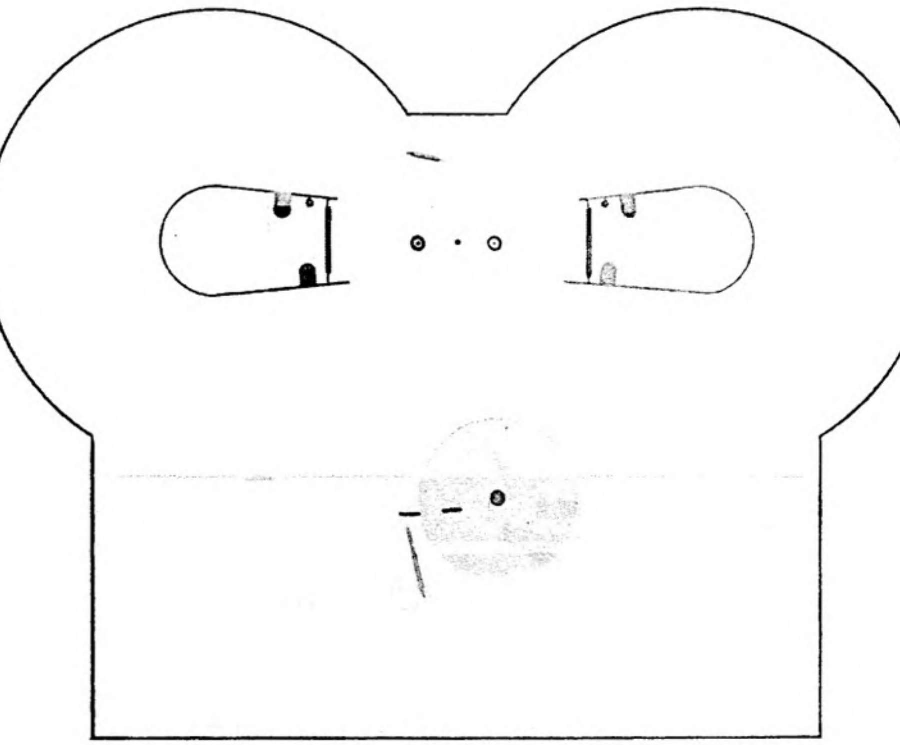
November 1971 25p

studio sound

INSIDE LANSDOWNE



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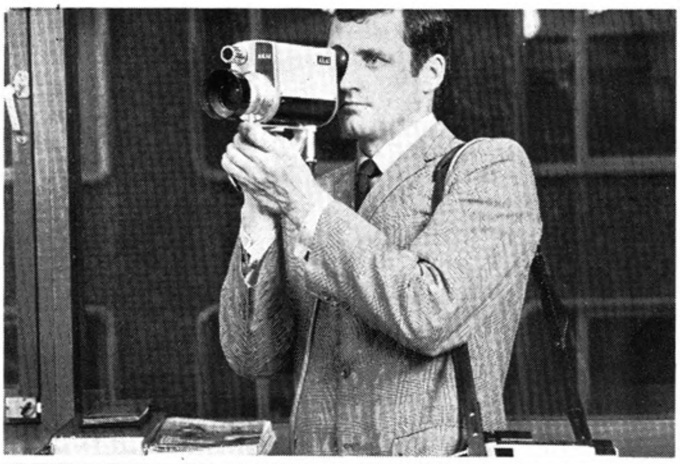

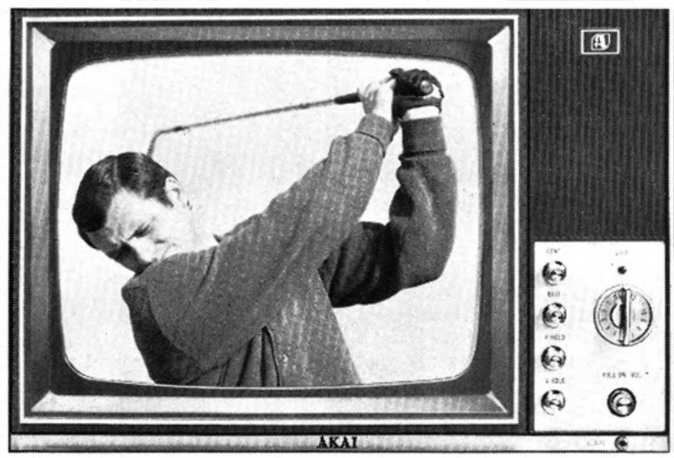

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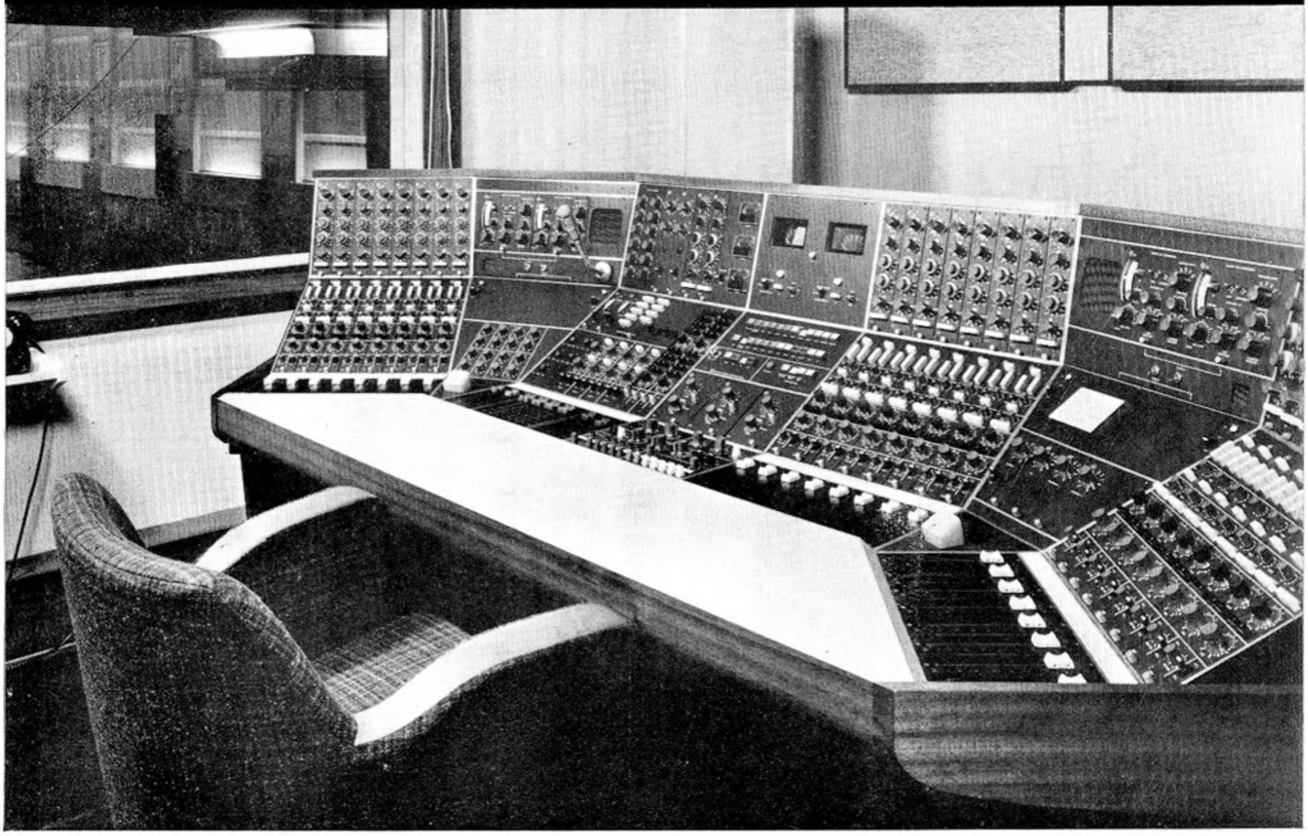

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studio sound
INCORPORATING TAPE RECORDER

NOVEMBER 1971 VOLUME 13 NUMBER 11

EDITOR DAVID KIRK **CONSULTING EDITOR** JOHN CRABBE

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AT THE MOMENT of writing (September 21), the national newspaper industry is disrupted by a printing dispute. The Fleet Street publishers are understandably irritated by the standstill since the public appetite for dailies is declining. This falling demand is largely due, in our opinion, to the rapid news turnround achieved by the electronic broadcasting media. Tuesday's newspaper is usually a history sheet of Monday's radio and television reports. The exception to this rule is the rare occasion when headline material reaches London between 11 p.m. and midnight. This misses the BBC's audience (unless they hear it at breakfast) but catches the later editions of some newspapers.

Producing a monthly journal we are faced by a more severe time delay between receiving information and passing it to the reader. Fortunately for us, however, we are not in competition with the radio and television news services.

Our news column is the most vulnerable to the passage of time. Any method of leap-frogging the traditionally slow-acting chain of managers and PR men would provide faster communication between development engineers and potential buyers of their equipment. We have found such a method and will introduce it as a permanent feature of STUDIO SOUND from the December issue. It is essentially an amplification of our existing 'Patents Review' column, hitherto ably but briefly contributed by Adrian Hope. Adrian's approach has been to select two or three recently published British Patents, discoursing on these in moderate detail. We shall extend these reviews to cover a larger number of patents and will also list all Complete Specifications Accepted that we consider relevant to our readership. The total number of specifications accepted in any week averages some 900 so we shall be faced with sorting through well over 3,000 entries each month. This service will save interested readers the laborious task of searching the *Official Journal (Patents)* for themselves, not to mention the £26 annual subscription.

So much for December. This month (the November issue) we begin a four-language precis of our contents which may or may not prove useful to overseas subscribers. Jacques Levy (temporary acting secretary of the APRS) has pointed out that some English readers have difficulty understanding this journal, let alone foreigners. The sore point is metrication: could we run imperial and metric dimensions alongside for a year? We did. Nevertheless, the point is taken and we shall endeavour to find room for a short metric/imperial conversion table covering the more common measurements.

FEATURE ARTICLES

REGULAR COLUMNS

EQUIPMENT REVIEWS

COVER PICTURE

Adrian Kerridge, Director and General Manager of Lansdowne Studios, at the Cadac mixing console. The equipment side of Lansdowne is described in this month's 'Around the Studios'.

SUBSCRIPTION RATES

Annual UK subscription rate for STUDIO SOUND *is £3 (overseas £3·30, $8 or equivalent). Our associate publication* Hi-Fi News *costs £3·12 (overseas £3·66, $8·64 or equivalent). Six month home subscriptions are £1·50* (STUDIO SOUND) *and £1·56* (Hi-Fi News).
STUDIO SOUND *is published on the 14th of the preceding month unless that date falls on a Sunday, when it appears on the Saturday.*

BINDERS

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

CORRESPONDENCE AND ARTICLES

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

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

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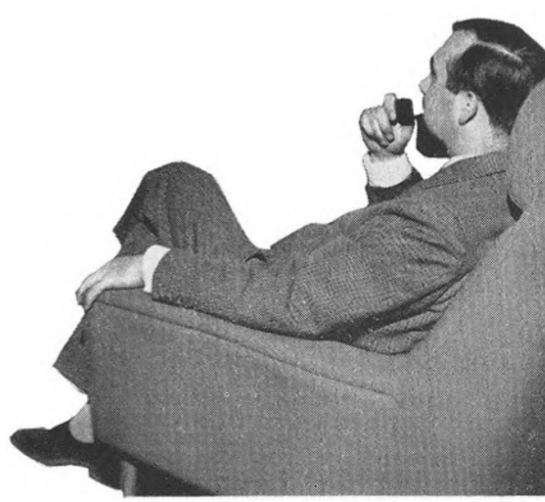

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Studio Diary

BY KEITH WICKS

READERS of the article on **Majestic Studios** that appeared in the September issue will have gained the false impression that Dave Hadfield is no longer connected with that studio. Dave has asked me to point out that he is still studio manager of Majestic and has a five year contract with the owner, Mike Morton. After spending a great deal of time setting up the studio, he left the running of it to the engineers, dropping in every now and then to check that everything was all right. Since things have been running pretty smoothly, Dave has not found it necessary to spend much time at Majestic. 'Possibly "out of sight, out of mind" is the problem here,' said Dave, 'but it is important to clarify the situation, as I deal with various manufacturers on behalf of Majestic'.

Most of Dave Hadfield's time is spent at **Maximum Sound Studios,** where he is studio manager and engineer. This month, they have done a lot of work with Kenny Lynch and Tony Hicks, and have had Flash Gordon's Apes swinging in the studio. This hairy group plays mainly rock, and includes Bernie Living, who has played in the bands of Manfred Mann and Mike Westbrook. Mike Hugg is in the process of completing an album, and American artist, Mike Glasser, is doing likewise. As we go to press, Manfred Mann's latest Maximum-recorded single entitled *Mrs Henry* has just been released.

John Mosely, managing director of the luxurious **Command Studios** in Piccadilly, has announced that from October 1, Eddie Kennedy of the Marquee Martin Agency in Wardour Street takes over responsibility for the sale of studio time, with the emphasis on the pop scene.

At **Wessex,** the Andy Ross Orchestra has been continuing work on a singalong LP for CBS. Mike Batt of Belfry Productions has done more work on his albums of tributes to Simon & Garfunkel and Elton John, and producer Arthur Frewin has been in with 11 session musicians doing a CBS album of *Songs That Won The War*. Singer and songwriter Phil Pickett, a newcomer to the business, came into the studio to add voices to tracks he had laid down elsewhere. On one of the numbers, he put Gino Washington (of Ram Jam Band fame) as the lead singer, with his own voice as backing. Open Road laid down some self-produced single tracks for Chapter One Records, and Les Reed of that company has been in for voice dubbing on Gerry Monroe and Jimmy Wilson album material. Don Hunter of the Gem company has just finished off a number of Milkwood singles, and the Alan Tew Orchestra has now completed an album of Alan's favourite songs, which include *America*, other numbers from shows, and past hits. Some time ago, Wessex recorded Lovelace Watkins at the Talk of The Town, and issued the material on an album along with some numbers recorded in the studio. Lovelace has been in with Deke Arlon of York Records to start another album, and the material is being put together and arranged with the help of Johnny Watson. Ronnie Oppenheimer and Bruce McClane have both been recording single material for Double R Records, and Brotherhood of Breath have been putting the finishing touches to an album of underground jazz. This group is part of the massive Centipede and consists of brass, drums, piano and bass. Putney Bridge have been in for Chapter One Records, as has nine-year-old Rickie Beaumont who made another single which was produced by Harold Geller. Timon Murray, songwriter, composer, vocalist and guitarist, has been recording album material for the new Greenwich Gramophone Company. Flutes and rhythm were added, and the sessions were produced by Tony Reeves.

Studio manager Adrian Ibbetson tells me he is considering buying an Astronic equaliser to cut excessive sibilance on some singers. Another piece of news from Wessex is that the studio acoustics are to be altered and made slightly more dead. The Wessex staff are more concerned about acoustics than many of their competitors. One end of the studio has been finished with reflective lino tiles which enable the engineers to get a 'bigger' sound, particularly on strings. The other section is carpeted to deaden the sound, making that part of the studio suitable for rhythm instruments.

Trident engineer Robin Cable has been working with producer Gus Dudgeon on sessions by Magna Carta and Ralph MacTell. Robin also engineered Van der Graaf sessions, the producer being John Anthony. Other artists produced by John Anthony at the studio in the last month have included Al Stewart and Atomic Rooster, the engineer on these being David Hentschel. Roy Baker engineered Marc Bolan sessions produced by Tony Visconti, and Ken Scott engineered Visconti-produced material by Mary Hopkin. Ken Scott was also at the desk for sessions by Lindisfarne and David Bowie.

Mike Cooper at the Pan desk.

A new studio has opened in Broadhurst Gardens in Hampstead. It is called **Pan Sound Studios** and was officially opened by Brian Matthew in September. The studio area is about 46 m², Neumann and AKG microphones are used, there are two foldback systems, and stereo playback facilities are provided in the studio. The control room is equipped with a 3M eight track recorder, two Ampex stereo machines, and an Ampex mono. The control console is a 16 channel eight track Lander, previously owned by Barry Gray who used it in his studio to produce the many effects for the television puppet programmes *Thunderbirds* and *Fireball XL5*. Studio manager Vic Hawley, who also manages Regent Sound and Pan Music, is very happy with the results they are getting in the studio. So much so that when I asked if the desk PPMs might be replaced by VU meters (VUs are used on the tape machines) I was told: 'We have got quite a fantastic sound, and I see no reason to change anything. If you start altering something on a desk where you have a load of electronic equipment, it may well be that you will upset something else, and alter the sound entirely.' So be warned.

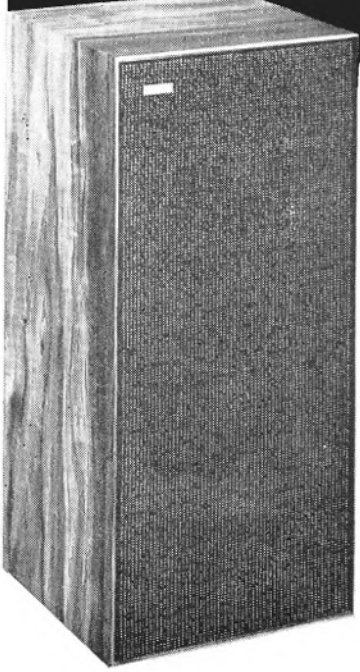
Other equipment includes two EMT stereo plates, various limiters and compressors and, for monitoring, H/H Electronics amplifiers driving Tannoy *Golds* housed in Lockwood cabinets. Pan's chief engineer is Mike Cooper, and his assistant engineer is Warren Leven. Hourly rates for eight track recording are £15 between 10 a.m. and 6 p.m., £18 between 6 p.m. and 10 p.m., and £20 at weekends. These charges include the use of a Strohmenger grand piano and a jangle piano as well. Up to 25 musicians can be accommodated, and the studio would appear to give very good value for money.

Barbara Ruskin has recorded a new arrangement of Elvis Presley's *Teddy Bear* which is soon to be released. The B side is a number written by Barbara. Deacon Records have demonstrated their confidence in the studio by booking it for one day every week for the rest of the year, and Brian Matthew will be another regular user of the studio. Anyone interested in using Pan Studios should ring Vic Hawley on 01-328 7222. He has told me he will be happy to arrange for prospective customers to visit the studio and hear the sounds that can be obtained.

Mayfair Recording Studios seem to specialise in the unusual. This month they have been recording bible stories read by John Le Mesurier, currently featuring in the television

(continued on page 556)

Introducing the Rogers BBC Studio Monitor Speaker



The Rogers B.B.C. Studio Monitor Speaker offers a standard of performance related to size without equal.

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series *Dad's Army*. The session was produced for Avenue Recordings by George Watkins. Labi Siffre has been laying down tracks for Groovy Music, and Peter Morris produced the group Nik for EMI. Other EMI artists at Mayfair this month included the Scaffold, and the Dubliners, who recorded a single *Free The People* which was produced by Phil Coulter.

Sound Developments report that they have been extremely busy this month. Johnny Hawkesworth has been doing a lot of work with the Hampton Hawes Trio, a jazz group well known in the States. A lot of voice recording for audio-visual work has been carried out including a presentation for the EMI reps' conference. The studio also recorded a Cadbury TV jingle at various speeds for an audio-visual presentation. The line-up featured organ, alto, tenor doubling clarinet, bass, rhythm guitar, trumpet, trombone, and drums.

On October 10, the old London Bridge reopens at its new location, Lake Havasu, Arizona. To coincide with the event, the Lake Havasu City Radio Station (KFWJ) broadcast a special programme recorded in London at the **Roger Squire Studios.** The show featured DJ Tony Mercer who played a selection of records by top British artists and interviewed a number of well known names in the recording business. The studio is very small, as it is really intended for use solely as a DJ studio. For this reason, it was necessary to put the interviewees in the lounge, linked to the studio by headphones and microphone. Things began to get rather hectic as people arrived to take part in the show, and filled the interview lounge. There was Richard Barnes, Maurice Gibb, Tony Hazzard, John Kongas, Tin-Tin, Tony Wilson, Joe Molland, and Manfred Mann. A red light indicated that the microphone was live and that everyone except the person being interviewed should remain silent. This worked very well at first but, as the number of people present increased, the situation changed. The light would go on just as someone was arriving or leaving, and it would take some time for everyone to notice it. The Richard Barnes dog was present and succeeded in making a mess of his interview and the room downstairs, but, in spite of all these difficulties, a successful programme emerged. Roger Squire described the session as one of the most hectic he has ever had, but I am sure it was all worthwhile in the end.

CBS used the Squire studio to record a promotional programme on CBS products for a big convention. The programme was played to the participants as they travelled to the convention in a chartered train, fitted out for the occasion with speakers in each compartment. Tony Reeves of the Greenwich Gramophone Company also booked the studio for promotional work. This was a presentation featuring Alan Black introducing items from the first three albums produced by the company.

Intersound have been recording another *Top Of The Pops* album for Pickwick and, as the other three in this series have all been best sellers, they are almost certain of success once again. Colin Hare's latest album recorded at Intersound is called *March Hare*, and not 'Page Full Of Hits'. The latter is the name of the company for whom the album was made and is part of the Larry Page Organisation. Al Saxon recorded a Patricia Lambert album, Honeybus have been in, and Simmsosrami of Paris are about to do another budget album.

At **IBC Studios,** Alegro Entertainments of Geneva recorded *When The Morning Comes*, a Guy Fletcher album, written and produced by Guy, with Doug Flett. Producer Brian Shepherd has been producing John Morgan for Carnaby Records, and engineer Bryan Stott has been working on a Tony Hazzard album for Bron Music's Hit record label. David Katz produced an album by Adano, described as 'hot property on the Continent—he's their Cliff Richard'. Sue Vickers has been in for the 'Moody Blues' company, Threshold Music, and Guy Benson recorded an album for CBS. Sir Michael and Lynn Redgrave have been recording Shaw's *Pygmalion* with Donald Pleasence and others for the Caedmon Record Company of New York. Engineering here was mainly by John Pantry.

From the **Tooting Music Centre** Studio, Engineer Steve Vaughan reports that a master disc has now been cut of their Western Echoes recording which was made at the Nashville Rooms, Kensington. Pressings are to follow shortly. Gear have been in to make a single which they expect to have released soon, and Brian Chapel did a four track multitrack recording of his own composition, *Scherzos For Four Pianos*. Rainbird have been recording an album intended initially for a limited pressing. This consists entirely of self-written material which Steve Vaughan found difficult to put into any category as the group were within earshot. Other recent visitors to the studio include Sir Washington, and Canadian Tim Buck too.

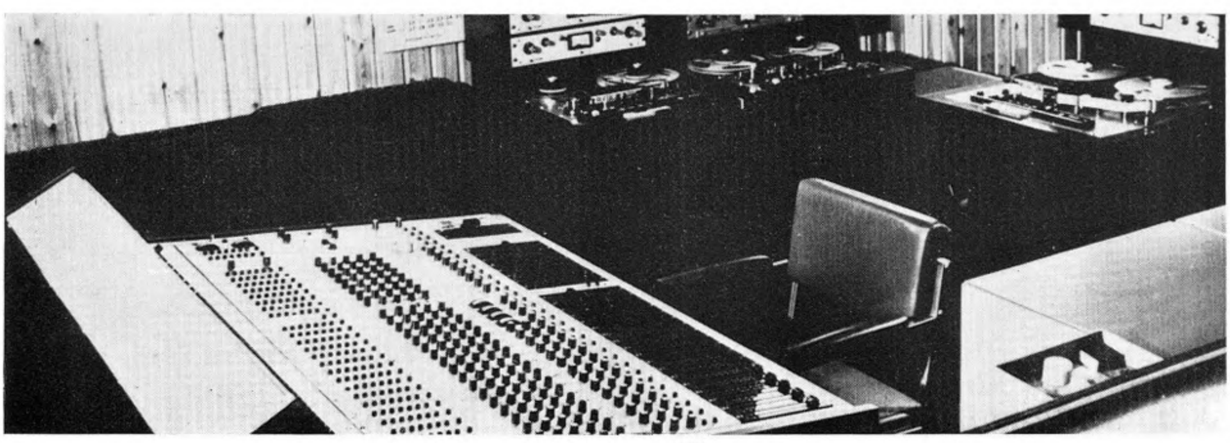
Musical Director Alan Lawrence has been at the **Jackson Studios** to record music tracks for a film of the Norwegian mining disaster which occurred about a year ago. Beef Bayonet, a 12-piece soul band, are now working on their second Jackson-recorded album, and the others who have made the journey to Rickmansworth this month include Bullett, Ross, Tamlyn, and Guy Fletcher.

Malcolm Jackson, engineer extraordinaire, employment agent and scrap dealer second-to-none, tells me they have just put out a sampler record on the Adrhythm label which features 20 tracks selected from the best of the Adrhythm albums, now totalling about 30. *All* makes of organ are included (I am told), as are '*all* the best organists in England', as well as three from overseas.

Sixteen track recorders are at last finding their way on to the secondhand market and Malcolm has one going for a song and a lot of money. He thinks that it will have been sold by the time this issue is published but, if you happen to be looking for a 16 track Ampex, it might be worth getting in touch with him.

Malcolm also deals in secondhand engineers, and has recently been approached by three studios to find suitable personnel. Twelve engineers have been interviewed, and one has been recommended for a job in Tel Aviv. (Presumably he failed the interview.)

Another studio looking for an experienced engineer is that of **Marc Aryan** in Belgium. Marc is a singer-composer and last year built what he reckons is the best-equipped studio in Belgium. At the moment it is eight track but conversion to 16 track will take place soon. Engineers applying for this job must be well experienced, and prepared to assume a great deal of responsibility. The rewards are: £4,000 to £5,500 per annum, based on a salary plus a percentage of the turnover, and free lodging for the engineer and his family in a villa close to the studio. The studio is in a 'calm and green part of the country', on the outskirts of Brussels. The equipment used at the moment includes an eight track Scully, two stereo Scullys, EMT plates, echo chamber, Revox tape delay, four limiter-compressors, and a vari-speed unit. References and c.v. should be sent to Marc Aryan, Chemin du Moulin, 7-1328 Ohain, Belgium.



Marc Aryan's Brussels studio.

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Suppose a drum track is being recorded at fairly high level. In addition to the sound the drummer has practised for years to produce, the tape delivers new sounds of its own that nobody asked for, such as modulation noise on drum beats that sounds like buzzing and added noise on cymbals which subtly reduces their clarity. Since these effects are reduced when the Dolby System is used, the Dolby tape will lack the harsh sounds present on older drum recordings. (Of course, some people may prefer the changed sound.)

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A Stereo Phase Indicator

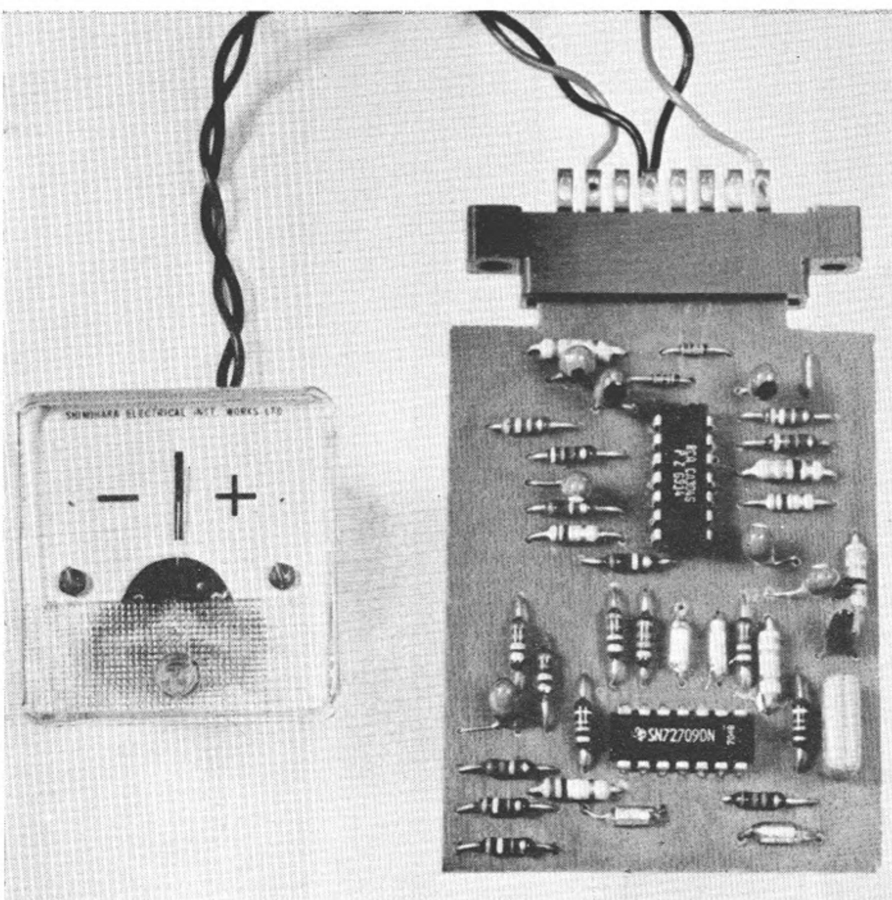
David Robinson contributes a postscript to his 'High Quality Mixer'

SOME years ago I described a visual stereo phase indicator (*Hi-Fi News*, October 1966) which enabled stereo microphones to be correctly phased before a recording session. It also allowed the phase and width to be monitored throughout the recording. This unit was based on a cathode ray oscilloscope display similar to the Lissajous figure experiment—the left channel was applied to one set of deflection plates, and the right channel to the other. Thus in-phase signals deviated along one axis, and out-of-phase components along the other (**fig. 1**).

Cathode ray tubes are bulky devices, requiring high voltages as well as having a heavy heater current consumption. I had often considered designing a simpler circuit but as usual nothing was done until the oscilloscope failed at an important session. This of course was not disastrous since ears can always be used with usually identical results; but sometimes it is possible to become confused in reverberant situations. There are also a few occasions when it is not possible to monitor the signal for one reason or another. After this particular session I decided to build a simple phase detector circuit which would register the phase between two signals on a meter, thus giving an unambiguous indication.

A little thought showed that a circuit which showed instantaneous phase differences between signals would be misleading. With all but truly coincident microphones, signals arise with phase differences corresponding to frequency and separation of the microphones. It is the average phase difference which is important, so that some method of integration is required; quite apart from the need to read the meter! A quick experiment showed that the integration time of the moving coil meter was not sufficient by itself, so that some electronics would be necessary to provide the necessary information storage and averaging.

FIG. 5



Conventional phase metering techniques were examined, but soon rejected. Procedures normally used are to take the two incoming sine wave signals and square by either overdriving and clipping, or by using a Schmitt trigger circuit, or by detecting zero-axis crossovers. Two trains of square waves are then produced, differing in on-off tone positions depending on the relative phase of the two incoming signals. The two trains are used to turn a further two-state stage on and off, producing a square wave whose on-off time varies according to the phase. This difference can then be read out on a meter which responds to the average dc component of the pulse (**fig. 2**).

This represents a complicated piece of electronic equipment, and is generally only suitable for sine waves or regular shaped input signals. A much simpler scheme, following some of the basic reasoning of the complex arrangement outlined above, was tried and found to be entirely satisfactory. **Fig. 3** is a block diagram of the meter.

Incoming signals pass to addition and subtraction stages; if we call our input signals A and B then the outputs from these stages are (A+B) and (A–B), respectively. Diodes D1 and D2 rectify the signal and a centre zero meter is connected between them. Consider what happens if the two signals are of equal amplitude but out of phase, e.g. B=–A. The output from the sum channel is A+(–A)=0; from the difference channel A–(–A)=2A. A current flows from point Y to point X, and the meter deflects accordingly.

If the signals are in phase, A=B. The sum output is 2A, the difference 0. The direction of the output current flow is reversed, from X to Y, and consequently the meter deflects in the opposite direction.

If input B is missing, the outputs from both sum and difference stage is A, so no deflection occurs. (The circuit as drawn is not fully satisfactory, since, according to the drawing, with input A=0 the meter will deflect; however, it serves to explain the design concept.)

The easiest method of realising the sum and difference amplifier is to use integrated circuits. Operational amplifiers can be obtained with high open loop gains that with the addition of feedback produce arithmetic accuracies far beyond the requirements of this application. ICs used in this way are a boon to a constructor, allowing complicated circuits to be wired up with the minimum of effort. High loop gain also allows for the possibility of considerable closed loop gain without degradation of the circuit operation.

(*continued on page 561*)


1. "Let me tell you that the MM-1000 Recorder/Reproducer comes in 8, 16 and 24 channels. Handles 1 and 2 inch tape, on 10½, 12 and 14 inch reels. Is the ultimate in audio recording."
2. "O.K. But the AG-440 B Recorder/Reproducers are a whole series of rack-mounted, console and heavy-duty portable recorders. With dual speed transport, separate solid-state electronics chassis for each channel. In 2, 4 and 8 track."
3. "Look. This new ABR-15 Broadcast Recorder/Reproducer has full bi-directional operation, so it's flexible in automated and semi-automated applications. Direct drive means precise tape speeds. Variable fast forward/reverse. 15 inch reel (or 10" on the ABR-10)."
4. "I mean the AG-500 and the AG-600 are portable recorders that offer professional quality in 1 or 2 channels and a choice of speeds."
5. "But did you know what the AA-620 Amplifier/Speaker offers in high-quality monitoring or sound reproduction? Used with equipment like the AG-600 and AG-500, or as a studio monitor."
6. "And would you believe the ruggedly designed CD-200 cassette duplicator which at 75 ips, turns out more, more quickly than any other cassette duplicator (up to 3000 C-30s per 8-hour day!) Start with one master unit and one slave, add on up to five slave units. Automatic operation. In two-track mono or four-track stereo."
7. "All I'm saying is the BLM-200 Duplicator System produces multichannel cassette or cartridge tapes very fast. Drives up to 10 or even (modified) up to 20 slaves. It's a self-contained bin-loop system."
8. "I want you to know about the RR-200 reel-to-reel Reproducer making 4 or 8 track stereo cartridges. Drives up to 10 Ampex 3400 Series slaves. Select 60/120 ips or 30/60 ips tape speed. Independent switching."
9. "And don't forget the AM-10 Mixer. Professional quality, compact, six-position, a two-channel mixer for studio or portable use."
10. "Not to mention professional audio recording tape as used in broadcasting, duplication etc. (600 series). Or 404 low noise tape, for all mastering recording including endless loop and wherever top performance is needed."
11. "Then there's the 360 series cassette for maximum frequency response in stereo. Lower noise. Higher output. More magnetic energy per square inch of tape. Response capability from 30 to 20,000 cycles."
"Why don't you guys stop nattering and send me facts about
1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ 10☐ 11☐
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SS 2

To buffer the IC from input and output loading, another IC is used. IC is somewhat of a misleading term here, for although fabricated on a single chip, the elements inside are four discrete transistors. In practice, such a device is only useful in highly automated mass production situations, where assembly time is significant. For building experimental circuits the time spent in figuring out the interconnections makes this IC somewhat useless, but I must admit the total package looks better!

Fig. 4 shows the finalised circuit. Incoming A signals are passed to Tr3 acting as an emitter follower; the input impedance is about 80 k Ω. Tr3 output drives both IC amplifiers (actually both are in a single package) via R3 and R13, feeding the negative or inverting input in both cases. Channel B, on the other hand, feeds the inverting input of one IC amplifier, IC2a, and the non-inverting input of the second, IC2b. The output of IC2a is therefore –(A+B) (negative as the amplifier inverts), and from IC2b is –A+B, or –(A–B). [Detailed arithmetic gives the gain into the subtraction terminal of the IC as $G = -\frac{R15}{R13}$ while into the summing terminal as $G = 1 + \frac{R15}{R13}$ (not $\frac{R15}{R13}$). Thus for small closed loop gains the extra factor 1 must be taken into account; the input to this terminal must be reduced, and this is the function of the attenuator R14/R24. The gain using this added circuitry is $\left(\frac{R24}{R14 + R24}\right)\left(1 + \frac{R15}{R13}\right)$, and this must also equal $\frac{R15}{R13}$. Further arithmetic gives

$$R24 = \frac{R14 \times R15}{R13} = R15 \text{ (as } R14 = R13\text{)}.$$

Thus if R15 is altered to change the overall gain to suit different input signal levels, R24 must also be changed accordingly. Because of the difficulties in circuit layout on the printed circuit board, it was easier to return R24 to 0V via C13; in a wired layout, R24 can be returned directly to the mid-voltage supply V_2, omitting C13.] The gains of both IC2a and IC2b are controlled by the two feedback resistors R5 and R15 respectively, and can be adjusted to increase or decrease the sensitivity; increasing R5 increases the gain; R15 must always equal R5 for correct operation. With a large open loop gain (80 dB) and a closed loop gain of 6 dB, the amplifiers are almost ideal; there is no interaction between channels, and common mode rejection (measure of the effectiveness of giving no output from IC2b for A=B) is excellent.

Most integrated circuits suffer from too much gain at high frequencies. Since the connections are short, and the transistor sizes so small, the natural cut-off frequency may be many hundreds of megahertz. With components so close and because of the method of construction, there will be inevitably stray capacitance between parts of the circuit. This often turns negative feedback paths into positive feedback routes, and results in the amplifier oscillating at high frequency. It is therefore necessary to shape the amplitude/frequency response to prevent there being greater than unity gain at the point where the feedback changes sign. Two networks are used to perform this bandwidth restriction; C10 and R21 shape the response of the input stages, and C9 tailors the output side of the IC.

The two combined signals are taken to two emitter followers Tr2 and Tr5, part of IC1, which isolate the detection circuitry from the adder and subtractor amplifiers. The rectifiers charge capacitor C5 either positively or negatively. Although C5 is a polarised device, it can stand the small reverse voltage if a tantalum device is used. The capacitor feeds a 50-0-50 μA centre zero meter. The prototype used a Japanese meter; the original scale was sprayed white, and a new centre line with – and + signs added with Letraset on appropriate sides.

The detection circuit works as follows. For all signals, the output of Tr2 is –(A+B), and from Tr5 is –(A–B). If A=B, then Tr2 output is –2A, and Tr5 is zero. C5 is charged on the positive half-cycles of this wave, and the meter deflects to the right.

If A = –B, then Tr2 output is zero and Tr5 output is –2A. D2 is connected so as to pass negative half-cycles and therefore C5 is charged negatively; the meter deflects to the left.

If only signal A is present, Tr2 output is –A, and Tr5 output is also –A. On one half-cycle D1 attempts to conduct, on the other D2 in opposition; the net average charge on C5 is zero and no deflection occurs.

If only signal B is present, then Tr2 output is –B, and Tr5 is +B. Again, remembering the – and + signs here represent phase of the signal only—IC2 inverts A signals, but not B—the net charge in C5, being determined by the polarity of the two diode connections, is zero.

The circuit is easy to set up. Applying the same sine wave 1 kHz signal of 0 dB to both A and B inputs should cause positive full-scale deflection, or slightly over, with the values given. (If a negative indication occurs, reverse the meter connections.) This input signal should correspond to a signal of somewhere about 4 dB below peak recording level, that is, about 0 VU. If the unit is being used with other signal levels, a wide range can be accommodated by changing R5 and R15, up to a maximum of 470 k Ω for 120 mV sensitivity or down to 10 k Ω for a 6V input. The unit is then set up, and can be fully checked if a suitable transformer or phase reversing circuit is available. If out-of-phase signals are fed into the circuit, the meter should deflect to the other full-scale position.

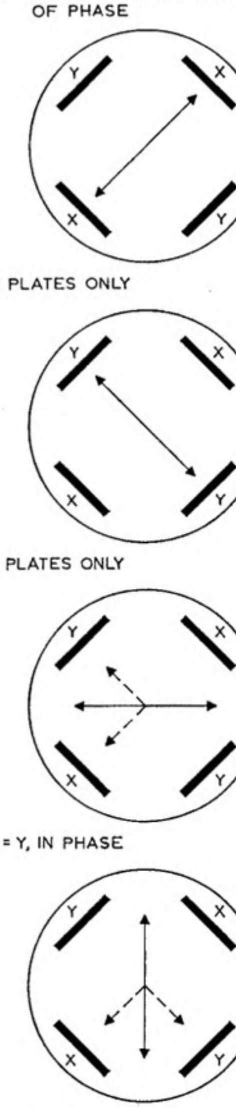
A signal applied to any single input should cause no deflection, although one or two mm is permissible—further deflection indicates that the resistances R3, 4, 13, 5 and 15 are not as precise as they might be. If the deflection is considerable, R15 *or* R5 may be slightly varied to correct the meter deflection. A significant variation (more than 10%) implies some circuit error.

Construction is not critical, except that power supply decoupling must take place near IC2 with both electrolytic and non-electrolytic capacitors (C7, C8); the minimum impedance of electrolytic capacitors is about 4 Ω which is often insufficiently low to prevent h.f. oscillation. The circuit operates on any voltage from 28V to 12V with no component or performance change. Current consumption is 10 mA at 24V, which means batteries can easily be used if necessary.

One additional use of the circuit is to separate the signal into its A+B and A–B components. As discussed earlier, the output of IC2a is the sum component A+B, and of IC2b is the difference signal A–B. These can be further processed to manipulate stereo separation and width (see STUDIO SOUND, May 1971). The outputs of the two IC's are buffered by Tr2 and Tr5, and then brought out to pins 5 and 6 of the printed circuit. In this mode the diode circuitry is not used. In some situations it may be important to achieve accurate balance; that is, zero output at pin 6 for A=B. Circuit tolerances allow for a maximum output of (A–B) of about 20 dB below (A+B), which is normally perfectly adequate (certainly as a phase indicator). If R24 is varied, the subtrac-

(continued on page 563)

FIG. 1 OSCILLOSCOPE PRESENTATION OF PHASE



(a) X PLATES ONLY

(b) Y PLATES ONLY

(c) X = Y, IN PHASE

(d) X = –Y, OUT OF PHASE

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tion can be made very much better than this. The fundamental may be entirely cancelled, leaving only the noise and harmonics generated in the integrated circuits.

Since the meter was originally designed to be a companion to the mixer recently described in STUDIO SOUND (June 1970-May 1971), a printed circuit was designed which is identical in size to those used in the internal construction of the mixer. The card measures 57 x 83 mm and is mounted in the same manner via an eight-way edge connector. The photograph (fig. 5) shows the assembled board, which is fairly well packed. To reduce the layout difficulties, drop tantalum capacitors weie used throughout. Nowadays these are almost as cheap as standard electrolytics and are much more reliable. This card can be obtained from the author through Link House. Normal building techniques apply. The first components to be put on the board are the smallest, so that on reversing it to solder the leads they are pressed up flush to the board. Progressively increasing the size will maintain this situation.

A small bit soldering iron should be used since some of the solder pads are closely spaced, particularly in the vicinity of the ICs where 3 mm spacing is used. Some care is required to stop solder bridges forming across adjacent tracks. To avoid damaging the chip heat should be applied to the integrated circuit pins for as short a time as is possible.

After the initial testing, much innocent amusement was derived from playing tapes and records into the unit, before settling down to use it in recording sessions. Multi-mike techniques showed up clearly as either no or little deflection, as did early stereo records with only left and right signals. Even older mono records showed a steady deflection to the right, as expected of course. I even rediscovered one out-of-phase record which I had been keeping as an example of how the early stereo record producers had not yet organised foolproof procedures. Phasing didn't matter in mono days, and there are very many transformers between master tape and master disc cutter, each with the possibility of phase reversal.

Those constructors who wish to mount the unit in their mixers will, I am sure, not find any difficulty in squeezing in the meter. An alternative display would be a miniature edgewise version; accuracy is not required, just the ability to register a positive or negative deflection. In the six months since it was built the prototype has already proved itself very useful, and has helped to clarify many a doubtful phasing problem.

Component Suppliers

IC1 RCA CA3086.
Electronic Component Supplies (Windsor) Ltd., Thames Avenue, Windsor, Berkshire. Price 38p each plus 33p post/packing/handling for any number.

IC2 Texas SN72709DN.
Quarndon Electronics Ltd., Slack Lane, Derby DE3 3ED. Price £1.22 each (no postage, charge but £1.50 minimum order).
Printed circuit. Ref 224 from the author c/o Link House. 40p.

Tantalum capacitors.
Union Carbide Kernet E capacitors:
3.3/15 Code K3R3E15 12.9p
22/15 Code K22E15 14.6p
10/20 Code K10E20 14.6p
6.8/35 Code K6R8E35 14.6p
Celdis Ltd., 37-39 Loverock Road, Battle Farm Trading Estate, Reading, Berkshire. £1 minimum order charge (prices include postage).

FIG. 2 PHASE MEASURING TECHNIQUES

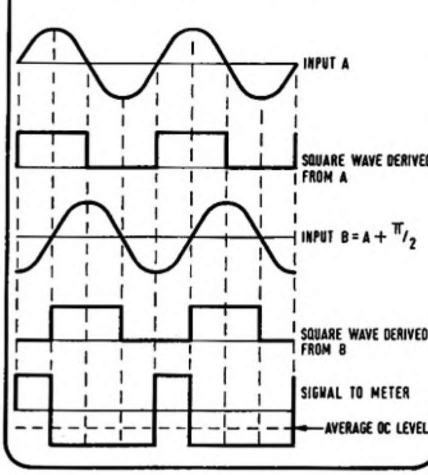


FIG. 3 SIMPLIFIED DIAGRAM OF PHASE INDICATOR

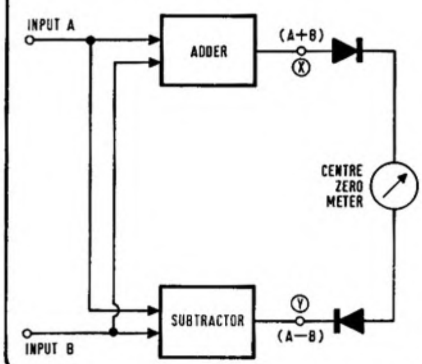
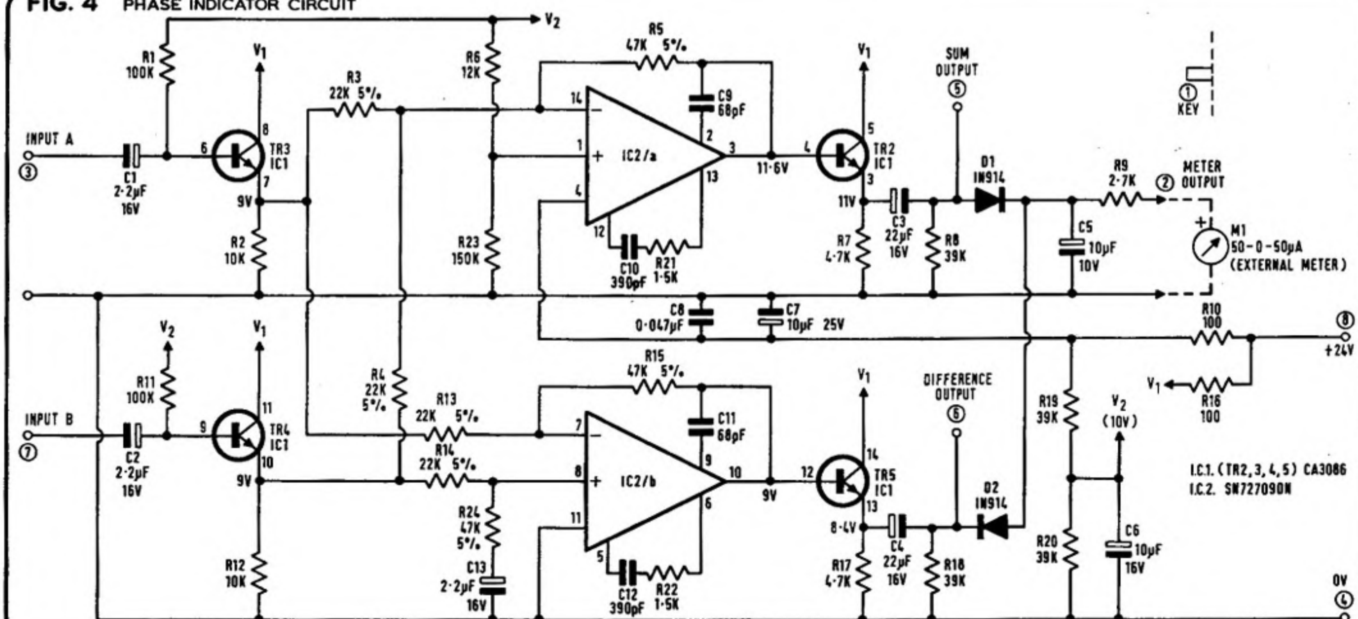


FIG. 4 PHASE INDICATOR CIRCUIT



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ADRIAN KERRIDGE TALKS TO 'STUDIO SOUND'

RECENT clients, as well as old friends of Lansdowne, saw towards the end of 1970 a change in our studio. Over a period of several years operation, the signs of hard work and wear were prevalent. Fading paintwork, fraying carpetry, and other outward signs of decrepitude. Outward only of course: we have always prided ourselves upon the talent of our young staff, our high technical capability and the desire to offer our clientele service and courtesy on a 24 hour, seven day a week basis. During the autumn of last year, Lansdowne were re-born and we feel is now as comfortable in furnishing, appealing in decor and technically advanced as any in the business. The atmospheric lighting is adjustable to please the temperament of the producer or the mood of the session.

The environmental changes were drawn up to our specification by Acoustic Consultants Ltd. The culmination of all these changes is a studio designed specifically to leave the engineer to concentrate on creating the sound. The engineers enjoy working here; the facilities back them up 100 per cent. Let's face it, recording is about putting it down, not worrying about the technicalities. The heart of any studio is the console and Cadac designed ours exactly for Lansdowne's requirements, which I will now go into in detail.

Our Cadac console may be conveniently divided into seven main sections:

1. Microphone and line inputs, with programme equalisers routeing switches and channel faders.
2. a. Group output section with re-routeing switches and group faders.
   b. A pair of group output modules may be replaced by one double module containing two different types of quadraphonic sound image controls.
3. Reverberation or echo outputs and returns, each with programme equalisation and a fader.
4. Monitor channels, with monitor output groups and metering facilities.
5. Auxiliary and main foldback controls, with playback to foldback facility.
6. Console control and communication functions.
7. Ancillary equipment such as compressors, limiters and special effects modules, etc.

We have 28 input channels each containing the following: *microphone input*: input impedance selection switch (300Ω to 1.2 kΩ); *gain switch*: maximum gain setting of 70 dB, reducing in 5 dB steps to 40 dB, then 10 dB steps to 0 dB gain (ref 300Ω input impedence).

There are two lamps indicating whether the channel has its microphone or re-mix input operating.

The re-mix input can be used by selecting the output of whichever tape machine is to be re-mixed by pushing the appropriate section button.

Re-mixing

The term re-mix is used to define the operation of using any number of microphone channels as line input channels, which may have switched into them the normal playback or sync outputs from a tape recorder. Channels turned into the re-mix mode can be changed back to microphone operation individually by using a 'cancel re-mix' switch. Each microphone channel contains one programme equaliser.

The output of the equaliser is routed via two rotary switches; the 'odd' switch routes to output groups 1, 3, 5 . . . and the 'even' switch routes to output groups 2, 4, 6 . . .

An 11-position pan control pans between these two switches, and is brought into use by a separate button. If the pan control is at the centre position, there is no change in the output level as it's brought into circuit. Furthermore, when the pan control is in the circuit and turned through its 11 positions, a sum of the outputs of the odd and even routeing switches will not change by more than 1 dB; thus providing a stereo image compatible to mono. This, in my experience, is an essential feature of a well engineered desk. We also have a facility for taking the output of the microphone amplifier from before the equaliser and before or after the channel fader to each or any of four echo channels via a single gain control, and each or any of two auxiliary foldback channels via another single gain control.

Each microphone channel also has 'prefade listen' and 'check' function. The check switch provides a very useful function, when in the check position, of turning all the other modules in that section of the desk off.

The equaliser and microphone input channel modules contain the microphone amplifier, high pass filter and a comprehensive programme equaliser. This is divided into three sections, with carefully selected frequencies covering the total audio spectrum, giving the maximum flexibility necessary for music recording. The bell curves have an average slope of 6 dB per octave with a maximum of 16 dB lift or cut in 2 dB steps.

There are twenty-four output groups from the microphone or echo return routeing channel, the signal is fed into a group mixing amplifier, then via the group fader to the output group amplifier. From here the signal goes straight out to a recorder via the distribution jack-field, or may be rerouted back into any of the other 23 group mixing amplifiers. Once a group has been rerouted to another, it cannot itself pick up a rerouted group. In other words, the console cannot be set into oscillation by feeding group signals back onto themselves. Provision is made for feeding to each or any of the four main foldback channels from either before or after the group fader, via a single gain control. Each output group has 'prefade' listen and 'check' functions. Any pair of output group modules may be removed from the console and be replaced by one double-width module containing two different types of quadraphonic sound image controls.

Each control has an 'in-out' switch. In the 'out' position the image remains in the 'centre'. Both types of quadraphonic controls are fully compatible to mono (i.e. if the four

(*continued on page 567*)

Messrs. Kerridge and Fi-Trench.

outputs from either control are summed, the resulting voltage will remain constant within 1 dB, for any position of the control).

There are four outputs of echo channels which process the signals before they leave the console to go to reverberation plates etcetera. Each channel has a master output fader, a programme equaliser, and also coarse and fine spin controls, for spinning tape loops and so on. There are eight echo return channels, each having a programme equaliser and fader. The signal is routed into the main mixing groups in the same way as a microphone channel, with the exception that it may alternatively be routed directly to the four monitor group amplifiers, to provide a 'phantom echo'. A 'check' switch is provided on each return channel.

We have 24 monitor channels, the inputs to which are selected via the 'line-tape' relays through one master pushbutton. Each channel has a stepped gain control, pan switch and pushbuttons routeing to the four monitor group amplifiers. Provision is also made for sending the signal from before or after the monitor gain control to each or any of the four echo send channels, via a single gain control. When this facility is used, the appropriate echo return channel is automatically routed to the monitor group amplifiers, and cannot accidentally be routed back to the main mixing group to cause oscillation.

Metering: we use VU meters, one for each monitor channel, two in conjunction with selector switches to reach echo send and return, and one for prefade listen. A dual trace, peak reading light beam meter and phase correlation meter are included in the desk, normally being used when remixing to stereo.

The gain of the four monitor output groups is controlled by one four-section linear motion fader with very accurately matched tracks. The four outputs may be instantly attenuated by 20 dB, when the 'dim' button is pressed. Further attenuation takes place when any talkback facility is used.

There are four main foldback groups, which may be directly fed from 24 output groups or the playback to foldback selection switches. The microphone channels go to 'A' and 'B' auxiliary foldback channels, which can then be switched to each or any of the four foldback groups. The outputs of the foldback groups can be monitored on the control room speakers by pressing the appropriate monitor selection button. Control and communication functions: talkback facilities provide for the use of a separate producer's desk in the control room and a conductor's rostrum in the studio.

Talkback communication is provided as follows:

a) Console to: Four foldback groups
Studio
Conductor's rostrum
Output groups, for tape identification.

b) Producer's desk to: Four foldback groups
Studio
Conductor's rostrum

c) Conductor's rostrum to - Four foldback groups
Studio
Producer's desk
Console.

The desk has a tone generator with a selection of nine frequencies. The output may be directly injected into the output groups of the console for line up and identification purposes.

A very comprehensive patch bay is fitted to the console to permit insertion of external equipment at various points in the recording channels. The microphone channels and output groups all have jack-field insertion switches allowing a quick 'in-out' comparison to be made with an external piece of equipment.

All VU meters are isolated from the signal lines they are reading by buffer amplifiers. The sensitivity of the VU meters on the monitor channels may be increased 20 dB by pressing one switch, thus enabling low level frequency runs on DIN test tapes to be read at 0 VU.

The frequency response of the complete recording chain in the console from the input of the microphone transformer to the output of the group amplifier is + 0.2 dB in the range 20 Hz to 20 kHz, and -3 dB at 5 Hz and 100 kHz.

The maximum amplification of a complete recording chain of the console is 94 dB reference to the 300 Ω input.

The normal operating position of the faders:

Members of the Mike Westwood band in session.

Channel faders, Echo send faders, Echo return faders } -10 dB from the 'top'
Group output faders -12 dB from the 'top'

The normal operating output level of the desk is + 4 dBm which corresponds to 0 VU on the meters.

The normal working level of all amplifiers in the console, except the group output, is 0 dBm. The maximum output from any of the amplifiers before clipping is + 24 dBm. Therefore a 24 dB headroom is maintained throughout the console with the exception of the output amplifier. We measure the system noise in the bandwidth 20 Hz to 20 kHz (-3 dB points) and divide it as follows:

a) From the input of the microphone transformer routeing through the equaliser with the controls 'flat' to the input of the channel fader. With a 50Ω source resistance (on the 300Ω input) the noise is better than -128 dBm equivalent input signal.

b) With all channel faders down, and through one mixing amplifier and group output amplifier, the output noise is better than -80 dBm.

The total harmonic distortion is measured by applying a tone to the 300Ω microphone input. The microphone amplifier was set to 45 dB gain, the equaliser was in circuit with the controls 'flat' and the channel and group faders were positioned at 10 dB from the 'top'.

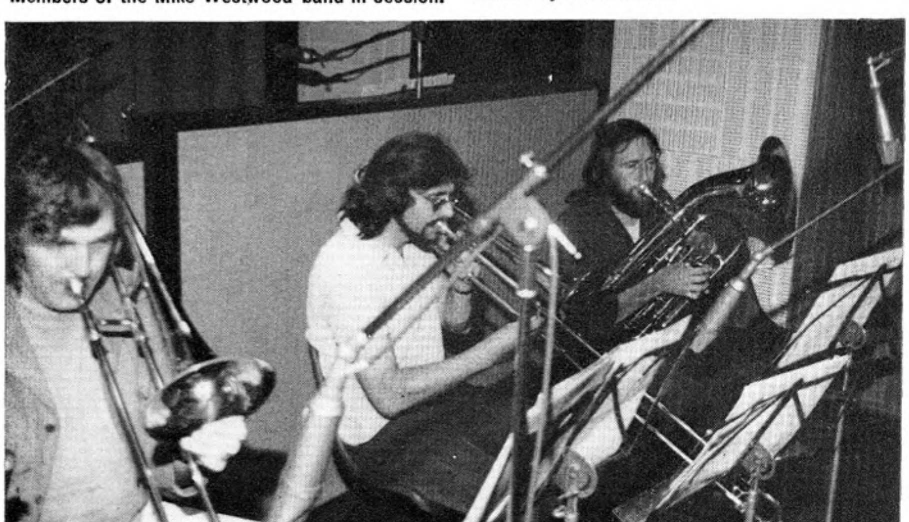
The output of the Radford oscillator at 1 kHz was adjusted so that the output of the group amplifier was +8 dBm. At this level into 600Ω total harmonic distortion was better than 0.05 per cent.

At +18 dBm into 600Ω the THD was better than 0.08 per cent.

At + 24 dBm into 600Ω the THD was better than 0.15 per cent

The shift in phase angle of a signal through the console was measured from the input of the microphone transformer to the output of a group amplifier, with the equaliser controls 'flat'.

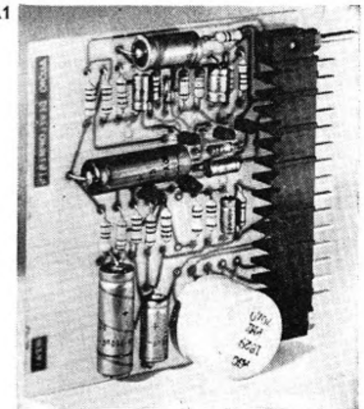
We found at 20 Hz that the phase shift was not greater than 5° leading, and at 10 kHz not greater than 13° lagging. Another feature of the console is that connections to all the external equipment are made via Tuchal multiway connectors.



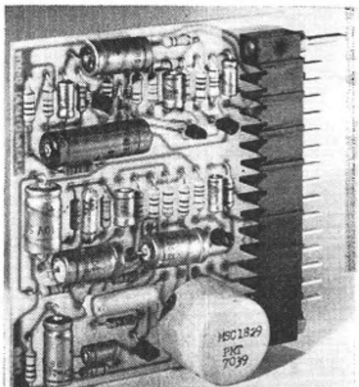
The MPA1 and MPA2 Microphone Amplifiers

The basic microphone amplifier design, the MPA1, comprises two stages separated by a gain or volume control. The first stage gives 40 dB gain and is designed for low noise and low input impedance (600 ohms). The second stage gives 20 dB gain and an output capability of 8v rms into 600 ohms.

MPA1



MPA2



The MPA2 has similar electrical characteristics but with more refined circuitry to compensate for a slight change in noise levels in the MPA1 when the microphone is disconnected.

Both printed circuit cards will fit to a Painton 15 way connector. The connectors are fitted with polarising pins and they are connected so that either board can be inserted without any alteration to the common connections.

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TAPE SPEED CONTROL

IN most studio tape machines, speed change is effected by switching the fields of a synchronous motor. Speed depends on the number of poles. The greater the number of poles the slower the speed, in direct proportion. A two-pole motor running from a 50 Hz mains supply rotates at 60 x 50 = 3,000 revolutions per minute. On a 60 Hz mains, it rotates at 3,600 rpm. To avoid the tape transport speeding up, the tape velocity increasing by 20 per cent, the capstan diameter may be reduced when the machine is exported to a 60 Hz mains area.

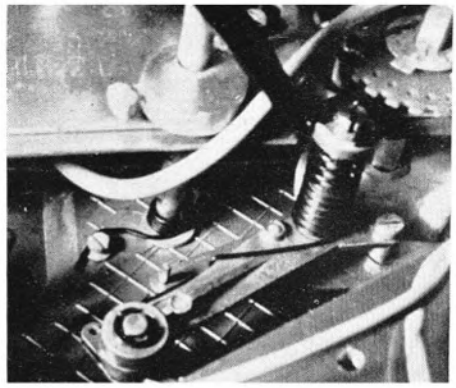
In practice, the basic capstan size might suit the higher mains supply, with a sleeve to increase its diameter for 50 Hz operation. This is seldom done. Interchangeable capstan pulleys are supplied with a number of imported tape recorders. If your machine has the wrong pulley, and you are not thinking of emigrating, then there is little you can do but change it. One tape speed changing device is a sleeve on the flywheel spindle, though this can give a lot of trouble.

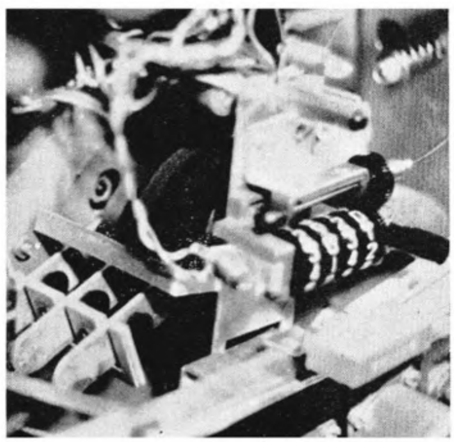
Problems arise when the sleeve is in any way eccentric, or is a loose fit. On many recorders, the sleeve is held in place by a cap screw which threads into the tapped capstan spindle. There is only one reason why the same attention to tolerances should not be given when the construction is complicated in this way: the cost of the operation.

Where eccentricity exists in a pressure drive, there will be a tendency for the tape to travel toward the point of highest pressure. If capstan and pressure roller 'lean inwards' towards the top, then the tape may ride up and out completely. It can be helped on its way by an increase in take-up torque, mentioned in the August contribution.

Where the eccentricity is regular (not a contradiction—think of a bent spindle), the effect is of varying azimuth. The tape rides up and down usually within quite small limits, and on a regular tone quite distinctive amplitude modulations can be heard. The answer, quite often, is to change both sleeve and securing screw, but there may be the problem of a bent spindle. The thinner the spindle, the more likely this is. The bend can start at the root—where the spindle is drifted or force-fitted into the flywheel. One solution is putting a steel tube, as close-fitting as possible, over the spindle and gently but firmly straightening it. This can work but it is tedious and untrustworthy.

Many of the same strictures apply to the master drive, the motor pulley. Although we are not contending with a sleeve, we have to take note that the capstan may either be a grooved pulley to take a belt, or a stepped arrangement to place an intermediate wheel on different diameters. Occasionally, we meet the constant master speed drive, with secondary speed changing from a driven pulley system. Whoever thought that one up probably imagined he was removing one bugbear from the tape deck by taking away the capstan change, but in doing so has introduced three others. We know of gramophone deck manufacturers guilty of the same singlemindedness.





Top: Sprung lever system from the late Truvox
Centre: Three-wheel Ferrograph 7 speed-change.
Bottom: Ferrograph again. A simple but effective upper bearing.

The capstan may be locked to the spindle by a grub screw. Sometimes a socket screw is used and this, properly hardened, can make a firm clamp. Too often, everything seems firm but there is a slight amount of play. Remove the capstan pulley and inspect the spindle carefully. Shine a bright light on the motor spindle and look for score marks. It may be that the level of the pulley was reset and the capstan pulley turned a little in retightening. This should be obvious on inspection.

When refitting, make sure that the clamping is really tight. You can do this with a socket screw, though less effectively with a slotted screw. If the latter is hard enough for one's purpose, the last twist tends to break off the half area of the top to the right of the slot. Whichever fitting system applies, there is almost certain to be a conjunction of different metals. The motor will heat. At the higher temperature, expansions of the spindle, the sleeve and the screw will all differ. The result can be a slackened pulley when the motor has been in operation for some time. Depending on the type of drive used, this can show itself as a wow, an irregular jerk or a constant slowing. On some BRC domestics, where the pulley is held by the pressure of a spring and washers trapped beneath a circlip, bad servicing can give this 'constant slip' fault, where everything runs slightly slowly though regular. I have had B & O machines with an odd effect of intermittent wow that has occurred because the socket screw has not allowed a good bite into the capstan after servicing. In all cases, after refitting a capstan pulley of a multi-speed motor device, run the machine till it is thoroughly hot and then retighten.

Earlier, in talking about sleeves and pressure, I commented that the tape tends to run to the point of highest pressure. The same thing applies to belts and intermediate wheels. The stricture arising from that comment is—see that your transport's on the level!

I don't mean you to go around with tape measure and bubble. I am referring to the angle at which the belt or wheel meets the pulley and subtends from it. Worn intermediate wheels have been a bugbear to tape recorder mechanics since the darned things were invented. That would not be so bad if they were always easy to get at, and to realign after

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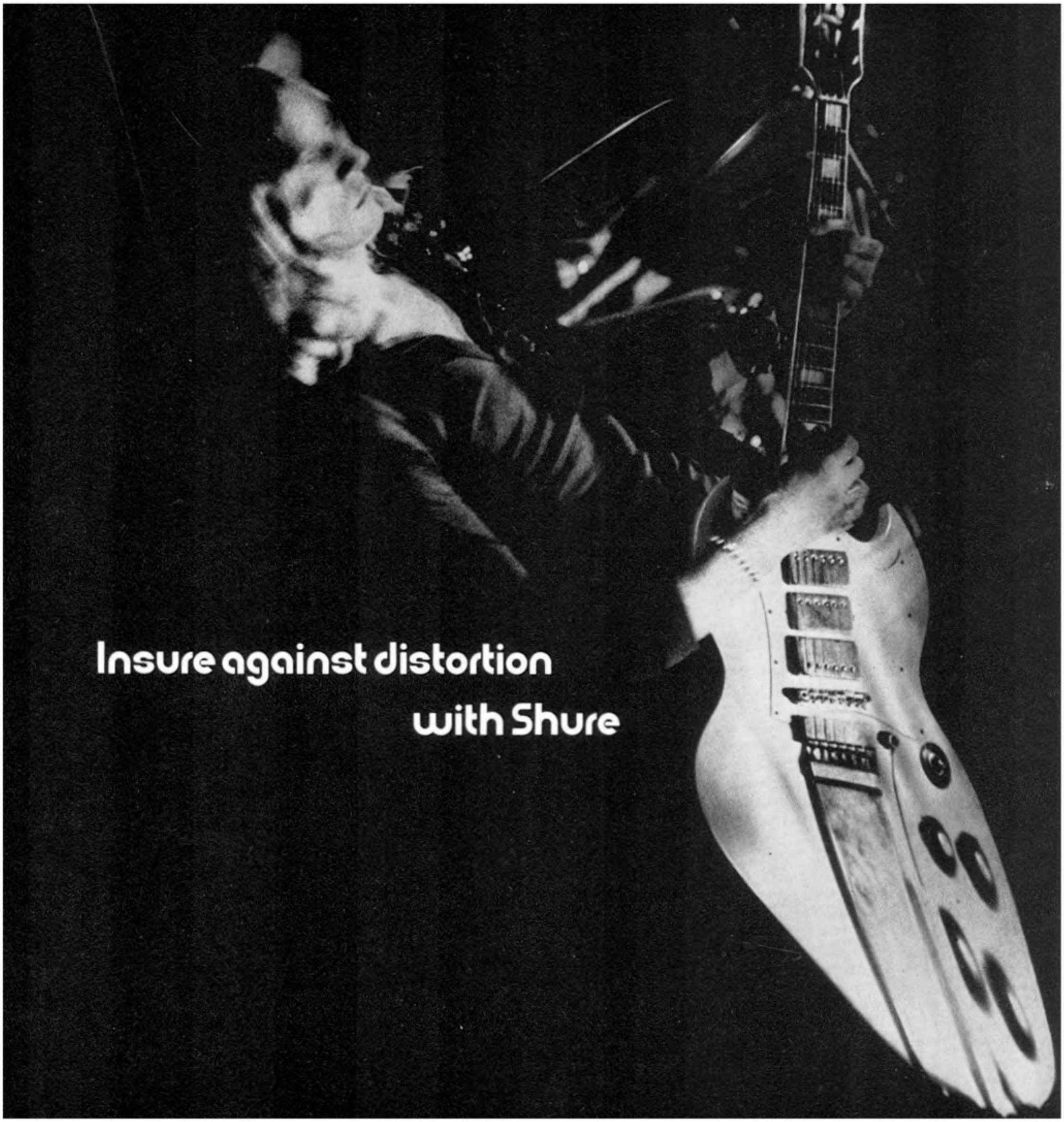

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Ron Geesin Unlimited

By Adrian Hope

THERE are two Ron Geesins; both are the same man. The first performs live on stage at colleges, arts festivals and alongside rock bands. The performances are totally acoustic with Geesin playing piano, banjo and more or less anything else that comes into a style that might best be described as 'speeded up and rather jazzier Ivor Cutler; which is not so surprising because both Cutler and Geesin hail from Glasgow. Although their musical paths have developed without influence, they obviously have much in common. The other Ron Geesin, and the one that we're interested in here, is the self-taught musician and juggler with electronics.

After meeting the man at his Ladbroke Grove studio, and celebrating afterwards at his local, I staggered away with enough material for a dozen articles and the sure knowledge that most of what I write will be out of date by the time it ever sees print. But with a man like Geesin, that's inevitable. Ideas shoot out of his head in all directions like sparks and already he has upped and moved his studio to a new house in the deep country.

'I've had enough of vertical living,' he explained, struggling to put a record on a turntable jammed too low for comfort below a bench carrying five Revox *G36* beneath a too-high-for-comfort rack of tapes.

Asked to describe his studio amenities, Geesin will dutifully list the Revoxes and his boxes of second-hand and often unserviceable electronics gear, but emphasise the amenities that he relies on most—skill and razor blades. To Geesin, human beings are what matter and he sees them too often harnessed by machines that started out as timesavers. He sees housewives ruled by kitchen gadgets, industry ruled by computers, and rock groups taken over by their electronics.

He started off as a self-taught trad jazz pianist ('a cross between Rachmaninov and Earl Hines' is how he describes his style), discovered tape at the age of 21 (six years ago) and has spent some of the past year working with rock groups like Pink Floyd (a lot of his writing is on their LP *Atom Heart Mother*, Harvest *SHVL 781*). But he thinks that rock music has become a self-satisfied bore—something safe and unoriginal.

Lack of original ideas is probably the one criticism that could never be thrown at Geesin. Sometimes his ideas work and sometimes they don't. But they *are* original and usually they centre around tapes made in his studio by multitracking his own performances on anything unearthed from the pile of extraordinary instruments which lie around ankle deep. Like a grand piano, a toy trumpet, numerous guitars and African stringed instruments. Like a clutch of banjos with crystal pickups (old gramophone cartridges with their styli glued to the vellum). The banjos he once recorded backwards in quartet for a TV commercial.

I asked him if he had a synthesiser.

'Not yet. I can't afford one and anyway you can't beat the backwards banjo. Or try whistling through a fuzz box; it would take you a week to set that up in sawtooths or sine waves. And this . . . this would take you a month at least.'

'This' was an old upright piano, gutted but for the strings, and played by pushing a Woolworths vibrating cocktail stirrer against them. The resulting sound is rather like a mandolin and, with subtle damping from a Geesin knee, is heard on a film soundtrack in John Schlesinger's *Sunday Bloody Sunday*. A previous film was the fairly controversial *The Body* (of which some of the music is on Harvest *SHSP 4008*).

Despite the successes and the financial rewards now beginning to come his way, Geesin is still less than extravagant. And it's not just his canny Scots nature that's behind it. There's a feeling of 'make do' about his studio which is encouraging to anyone with limited funds. For example, the five Revox *G36* are not hitched to Dolby. 'I can't afford it—and anyway I'd rather have a bit of hiss than all those lining up problems.'

Geesin's routeing patchwork is home-made from standard GPO telephone jacks; he bought a box full of them cheaply from a warehouse in the St Pancras area. There's a 12-channel mixer made up specially for him and which works well but arrived nearly eight months after the promised delivery time.

'Don't mention their name. They can do without the plug. But do mention Woods & Porter (Amperon) of Dartford.'

'Who are they?' I asked, rather shamefacedly.

'A very nice company who've built me all kinds of odd little bits of gear, like impedance converters and this sync unit.'

The sync unit does the remarkable job of ganging up two or three Revoxes at a time and enabling Geesin to do what I would have thought was out of the question. Namely, start and stop them in unison and allow up to four minutes of four or six track recording on to two tracks of each machine. According to him, and he's tried it so he should know, as long as the same tape is used on each machine (to account for spindle variations) and as long as the machines are well warmed up before it's tried, the system really does work. I mumbled about tape stretch and other problems but he squashed me with a 'Well it works anyway'. Point taken.

The plug for Woods & Porter follows from Geesin's slight bitterness at the attitude of most firms who would not help in any way until he became well known. Probably this is one of the reasons why so much of his studio is home made, though very neatly.

Initially he started with a rigid rule that everything should be dropped to 600Ω and religiously run through balanced lines. But now he's dropped all that ('I changed my mind') and works unbalanced with a general low to high impedance rule of thumb. It all seems to work well and if the results are good enough for Schlesinger, that's really what matters.

So we're back (as in the case of Peter Townshend) to the circumstances where someone running a studio, and successfully producing saleable finished products, really has only personal trial and error behind him. And clearly trial and error has played a large part in Geesin's career to date. Littered round his studio with the various odd musical instruments I spotted numerous Leak amplifiers (a couple of mono Leaks being hitched up to feed Tannoy monitors, a Sugden control unit, numerous BFO's and signal generators, at least a dozen different types of headphones, odd reverb units, several AKG *D19E* mikes, and a couple of Grampian mixers discarded in a corner.

'I've made a lot of mistakes over buying gear,' said Geesin, a little sadly. He explained his basic mistrust of the world of commerce which is geared to selling regardless of merit.

From the routine question 'What kind of tape do you use?' Geesin put an idea into my head. He goes to the large studios and buys up all their second-hand tape. This is sold off cheap because it has (or may have) splices in it,

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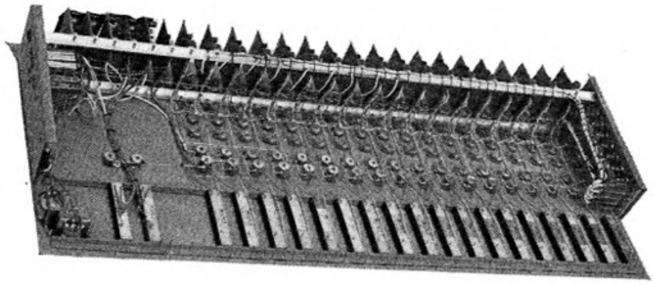

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and Geesin simply runs it through a Revox, feeling for splices. At each splice he cuts the tape and so ends up with a rack of rolls of unspliced tapes of various lengths. It sounded such a fine way of getting good BASF tape cheap that I asked whether he minded my passing on the suggestion. Would it spoil it for him, if everyone else did the same thing?

'No, suggest it to them,' he shrugged. 'There's always plenty of tape—the studios can't ever be bothered to get their unspliced lengths together. If I'd used new tape I'd have been broke long ago.'

A great deal of what Geesin does involves patchwork taping. He played me something he's produced for one of John Peel's BBC programmes. It involves a conversation between two Ron Geesins, one on track A and one on track B, but for undefinable reasons it sounded curiously lifelike—almost as if there really were two Ron Geesins talking to each other in a studio. I asked him why this should be and the answer is interesting. He records one voice on Track One of a first reel of tape (call it Tape A). He then records the second voice on Track Two of another reel of tape (call it Tape B). He then splices Tapes A and B together so that what results is a tape with the voice on Track One talking to the voice on Track Two. When both tracks are reduced to one, you get a conversation with a rather clipped and edited feel about it. This is removed by rerecording the whole thing and putting a little reverb on at least one of the tracks, so that the voice on that track overlaps or overhangs the voice on the other track slightly.

I noticed in the corner of the room a 16 mm Siemens projector which Geesin had used to do the soundtrack for the Schlesinger film. He played me some of the music he made for that film and, while there is not enough in the film to fill an LP, I hope someone lets him fill out an LP with similar material because it is very melodic stuff. It is also particularly interesting for a curious reason: he has used an entirely new technique (by which I mean a technique he cooked up himself).

The basis of the idea is to use two tape recorders with tape running from one machine to the other. Let's call them Machine A and Machine B. First a reel of tape is loaded on to the supply turntable of Machine A and threaded through the heads of Machine A. It is led in a tight curve through the heads of Machine B, standing to the right of Machine A, and thence to the take-up spool on Machine B.

Sound picked up by the microphone passes through the mixer and is recorded by Machine A on the tape. The recorded signal then travels to Machine B, the playback signal being sent to the mixer and again into Machine A. Such a set-up used without skill produces an increasingly scrambled mess on the tape. But using headphones or a low volume studio monitor, a musician can play into the microphone and keep in time with the delayed echoes of his playing, assembling an ever-increasing orchestral sound. Geesin demonstrated this technique to me with a toy trumpet and within half a minute had produced a whole orchestra of sounds.

On one part of his film soundtrack, he begins by playing a simple background on a guitar. The recycling system perpetuates this background and Geesin then goes on to put further tracks over the top with further instruments or further registers of the same instrument, all of which tracks are perpetuated by the recycling. In practice there is a difficulty because the tracks do tend to decay a little but they can be reinforced every now and again—subtly so that there is no sudden leap in volume.

As I hope I've made clear, the problem of making a rhythmic musical sound relies on the musician being able to phrase in time with his own echo. Few humans have a sufficiently good sense of rhythm to be able to keep in time with widely spaced pulses; the echo delay and thus the length of tape between the two machines can only be relatively short.

Geesin has the technique down to a fine art and he assures me it is food for a nervous breakdown, because one mistake throws the whole thing out; but it can be made to work and the proof is there on the film soundtrack. In fact he is now working on a development (and has spent a couple of hundred pounds having one-off equipment made up) which will allow much longer machine spacings and tape lengths to be controlled. This equipment uses a number of heads strung out along the tape so that he can get really complicated rhythmic effects. What is more, the spacing of the heads is adjustable so that the rhythmic effects will be adjustable as well.

'Do you enjoy your work?' I asked rhetorically.

'It's not my work—it's my life,' he put me straight.

And I left him wondering aloud on what would happen if he got some really large reverb springs, hitched them to a transducer and hit them with a golf club. 'We should get some sounds out of that, don't you think?' he asked.

I didn't argue.

SERVICING continued

replacement. It is helpful to be able to look at the revolving wheel along a horizontal plane, into a smoothly lit area.

One trick that is worth passing on is to view revolving spindles, spokes, drums and wheels in this way, propping a sheet of white card beyond the mechanism and illuminating this. The smoothly lit background is much better than the bright light usually advocated. Mirrors can be handy, both as reflective surfaces and to view revolving parts with a light held obliquely. The stroboscope trick of the light shining directly on a rotating plane surface is also effective. But do not be misled by the method of looking in plan on a rotating spindle or pulley. Depending on the method of construction or finishing (for example, the type of spindle turning chuck used) so the plan view may give rise to all sorts of apparent eccentricities. Where a spindle has an attached disc, as a pulley with steps on a motor spindle, it is best to view along the horizontal plane, line up the edge of the step with some reference and watch for up and down movement. Azimuth differences with this type of mounting will produce vertical shifts often more easy to see and interpret than the elliptical orbiting of a small spindle looked at from above.

Belt runs should sit cleanly in grooves. Usual fault is not—as generally reported—a twisted belt. Where this happens, the fault is usually temporary; the twist runs out. More often, it is the angle of entry, causing the belt to rub on the groove flange.

This can have some peculiar drive effects, depending on the system. Tandberg have used the crossed belt system running in pulley grooves very effectively for some years (departing from it in the latest models). I can't say I like it particularly, neither for the hiss it makes nor for the occasional troubles from worn belts. You should see a Tandberg belt that has been 'treated' by an over-enthusiastic engineer in an attempt to clean it and the running surfaces. The thing looks like a string of beads. At least it is easy to change. Not like some horrors which demand complete dismantling of sound channel components, half the drive system and a fistful of electrical connections.

Speed changing, when belts run in alternative grooves of a motor pulley, entails moving the belt while it is running. This argues some form of fork lift and some are part of the upper bearing of the motor pulley, or part of the pulley itself. Wrongly used these can cause belt damage. The type which moves the belt by clawing it along one of its travelling 'arms' can rub, causing curious noises and sometimes slippage.

Because of design compromises, the need to change speeds more than doubles the risk of exceeding the speed stability figure. Look for a lateral 'tremble' as the belt runs, just after the speed has been changed. This is generally an indication that the belt needs replacement. Apply gentle finger pressure to the belt, attempting to retard it. When you have to practically grab it and hold it to a standstill, the belt is slipping far too much—change it.

If the belt is the right one for the machine and is new, it should certainly never be too tight. It may sometimes appear so. Then we must check the grooves and flanges of the pulleys, looking for small rubber particles that have flaked and adhered; for the film of sprayed oil and dirt that can look like a coat of varnish and for mechanical components out of line.

The last fault is more prevalent, of course, when the speed changing apparatus comprises an intermediate wheel and a stepped motor pulley. A ramp shifts the wheel vertically (having regard to a horizontal deck) until it is opposite the approximate centre of the rise of the appropriate step of the capstan. But often the wheel does not contact at the right angle, or has worn so that its contact angle tends to 'throw' it. I have seen thin wheels riding up and down the flat periphery of a flywheel like fairground roundabouts. Thick wheels may run with lateral stability but can lose grip. Sometimes the speed variation is constant and the idler wheel is the last thing one would suspect.

SYSTÈME INTERNATIONALE- THE AWFUL TRUTH

FIG. 1 The MKS System

BASIC UNITS
MASS—kilogramme
LENGTH—metre
TIME—second

FORCE =
mass x acceleration
1 kg at 1 m/s² is 1 newton (N)

▶ **ENERGY or WORK =**
force x distance moved
1N moves through 1m and produces a joule (J) of work

▶ **POWER =**
rate of working
1J of work in a sec needs a power of 1 watt (W)

CURRENT: when two wires placed 1m apart are passing a current such that a force of 2 x 10⁷N exists on each conductor for each metre of their length the current flowing is 1 ampere (A)

▶ *RESISTANCE: when a steady current of 1A in a wire generates heat at the rate of 1J every second then the resistance of the wire is 1 ohm (Ω). (In SI the ohm is defined as 1 V/A)*

↓

CHARGE: when a wire is passing a current of 1A then 1 coulomb (C) of charge passes a point on that wire every second

POTENTIAL: when a current of 1A passes through a resistance of 1 Ω the potential drop is 1 volt (V)

▶ *(In the SI potential is defined as 1 volt=1 watt per ampere)*

↓

MAGNETIC FLUX: when a conductor develops a potential of 1V across its ends by passing through a magnetic field in one second then that field has flux of 1 weber (Wb)

FIG. 2

$$\theta^\circ = \frac{180}{\pi} \text{ RADIANS}$$

(Length round circumference is $2\pi r$. There are 2π radians in a complete revolution, which is 360°.)
1 radian is about 57°

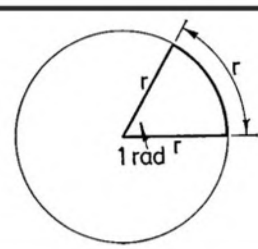


FIG. 3

MULTIPLES AND SUB-MULTIPLES

Factor by which the unit is multiplied	Prefix	Symbol	Factor by which the unit is multiplied	Prefix	Symbol
10^{12}	tera	T	10^{-2}	centi	c
10^{9}	giga	G	10^{-3}	milli	m
10^{6}	mega	M	10^{-6}	micro	µ
10^{3}	kilo	k	10^{-9}	nano	n
10^{2}	hecto	h	10^{-12}	pico	p
10	deca	da	10^{-15}	femto	f
10^{-1}	deci	d	10^{-18}	atto	a

THE European mainland had changed to one form of metric system or another by as long ago as 1840, so it could be said that we in Britain have been somewhat cautious in our approach to metrication. Now, in the 1970s, we are in the process of changing to a different way of measuring everyday quantities. Before studying the merits of the system, it might be as well for those not familiar with Système Internationale to examine its requirements.

SI is really a modification of the metre, kilogramme, second (mks) system of units and, hopefully, an improvement on it. The three mks units were originally the basis for all other units (even the ampere, which is defined in terms of the force which two current carrying conductors exert upon one another). The rest of the electrical and magnetic units follow from that (**fig. 1**).

In the SI scheme, the ampere becomes a basic unit along with the kelvin (a unit of temperature) and the candela, a unit of luminous intensity. The kelvin is an identical interval of temperature to the degree centigrade, but the kelvin scale has its zero at −273°C, which is the unattainable temperature at which perfect gases have zero volume. Thus you merely add 273 to convert from centigrade to kelvin.

In spite of the fact that the kelvin is the official SI unit of temperature the centigrade scale is the one which will be in 'common use'. Further, the name will be changed to the non-SI unit 'degree Celsius'. It seems there exists in one of the European countries a little-used unit of angular measure called the grade, and it is feared that centigrade might be confused as one hundredth part of a grade. The country concerned is France.

The SI unit of angular measure is the radian, although it seems that the degree will also be 'in common use'. As you will no doubt know. one radian is that angle formed at the centre of a circle by two radii, such that the distance around the perimeter of the circle from one point where a radius intersects the circle to the other is equal to the radius, as shown in **fig. 2.**

Another important thing to remember about SI is that the kilogramme is a unit of mass, not weight. This may seem an over-subtle distinction, but it is quite important. A body has the same mass or amount of substance in itself wherever it is, while weight is a measure of the gravitational force exerted on its mass. Force and mass are related by the formula:

SYSTÈME INTERNATIONALE: THE AWFUL TRUTH

BY JOHN DWYER

Force=Mass x Acceleration.

In this case the acceleration is a constant: any two objects dropped from the same height at the same time will reach the ground at the same instant, because the acceleration due to gravity is constant at a particular place. (Since air resistance complicates the issue, practical tests are best carried out in a vacuum.) Thus a mass of one kilogramme at a place on the earth's surface having the normal acceleration of 9.81 m/s^2 will have a 'weight' of 9.81 newtons. That at least is the theory. In practice everyone uses the kilogramme as a unit of weight—this is possible because all we have to say is that a kilogramme weight is the force exerted by gravity on a mass of one kilogramme. To put it another way, 1 kg weight=9.81 newtons.

SI also has a specified set of prefixes which act as multiples or sub-multiples. These are shown in **fig. 3.** For length, engineers will be expected to use metres or millimetres. There is also a standard set of abbreviations but, before coming to that, it might be as well to say something about the units themselves. The most striking thing is that, looking at **fig. 4,** relatively few units are called by the names which would make them easily understood. There are a number of reasons given for changing the names but the main one, according to a spokesman at BSI, is that the countries who have adopted or are in the process of adopting SI (some 30 in all) have been anxious that their own prominent scientists have a unit named after them, giving those countries a certain amount of 'kudos'. More about this later.

The abbreviations for units derived from surnames are always capital letters whereas, if the unit is written out in full, a small letter is always used at the beginning of the word. In all other cases small letters are used whether the abbreviation is used or not. This also applies to multiples and sub-multiples, as in kg for kilogramme and mm for millimetre. The exception, though not strictly part of SI, is the aforementioned degree Celsius, which has the abbreviation °C.

Having outlined the basis of SI, one would expect the reasons for changing to it to be fairly obvious. Yet if you read any of the official literature which is available you become more than a little confused. To begin with, there is an HMSO publication which states: 'The reasons for the decision to change are not as

(*continued on page 576*)

FIG. 4 *SI units*

Quantity	**SI unit**	**Symbol**	**Derivation**
Electric field strength	*V/m*	*V/m*	*V/m*
Displacement	C/m^2	C/m^2	C/m^2
Electric flux, Displacement of Flux, Basic Quantity of Electricity	*Coulomb*	*C*	*1C=1 As*
Capacitance	*farad*	*F*	*1F=1 As/V*
Permittivity	*F/m*	*F/m*	*F/m*
Current Density	A/m^2	A/m^2	A/m^2
Magnetic Flux Density	*tesla*	*T*	$1T=1\ Wb/m^2$
Conductance	*1/Ω*	*1/Ω or S (siemens)*	*1/Ω*
Resistivity	*Ωm*	*Ωm*	$1\ \Omega m=\frac{m^2\Omega}{m}$
Inductance, Permeance	*henry*	*H*	*1H=1 Vs/A*
Frequency	*hertz*	*Hz*	*1 Hz=1 c/s*
Force	*newton*	*N*	$1N=1\ kg\ m/s^2$
Work, Energy, Quantity of heat	*joule*	*J*	*1J= 1Nm*
Power	*watt*	*W*	*1W=1 J/s*
Electric Potential, PD, EMF	*volt*	*V*	*1V=1 W/A*
Resistance	*ohm*	*Ω*	*1Ω=1 V/A*
Magnetic induction Magnetic flux	*weber*	*Wb*	*1 Wb=1 Vs*

clearly defined as one would perhaps have imagined. The basic reason was undoubtedly that industrialists were convinced that a change to the metric system was inevitable in view of its spread throughout the world.' Apart from the fact that the inevitability of something happening is a very poor reason for causing it, the use of the word 'undoubtedly' is quite staggering. You further discover that, as in the case of the temperature scale already mentioned, although ourselves and others are supposed to be 'going SI', certain aspects of the system will for the greater part be ignored. You will even find, in the publication from which I took the above quotes, 'Metrication in the Construction Industry Part One,' a list of permitted non SI units.

There seems to be some reluctance to finish the job. Again and again one gets the impression that, after an initial burst of enthusiasm, those responsible are having second thoughts. The naming of units is a good example of this. One can overcome one's reactionary tendencies sufficiently to admit that a Joule (sorry, joule) is as good a name and as sensible for a kg m^2/s^2 as anything else, but was there really any necessity to saddle engineers with hertz, particularly when the abbreviation would still be c/s in most languages anyway? We now discover that there is to be no more name-changing because, again according to a BSI spokesman, 'people have begun to object'. Does this mean that if 'people had begun to object' a little earlier we might now be talking about Wb/m^2, just as we use A/m^2, instead of teslas? It hardly encourages consistency. Neither does the fact that, although we are supposed to be going metric, distances are still measured in miles. Is this another example of the influence of the motor manufacturers' lobby? And has it escaped your notice that, as often as not, the weather forecast is still being read with temperatures in both fahrenheit and centigrade, *neither* of which are SI units?

What it all amounts to is that insufficient thought seems to have been given to the practicalities of going metric before all the agreements which seem to have been necessary were signed. It would appear that those documents which have been signed are practically worthless. In France and Germany, for example, the predecessor to the SI was the Metric Technical system, under which units were given their own names and which approximated to the mks system. This system will become 'illegal' in those countries in 1977 according to the SI agreement. If SI units have the force of law behind them, why was it considered necessary to change the name of centigrade to celsius (sorry, Celsius) because the former might be confused with an illegal unit?

Is there any real difference between MKS and SI? I asked a spokesman at the British Standards Institution this question and he answered that the difference lay in there being six basic units (seven with the mole [abbreviation: mol], a unit of 'amount of substance') instead of three. I then put it to him that, while one can simply grab a quantity of something and say it has a mass of 1 kg and/or a length of 1m, it is rather more difficult to do this when talking about current flows, so what was the starting point for the definition of the ampere? He replied that the ampere was still derived in terms of the forces acting on or between two current carrying conductors.

The most annoying thing of all is the name changing. There was even going to be another one for the engineer to puzzle over: pressure in N/m^2 was to be changed to pascals (Pa)—but it is doubtful whether it reached the first furlong marker. The names that have been given to units and the reasons why the names have been changed at all gives a more accurate picture of the type of person behind it all than any other single aspect of SI. He sits there signing agreements and no doubt considers he is doing everyone a favour in the name of glorious consistency, forgetting that someone just as zealous kept the same seat warm back in 1950, when mks was 'internationally adopted'.

A classic example of the BSI's poor reasoning is the changing of colours on mains flex, and they signed an infamous agreement not long ago standardising the way we ought to write the date. On that occasion even the Board of Trade didn't know about the arrangement. Then the BBC started asking questions and a gentleman from BSI was interviewed. He said: 'People shouldn't worry about these things—this is only a minor example; one of a number of agreements the BSI is contemplating at the moment'. As the chap in the studio wryly commented at the end of the interview: 'And are we going to get a say in those as well?'

News

CBS Quadraphonic

BENJAMIN BAUER, a leading figure both in CBS and in audio generally, was on hand on the evening of September 6 to demonstrate the 'SQ disc'—his company's answer to the dilemma which disc recording is facing with the advent of quadraphonics. The meeting, held in the Court Suite of Grosvenor House on Park Lane, was organised as a late entry in the annual programme of the British section of the AES.

Briefly the disc works in the following manner. Front right and front left signals appear modulated at 45° angles on the right and left walls respectively of the groove, just as they do on a normal stereo record. Right rear signals appear as an anticlockwise circular movement, and left rear signals as a clockwise circular movement, thus either of these latter signals traces a helix along the groove as it progresses. If the two rear signals are equal to one another, a situation which arises when a centre signal is required, then the lateral motion of each helix is cancelled out although the vertical motions remain, so that a centre rear signal in the SQ system is the same as the difference signal in the ordinary stereo disc. In this respect it is easy to see similarities between the SQ disc and the methods suggested by Hafler, though the SQ is more elaborate. Since some sort of compromise was inevitable, it was decided to accept a degree, even a substantial degree, of crosstalk between front and back.

The record was played via an ordinary Shure cartridge and a CBS laboratory turntable. One of the major assets of the disc is that no special cartridge is required, although Mr Bauer did mention that some care might be needed in the selection of the cartridge.

The remainder of the equipment which had a direct bearing on the demonstration was the provision of a Studer 12.5 mm tape recorder, used to compare the disc with what we were told was the original master tape. The four speakers used were Altec Lansing *9845A* monitors. These were set so that the HF attenuator control was at 3 dB for the rear two speakers and about 3.5 dB for the front two.

The programme on one side of the disc was a selection of short pieces connected by a commentary by David Frost, who went on to exclaim the wonder of a machine that could transport you aurally to the middle of a Siberian forest (surrounded by hungry wolves) or to the depths of the sea (surrounded by equally hungry whales). There was also a point where Frost claimed to be speaking from the cavernous interior of an EMT plate.

When the gimmicks were over, the working of the disc was very ably explained by Mr Bauer and then the second side of the record, uninterrupted music of various kinds, was played. An eight button selector device enabled the user to compare the disc with the master or convert the output to two channel stereo or to mono.

Opinions were mixed. There was no question that the disc was a major advance, but the poor reproduction quality prejudiced people against it. It was said, with some justification, that the only way to judge the thing was to take it home and live with it for an extended period.

These criticisms aside, the comparisons were very interesting indeed. It was particularly enlightening to hear an apparent improvement in treble response, slight but noticeable, on the disc compared to the master tape. The four channels are matrixed into two before being recorded, these forming the two channels for normal stereo. For four channel stereo, the two signals must be decoded. Thus the fact that the disc had 'better' top response than the master—if such it was—is not as strange as it would seem because the decoder matrix may have had an inherent treble lift. It should not be forgotten that a poor signal-to-noise ratio often gives the impression of more than is actually present. Some did complain that the signal-to-noise ratio was poor but, again, this does not materially affect the validity of the demonstration. There could also have been an anomaly in the equalisation applied to the playback of the master tape.

The images seemed generally confused—David Frost seemed to move around all the time, even when he should have been in one place, and the result was irritating after a very short while.

Switching from four channels to two the latter sounded quite flat, though less overwhelming, and it was difficult to judge how good the two channel was. The result was that the mono signal and the stereo two channel signal seemed much the same. Certainly the difference between two channels and four was more marked, though whether an improvement is a matter of conjecture.

Nevertheless, taking into consideration the poor listening conditions, the consensus was that the SQ disc had been an agreeable surprise.

HH Telephone Change

H. H. ELECTRONICS, manufacturers of the TPA series-D integrated circuit power amplifiers, have changed their telephone number. The new number is Cambridge (0223) 65945.

Sait Market Mixers

A NEW COMPANY, Allotrope Ltd., has been formed to market the Sait (Belgium) range of Studio and PA mixers in the UK and Eire. Sait was formed in 1901 and have specialised in electronic equipment for ship and aircraft navigation, radar, telecommunications and, recently, space telemetry and data systems. The broadcast division have now produced a range of mixers which have been very well received on the continent. For further information contact Allotrope Ltd., 5B Thame Industrial Estate, Thame, Oxon.

Leevers-Rich Language Laboratory

THE UNIVERSITY of Warwick have installed an extensive array of language laboratory equipment with a view to producing a large amount of teaching material themselves. They feel that the material currently available is of a very low standard, with the result that students are unable to realise the full potential of the language laboratory teaching method.

The equipment has been supplied by Leevers-Rich and includes four console recorders, used to record full track at 38 cm/s on 6.25 mm tape from a three channel mixing desk manufactured by Stancoil Ltd, Windsor, and from which 19 cm/s master tapes are made. It is at this stage that the pauses are added, during which the student may reply. With the inclusion of this new equipment, the University's language lab facilities have now been doubled to some 78 booths.

High Quality Mixer Parts

READERS HAVE been having difficulty obtaining the coil parts for the various circuits in the high quality mixer series. A new source has been arranged for small numbers. Note that there has been a renumbering of parts to cater for a new mounting method. Core *LA1103*. Adjuster *LA1274*. Tagboard *DT2359*. Bobbin *DT2178*. Ring *DT2356*. Clip *DT2357* (4 required). Price for the set is £1 including postage from: Gurney's Radio Ltd., 91 The Broadway, Southall, Middlesex.

Low Cost Illuminated Switches

GUEST INTERNATIONAL are now marketing a new range of illuminated multi-pole switches. Described as *Compu-Lite Series 11* they are fully enclosed and sealed and switch up to 5A at 250V. If a low level switching application is envisaged gold contacts are available. The range features a number of coloured bazels and split-screen or full legends. Maximum depth is only 38 mm. A number of different switching actions are available and each switch has one pole which is switched in before those remaining make contact.

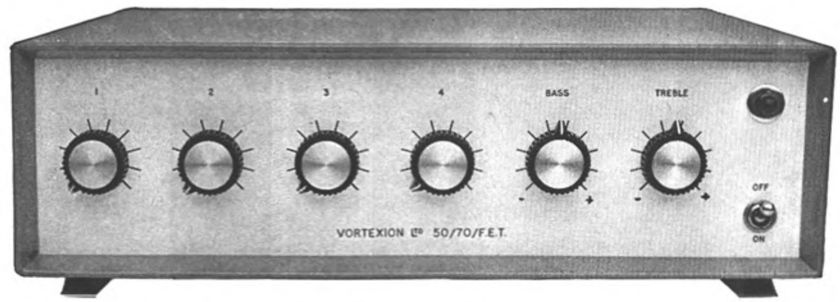
Errata

ATTENTION IS drawn to two errors in the October issue. On page 515, fig. 3, the angle labelled 57.4° should be 54.7°. Secondly, the *Tonmeister* course is being held at Surrey University, not Sussex. Living there, the Editor regrets having the latter county on the brain.

Vortexion

THE VORTEXION 50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4-WAY MIXER USING F.E.T's

This is a high fidelity amplifier (0.3% intermodulation distortion) using the circuit of our 100% reliable—100 Watt Amplifier (no failures to date) with its elaborate protection against short and overload, etc. To this is allied our latest development of F.E.T. Mixer amplifier, again fully protected against overload and completely free from radio breakthrough. The mixer is arranged for 2-30/60Ω balanced line microphones, 1-HiZ gram input and 1-auxiliary input followed by bass and treble controls. 100 volt balanced line output or 5/15Ω and 100 volt line.



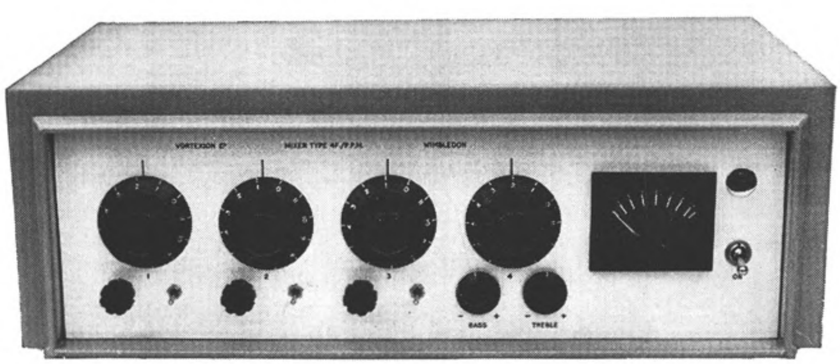
50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 5-WAY MIXER USING F.E.T's
This is similar to the 4 way version but with 5 inputs and bass cut controls on each of the three low impedance balanced line microphone stages, and a high impedance (10 mg) gram stage with bass and treble controls plus the usual line or tape input. All the input stages are protected against overload by back to back low noise, low intermodulation distortion and freedom from radio breakthrough. A voltage stabilised supply is used for the pre-amplifiers making it independent of mains supply fluctuations and another stabilised supply for the driver stages is arranged to cut off when the output is overloaded or over temperature. The output is 75% efficient and 100 V balanced line or 8/16Ω output are selected by means of a rear panel switch which has a locking plate indicating the output impedance selected.

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

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

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

F.E.T. MIXERS and PPM's



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

The various sections of the FET mixers and BBC type PPM's have been performing successfully for several years in other equipments with complete reliability. The PPM also uses an FET in its time constant circuit so that polyester capacitors can be used. The response from the 600Ω output (25Ω source impedance) is level 20 Hz to over 30 kHz with very low intermodulation distortion to zero level +12 dB. The input signal voltage range is over twice that of the valve unit and the noise at least halved.

VORTEXION LTD., 257-263 The Broadway, Wimbledon, S.W.19 1SF

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

A Versatile Recording Amplifier

Part One By L. Hayward

THIS is the first article in a series of three. The remaining two circuits will be published in succeeding months and will consist of a bias and erase oscillator followed by a playback amplifier.

This design is intended to give a high standard of performance, particularly with high-output tapes such as EMI *815*. The main points of note in the design of such an amplifier are: that it should supply sufficient power to the record head to saturate the tape while itself contributing little distortion; and that it must deliver this power at a constant current, the reason for this being the variation of head impedance with frequency. If a constant current were not supplied, then the flux produced would be dependent upon frequency.

The simplest method of producing a constant current feed is employed here—namely, feeding the head via a resistor of sufficiently high value that the maximum current is determined by the resistor rather than the head. A few years ago, the disadvantage of this method was the shortage of transistors having a high enough V_{ceo} rating to provide the required voltage swing. No such problem now exists. Of course it is possible to produce a constant current by other methods, requiring less volts, but it must be remembered that, because of bias, upwards of 100V may be present across the head and this must be removed from the amplifier by some form of filter. The system finally adopted (emitter-follower with high resistor feed) is ideal for bias rejection, since the bias signal will be reduced by a factor of the series resistor over the amplifier output impedance, and is thus so small that it can be ignored.

Fig. 1 shows the basic circuit, clarifying the feedback paths. It was decided that the practical amplifier (**fig. 2**) must tolerate the swings of power supply voltage which are normally encountered when using direct mains-derived power, avoiding the need to stabilise the +120V ht rail. In order to do this, a large amount of dc and ac feedback have been incorporated. The overall signal gain has been set to saturate the tape from an input signal of 0 dB (about 800 mV). The bridging impedance of the input is a little less than 10 kΩ, the value of the level potentiometer. The maximum signal that the specified transformer will handle is +12 dB. The overall frequency response is set at 20 kHz by C6 and at 30 Hz by the transformer (–0.5 dB points).

No low level mic input stage or PPM has been included here, since these would normally be incorporated in a separate mixer, a subject very well covered in the recent series by David Robinson.

The amplifier is suitable for use with any tape or tape speed, and all but very low impedance record heads. The resistor R12 may be reduced to feed other than high impedance heads. The terminals marked xx in the circuit diagram refer to a suitable position for a series-resonant L/C equaliser if this is required. The values used will depend on tape speed, tape, head and bias, but an indication of the device is shown in **fig. 3.** This is similar to that used to make up for head losses in the playback amplifier which will be described next month, and resonates with the values described at 20 kHz.

The amplifier was tested using a Bogen type *UK200* head, EMI *815* tape, and bias set to 100 kHz and 1 dB overdrop.

It was found that about 30V peak to peak was required at Tr3 emitter to modulate the tape fully, and the amplifier output before clip point could be increased to 60V (+6 dB). This can be considered a quite good overload margin, since the distortion is sufficiently low until clipping occurs. An accurate distortion figure could not be produced, due to lack of instrumentation, but was checked approximately using the differential-null technique and found to be well below tape level. Noise was so low as to be ignored.

Care should be exercised in construction, in regard to keeping leads as short as possible. The transistors used have ft's well into the vhf region and will obligingly oscillate if allowed to.

It is advisable to mount the amplifier in a screened box to prevent interference pick-up. The only adjustment other than level which will need attention is the equaliser. This should be set to give an even hf response on playback, having first aligned the playback system accurately, with a standard test-tape.

FIG. 1 FEEDBACK PATHS

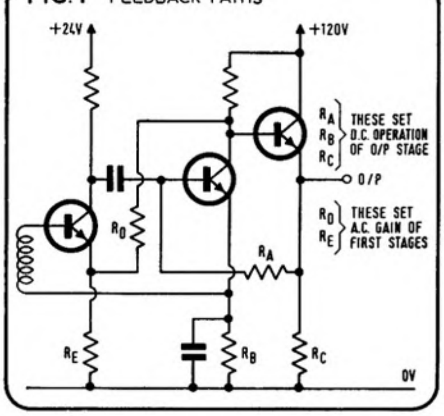


FIG. 2 CIRCUIT OF RECORDING AMPLIFIER

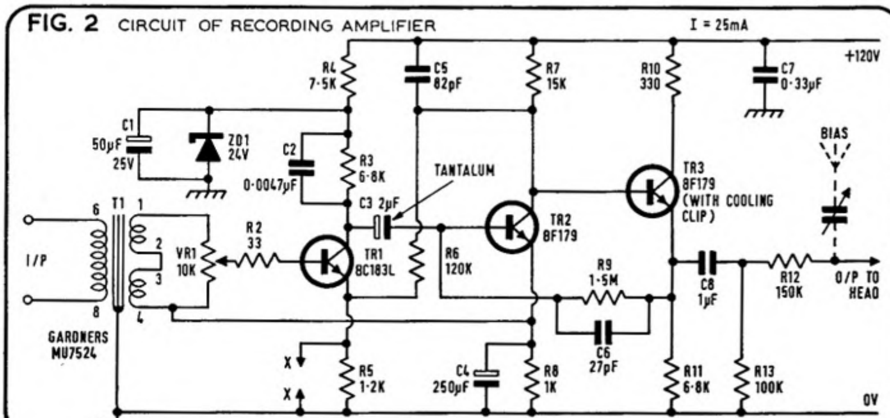
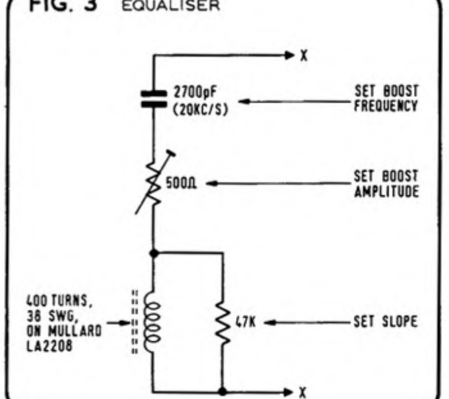


FIG. 3 EQUALISER



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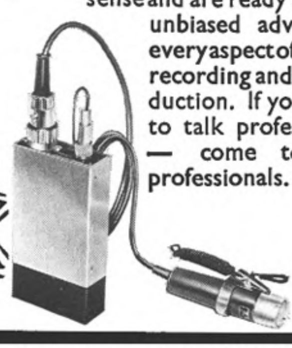

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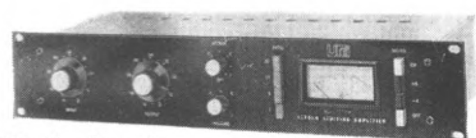

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Designing a Studio Mixer

Part Five By Peter Levesley (Walsall Timing Developments)

THE most commonly found type of equaliser is that which appears on many record players as a 'Tone Control'. Generally this is a treble cut equaliser and the usual circuit is shown on **Fig. 1.** This is simple and cheap to provide and to some degree it is effective as a means of getting rid of record hiss and scratches. It is a Type One equaliser of the shelving variety, the variable control R_2 controlling the gain reduction. The circuit works by reducing the amplification of the transistor amplifier by altering the value of the load impedence as frequency varies. Since the gain depends on the load impedance, as the reactance of the capacitor reduces with increasing frequency the amplifier loses gain. The curve shape would be the same as was shown in fig. 6c in last month's article, the amount of loss being limited by the action of R_2. If the control is rotated so that it is short circuited, the curve shape will become the same as fig. 6b.

The bass cut type of equaliser is also easy and cheap to make because it is only necessary to select a low value capacitor for use in the coupling circuits between two amplifier stages. **Fig. 2** shows the normal method. In this case, we are concerned with the increase in capacitive reactance which occurs as frequency is reduced. C and R in parallel form a frequency conscious element in series with the input impedance of the following stage, the whole arrangement operating as a potential divider the ratio of which varies with frequency. As with the treble cut circuit, the degree of bass loss is limited by the action of R and the curve will once again be the shelving type.

This bass cut circuit is not commonly found on its own in record players because bass is not often a commodity in over-abundant supply and so getting rid of it is not usually a problem. The principle has been introduced, however, to illustrate how easy it is to make a loss type equaliser. It is not quite so easy when it comes to boosting a range of frequencies.

Life rarely gives us something for nothing and equalisers are no exception. If we want to obtain a boost in gain we have to make some preliminary sacrifices to get it. In reality of course, all equalisers, boost or cut, are loss equalisers, and it all depends what we are prepared to accept as the reference range. As we saw in fig. 2 of last month's article, we rely on a convention in naming a particular equaliser, the same curve being capable of interpretation in at least two ways. Consider the circuit in **fig. 3**. Here we have a normal potential divider formed by two resistors. With the switch in the OUT position, we can measure the difference between the input and the output and we would find that there was a loss of approximately 20 dB between the two. This would represent the normal transmission or 'insertion loss' of the network, the same at any audio frequency. If we agree to accept this state of affairs as normal, we can call it the 'reference condition', using this term to mean the same as last month. When we close the switch to the IN position, we shall find that now, as we increase the frequency, the reactance of the capacitor will progressively reduce the amount of loss contributed by the network and we shall get a rise in gain above our agreed reference condition. The shape of the response curve is shown in **fig. 3b**, the dotted line illustrating the reference condition. The possible rise in gain is limited to the situation when the 10 kΩ resistor is completely short-circuited by the reactance of C—in other words to 20 dB maximum. This is the principle upon which all boost equalisers work ; if you want a boost, you must first of all take a cut and then recover some of it. The degree of boost obtainable depends on the amount of loss we are prepared to accept.

The bass boost circuit is made in a similar manner to the treble boost, the capacitor in this case being in series with the 1kΩ resistor. These simple networks show how the basic functions can be realised, but in mixer design our requirements tend to be more elaborate. It has become customary in high fidelity preamplifier design as well as in mixer equalisers to combine the boost and cut for bass or treble frequencies on a single control,

(*continued on page 582*)

FIG. 3

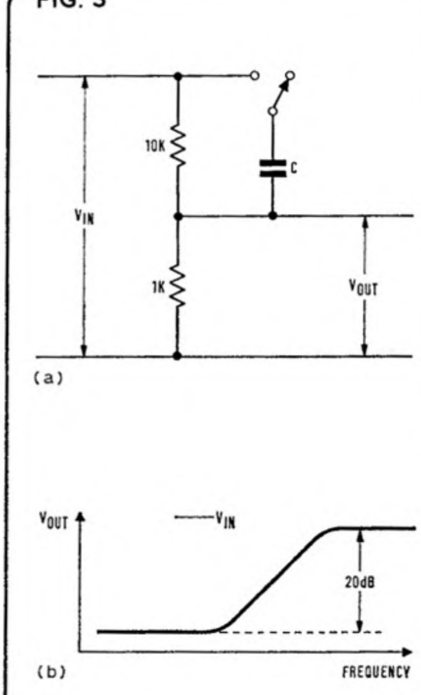


FIG. 1 TREBLE CUT

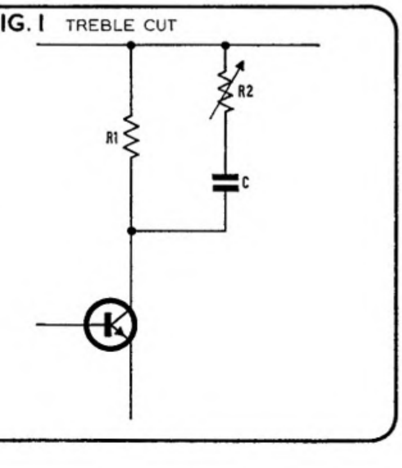
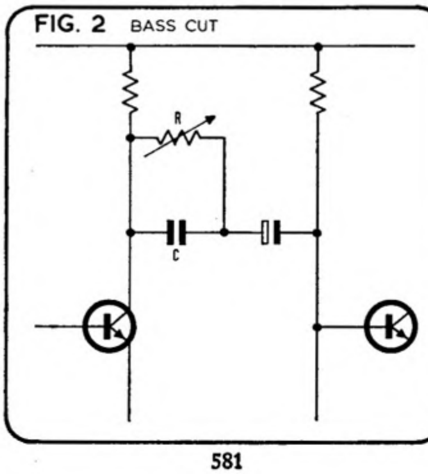


FIG. 2 BASS CUT



the centre position being a reference or 'flat' position. The most widely used version of this system is that due to Baxandall.*

This circuit works on the virtual earth principle and it is worth considering in some detail. **Fig. 4a** shows the arrangement of the bass control while **4b** shows the current redrawn for the purposes of explanation. It would be worthwhile to compare this circuit (**fig. 4b**) with Fig. 4 on Page 453 of the September issue. In this case we have reactive components in place of the purely resistive elements in the previous case, but the circuit performs in much the same way. Indeed if C_1 and C_2 were short circuited, it is exactly the same circuit.

We can measure the overall gain of the virtual earth amplifier with S_1 and S_2 closed and, if R_1 is equal in value to R_2, we know from previous discussion that the gain from input to output will be unity or 0 dB. This is shown by line (a) in **fig. 5**. We have already shown that the gain of a virtual earth amplifier is given by the relationship.

$$\text{Gain} = \frac{R_2}{R_1} \quad \ldots (1)$$ if the operational amplifier gain is high.

This relationship is still true if instead of pure resistance in the input and feedback positions, we have complex networks including reactive components. We should of course have to rewrite the formula thus.

$$\text{Gain} = \frac{Z_2}{Z_1} \quad \ldots (2)$$ where Z is the computed impedance of the complex network.

*P. J. Baxandall, Wireless World, October 1952

What would the effect of opening S_2 in **fig. 4**? As frequency was varied, the impedance of the feedback network would start to alter. The only way it can alter, of course, is to increase in value, since the minimum value is set by the Resistor R_2. As frequency is lowered therefore, the reactance of the capacitor C_2 will increase and the impedance of the network R_2, R_4 and C_2 will increase. This impedance is equivalent to Z_2 in formula (2) above and we can see that the increase in Z_2 will give an increase in overall gain. This effect is shown by line (b) in **fig. 5**. By a similar argument, we can see that if S_1 is opened and S_2 is closed, Z_1 will be increased as frequency is reduced. **Fig. 5c** shows the curve that would result. By bringing into circuit one capacitor or the other we can obtain a curve which will either boost or cut bass frequencies.

In either case, the effect of the resistor in parallel with the capacitor will be to vary the maximum boost available since we have what amounts to a shelving equaliser network. See **fig. 6c** and the accompanying text in the October issue.

We can, by opening S_1 and S_2 at the same time, make the circuit generate curves 5(b) and 5(c) simultaneously, but if the overall frequency response curve were plotted we should find that the two curves would combine to give a resultant (or conjugate) curve. If R_3 were made equal in value to R_4, the conjugate curve would coincide with line 5(a).

This, of course assumes that $C_1 = C_2$ and $R_1 = R_2$. Varying the ratio between R_3 and R_4 will cause the conjugate curve to depart from the 5(a) position in the following manner. If R_3 is short circuit and R_4 is maximum, we shall have the same effect as if S_1 were closed, in other words the bass boost condition. On the other hand, R_2 at maximum value and R_4 at Zero would give the effect of bass cut. In practice, R_3 and R_4 are replaced by a variable linear resistor and, at the electrical centre of the track, the circuit will give the curve 5(a). On either side of centre, either the boost or the cut condition will pre-dominate in the conjugate curve until at the extremes of travel we have maximum boost or cut. We have thus combined, on the one control, a convenient way of varying the response curve at bass frequencies *without altering the level in the reference range*.

This final point is most important because

FIG. 4

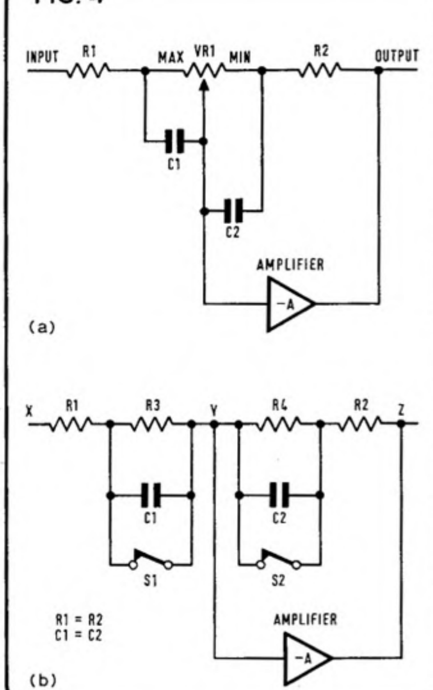


FIG. 5

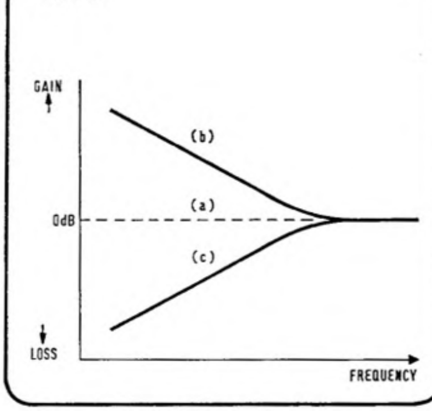


FIG. 6

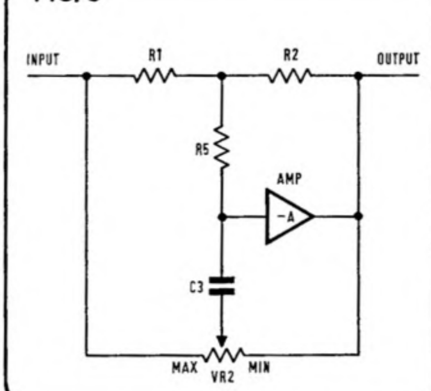


FIG. 7

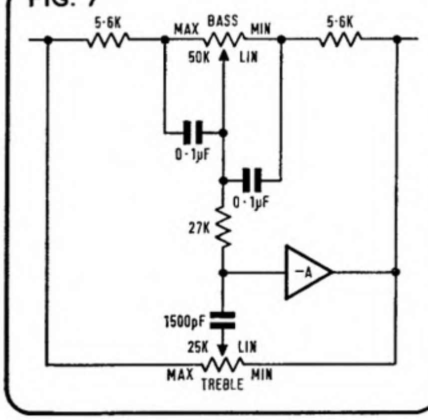
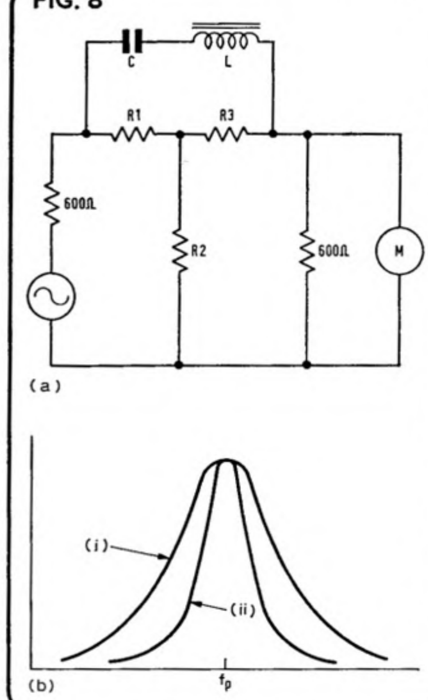


FIG. 8



the operation of the treble control depends on it. See **fig. 6**. Here we have the treble control VR_2 and the other parts of the circuit which are effective at high frequencies.

R_5 is only introduced to isolate the treble control from the low impedance formed by the virtual earth at the junction of R_1 and R_2. If we rotate the treble control so that C_3 is connected to the input point, R_1 will have C_3 parallel with it. This will cause the input arm impedance Z_1 to reduce as frequency is increased and give an increase in gain. The opposite effect will occur with the control at the other extreme where a treble cut characteristic will be obtained. In the electrical centre of VR_2, we shall find that once again the conjugate curve will be a straight line similar to that obtained with the bass control, while between centre and the ends of travel of the wiper, either the boosting or cutting tendency will predominate.

By suitable selection of component values, it is possible to combine these two controls in a single network wherein there is minimum interaction between them. This is made easier by the isolating effect of the virtual earth point, which has already been fully discussed. The complete circuit for a suitable bass and treble control is shown in **fig. 7**.

The circuit values are so chosen that at about 1 kHz the reactances of all capacitors have little or no effect. For C_1 and C_2 this means that their reactance must be sufficiently low virtually to short-circuit VR1 (the bass control) and to be low in value compared with R_1 and R_2. At the same time R_3 must have a sufficient high reactance so as not to shunt either R_1 or R_2 significantly, whatever the setting of VR_2. The values shown in **fig. 7** fulfil these conditions adequately and the curves given in **fig. 18** show the effect of the controls. It is most important for the correct working of the circuit that the input terminal be fed from a low impedance source. If this point is neglected, the symmetry of the circuit will be upset because the input arm of the network will partly consist of the output impedance of the source. In practical terms the signal source should have an output impedance of not more than 600 ohms if good results are to be obtained.

Peaking Equalisers

The simplest form of peaking equaliser is made by the use of resonant circuits using inductors and capacitors. In these, use is made of the variation in impedance that occurs at resonance, to alter the attenuation of a potential divider. **Fig. 8** shows a typical circuit. In this, we have a normal T pad attenuator consisting of R_1, R_2 and R_3. This can be designed to give a fixed attenuation of any desired amount between a source and a load. These are shown in our case as a source generator of 600Ω impedance and a load resistor of 600Ω. Many standard works have been written on the subject of matched impedance attenuators and I do not propose to repeat it all here. In this series we have already met one example of such an attenuator in the input circuit to the microphone amplifier. See fig. 1 of the first article—Page 346 of the July issue. This is known as the box attenuator, the name being derived from its shape. For the same reason, the attenuator in **fig. 8** is called a T attenuator. The capacitor and inductor are arranged in the form of a series tuned circuit and this has the property that at resonance the impedance falls to a very low value, limited only by the losses in the components. At the resonant frequency the attenuation falls to 0 dB; in other words there is a relative boost at a particular frequency by the amount of fixed loss of the attenuator. **Fig. 8b** shows this kind of curve. The peak or resonant frequency of the LC network is fp. The shape of the curve can be altered by altering the ratio in values between the inductor and the capacitor without altering the peak frequency. This can be an asset or a liability depending on your point of view. It is generally better to be able to keep a fixed band spread and vary the peak frequency. A similar circuit arrangement can be derived to give a dip in the response curve of much the same shape as the peak. The problems with inductor/capacitor filters of this type can be summarised thus:

i) The inductors, since they are magnetic devices, are particularly prone to picking up interference from stray magnetic fields—mains transformers for example. Thus they need to be well shielded with screening cans.

ii) Inductors are bulky and expensive, particularly on account of i).

(continued on page 584)

FIG. 11

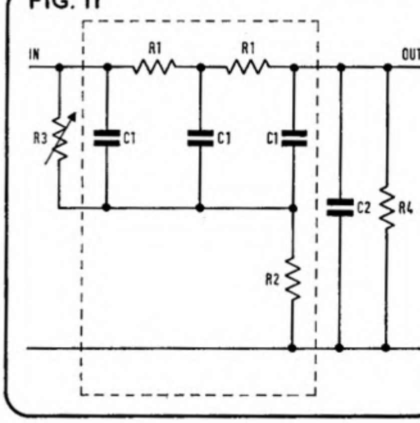


FIG. 9

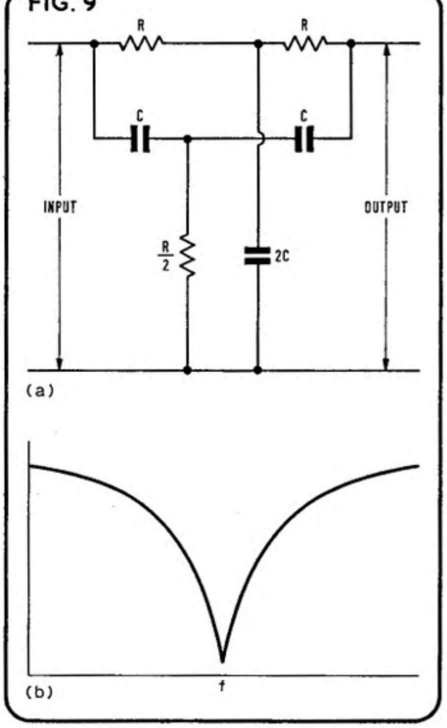


FIG. 10

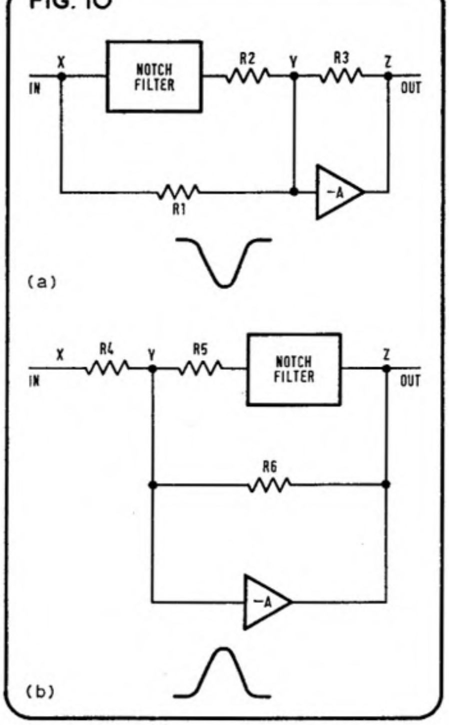
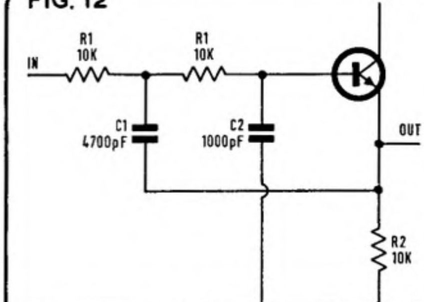


FIG. 12



(a) LO-PASS (9·5kHz)

(b) HI-PASS (75Hz)

iii) When switching the frequency of the peak, it is necessary to switch both the inductor value as well as the capacitor value to enable the same curve shape to be maintained at all frequencies. This implies using variable tapped inductors which, again, adds to expense.
iv) When peaking circuits operating at around 100 Hz are needed, the sheer magnitude of the inductor value needs very careful consideration, as well as the fact that circuits tuned to this frequency (a harmonic of the mains frequency) are particularly prone to i). For one or all of these reasons, many attempts have been made to synthesise the curve shape of the inductance/capacitance circuit using other means and one of these attempts has resulted in the circuits that follow.

It has been well known for many years that a circuit consisting of resistors and capacitors can behave in a way which is similar to a tuned circuit. This is known as the 'Parallel T' network and the circuit is shown in **Fig. 9.**

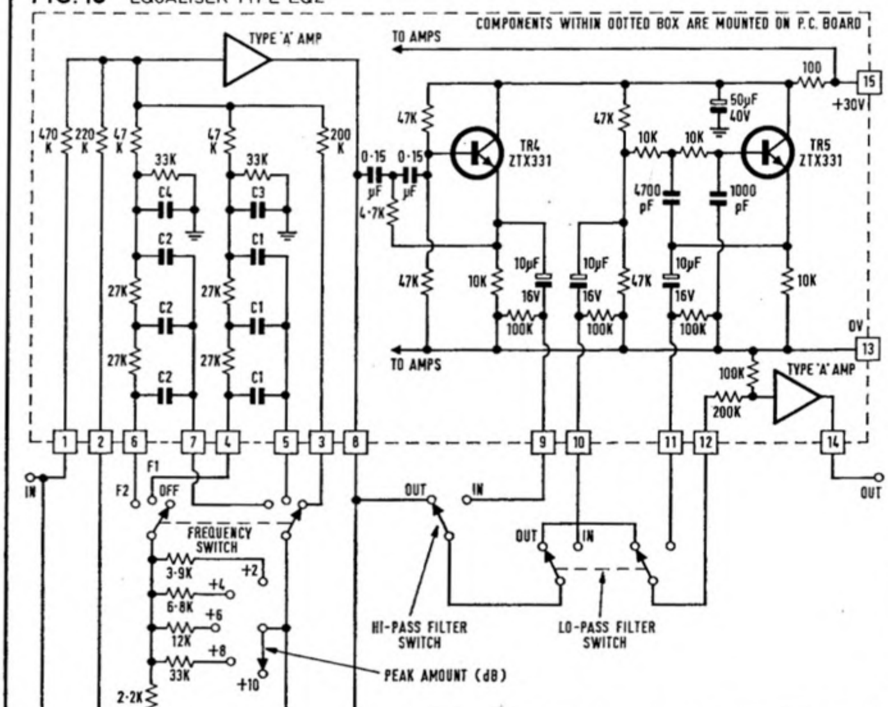
9a shows the values of the components and **9b** shows the attenuation characteristic. This type of circuit is called a 'Notch Filter', and if the components used are electrically perfect (impossible in practice) the attenuation at the notch frequency is infinite. With normal components, and matching to say 2 per cent, attenuations of some 55 to 60 dB are obtainable. The frequency of the notch is given by:

$$f=1/2\pi CR$$

The working of this circuit is extremely complex and produces only a dip. To produce a peak we must once again use the virtual earth amplifier.

Fig. 10 shows two different arrangements producing either a boost or a dip in the frequency response. **10a** shows the version which produces a dip and it may be more helpful if we think in terms of signal currents rather than resistor values. By this, I mean that we have to date talked about the gain in terms of the ratios between resistor values. We must remember that a given resistor value is only a means of converting the input voltage into an input current and the notch filter can be considered to work by acting as a diverting path for the signal current. The input arm of the virtual earth amplifier in **10a** consists of the notch filter and R_2 in parallel with R_1. The notch filter can be considered as a series resistor of value approximately 2R (see **fig. 9**) at frequencies below the notch frequency. This resistor in series with R_2 enables us to establish the basic gain of the system, R_3 being chosen to give unity gain. R_1 has small effect since its value is generally high compared with R_3. At

FIG. 16 EQUALISER TYPE EQ2



FREQUENCY Hz	150	300	600	1K	2K	3K	5K	8K
C1 C2µ	0·068	0·033	0·015	0·01	0·0047	0·0033	0·0022	0·001
C3 C4µ	0·1	0·047	0·022	0·015	0·01	0·0047	0·0033	0·0015

TABLE SHOWING PEAK FREQUENCY VERSUS CAPACITOR VALUE

FIG. 14

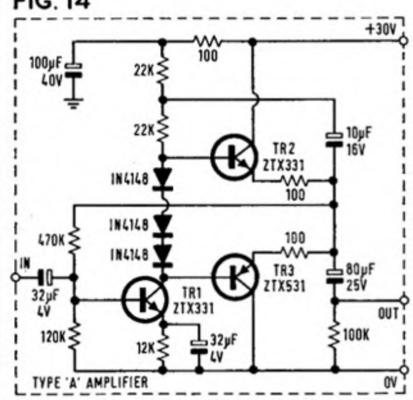
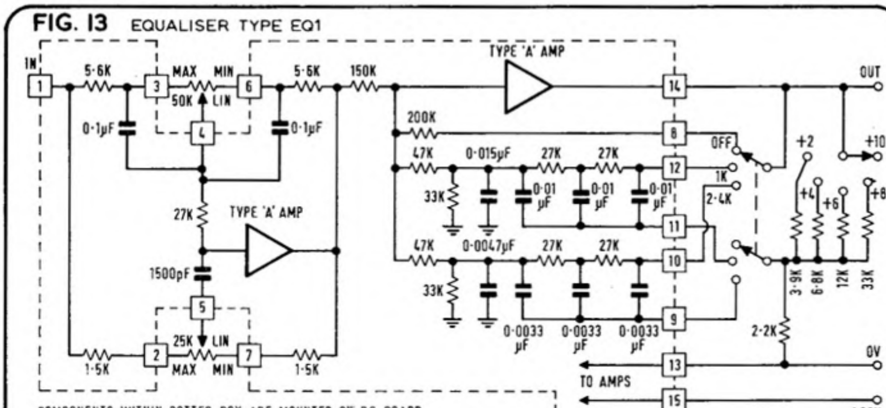
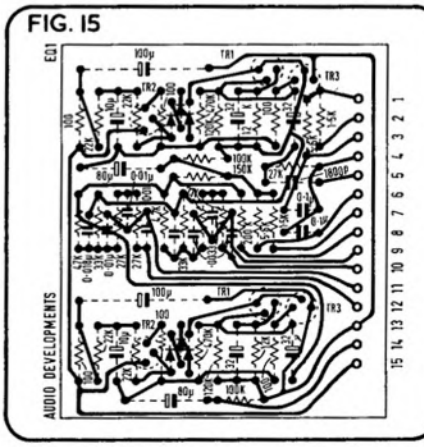


FIG. 13 EQUALISER TYPE EQ1



COMPONENTS WITHIN DOTTED BOX ARE MOUNTED ON P.C. BOARD

FIG. 15



the notch frequency, a very small current will be able to pass to R_2 because most of the input current will be diverted to earth via the notch filter. The notch filter and R_2 now behave as a very high resistance path as far as the input signal to Y is concerned and in effect R_3 is totally responsible for the input current. (Thus the gain has fallen to a value determined mostly by the ratio between R_1 and R_3. This gives a dip in the response curve. Similarly, altering the circuit around so the network including the notch filter appears in the feedback arm (as shown in **Fig. 10b**) will have the effect of reducing the feedback current at the notch frequency, thus producing a peak in the response curve. It will be found that the circuits are symmetrical, that is if we make R_3 equal in value to R_4, R_6 equal to R_1 and so on, the peak will be a mirror image of the dip. We can see also that to alter the height of the peak, we only have to alter the value of R_1 or R_6. This seems at first sight to be very convenient but things are seldom as simple as they seem. The problem is that if we alter the value of R_1 in **fig. 10a** to alter the dip height, we shall also alter the basic gain, necessitating a corresponding alteration in R_3 to keep the basic gain at unity in the reference range. This would lead to complications in the switching circuits which would add to expense. It has therefore been necessary to seek for an alternative sort of notch filter which can be more easily adapted to this duty in terms of altering the actual performance of the filter to obtain variable peak or dip height. An additional problem was the switching arrangements to allow different notch frequencies to be used. The parallel T network is not particularly easy in this respect as it has three capacitors to be switched.

I came across the basic design, which I was eventually able to adapt to my needs, in a copy of McGraw-Hill *Electronics* (my bedside reading), for September 15 1969 to which I am indebted. The circuit, reproduced in **fig. 11,** is that within the dotted box. The formula giving the notch frequency is:

$$f = \sqrt{3}/2\pi R_1 C_1$$

while R_2 is selected to be $R_1/12$. This value of R_2 gives zero phase shift at the notch frequency, a very important advantage compared with other forms of peaking equaliser.

I did some further work on the basic design and discovered that the symmetry of the response curve could be improved by the addition of R_4 and C_2, to give a reactive load to the circuit at frequencies higher than the notch. The approximate values are:

$$R_4 = R_3 \times 1.2$$
$$C_4 = C_1 \times 1.5$$

It was further discovered that the severity of the notch, and thus the height of the peak, could be smoothly altered by partially bypassing the network by means of R_3. This has some slight effect on the symmetry of the curves but does not affect the phase shift. The main advantage is of course that there is negligible effect on the basic overall gain of the system since R_3 only works around the notch frequency In other respects the circuit is the same as **fig. 10**, to give a peak or dip.

Pass Equalisers

Finally, we must consider the type of equaliser which is used to define the limits of the response range. These equalisers are generally called 'High Pass or Low Pass' (sometimes Hi pass and Lo pass), and may be considered to have an ideal response when the transmission is total (unity gain) up to the selected frequency and zero (no pass) beyond that point. The curve falls off like the side of a house in other words. It is sometimes found that this theoretical ideal makes peculiar noises on some signals and a steep slope of about 12 to 15 dB per octave is usually considered more satisfactory. For the reasons mentioned before,

(*continued on page 597*)

FIG. 18

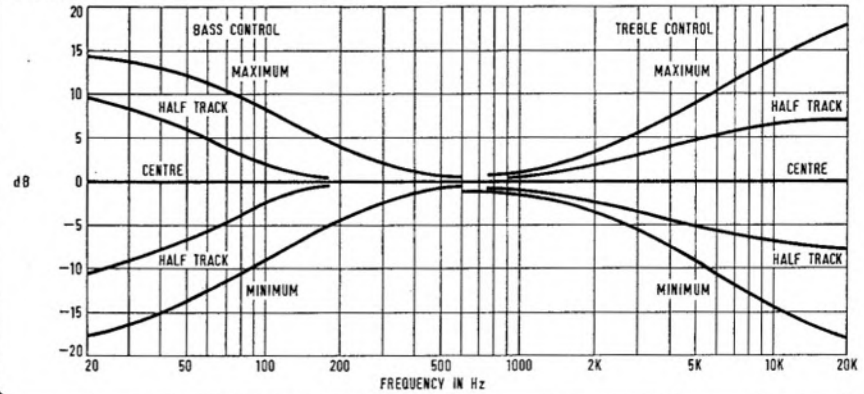


FIG. 19

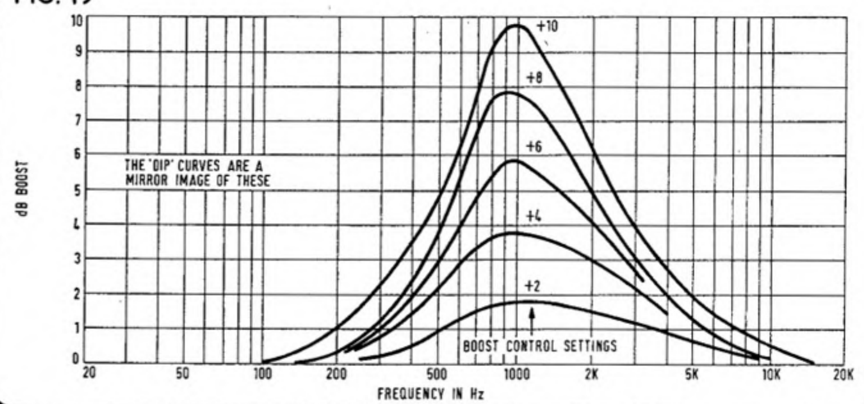


FIG. 17

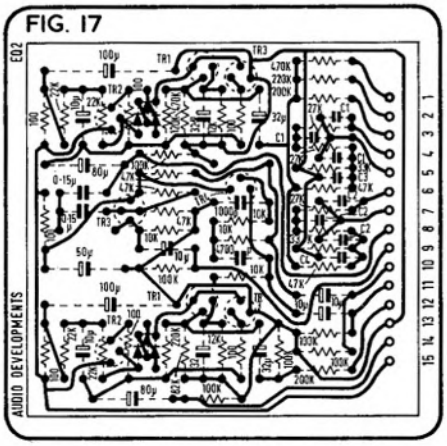
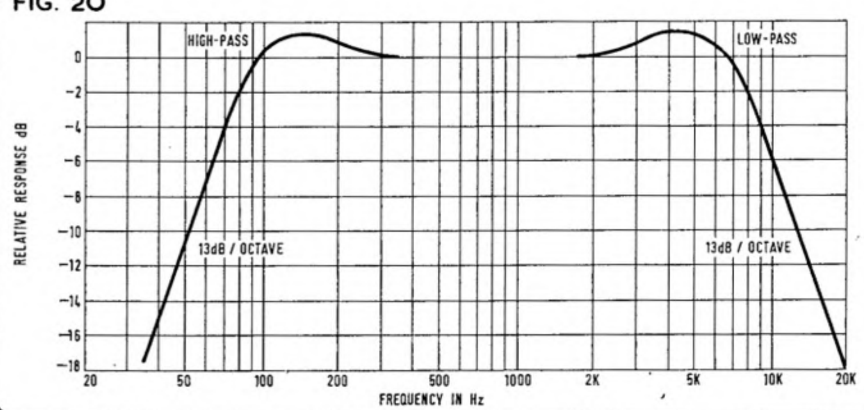


FIG. 20



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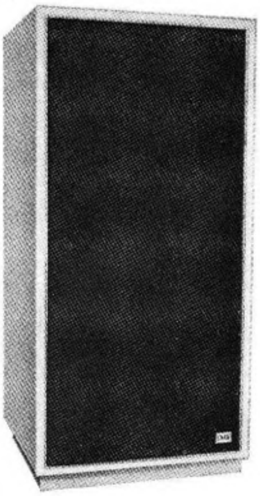

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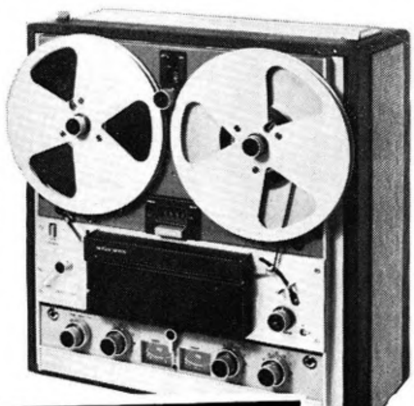

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What Happens at Feldon?

Rex Baldock visits Feldon Audio

CENTRALLY situated in London W1 at 126 Great Portland Street, the plain facade of Feldon Audio conceals a modern interior, often stacked with expensive audio equipment. The firm was created a few years ago with the intention of supplying studios and retailers with high grade products manufactured abroad.

It all really started round about 1966, when Dag Fellner, an emigrant from Sweden, set up Feldon Recording Ltd, a mobile recording service also undertaking mixer design and construction. Dag had begun his career with the Swedish Navy as a radio officer (in a submarine!), after which he joined Europa Studios in Stockholm as a sound recordist. He came over to the UK in 1960 and joined Angus McKenzie at Olympic Studios, later transferring to Advision Studios, working there on mixing consoles and multitrack tape.

Close association with recording studio requirements and the problems experienced with some of the equipment led Dag to the notion of expanding Feldon Recording into an equipment import agency, specialising in additions and modifications and offering a comprehensive after-sales service. The venture was precipitated by a visit to the USA in 1968, during which he secured the UK distribution rights for the Scully range of the tape recorders. Feldon set about familiarising himself with the intricacies of import duty, storage, packaging, checking out, calibration, installation and servicing, together with all the associated paperwork.

Inside 126 there is plenty of floor space, Feldon occupying some of the basement, all the ground and first floors, and sharing the administrative upper floors with Advision, whose studio backs directly on to Feldon's premises. This is a mutually convenient juxtaposition, since Advision are one of Feldon's customers and have, to some extent, allowed themselves to be used as 'guinea-pigs' in trials of new types or layouts of recording equipment. Hence, Feldon have the advantage of an operational studio available for experiments literally on their back doorstep, while Advision benefit from being allowed to assess the suitability of the latest professional products and techniques over a period, without necessarily committing themselves to actual purchase.

Since initially undertaking the Scully agency, the equipment range handled by Feldon has broadened into other domains, notably the J. B. Lansing loudspeaker and electronic products, as well as the Moog audio synthesisers, in addition to such items as microphones, amplifiers, programme meters, test tapes and recording ancilliaries. For many of these products, either Feldon Recording Ltd or Feldon Equipment Ltd are the sole UK agencies.

Despite this wide coverage, the total staff involved has so far been limited to five people, three technical and two administrative.

The technical side is handled by Stephen Court (another ex-radio officer and a former BBC sound recordist, who joined Advision late in 1966) and Bill Dyer, originally of Ryemuse Records. They both therefore have radio and recording experience. When not occupied purely with business matters, Dag is also available for technical advice and customer demonstrations; reception, public relations and publicity are the responsibility of Mrs Fellner, with an assistant for the secretarial work.

Within this compact set-up, Stephen Court is, strictly, fully occupied with the JBL products, but if things get extra busy it is a matter of 'all hands to the pumps'. Sudden changes of activity are nothing new to him, since with the JBL installation and operation covering the fields of domestic audio, studio monitoring, PA and assisted live performance, he may easily be involved in a 'beat' session one minute and dealing with opera the next. Since Bill Dyer's area of responsibility includes servicing, it might be imagined that he is out at studios a great deal. In fact, this is not so, a consequence of the company policy of handling

(continued on page 589)

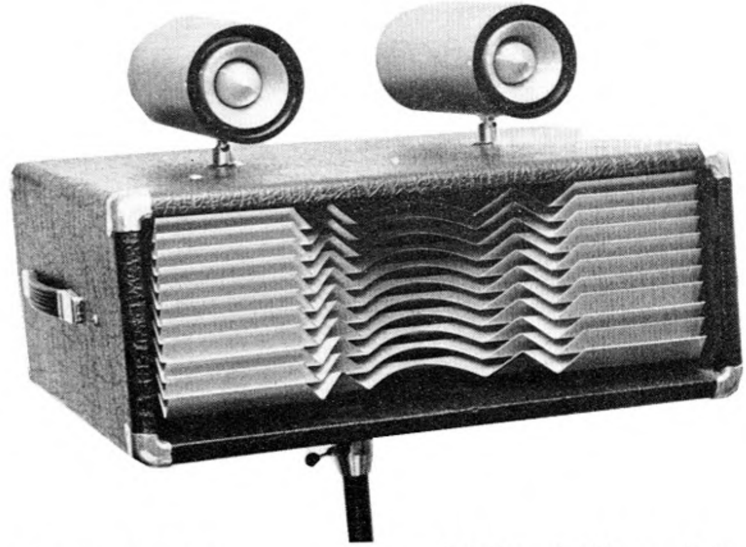
only reliable equipment. Bad luck aside, therefore, only routine attention is required following installation.

Such reliability, both mechanical and electronic, is achieved in the Scully multitrack recorders by a combination of basic simplicity, accurate construction and generous rating. For instance, the use of feedback from the record head windings obviates critical bias setting, while low distortion and wide dynamic range are partly secured by the use of non-linearity correction circuitry. Scully concentrate especially on the spectrum up to about 5 kHz, rather than attempt to achieve spectacular performance figures above at the expense of what, in their opinion, is the most significant part of the audio range. They believe that this design philosophy leads to a cleaner overall subjective performance. Foı example, the new *100* series 16 track machine using 50 mm tape (costing about £8,800) has numerous special features. Its outward appearance is nevertheless very clean and uncluttered and it is simple to operate, only the basic controls being visible. All the principal electronic sections are on readily accessible printed circuit boards, quickly exchanged in the unlikely event of fault or failure; loss of time on a recording session can be a very expensive matter.

In addition to installation, Feldon deal with import and duty problems, and all equipment is unpacked on receipt and checked over. Where necessary, it is adjusted for optimum performance or to suit the customer's particular requirements. Special attachments or additions (such as Dolby systems, for which Feldon are licensees) are made and tested in the main building, some simpler assembly work also taking place at a warehouse they have near Regents Park.

In the main demonstration area, prospective purchasers of hirers may experiment with the comprehensive Moog Synthesiser or the simpler Mini Moog *Model D*, results being heard via the selection of JBL speakers available. If anybody wants to hire the full-size Moog for a month it will set them back £600 (for the same fee they can have an eight track Scully), but the more likely requirement of using a Mini Moog for a one-day session brings it down to only £10.

The rugged JBL speaker range has some interesting and unusual features, particularly within the drive units for the *S7* Monitor. Its mid/high range compression driver uses a 100 mm diameter aluminium ribbon coil, edgewound by hand, joined to a domed duralumin diaphragm. In contrast to the more usual 'pepperpot' phase corrector, this drives the associated horn throat via annular slots, the horn mouth feeding a diffusing lens of multiplate construction. The whole drive assembly is extremely rigid and has to be built to very close tolerances, since the magnetic gap is rather less than 400 μm. The gap flux density is 2T (tesla), and external leakage is virtually undetectable. This unit can cover 300 Hz to 12 kHz at a continuous programme rating of 60W. The HF unit has a 450 mm coil and silver impedance control shorting ring, and the LF band is radiated by a reflex loaded 380 mm cone driver. On speaker performance, Dag likes to make an analogy with camera lenses and says the JBL monitor systems are favoured for their 'resolution'; they are being adopted by several studios, including EMI.



Insect-like JBL treble system

High quality tape and disc signals are available for the purposes of demonstration, amplified via one of the range of Spectrasonic amplifiers, built in the USA. These feature electronic crossover circuits which, with the output stages on separate printed boards, are all built to the highest professional standards, but even so remain relatively compact. Principal performance features are high slew rates and under 0.001 per cent distorticn for 30W continuous output.

In addition to other studio equipment in the Spectrasonic catalogue, Feldon are also distributors of the Norwegian Kongsberg sound consoles and auxiliaries. Other items include a useful general-purpose feedback amplifier 'block', the *M100*, costing only a few pounds, various types of filter, and compressor/limiter designs offering controlled transient overdrive features. Also included are the expensive but very wide dynamic range optical display PPM units by NTP (of Denmark), on which both programme and background noise levels may be monitored on the same range setting, that (*continued on page 591*)

The Feldon test bench

Patents Review

BY ADRIAN HOPE

FIG. 1 (DECCA)

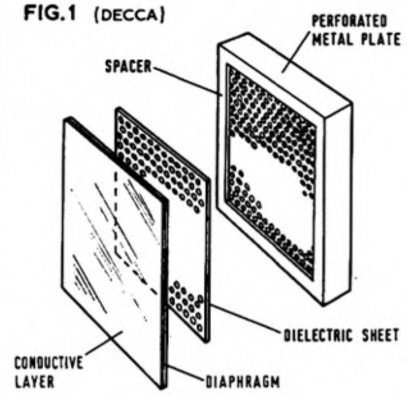
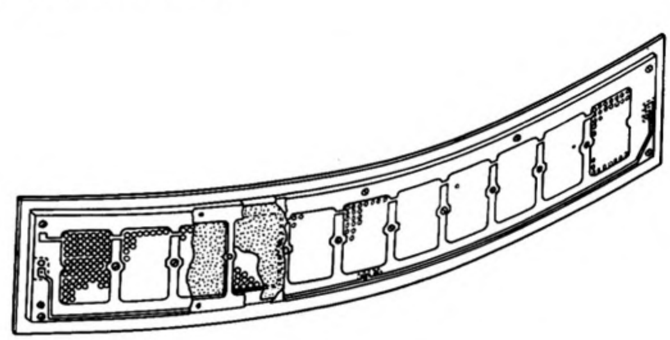


FIG. 2 (BOWERS AND WILKINS)



IN the August 1971 issue of STUDIO SOUND, Michael Gerzon explained how his tetrahedral reproduction experiments had proved an ideal way to show up usually subtle loudspeaker colorations. He concluded that there is 'clearly an enormous amount of progress yet to be made in loudspeaker design' and implied that Quad *ELS* speakers have a generally better than average performance. Patents for new loudspeaker designs are being introduced continually and this backs up what Gerzon says. Because when something approaching perfection has been designed, there is little point in developing further. Here are two new developments in electrostatic speakers.

The first is from Decca Ltd. Their BP 1,234,767 concerns itself with electrostatic speakers of the type having a rigid perforated conductive plate spaced from a diaphragm which is formed from a sheet of non-conductive dielectric material, such as polyethylene terephthalate. The dielectric sheet has a conductive film on its surface remote from the perforated plate and the dc polarising voltage is applied between the plate and this film. Of course the audio signal is also applied to produce vibration of the diaphragm and audio transduction.

Decca suggest that this type of speaker suffers from the disadvantage that the dielectric sheet of the diaphragm may acquire a tertiary charge which opposes that created by the dc polarising voltage. The net effect is reduction in loudspeaker sensitivity.

Decca claim that, by putting a layer of non-conductive dielectric material over the fixed perforated plate, this tertiary charge will find it hard to build up and sensitivity will be maintained. In practice the non-conductive layer is perforated so that its perforations are aligned with those in the plate it covers and this can be achieved by using coating techniques. But a more simple way is to use a sheet and burn it away from over the perforations with a flame. Apparently it is proposed to use the same material (polyethylene terephthalate) to form not only the diaphragm itself but also the layer.

Another invention in the electrostatic field comes from Bowers & Wilkins Electronics Ltd (BP 1,239,658). B & W describe a basic form of speaker similar to that described by Decca but their diaphragm is sandwiched between a pair of rigid insulating perforated plates, each with a conductive layer on the side facing away from the other plate. The diaphragm is of flexible insulating material coated with electrically resistive material and each of the plate conductive layers is perforated in alignment with the plate it covers. In view of the perennial difficulties in raising enough power without loss of quality from such electrostatic elements, each of the perforated plates will normally have a number of perforated areas separated by solid areas, the diaphragm being held stationary in the solid areas of the plates and being free to vibrate in the vicinity of the perforated areas. This way a lot of separate loudspeaker elements are formed; sometimes different elements handle different frequency bands, possibly with reinforcement by moving-coil speaker components.

B & W suggest speakers in which the two perforated plates each include 11 metallised perforated areas produced by a printed circuit technique. These metallised areas are electrically interconnected by tags and after etching are drilled to provide 75 holes per metallic area. The diaphragm is pvc with a graphite or similar electrically resistive coating on both sides and the whole string of 11 elements are stretched out on a curved frame to improve directional characteristics.

An important feature of the invention is that the holes in the conductive surfaces correspond with those of the perforated plates; but the diameter of each hole in the conductive surface is greater than the diameter of the corresponding hole in the plate that it overlies, e.g. by counter-boring, counter-sinking or etching. According to the inventors this technique helps control the behaviour of the diaphragm at high frequencies.

FELDON continued

displayed being useful over more than 80 dB. These can also serve as useful check facilities on system condition, since incipient faults may be detected before they become significant. Also by NTP is a modular stereo monitor oscilloscope for checking 'phase register', both normally and for mono mix-down.

Feldon's equipment supplier catalogues show the extensive variety of products that may be obtained with their assistance, and this is reflected in the changing aspect of their storage areas. This was noted over an interval of only a few days, during which the scene was completely transformed. Here one day may be seen one of the very large JBL Paragon integrated stereo speaker systems awaiting a customer, to be replaced by a set of packing cases housing mixing console parts, or perhaps some studio monitors. In some instances—say a 16 track tape recorder—the value packaged per cubic metre is enormous, possibly £10,000 or more. Valuables such as this account partly for the exceptionally high turnover per employee, some 10 times greater than found in many manufacturing industries. Of course, Feldon are not manufacturers, apart from relatively minor attachments and the like, so the stock is almost entirely in the form of finished articles, permitting a throughput equal in value to that of quite a large organisation.

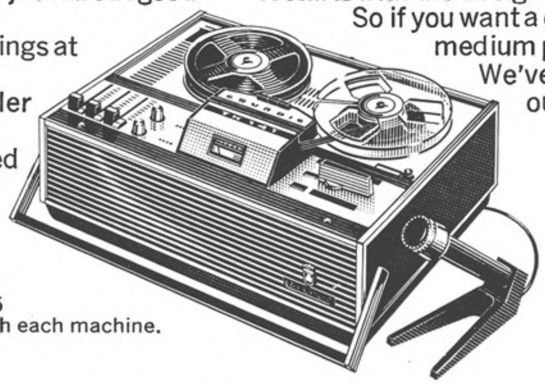
How we've smoothed out the ups and downs.

If you've ever been in a professional recording studio, you'll know that sound control is done by means of sliders not knobs. That's because sliding controls make it much easier to make the ups and downs, highs and lows of a recording really precise. And what's good enough for the professionals is just about good enough for you.

At least that's the way we see things at Grundig. Look at – and listen to – the new Grundig models at your dealer and you'll understand. Our stream-lined, fully transistorised machines are superior in every detail.

Each one has the new slim-line microphone that's as sensitive about sound as only a Grundig mike can be. In fact, each machine shows the extra thought and care we take at every stage of manufacture. It starts with the design and finishes with the finish.

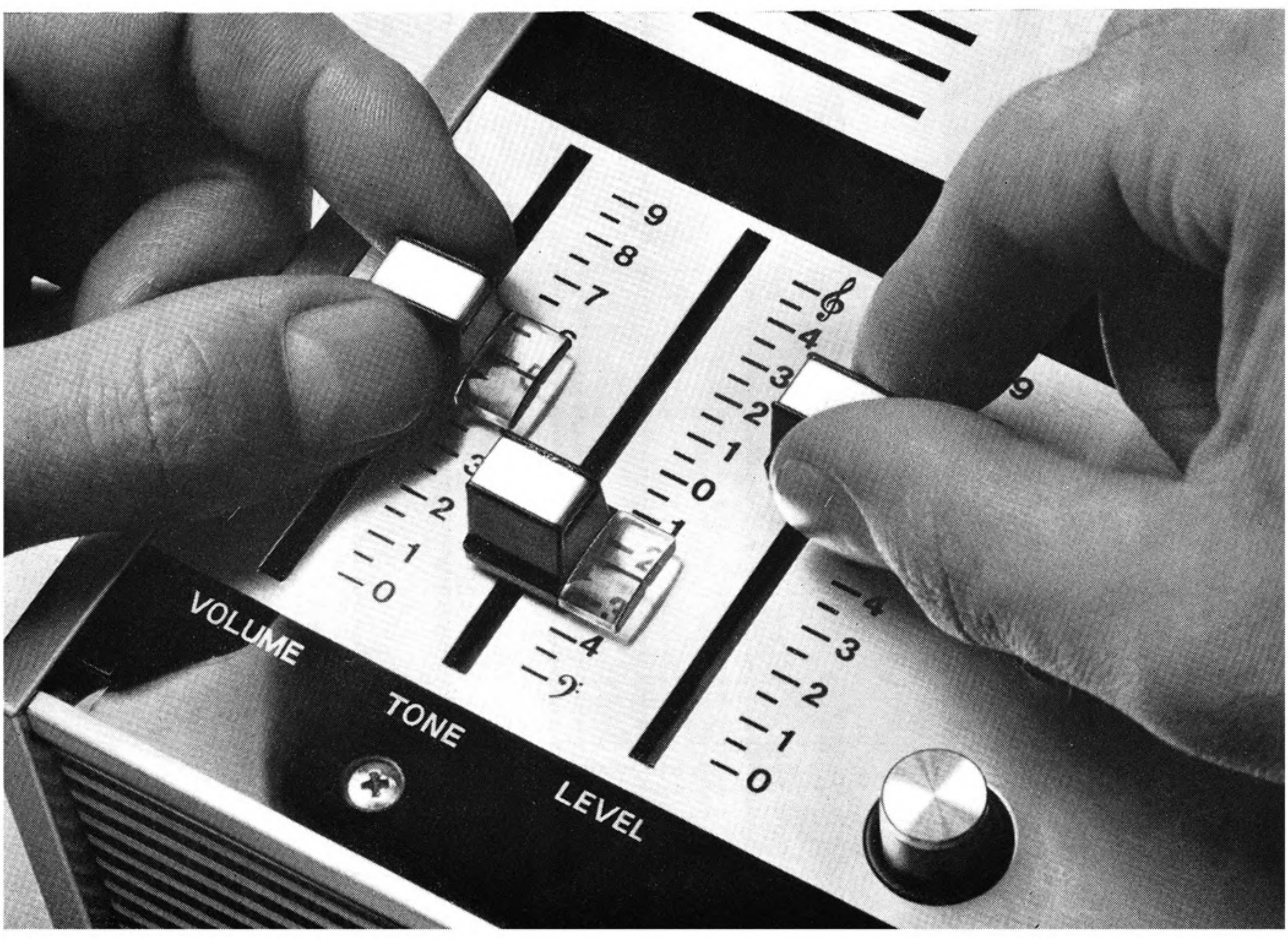
So if you want a quality tape recorder at a very medium price, the choice isn't hard. We've really smoothed things out for you.



Grundig Tape Recorders.
TK 121 2 track mono £55·30
TK 141 4 track mono £61·55
TK 146 4 track mono automatic £67·25
TK 147 4 track stereo automatic £93·35
A Grundig Hi-Fi tape is supplied free with each machine.

GRUNDIG

MADE BETTER TO SOUND BETTER
Grundig (Great Britain) Ltd.,
London S.E.26.



MASS CASSETTE AND TAPE DUPLICATION

SINCE the sales of prerecorded cassettes and eight track cartridges have now reached significant proportions, a knowledge of both the preparation of copy masters and the duplication process is most important. The manufacture of prerecorded cassettes and tapes should be regarded as two distinct processes, although it is important at each stage to have a knowledge of the remainder of the process. Copy masters may well sound satisfactory at the recording stage, but even minor mistakes made then may have a seriously detrimental effect on the sound of duplicated tapes replayed on domestic machines.

One of the most important considerations is the careful choice of the maximum levels to be recorded on the duplicated product without undue distortion being audible on playback. It seems obvious that in the last year or so there has been confusion as to the correct choice of levels. Some prerecorded cassettes have been heard to produce distortion so intolerable that even those not using hi-fi equipment have noticed it. The industry regarded this as so serious that highly qualified engineers from Germany and the States were invited to sort out the problems that several companies have had—problems caused mostly by errors of levels and biasing.

Since most prerecorded cassette manufacturers are using the Dolby B system, or will shortly be doing so, a description of the entire process using the Dolby will be given first. The Decca Record Co have been most helpful in furnishing the details of their processes, for which many thanks.

Decca copy masters are made from the original A-Dolbyed 38 cm/s master tapes. These copies are recorded at 19 cm/s, the master first being de-Dolbyed and then processed before being Dolbyed to the B type process. 98 per cent of their present cassette production now uses the Dolby B system. In order to avoid the cassette being severely overloaded at high frequencies, thus creating serious intermodulation distortion besides squashing these frequencies, in the preparation of the copy master sound is passed through a limiter having special characteristics. To reduce the threshold at these frequencies it is not sufficient to boost treble frequencies in the limiter side chain since in such a limiting action middle frequencies—and to a certain degree bass ones—will also be affected. When large high frequency transients are present in the programme. Too short a compressor recovery time will cause distortion to become evident, particularly at low frequencies. Alternatively, if a longer decay time is chosen the entire level of music will appear to go down and recover gradually, producing a rather unusual effect. Therefore a limiter having separate thresholds for very high frequencies and lower frequencies, and with crossovers allowing the two bands to limit separately, becomes almost essential. This allows the wide dynamic range of many A-Dolbyed masters to be sensibly accommodated on a cassette, which even when B-Dolbyed will not give the full dynamic range found on a disc, particularly at high frequencies.

Decca are currently recording a peak level of approximately 250 pWb on most of their prerecorded cassettes, and they use a high quality BASF ferric oxide cassette tape in both C 60 and C 90 format. Their copy masters, at 19 cm/s, are therefore recorded to this same peak level, thus allowing the Dolby processing levels to remain constant throughout the duplicating process. Since the peak recording level is somewhat low for 19 cm/s, to reduce any build up of hiss, still further copy masters are recorded to the NAB curve of 50/3180 µs on tape with a very low inherent noise level, rather than one of high output capability. PPMs are used to ascertain the peak recording level that is satisfactory for the cassette type tape being employed.

At the factory the 25 mm wide copy master tapes, usually supplied on NAB spools, are threaded on the high speed reproducer, not only through the normal path but also through a tape loop bin which allows the master tape to repeat its programme continually as often as required without the slight fraying or cockling of the tape often associated with the use of the older bins. The latest pneumatic action Gauss bin can accommodate up to 550m of tape quite easily, thus allowing 45 minutes per track. The master sending machine can replay tapes at 1.52, 3.04 or 6.08 m/s and has the facility of compensating for the more usual recording characteristics. Decca normally duplicate at the highest speed which is equivalent to a 32 times speed-up. It is therefore quite remarkable that they obtain a very flat response to approximately 320 kHz at duplication speed, and such a response necessitates a very high bias frequency to remove any trace of whistles caused by harmonics beating with the bias. The crystal controlled bias oscillator on the Gauss equipment therefore runs at 10 MHz, all the slaves' bias settings being interlocked to give a common bias frequency with all the machines. This high bias frequency necessitates very unusual record heads with a special focusing system for the bias which allows the high recorded frequencies to be magnetised well inside the more usual surface oxide layer of the tape. This allegedly provides considerable improvement in high frequency performance on replay.

The slave machines are loaded with what are termed 'pancakes' on NAB centres carrying 1.1 km. At 4.8 cm/s this represents approximately 14 programmes, each dubbed end to end, with the master running through its loop bin. The master playback machine requires 10s to stabilise at full speed whereas the slaves require approximately 5s to reach stability.

For the quicker identification of the beginning of each programme on the duplicated tape, a 100 Hz ripple voltage is passed through a special erase head at these points on the slaves, thus speeding final assembly into the hardware. During the duplicating process the cassette type tape is continually cleaned to prevent any oxide shedding on to the tape transport and head assembly. Incidentally Decca make cassette hardware themselves but cartridge hardware is bought in.

Quality control in cassette duplication is vitally important and on average each slave's output is checked every three or four runs. Since Decca operate up to a maximum of 10 slaves at once this means that three cassettes are checked per run, each duplication run lasting approximately 12 minutes.

With 10 slaves it is therefore possible to produce at least 500 cassettes per hour although from my own experience of duplicating with 6.25 mm tape this would require a fair degree of skill from the operator to maintain output.

At present only four tracks of the eight available on the copy master are recorded with cassettes, whereas on tape cartridges all eight tracks are recorded. In both cases all the tracks are recorded simultaneously. For cartridges the crosstalk below 250 Hz is better than 30 dB and, above 250 Hz, better than 50 dB. No figures are available for cassettes. Gauss claim that the tape recording process adds not more than 0.75 per cent distortion to the theoretical minimum inherent in the cassette tape itself, and the recorded hiss level is claimed to be only 2 dB above the measured noise of a perfectly bulk-wiped cassette.

Approximately the same number of cartridges per hour can be produced as cassettes, the extra number of tracks on the former being offset by the shorter length of each section of programme on each track. Copy masters for cartridges usually have a burst of 10 Hz at normal playback speed added at the end of the programme, allowing the cartridge make up machine to stop automatically at the point where the silicone-backed tape has to be cut. The tape is then automatically spliced to form the cartridge loop, the operator finally assembling the cartridge in its saleable form. Since cartridges are not at the moment recorded with a noise reduction system some companies prefer to record copy masters at a higher level. In any case tapes at 9.5 cm/s will accept a high recording level and so although the width per track is very similar to that on cassettes the signal-to-noise ratio produced by cartridges can be considerably better provided noise reduction is not in use in the cassette. It is of course impossible to predict which system will ultimately be the more favoured, for it might be said that noise reduction applied to eight track cartridges could make them appreciably better

(*continued on page 600*)

At last, Philips have come up with the final piece of equipment you need to make your hi-fi system complete.

The N2503 Stereo Cassette Deck. You use it in conjunction with your existing amplifier and speakers to record and play back cassettes in stereo and to play pre-recorded Musicassettes of your favourite artists.

The N2503 is built to the same high standard enthusiasts have come to expect from Philips hi-fi equipment. It has an extremely fast wind/rewind time, a very impressive signal to noise ratio, a sliding recording level control and a recording level indicator. It comes complete with a moving coil stereo microphone, and is also a very handsome piece of equipment, designed to look good in any hi-fi system, with real rosewood sides and brushed silver finish.

The N2503 Stereo Cassette Deck. We think that no hi-fi system is complete without it.

We want you to have the best.

THE MISSING LINK.

PHILIPS

Equipment Reviews

SONY 3664

THE tape recorder under review is a four channel 6.25 mm tape version of the two channel Sony *366*. Like the latter, this equipment has low and high level inputs, headphone outputs, and outputs to plug in to external amplifiers. The high level inputs and outputs are via phono sockets, whereas the low level (microphone) inputs are via miniature jack sockets. The headphone outputs intended for 8Ω phones are of the normal stereo jack type. The recorder can run at 9.5 or 19 cm/s and is intended for working with 18 cm spools.

The Sony is designed to operate in a vertical position in which the deck slopes slightly back from vertical, the spools being held on the spindles by push-on rubber clamps. The machine can be used either as a conventional ¼ track stereo machine, selecting tracks one and three or two and four or, when two levers are depressed, it will record on all four tracks simultaneously. Very high quality recordings can be made on this recorder, and the play back amplifier is of a similarly high standard. The recorder is equipped with VU meters for monitor levels and with tape monitor controls, allowing the output from the machine to be switched either to the input or to the tape output for a/b checking. The meters and headphone outputs follow this switch, allowing the meters to be used for monitoring the playback tape level.

The microphone inputs have a measured input impedance of 75 kΩ. Sony claim that they are suitable for use with 200 to 600Ω microphones. Frequency response was checked and found to be ±0.5 dB (40 Hz to 25 kHz) and 1.5 dB down at 30 Hz (microphone in direct to line out). Input clipping level was measured as –31 dBm, and, although this is perfectly satisfactory for other than capacitor microphones, the latter might tend to overload if used close, although the programme would have to be at quite a high level to do so. The maximum microphone input sensitivity is –64 dBm to give about five per cent distortion level on high output tape (approximately 6 dB above 320 pWb/mm). The microphone inputs and high level inputs have independent channel gain controls which therefore allow mixing.

The high level input will accept any reasonable audio level without distortion and in fact work satisfactorily even at 10V rms. The maximum sensitivity of this input is 180 mV to give the same peak recording level of 6 dB above DIN level, which incidentally becomes 10 dB above NAB level when measured on tone. On music it will be found to under-read by between 6 and 10 dB on average. The recording equalisation is unfortunately preset at the factory although an inductance (which has different capacitances switched across it for equalising the two speeds) can be tuned to alter the peaking frequency.

The machine is equipped with a normal/special switch to match either ordinary LP or high output, low noise tape. The switch alters the record equalisation and bias, and decreases the playback amplifier gain. Hence the playback VU meter reading makes the user record at a slightly higher level for high output tapes when the switch is in the 'special' position. Bias frequency was checked when driving either two or four channels and found to be 124 kHz, drifting a few hundred Herz each side over an hour. This was regarded as excellent and was close to the manufacturer's claimed frequency of 125 kHz.

The playback amplifier can be set to give an output level of +8 dBm for a recorded level of 320 pWb/mm and the machine was tested under these conditions. The main output amplifier clipped at +18.5 dBm, more than adequate for industrial purposes let alone hi-fi ones. The output impedance was checked and found to be 3.3 kΩ, due to a series resistor of this value isolating the main output from the buffered and amplified headphone/metering amplifier. This resistor could in fact be reduced to give a lower output source impedance and I would suggest a value of 560Ω. Together with the output impedance of the output transistor itself, this would give a 600Ω source which could then be bridged by 10 kΩ in the normal way without any significant voltage drop.

MANUFACTURERS' SPECIFICATION
(19 cm/s, Sony *SLH* tape).
Four-channel 6.25 mm domestic tape unit.
Frequency response: 30 Hz to 20 kHz ±3 dB.
Signal-to-noise ratio: 55 dB.
Distortion: 1.2 per cent.
Wow and flutter: 0.09 per cent.
Speeds: 19 and 9.5 cm/s.
Inputs: –72 dB (microphones); –22 dB at 100 kΩ (auxiliary).
Outputs: 0 dB (0.775V into 100 kΩ). Two sockets for 8Ω stereo headphones.
Spool capacity: 18 cm.
Price: £240.74.
Distributors: Sony (UK) Ltd., Pyrene House, Sunbury Cross, Sunbury-on-Thames, Middlesex.

In normal use the output from the headphone socket was not considered anywhere near adequate for a reasonable volume. The headphone socket output source impedance was measured at 1.5Ω and just under 1 mW was dissipated into an 8Ω load at peak recording level. I consider here that 8 dB extra gain would give a more satisfactory listening level. The headphone output should be provided with a volume control as there is no means of adjusting the replay volume other than by adjusting presets inside the recorder.

The meters are rather crude in that only 0 VU is actually calibrated, with dots over the scale representing the normal VU markings.

Input and output amplifier distortion was measured in the direct monitor mode. At a level equivalent to peak recording level (+14 dBm out), the distortion measured 0.05 per cent and was considered most satisfactory.

The replay amplifier has an extremely low noise level, measuring between 57 and 58 dB below 320 pWb/mm on each of the four tracks. This is without doubt the lowest noise level yet measured on any ¼ track machine, the measurements being checked at 19 cm/s on the output sockets with the motor running but the tape pause control employed. The equivalent DIN weighted noise figure was 69 dB below the same reference point, again this figure being fairly consistent between the four tracks. Most of the noise measured was found to be 50 Hz, this being 61 dB below DIN level with a small component of noise at 150 Hz. At 9.5 cm/s, the average unweighted noise figure was –54.5 dB the weighted DIN equivalent being –66 dB, again with the same reference level of 320 pWb/mm.

On examination of the replay amplifier circuit, it was noted that the head is not resonated but works into a load impedance across the base of the input transistor. The equalisation network is purely a 6 dB per octave bass boost except for the NAB bass compensation for the two speeds, levelling off to a flat high frequency response. The equaliser shifts the entire time constant so that it can be set accurately. Since no treble peaking exists in the circuit, a slight boost must be tolerated between 2 and 8 kHz, under which circumstances three of the four tracks extend to 18 kHz with almost no fall-off. However, one of the tracks (Track Three) would appear to have a faulty replay gap. At 19 cm/s the response was 3 dB down at 18 kHz with respect to 5 kHz, whereas at 9.5 cm/s it was 3 dB down at 9 kHz with respect to 2.5 kHz, the lower reference frequencies incidentally being chosen as being well above the 3 dB point in the time constant curve. This measurement showed that the replay head has an effective gap width at least of 4 μm or so on Track Three, whereas it would appear to be well below 3 μm on the other three tracks. The replay response from a 19 cm/s NAB test tape was ±1 dB on all channels between

(continued on page 597)

JVC NIVICO
Steps up the Stereo Pace for '71

5340 4-Way 4-Speaker High Fidelity Speaker System. 40 Watts (RMS). Multi-channel input gives this bookshelf-type system rare versatility. Frequency response is 20 to 20,000Hz. Complete with walnut cabinetry.

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125 Hz and 14 kHz and extended to 18 kHz on Tracks One, Two and Four with a 3 dB drop on Track Three due to the fault already explained. At 31.5 Hz there was a boost of 2.5 dB on all four tracks, due mainly to the fringe effect of the adjacent tracks to the track being measured (a common LF phenomenon when using full track test tapes on multi-track machines). At 40 Hz the response was virtually flat, whereas at 60 Hz the maximum fall-off on any track was -1.5 dB. At 9.5 cm/s, Tracks One, Two and Four measured ± 2 dB from 31.5 Hz to 12 kHz, all of them having to a degree a shelf lift up to 8 kHz, falling steeply above 14 kHz. Track Three was -8.5 dB at 12 kHz and -14 dB at 14 kHz, the -3 dB point being at approximately 9 kHz. The bass end was excellent on all four tracks.

The overall response at 19 cm/s showed a general bass roll-off shelf which would appear to be partly due to insufficient bass boost being applied for the NAB curve, the average fall-off at 40 Hz being just under 3 dB. From 6 kHz upwards, there was a general shelf of approximately 2 dB on all tracks up to 16 kHz, the response then falling fairly quickly. These responses were taken in the 'special' switch position and were made on BASF *LP35LH*. It was felt that the time constant capacitor in the recording amplifier for this position was some 20 per cent too large in value and if this was changed, in addition to the bass boost capacitor, the response would then be ± 1 dB from 30 Hz to 16 kHz on all four channels. In the 'normal' position, and using a very much poorer LP tape, the response was fairly similar with in fact slightly less of a shelf boost at the high frequency end. At 9.5 cm/s the overall response was not at all good, there being quite a serious bass loss of well over 3 dB on all channels, up to 4 dB on some channels at 40 Hz, the fall-off common from 125 Hz. Again it would appear that the NAB time constant bass capacitor had been left out of the recording amplifier circuit. The response held up to 10 kHz where it had fallen to -2 dB on two of the tracks, the faulty channel having fallen some 5.5 dB. Above 10 kHz, the fall-off was fairly steep even on the good channels.

I consider the recorded response at 9.5 cm/s inadequate by present standards. However, it might well have been improved on the better tracks with a slight adjustment to bias, although this would have given a very noticeable additional treble boost at 19 cm/s.

The phasing of the four tracks was reasonably accurate, as checked with a double beam oscilloscope examining the 10 kHz waveform on combinations of two tracks at a time. The azimuth was very carefully set by the factory and only a very minor improvement was gained after re-azimuthing. The crosstalk performance was also checked, in particular recording and replaying Tracks One and Three only and measuring their crosstalk on Tracks Two and Four. At 1 kHz the worst crosstalk was between Tracks One and Two, this being the surprisingly good figure of -67 dB. The overall crosstalk when recording on all four channels was again very good indeed, the worst figure being approximately 60 dB between any two channels at 1 kHz.

Distortion was measured at 19 cm/s and found to be one per cent at 320 pWb/mm, rising to only three per cent at 5 dB above this.

The bias and recording amplifiers put very little noise on to the tape, the overall noise figure averaging at -54.5 dB below DIN level, quite an achievement for a ¼ track machine. Using *LH* tape, an overall signal-to-noise ratio of some 60 dB can be achieved below absolute peak recording level.

Record amplifier

The recording amplifier was checked and found to have plenty in hand at this output to drive very high output tapes or tapes with lower than usual efficiency. B.A.S.F. *LR56* was tried at 19 cm/s and, although run at considerably below its correct bias, only 3 per cent distortion resulted when a 1 kHz tone was recorded, giving a playback level of 8 dB above DIN level. Thus all the measurements made were confirmed.

One final electrical feature is the provision of what Sony call a noise suppressor, switchable in and out, which proved to be a fairly steep cut filter with a 3 dB point at 9 kHz, the response being 10 dB down at 15 kHz. This response characteristic was checked at different levels, confirming that it was purely a filter (which, incidentally, acted on playback only).

Mechanically I consider the machine very sound indeed, with particularly good head to tape contact. The wow and flutter at 19 cm/s was measured and found to be 0.05 per cent, peak-weighted to the DIN standard. At 9.5 cm/s, the figure was 0.09 per cent peak-weighted. In practice, no wow or flutter was ever audible on any of the recordings made. Despite the machine being used on a number of quadraphonic sessions, no dropout was ever noticed on any of the tracks over 15 hours or so total music recording.

The absolute speed of the machine was checked and found to be 0.8 per cent higher at 19 cm/s and 1.6 per cent higher than nominal at 9.5, the latter figure being regarded as on the poor side. I found that many ¼ track stereo tapes I made some years ago, which have given head contact problems on certain other machines, played back without trouble on the *3664*. The function control is very simple to use and has only four positions, rewind on the left, then stop, record/replay and forward wind. At the end of the tape on any function, the machine automatically stops and the function knob sets to the stop position. On rewind, the tape is held away from the heads although the heads remain live. The pause control is very effective and the machine is easy to lace up, in fact one of the easiest I have come across since the pressure roller withdraws below the deck surface until the control knob is in the record or replay position. The recorder has only one motor and I have purposely held back this review for some while to see if the performance of the machine deteriorated after considerable use. I am pleased to say that no deterioration has been noticed. To rewind an 18 cm reel of LP tape took approximately two minutes; the spooling was reasonably tight.

Anyone wanting to deal with presets inside this machine will find some difficulty both in locating and adjusting them. A service manual is not normally supplied but can be obtained for an extra charge. The machine is rugged by domestic standards and no faults whatsoever developed despite its being carried round London to several locations. I must criticise the rather high price, however, this being well over double that of the normal two track model. Sony tell me this is because at the moment so few of these machines are being made, and it is therefore far more expensive to produce than the two track version. **Angus McKenzie**

circuits including inductors and capacitors which can be made to fulfil these conditions quite easily, are nevertheless not acceptable. I am referring to bulk, expense, hum pick up and so forth. Recent work has been concentrated on the use of a technique called "Active Filters" to synthesise the performance of resonant filters.

Fig. 12 shows the basic arrangement of the two types. The transistor is used as an emitter follower which gives the conditions of amplification of just less than unity (to avoid instability) and high input impedance together with low output impedance. Complete analysis of the circuit is not important at this stage and is rather complicated. Biasing arrangements have been omitted for clarity. The component values given give cut off frequencies as shown.

We have now considered examples of all three main types of equaliser and all that remains now is to describe briefly the two types of Equaliser Module that are available incorporating the circuits described.

The *Type EQ1* equaliser combines a Baxandall bass and treble circuit with a presence equaliser. The circuit is shown in **fig. 13** and the printed circuit layout is **fig. 15.** Two peaking frequencies are available and the components listed give frequencies of 1 kHz and 2.4 kHz. Selection is made by a two pole, three way switch while a second switch adjusts the height of the peak in 2 dB steps. In the OFF condition, the circuit operates at unity gain. The overall circuit is designed so that its output is 'in phase' with the input. This means that if the whole equaliser were to be bypassed by means of a switch the phase relationships would be unaltered whether the equaliser were in or out of circuit.

The circuit in **fig. 4** is that of the operational amplifier Type A which is used both in this equaliser and in the following one.

The *Type EQ2* combines another peaking equaliser, with a pair of pass filters. This time the peak can be arranged to boost or dip by operation of a two pole switch. The two frequencies can be selected from the table given, the change in capacitor effecting the change in frequency. The frequency and amplitude switches function as before. If desired the capacitors in **fig. 14** could be altered to others selected from the table to give alternative presence frequencies. The circuit for EQ2 is **fig. 16** and its printed circuit is **fig. 7.** Measured frequency response curves are shown for both circuits in **figs. 18, 19** and **20.**

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Sony DVK 2400 ACE

THE Sony *DVK 2400 ACE* is a helical scan video tape recorder recording 50-field 625-line monochrome on 12.5 mm tape at 29 cm/s. It costs £475 complete with camera and differs from the majority of VTRs in being battery-powered. Space and weight are saved at the cost of omitting all replay facilities. The *DVK 2400 ACE* complements the £369 *CV-2100 ACE* mains-powered recorder/player. The cheapest Sony monitor (230 mm diagonal screen) adds £116.8, creating a very flexible VTR system for a total £960.8.

I field tested the *CV-2100 ACE* in December 1970 and found the system robust and easy to use. The equipment is still working well after a year's use, the only chore being occasional head and slip-ring cleaning.

Since the battery portable is in rather short supply Sony supplied for test a machine normally used by one of their sales representatives. Marks on the metal casework showed that the unit had taken a fair battering and appeared to be tolerating it.

Fig. 1 shows the camera, connecting lead and open recorder. The dark bulge above the camera lens houses a microphone. The white object on the top right of the VTR lid is a clip-on handle for emergency rewinding. No motorised fast-wind is incorporated since it is of little value and would cane the batteries.

When the recorder hangs from your shoulder, the control panel shown in **fig. 2** falls conveniently to hand. This contains a miniature jack mic input (over-riding the camera mic), an earphone socket, battery level meter, stop/standby lever and a red start button. That's all. Video and audio levels are controlled electronically, leaving the operator to concentrate on the CRT viewfinder. The only other controls to worry about are those in front of the camera: focus, zoom and aperture.

Pushing the standby switch forward sets the video heads in motion and powers the camera. Some 20 seconds later, the viewfinder registers a picture, assuming you have removed the lens cover. You place your eye to the flexible eye-piece and zoom in to the object you wish to record. You then focus, zoom out if necessary, and check the aperture setting. When you are ready to shoot, you squeeze the trigger beneath the camera or press the start button on the recorder. The start button locks down whereas the trigger must be held. To stop, you release the button or trigger, then disengage the standby selector.

Replaying my first outdoor recordings, I was very surprised indeed to find that scene changes were almost undetectable. Most VTRs are unstable for the first few seconds after starting and the concept of 'editing in the machine' is not very satisfactory. Picture break-up in the Sony portable was limited to a flash of one or two frames after each restart and was visually no worse than a badly spliced cine film.

Fig. 3 shows the deck and tape path. A mechanical servo governs the supply tension. After this the tape passes 90° round an indented nylon roller (A), over a fixed metal guide, then 180° round flexible roller B. Here it meets the full-track erase head and enters the video helix. Leaving this at a lower level, the tape crossed the audio/sync head and is pinched between flexible roller D and a metal capstan out of sight beneath roller C. Thence over another stabilising arm to the right-hand take-up spool. Motion from the capstan is transferred through pinch wheel D and roller C to the back of the tape on roller B. The tape is thus powered on both sides of the video drum, isolating the heads from tape bounce. The excellence of this system provides the stable scene changes mentioned above.

A metal plate normally covers the video heads; this and a plastic cover plate have been removed in **fig. 3.** Needless to say, the video/audio head spacing is practically identical in the battery and mains VTRs to ensure exact sound synchronisation.

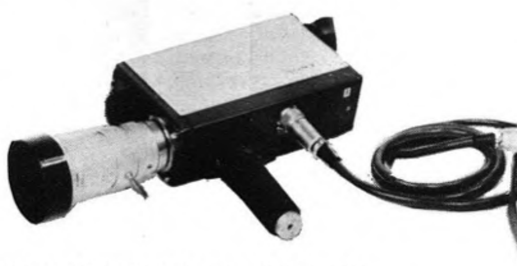
The tape supplied with the *CV-2100 CE* differs from earlier Sony brands in being black rather than brown and in appearing very definitely inside out. The back is matt and the coating so highly reflective that I had to phone Sony to confirm that all was in order!

Two rechargeable batteries occupy a recess in the base of the recorder and are rated at 40 minutes running time. The tape lasts 20 minutes per reel. Care must be taken to switch on the charger *after* connecting the batteries or no charging takes place.

A few points to keep in mind when using the camera. Firstly, it must not be pointed directly at the sun since this is likely to burn out the vidicon. Similar care should be taken in the presence of spotlights. When the camera is

(continued on page 600)

FIG. 1



MANUFACTURER'S SPECIFICATION
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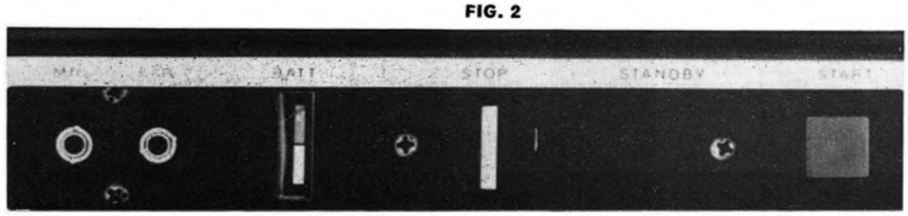
Audio signal-to-noise ratio: 38 dB.
VTR Dimensions: 305 x 330 x 126 mm, 11 kg.
Camera dimensions: 70 x 126 x 215 mm, 4 kg.
Price: £235 (VTR); £240 (camera).
Distributor: Sony VTR Division, Clockhouse Lane, 11 Ascot Road, Bedfont, Middlesex.

FIG. 2



SONY VTR FIELD TRIAL continued

stored after use, the lens cap should be fitted to prevent accidental burn-in. In the absence of a cap, the lens aperture should be set to minimum (f16) and any convenient covering used. The lens cap was in fact the only mechanically dubious component in the entire system, being inclined to fall off. The plastic clasp was either worn or excessively flexible.

The CRT monitor is rectangular and tended to stretch the view horizontally. The contrast setting suggested that some indoor shots would not be successful though, on playback, they proved quite adequate. Most CCTV cameras, including the larger Sonys, incorporate external viewfinder controls for brightness, contrast and vertical/horizontal sync. For simplicity, these are omitted in the battery system.

A short report but there is little to criticise in the performance of this equipment and still less to carp on where ergonomics are concerned. Lacing up the convoluted tape path is the only tricky aspect of operation, one which videocassettes will shortly eliminate. The only risk a company incurs in buying a Sony VTR is that in two or three years smaller and lighter equipment is likely to be available. Which is a comment applicable to almost any field of industry.

David Kirk

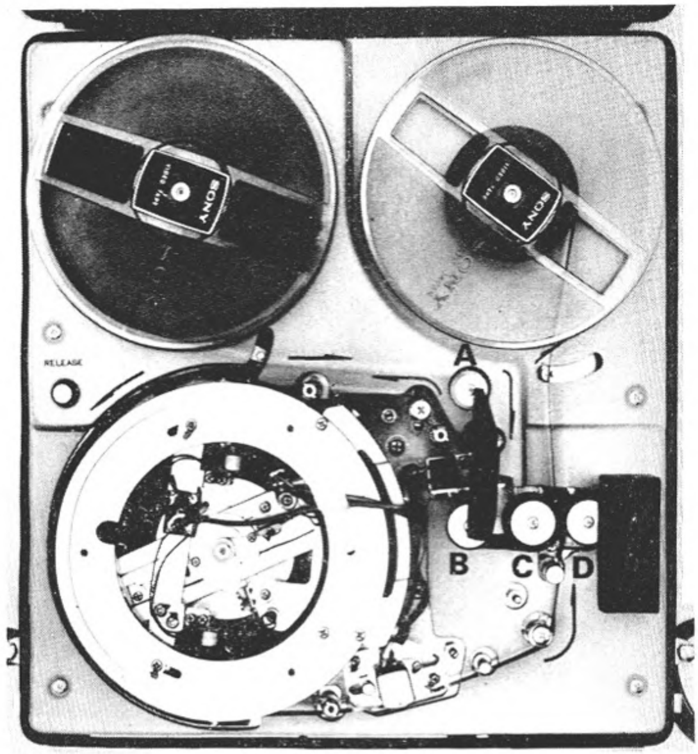


FIG. 3

RECORDING STUDIO TECHNIQUES continued

than cassettes. At the time of writing BASF have just announced their new chromium dioxide cassette tape which, together with noise reduction, should swing the pendulum in favour of cassettes once more. There can now be no doubt that the quality of cassettes likely to be produced in the foreseeable future should be far superior to that envisaged by Philips when they first introduced their system. For this reason a vast expansion in cassette and cartridge duplication facilities is forecast. Although at the moment a sharp fall off above 10 kHz occurs on pre-recorded cassettes new equipment is being developed to extend the response using improved magnetic material such as chromium dioxide.

A degree of controversy has arisen about methods of biasing high speed duplicator slaves. Gauss recommend that, when biasing at a speed of 32 times nominal, a frequency of 32 kHz should be recorded at a level of 20 dB below NAB level, properly referred to as Ampex operating level (185 picowebers). The bias current should be noted for outputs corresponding to 0.5 dB below and above the bias level giving peak signal output. Gauss then recommend that the correct bias setting occurs approximately one-third of the way up from the lower bias setting. However, as a result of a certain amount of trouble in this country with this procedure BASF have advised that the tape should be biased on high speed duplicators for a 2 dB overdrop at 6.5 kHz nominal, i.e. 208 kHz actual at duplicated speeds. It is claimed that with such a bias setting procedure consistent levels and a more stable high frequency response for any particular type of tape are possible in addition to a more precise setting, allowing improved recording of transients. It remains to be seen whether any snags develop with such a technique.

Because of the high cost of the Gauss equipment for smaller scale production it becomes more economic to consider either a large bank of simple cassette machines, kept in good order and copying at normal speed, or to use a high speed duplicator such as that made by Fraser Peacock for around £4800 with 12 slaves and a master playback machine, and which is capable of being operated by only one person. This equipment costs only a fraction of the Gauss duplicator, and with 12 slaves it is possible to produce at least 160 finished cassettes per hour. Therefore although the labour cost per cassette is high for larger runs this should be weighed against an initial outlay of perhaps £50,000 for an installation having ten slaves and a fast rate of depreciation.

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5" 1200'	£2·16	£1·42
5¾" 1800'	£3·10	£2·04
7" 2400'	£3·83	£2·50
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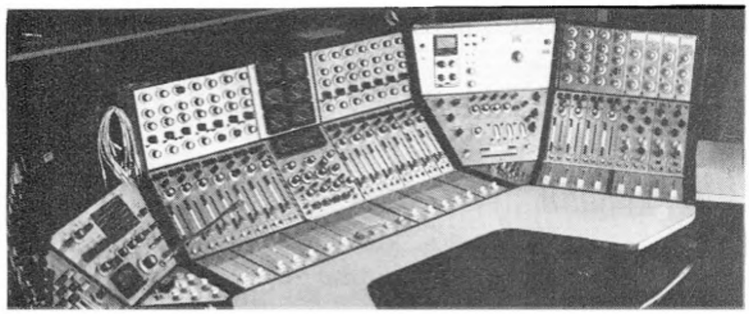
where helios leads others follow

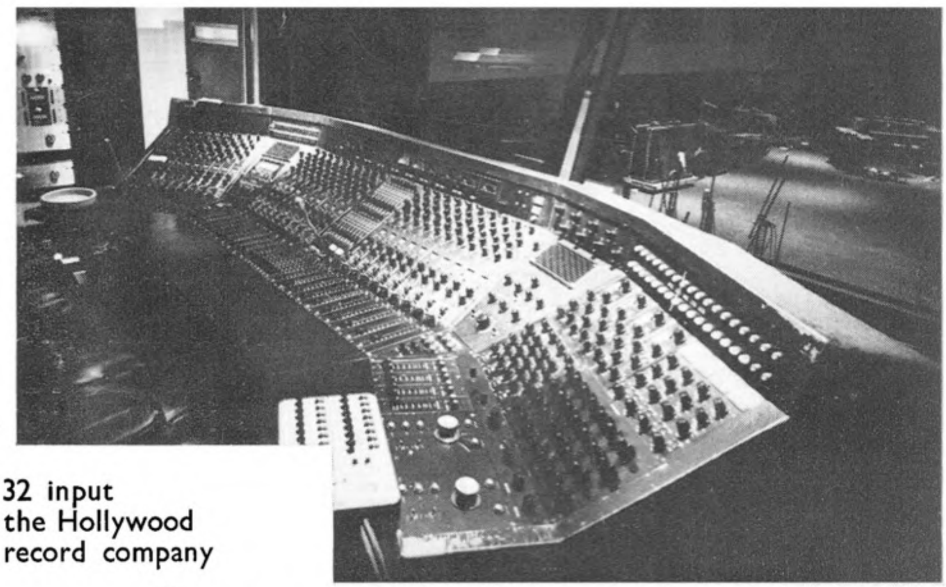
Looks familiar? It should. Many engineers know this 24 channel 8 output desk designed by Richard Swettenham for Olympic Sound Studios, pioneering his ergonomic wrap-round concept . . . . .

in 1965



1969

Helios supplied this 28 input 16 output console for the new Island Studios



1971

Helios are building this 32 input 16 + 32 output desk for the Hollywood studios of a leading US record company

see Design, Aug. 71
Photo : Philip Sayer

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