig. 4 shows that the frequency response is in fact extremely smooth from 100 Hz to 10 kHz and that the tone controls really do 'hinge' nicely at approximately 300 Hz and 2 kHz to boost the extremes where required to suit the room acoustics. **A. Tutchings.**

FIG. 4 PHILIPS 4408 ACOUSTIC RESPONSE (WHITE NOISE TEST TAPE ON SPEAKER AXIS)

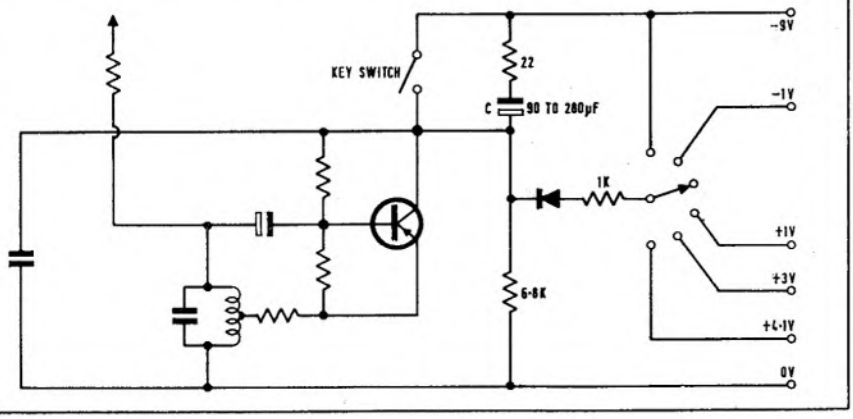


anyone for very long. In fact, the experience which stimulates such a comment is compounded of a large number of elements of which probably most important is *contrast* in tone quality rather than some inherent fixed characteristic. The phenomenon is a well-recognised psychological mechanism of which the most obvious musical manifestation is the apparent freshness and beauty of conventional classical harmony sounded shortly after a passage of 'discordant' progressions. In the present context, a tone having relatively little higher harmonic content will, for a time (and especially if used in the playing of a significant melodic passage) seem to acquire a particular beauty and purity by virtue of the contrast with previously sounded tones of fuller harmonic development.

Remembering that the harmonic content of the steady tone is only one of several factors by which an instrument's tone is

(continued on page 85)

FIG. 66 SIMPLE ATTACK AND SUSTAIN CONTROL CIRCUIT



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identified, and that variation in tone colour will normally be associated with variations in other parameters such as attack and noise content, you will appreciate that the degree to which harmonic levels need be controlled is not very great. Indeed the matter can be managed by a fairly simple form of variable control, preferably of the active feedback type so as to avoid severe loss in signal strength and permit sufficient flexibility. A suitable circuit is given in **fig. 63**.

Bowed string instruments may be played muted, or with the bow nearer to the bridge than normal, or very lightly with the edge of the bowhair, or with a finger lightly touching the bowed string so as to produce 'artificial harmonics' or pizzicato, the strings being plucked with the finger-tip or finger nail. Provision for these special effects is best made by incorporating additional, independently-switched filters and 'percussion' circuits of which a selection is given in **figs. 64** to **68.**

In **fig. 66** C is normally charged. When the key-switch closes it shorts and discharges C. On reopening the key-switch the recharging current flows through the oscillator and the tone continues, with diminishing volume, until C is fully charged again. The duration of the decay is varied by varying the bias as shown (Gulbransen).

Fig. 67 is a gate producing percussive attack with rapid fall, followed by slow decay. Also rapid damping on release of playing key (piano characteristics). The transistor bias is held just below on level. When S1 is closed, the pulse of current charging C1 makes the top of R1 momentarily positive and turns the transistor hard on. This initial positive voltage also biases D1 on and this supplements the initial rapid charging rate of C1. But as C1 continues to charge, the current through R1 decreases and the positive bias on the base falls. The fall is rapid at first, but when D1 is turned off, charging proceeds more slowly. When C1 is fully charged a very low-level tone continues because of the small bias through R3, which persists as long as the key-switch remains closed. When the key is released, C1 discharges rapidly through D2, R1 and R4. If the key be released before C1 is fully charged, the charge on C2 leaks away through R5 and the transistor, giving a suitable turn-off rate. C3 shorts any signal leakage to ground (Gulbransen).

In fig. 68 the attack and sustain effects depend on the fact that resistance drops rapidly but returns slowly when a CdS cell is illuminated by a pulse of light.

To be continued

FIG. 67 (SEE TEXT)

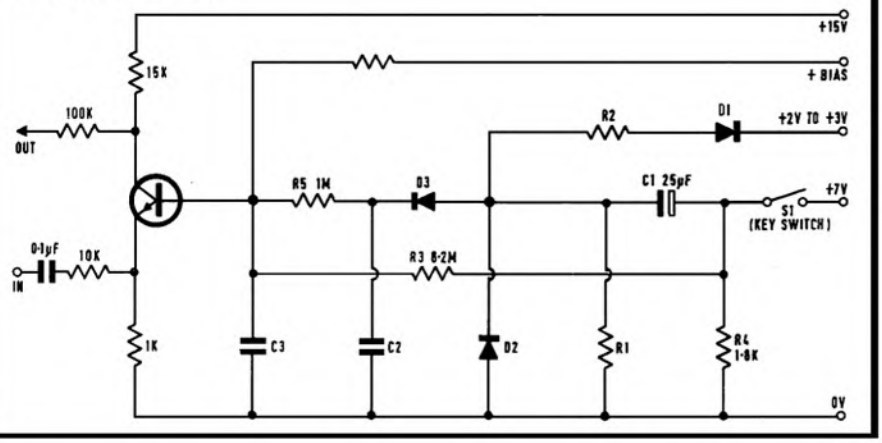
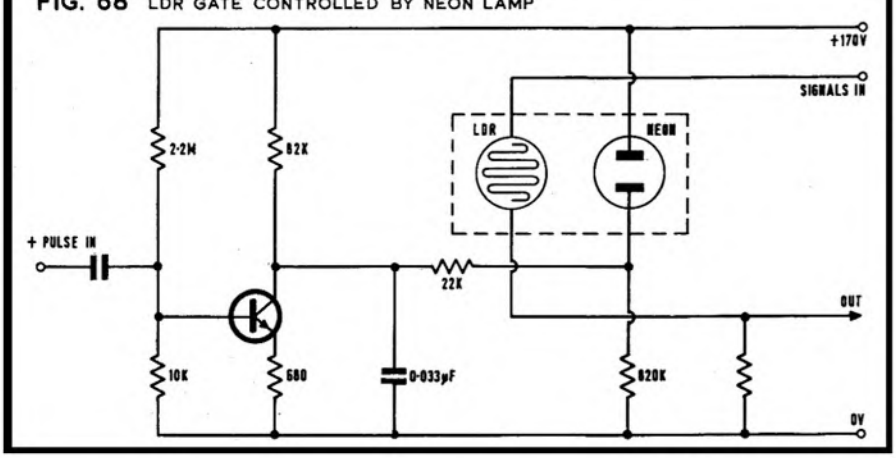


FIG. 68 LDR GATE CONTROLLED BY NEON LAMP



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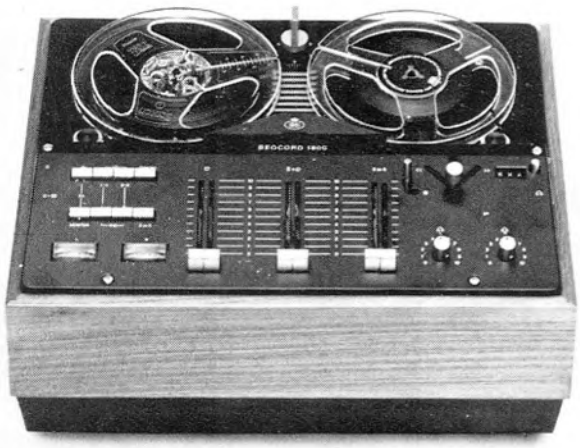


BEOCORD 1800

BEOCORD 2400

Made by Bang & Olufsen for those who consider design and quality before price.

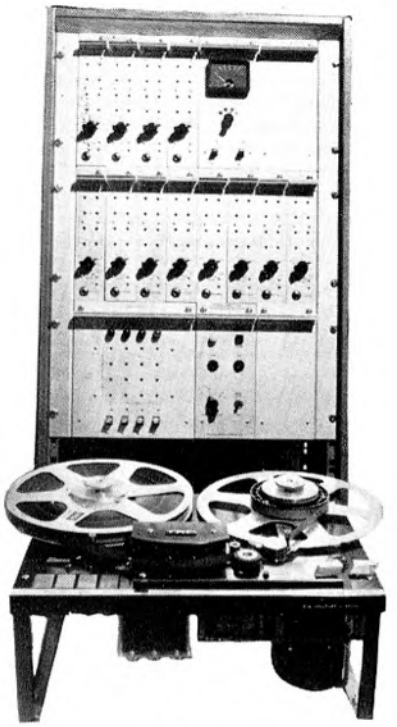
Whether you prefer to centre your High Fidelity system around a separate amplifier, or to base it on an amplifier integrated into one of the audio units, your needs for a tape recorder to complete your system can be satisfied by choosing one of these new Beocords. Both machines exceed the minimum requirements for DIN 45.500, and have operational facilities comprehensive enough to attract the semi-professional as well as the domestic user. These include a 3 digit tape counter with push button reset. Foil operated auto stop plus thyristor controlled photo-stop for end of tape, tape break or programme scanning. Push button selection of A-B monitoring, sound on sound, echo, syncroplay, mono left, mono right, mixed mono, or stereo play. New hyperbolically ground tape heads with special patented machining give greatly improved contact between tape and tape head and less friction and noise during operation, resulting in less wear to tapes and tape heads.

The Beocord 1800 – designed for use with a High Fidelity amplifier such as the Beolab 5000 or Beomaster 1400.
Available in 2 versions: (a) $\frac{1}{2}$ track record and replay with extra switched $\frac{1}{4}$ track replay head, (b) $\frac{1}{4}$ track record and replay only. Sockets duplicated in DIN and phono type to simplify connection. Special amplifier and volume control for output to headphone sockets.

The Beocord 2400 – complete with its own stereo amplifier section giving 2 x 10 watts RMS output. $\frac{1}{4}$ track record and replay. 4 dual channel inputs in mixer section including a magnetic P.U. input. Bass, treble and split channel volume controls. Switched output for 2 pairs of speakers. The amplifier may be operated independent of the motor.

As we want people who choose B & O to receive really good service, every effort has been made to appoint only dealers of the highest ability and integrity and this policy may necessarily limit the number in your town or city. So write today for the name and address of your nearest dealer and for further information about the B & O range to :—
Bang & Olufsen U.K. Limited. Eastbrook Road, Gloucester. Telephone : 0452 21591
London Showrooms : 70/71 Welbeck Street, London, W.1. Telephone : 01-486 2144.

J. RICHARDSON ELECTRONICS & T.R.D. LTD.



FOUR TRACK HALF INCH TAPE TRANSPORT WITH MODULAR ELECTRONICS

TRANSPORT

Indirect drive using Papst hysteresis synchronous motors providing speeds of 76, 38 and 19 cm/s. Spooling motors Papst asynchronous. Fully remotable solenoid controlled with facility for variable speed spooling if required. 19 or 21 inch rack mounting or free standing, vertical or horizontal mounting.

HEADS

Bogen professional series fitted as standard.

ELECTRONICS

Fully transistorised using silicon planar transistors throughout, providing up to four equalisations of any Standard, switched electronically. Full facilities to drop into or out of record on any channel with automatic Sel-sync, remotable if required. All inputs and outputs to match 600 ohm balanced line. Construction, 19 inch rack mounting unit with plug-in modules.

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