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SOUND 71 EXHIBITION REPORT
AROUND THE STUDIOS: RECORDED SOUND
SPENDOR TRANSISTOR POWER AMPLIFIER REVIEW

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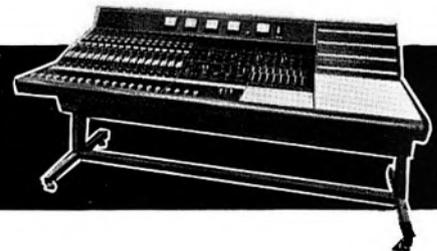
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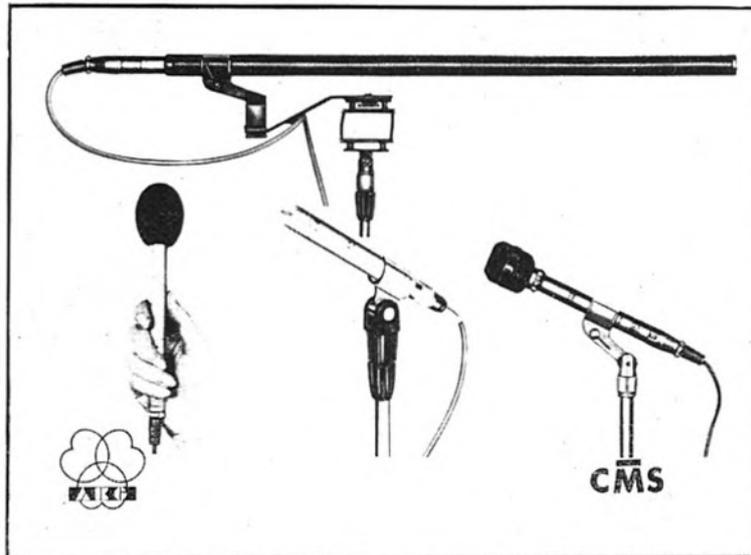
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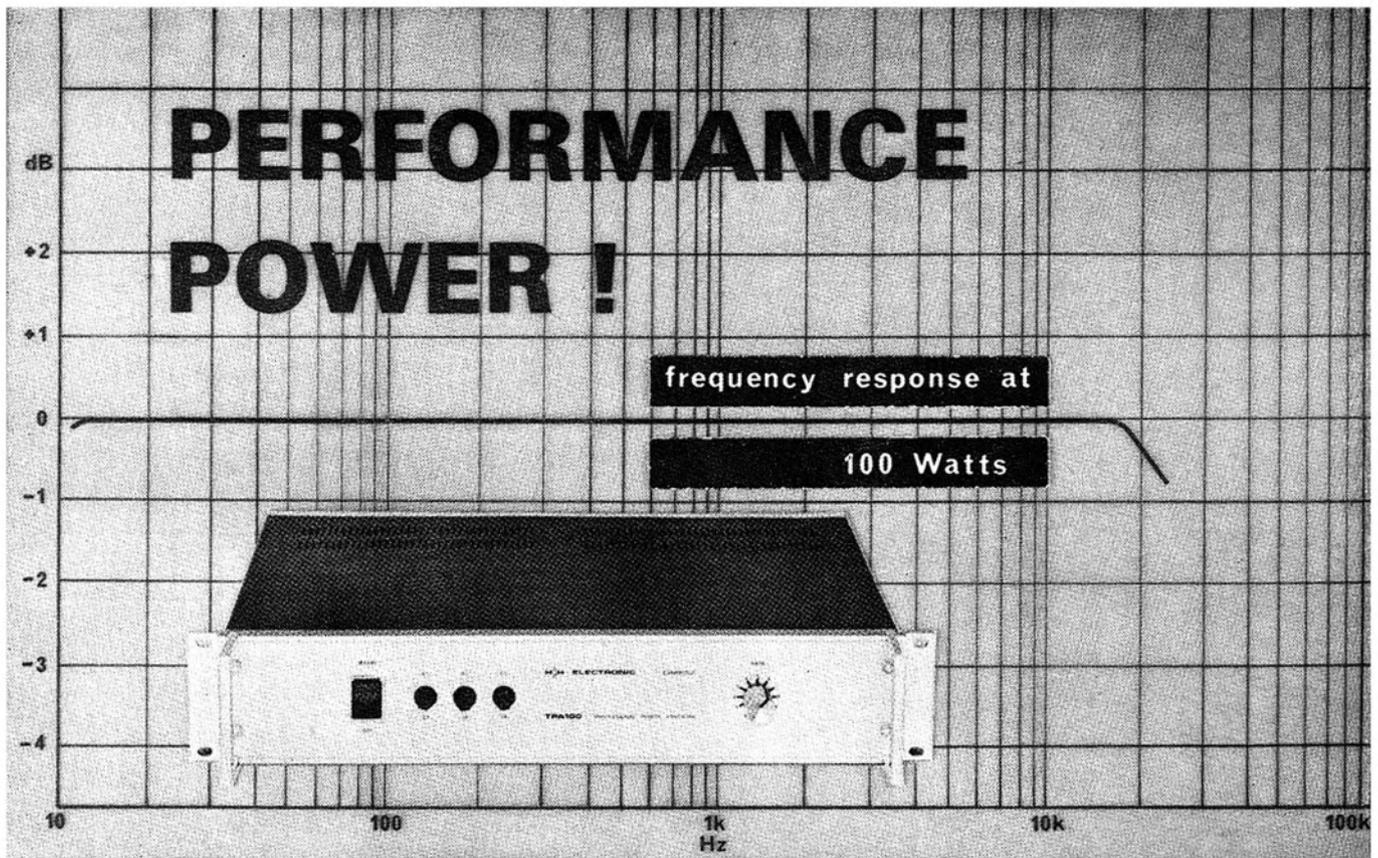
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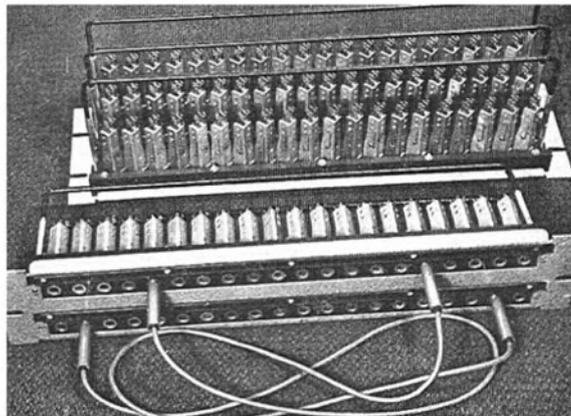
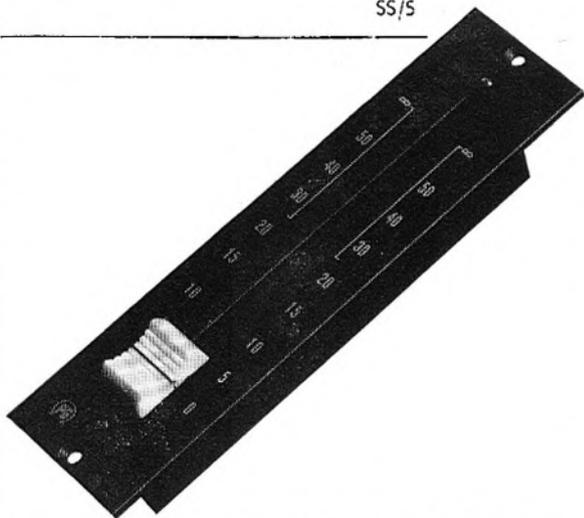
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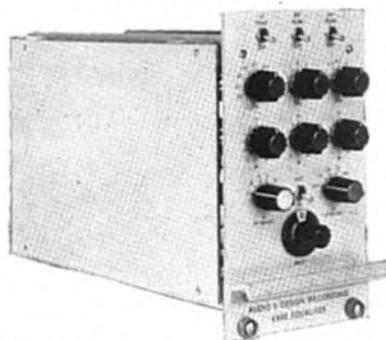
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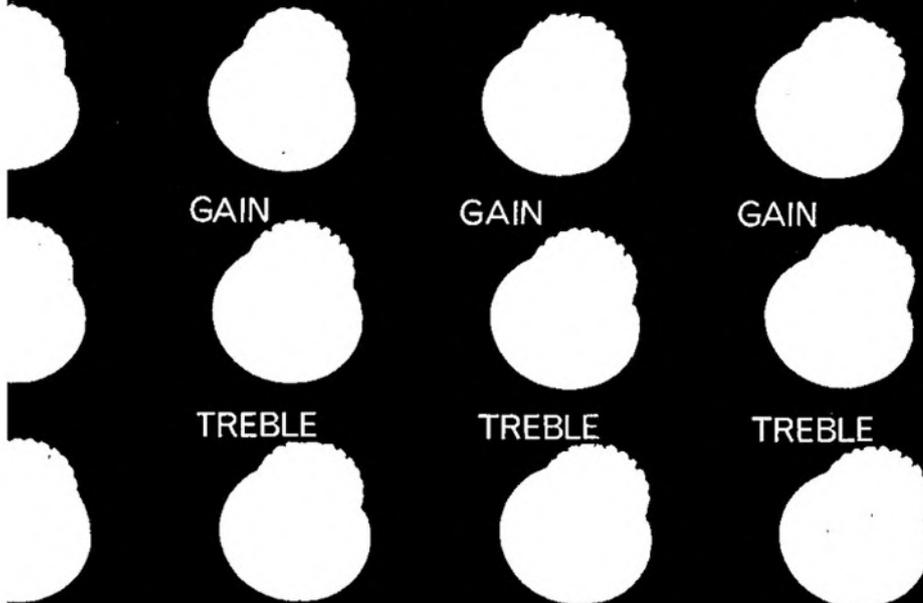
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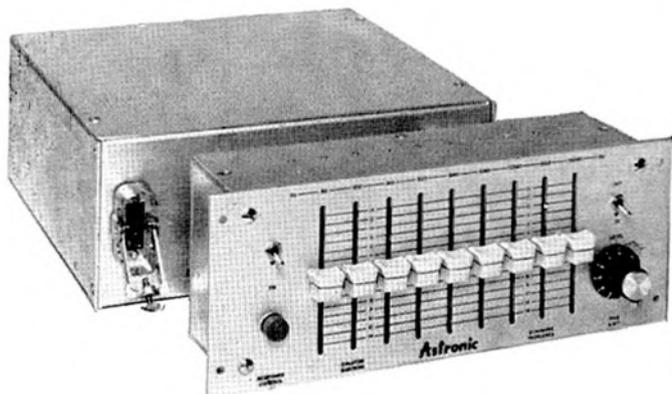
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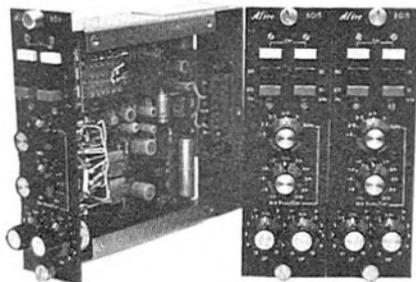
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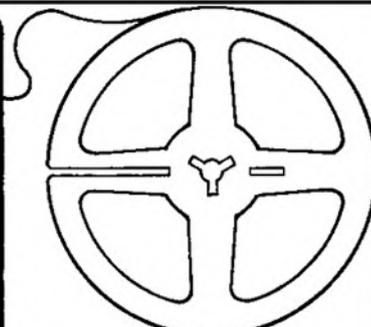
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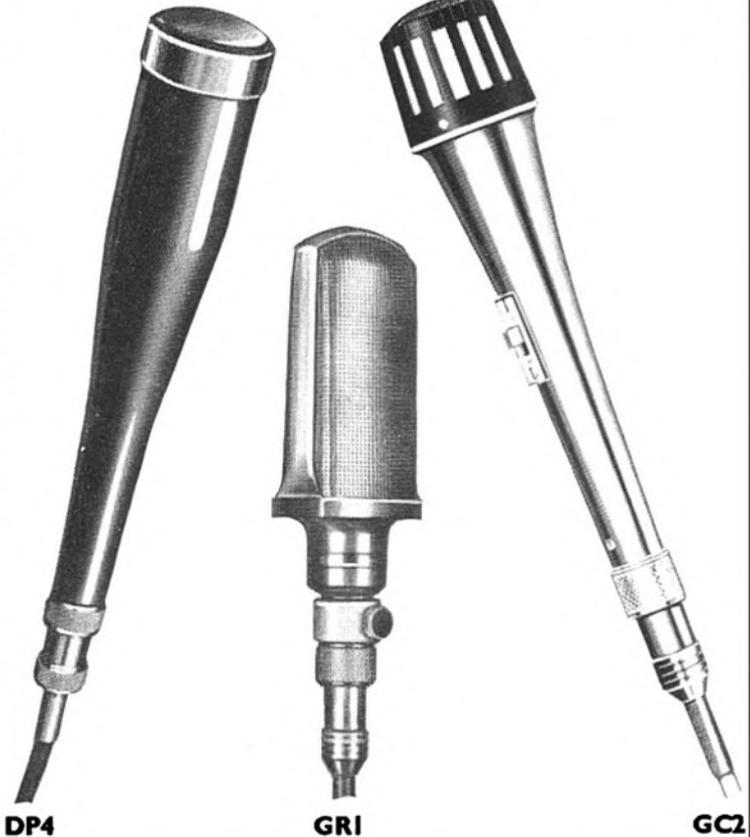
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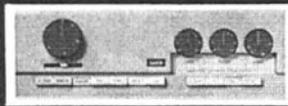
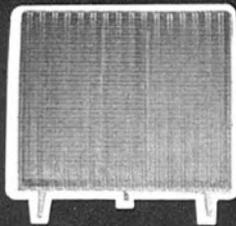
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MAY 1971 VOLUME 13 NUMBER 5

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COVER PICTURE

Not a hat factory but the loudspeaker drive unit assembly line at Tannoy. Studio monitor speakers are surveyed on pages 222 and 223 of this issue.

SUBSCRIPTION RATES

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

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

PREPARING THE survey of studio mixers for our March 1970 issue, we were surprised to find so many companies catering for that one aspect of the recording industry. Quite the opposite was experienced in preparing the monitor loudspeaker survey published this month. With very few exceptions, the currently available 'monitors' (our definition is given on page 222) are divided into two camps: those offering relatively high quality at low power levels and those offering doubtful quality at very high levels.

In the former camp, the Spendor/BBC Monitor and the Quad *ESL* are among the least coloured speakers we have heard in or outside a studio. Before you can disturb the neighbours, however, the Spendor is distorting and the Quad hitting the plates.

In the latter camp, who needs to mention names? Any transducers capable of turning out a sustained 120 dB deserve praise, in common with the engineers who endure them, but the notion of producing an ideal balance at such a level when normal reproduction will be at much lower domestic levels is inherently unsatisfactory. Is allowance made for the Robinson-Dadson curves, or is the main purpose of high level monitoring merely to impress the performers?

The majority of loudspeakers currently used by commercial studios combine impressively high output capacity with unimpressively high coloration, coupled with occasional contributions from overdriven amplifiers. The coloration is discernible to those of us who do the rounds of the studios, though the average engineer evidently learns to live with it, just as our older brethren learned to live with their seventy-eights.

The prospect of premature HF hearing attenuation has done little to discourage high level monitoring in pop studios. We have yet to meet an engineer of any age prepared to admit that his own hearing had suffered in this way. The human brain evidently makes a convincing job of 'equalising' nulls in the frequency response of the ear mechanism. In severe cases, ageing engineers may further equalise their hearing by using stridently topky monitors. One need not look far to find such loudspeakers: they are among the most widely used.

Cadac equalise the frequency response of their monitors to suit the acoustics of each location. They bypass the problem of designing a 'flat' loudspeaker, realising that the room in which the speaker is mounted inevitably affects the overall frequency response. The

concept is a good one, though rather more than a conventional graphic equaliser would be needed to rescue the response of some loudspeaker designs. If the expense of two equalisers is too high for the smaller studios, they might consider an Astronic development shown at this year's (Sound 71) APAE Exhibition. This comprises one or more preset modules, adjusted to the readings of a rented master equaliser.

The idea of continually resetting equalisers to suit new listening conditions is unlikely to appeal to location recording engineers. The time factor must be considered, as well as the considerable danger of altogether confusing the ears.

There appears to us to be a very large gap in the loudspeaker market, waiting to be filled by a design combining high quality, high consistency and high power capacity. We know of no such creature. If and when it appears—there seems nothing impossible in the concept—perhaps we shall at last see standardisation on a uniform studio monitor.

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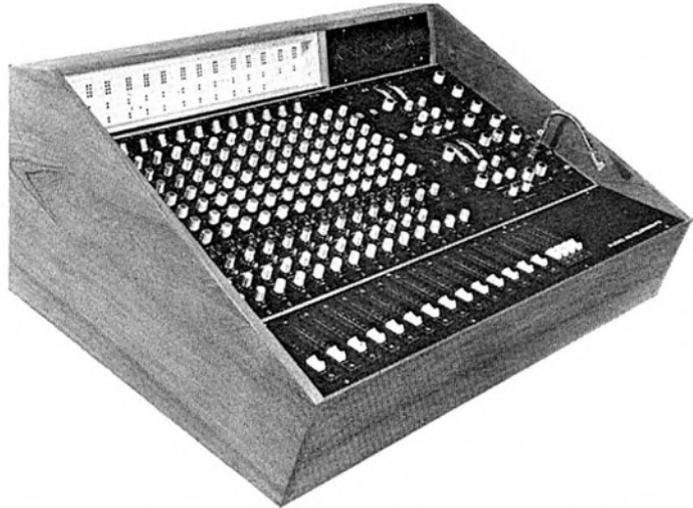
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Events

MOOG INTRODUCES HIS MINI

IN A SERIES of lecture-demonstrations at Advision, Marquee and the Northern Polytechnic, Dr R. A. Moog recently introduced a scaled-down version of his voltage-controlled synthesiser. The new unit, *Model D*, is designed for live performance and employs a simplified switch system in place of the more versatile but more time-consuming controls hitherto used. The instrument is monophonic and incorporates a $3\frac{1}{2}$ octave keyboard. Five groups of controls occupy a slanting panel above the keyboard: 'Controllers', 'Oscillator bank', 'Mixer', 'Modifiers' and 'Output'. *Model D* can be tuned to any standard pitch or to a fixed-frequency reference oscillator. Facilities are provided for the connection of external pitch, level and filter modulators and contour triggers. Price is £650. Moog is represented in the UK by Feldon Recording Ltd, 126 Great Portland Street, London W1.

QUADRAPHONICS

A LECTURE on the design of quadrasonic studios was given to the British AES at Command Studios on March 9. John Mosely explained that, to simplify compatibility between the three studios at Command, it was necessary to furnish all the control rooms with identical equipment and acoustics.

Mr Mosely answered some interesting questions and discussed the various quadrasonic techniques which he will be covering more thoroughly at a forthcoming AES lecture.

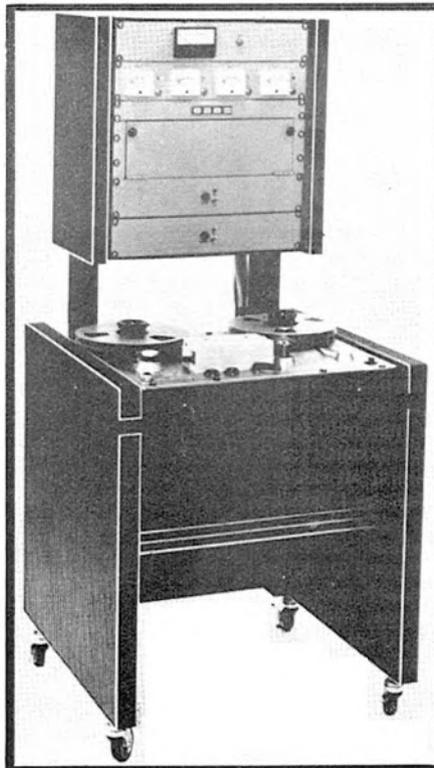
The studios themselves, were described by David Kirk in the January issue.

It was interesting to note that John Mosely preferred to use only two basic microphone types, cardioid dynamics and cardioid capacitors, achieving various characteristics by using coincident cardioids back-to-back in order to obtain different types of polar diagram.

A demonstration was given of quadrasonic tapes made at the studios. Full, if not excessive, use of quadrasonic was made in the recordings.

The next meeting of the Audio Engineering Society will be held on April 20 at Imperial College, when a lecture on high performance ribbon tweeter units will be given by Stanley Kelly. The lecture starts at 7 p.m.

BSI PUBLISH FILM/TAPE SYNC STANDARD TO MEET THE need for a standard method of synchronising 6.25 mm magnetic tape audio tracks with cine film, the BSI has published *BS 4612*. The standard covers the reference code, sync signals, replay speed and related film speed, tape spools and track orientation. The standard is entitled 'An identification code for synchronised 6.25 mm audio tape used in conjunction with motion picture film'. Copies are available from the BSI Sales Branch, 101 Pentonville Road, London N1 9ND. Price is 50p (subscribers 40p).



MASTER REPRODUCER

AMPEX HAVE announced a new master tape player designed for rapid duplication of cassettes, cartridges and reel-to-reel tape records. UK landed price of the *RR-200* is a basic £5 500.

Further data: Jennifer Clubbe, Ampex International, 72 Berkeley Avenue, Reading, Berkshire.

PRINTED CIRCUITS

'PRINTED CIRCUITS General Data' is the title of a four-page leaflet available from Nevin Electric Ltd, Arkwright Road, Poyle Trading Estate, Colnbrook, Buckinghamshire. It outlines the company's capacity to produce single and double sided printed circuit boards. Nevin are equipped for exceptionally short delivery dates and extend an open invitation to engineers wishing to visit their plant.

FRENCH SOUND FESTIVAL

FOLLOWING A TRADITIONAL pattern, the *Festival International du Son* took place at the Palais d'Orsay in Paris from March 4 to 9. Primarily an exhibition of audio consumer products, this show nevertheless has the full and very active support of ORTF, the French radio and television authority. Also, a certain amount of studio and discotheque equipment were on show and demonstration. Throughout the event, lectures were given on a variety of communications topics. First of the latter was by Sir Francis McLean of the EVR Partnership. He outlined the theory and practice of electronic video recording (see *Studio Sound*,

December 1970) to a full and interested audience which had assembled at 9.30 on a Friday morning.

Of the 120 or so trade names exhibiting, 26 were British, and among these were Audix, Ferrograph, Millbank and Brenell. The latter had several items said to be new, including the *Type 19* professional tape deck. Sound quality heard in the many demonstration rooms was generally low by British exhibition standards. There was a marked tendency to rely more on disc for signal sources than in previous years, surprisingly little emphasis on developments in the cassette field, and only two exhibitors bothering to demonstrate video recording.

On the other hand, various concerts of live music were presented under the auspices of l'ORTF, who had a control room installed in the hotel for monitoring and presentation of programmes on the *France Musique* service.

Everything seemed to be recorded or broadcast in stereo, but always with crossed-pair cardioids—never single spot-mikes. ORTF engineers also had a small room in which they displayed a television recording accompanied by stereophonic sound, and demonstrated the effects of various microphone configurations for quadrasonic recording, with corresponding loudspeaker positions on replay. They called this 'tetraphonie', though they had not tried the true tetrahedral arrangement advocated in this journal by Granville Cooper and Michael Gerzon.

INSTAVIDEO

CONFUSION WITH another television recording medium has prompted Ampex to change the name of its *Instavision* system to *Instavideo*. The new name is also felt to denote more clearly the technology behind the Ampex system, as distinct from RCA's laser-optical *Selectavision*. *Instavideo* was announced last September as a new-generation battery/mains domestic/industrial VTR system.

ZONAL INTRODUCE NEW RANGE OF AUDIO TAPES

TWO NEW types of professional audio tape are being introduced by Zonal Films (Magnetic Coatings) Ltd. *Spectrum 1 Low Print* uses a polyester base with matt backing. It is consequently not recommended for recorders employing pressure pads. *Spectrum 1 Low Print* is available on acetate, polyester or vinyl. Both coatings are finished with a surface claimed to reduce head and guide wear. The tapes are available in various widths.

Further data: Tony Pitter, Zonal Films (Magnetic Coatings) Ltd, Holmethorpe Avenue, Redhill, Surrey.

NEXT MONTH

JOHN SHUTTLEWORTH reviews the Nagra 4L and David Kirk previews the May 28/29 exhibition to be held in London by the Association of Professional Recording Studios. Keith Wicks visits Island Studios.

spendor

LOUDSPEAKER TYPE BCI

The top quality medium sized professional monitoring loudspeaker reviewed in Studio Sound September 1970. Recommended Retail Price : £59.00

LOUDSPEAKER TYPE BCIA

Fitted with the Spondor 20 watt power amplifier. Price : £79.00 unbalanced input. £85.00 balanced input.

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Designed as a drive amplifier of fixed gain, is compatible with most makes of pre-amplifiers and studio equipment. Power rating : 20 watts per channel. Price direct from Spondor : £32.50.

You are welcome to call at our office in Redhill where we will be pleased to demonstrate our loudspeakers. We invite you to bring along your own discs and tapes to enable a fair assessment to be made using programme material familiar to you.

Should prospective clients wish to bring their own loudspeakers to make a direct comparison we will be pleased to arrange special appointments.

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4 CHANNELS ON A BUDGET

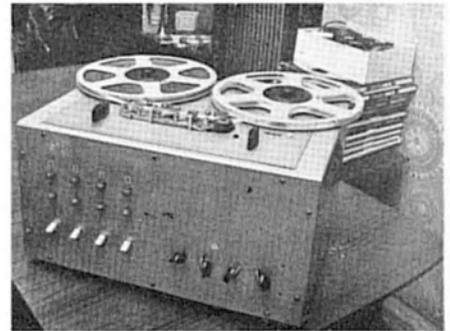
Michael Naylor describes a staggered-head unit based on a Brenell

DURING December 1968 I decided it was time I built another mixer. I had built eight other mixers during the preceding nine years, each more elaborate than the one before. This, the *Mark 9*, was naturally to be even better. I had long considered that the big boys had something with their multitrack machines, and that I, owning one Ferrograph and borrowing another, was definitely lagging behind. So, with blind confidence, I set out on a one way make-it-or-bust basis to narrow the gap. First I evolved a design on paper showing the facilities that I thought necessary. Design factors important to me at that time were a minimum of eight channels, two echo circuits, two-channel reduction monitoring and, most important of all, a patch panel giving access to every strategic point in the system. I also required the levels at these points standardised to +8dBm peak at compatible impedance with other studio equipment.

All these factors were incorporated, with much thanks to Mullard as nearly all the circuits are based on their 'Circuits for Lockfit Transistors'. Having decided on a system, I required a front panel design. I always draw these up to full scale and imagine I am using the thing so that any operational inconveniences can be discovered before it's too late. In view of the number of modifications some of my earlier mixers had gone through, I opted to break the facilities into definite areas and separate panels. To have built the mixer in modular form would have been beyond my pocket.

The left of the panel is blank, so that talk-back, cueing and anything else for that matter, could be added if needed. All the input channel faders, preset source selectors, mike gain, echo send and return, and channel routing, are along the bottom panel. One of two echo send circuits and one of two sub-groups, as well as the four output groups, are selectable and these return to the panel left of the meters. Here the routing is carried out on separate switches so that each fader can be assigned to more than one output group at a time. The echo having the capability of being routed to the sub-groups.

The meter panel is easy: one povum (peak-



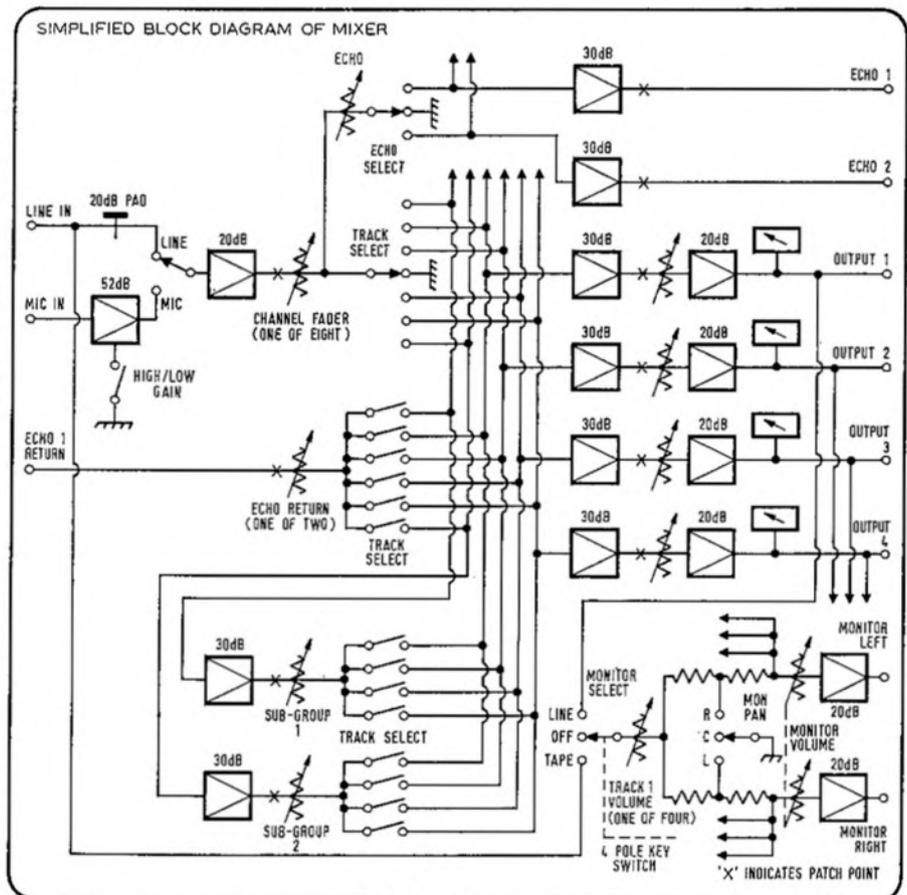
oriented VU meter—see January *Studio Sound*) and master fader per output group. To the right is the monitor panel. The four-pole keyswitch, as can be seen on the simplified block diagram, selects either the mixer output line or the tape return (which is explained below). Each of the four switched inputs to monitor has its own volume control and then its own pan switch; the latter has only left, centre or right positions between the two monitor outputs. A master stereo volume is also provided.

The reason for not providing full pan on monitoring is simply that there are no full pan facilities on the input channels. Stereo mix-down positioning is accomplished via a sub-group where the image can be placed centrally by double routing. The philosophy behind this design was that in 'pop', for which this

equipment was to be used, real stereo is a nonentity. Left, centre and right were thought to be adequate, if not preferable. Certainly cheaper.

The remaining panel is the patch panel, on the extreme right. Eighteen break points are available here which account for 16 faders plus two echo send lines. Ring-tip-sleeve jacks are used so that the go and return can be sent up and down the same twisted pair. All other external connections are made on a side panel. Cannon *XLR* for the floating mike inputs, Cannon *F & E* for the remote power unit, echo, two and four channel tape machines. By this multiway method of connection, cables are kept tidy and mistakes, that could otherwise easily be encountered while setting up in some

(continued overleaf)



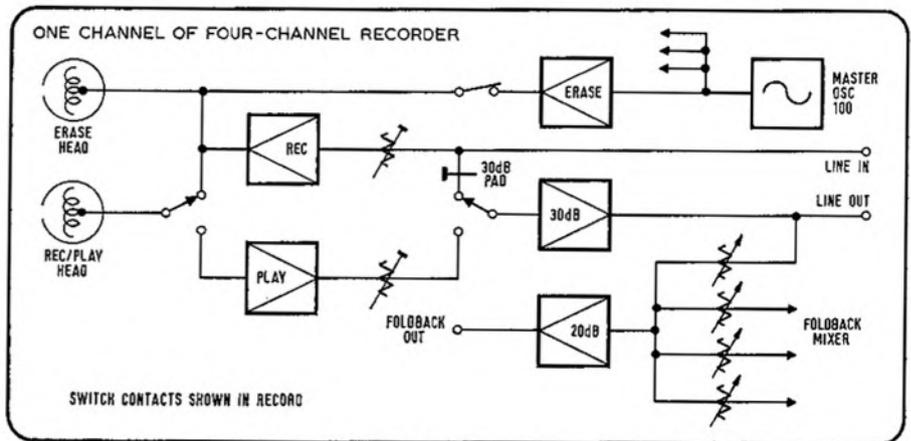
4 CHANNELS

dark corner for a live session, easily avoided.

The whole lot slid into a steel case, made and stove enamelled by local sheet metal workers.

The four-channel recorder uses 6.25 mm tape rather than the usual 12.5 mm. The reasons are once more, I'm afraid, of an economical nature. Not only is the tape more costly (that can be recovered and used again once reduction has been made), I had to consider the price of the heads. At the time of building I was unable to obtain any 6.25 mm four track in line heads so I used Bogen $\frac{1}{4}$ -track heads and staggered them. The deck is a modified Brenell Mark 5 Industrial-NAB with two $\frac{1}{4}$ -track erase and two $\frac{1}{4}$ -track record/play heads, providing four independent tracks on the tape. To simplify the circuitry, I decided to regard the deck as a single speed device and chose 38 cm/s with a DIN equalisation curve. Less controls mean less mistakes so off came the speed change, the superimpose knob, and the pause control. Hence the satin chrome deck plate instead of the grey thing supplied by Brenell. The case is of the same origin as the mixer.

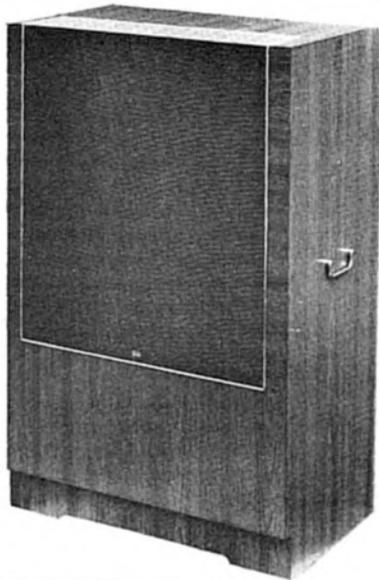
The simplified block diagram shows one channel. A 100 kHz master oscillator drives



four erase/bias power amplifiers, one for each track. This was the most difficult part of the construction as I had quite a lot of bias induced into the other replay amplifiers at first. This, I discovered, was mainly due to transformer action on the record/play heads. The answer was to insert a low-pass filter at the input when any other channel was in record. The line output is synchronous with other tracks, thanks to the combined record/play heads. Furthermore the line output of individual tracks is automatically changed over to line in when that track is in the record mode. This means that all four tracks, whether in record or play, are always available for a built in foldback mixer or at the monitor panel on the main mixer.

Another point worth noting is the fact that, although I took the precaution of having a C-core mains transformer specially wound in an effort to reduce hum being induced in the heads, I still found myself in trouble. In the end I had to remove the transformer and regulator altogether and mount it in an Eddy-stone diecast box to overcome the problem. Providing one sticks to 'pop', avoiding music of wide dynamic range, the quality obtainable is quite adequate for mastering.

Construction from start to finish took me just under nine months and the equipment has proved to be extremely reliable. It is used full time now by an acquaintance to make demos for a publisher.



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BY KEITH WICKS

AT Trident Studios in Soho, engineer Robin Cable has been extremely busy. Studio manager Malcolm Toft reports that Robin recently received an award from the *New Musical Express* for the best engineered record, which featured Elton John. With producer Gus Dudgeon, Robin has been doing further work for Elton, and albums for Magna Carta and Audience. I dropped in on one of the Audience sessions and was disappointed that I was unable to stay longer. This group is good, and the sound in Trident's control room is, for my money, better than most. Colin Scott has been in with producer John Anthony, the sessions again engineered by Robin Cable. Meanwhile, Ken Scott has been working with producer Phil Spector, and Roy Baker has been mixing some material for Frank Zappa's film, *2000 Motels*. Roy has also engineered for Doctor Marigold's Prescription, the producer here being Des Champ, and mixed on a session produced by Tony Visconti for the African group, Osibisa.

The Jackson Recording Company of Rickmansworth have been recording Indian music by some of the inhabitants of Hayes and Southall. Engineer Malcolm Jackson thinks that this material, which is to be used on the Sangam label, will be a big hit with the Indian and Pakistani population who, at the moment, are restricted to a rather limited range of pricey recordings. McGuinness Flint rehearsed and recorded music for their BBC 2 show, *In Concert*, and a 17 piece Glenn Miller style band run by Cyril Herring have also been recording at the studio this month. Malcolm Jackson is involved with other things besides straight recording. At the moment, he is producing a sound track which he will set to a short film for Radio Mobile, who produce car radio/cassette-players and accessories. In addition he runs a second hand equipment business and has just sold a large mixer to Pan-Musik who are opening a new studio in Broadhurst Gardens, Hampstead, at premises which used to be Walt Disney Studios. Joe Brown is setting up a studio at Chigwell so that he can record all his own material. He will use a Neve desk, the purchase of which was negotiated for him by Malcolm. An increasing number of people have been asking about video equipment and Malcolm considers that before long VTR will have enormous success in this country. He intends to be prepared for the expected boom. Meanwhile, he is dealing in recorders, six four-track machines having been sold in the first couple of months of the year. It seems that a lot of artists are getting their own recording equipment, to save the expense of hiring studios, and others have found alternative methods of economising. One group is saving money by recording rhythm at Jackson on a four track tape, and then taking the tape to a major studio where it

is copied on to 16 track so that the other instruments and vocal can be added. A recent 20 hour session of rhythm recording cost a group £10.50 per hour at Jackson, instead of £31.50 per hour at their usual studio, which is a great saving.

While some studios have no plans for expansion, because of the economic situation, others are taking the plunge, especially De Lane Lea, whose new Wembley complex will probably be the most advanced in Europe. This should be in operation by the summer; meanwhile work continues at their other premises. At Kingsway, Martin Birch did more work on albums for Peter Green and Rock Workshop, and started on albums by the Swiss group, Toad, and Orange Blossom who do folk and country-and-western. Martin also engineered sessions for Skid Row and Deep Purple, whose recent single *Strange Kind of Woman* is now in the charts. Louis Austin engineered a Peter Noone single, continued work on an album and single for Main Horse, and completed a Caterpillar album. Dave Siddle's work at Kingsway included three numbers with CCS. At De Lane Lea's Dean Street address, John Stewart completed a Curtis Muldoon album, and David Stock did a single with John Paul Jones.

As reported last month, EMI have been improving their Abbey Road Studios. Studio Three's new mixer has now been installed, and they await delivery of a 16 track Studer machine. A violin concert for the British Council was recorded in Studio One, and the rebuilding of this studio's interior has apparently proved very successful. Pink Floyd and Third Ear have also been in, and the studios are busy recording their own artists, as well as doing a lot of work for other companies, including RCA and CBS.

Advision are also expanding and their new reduction studio should be in operation very shortly. The 16 channel, four track Neve desk is designed for reducing multitrack down to quadruphony, stereo, or mono. Advision favour PPMs as opposed to the usual VU meters, and those on the reduction desk are the light beam type, made by NTP. For monitoring four J.B. Lansings are used and a 4.5 x 3 m

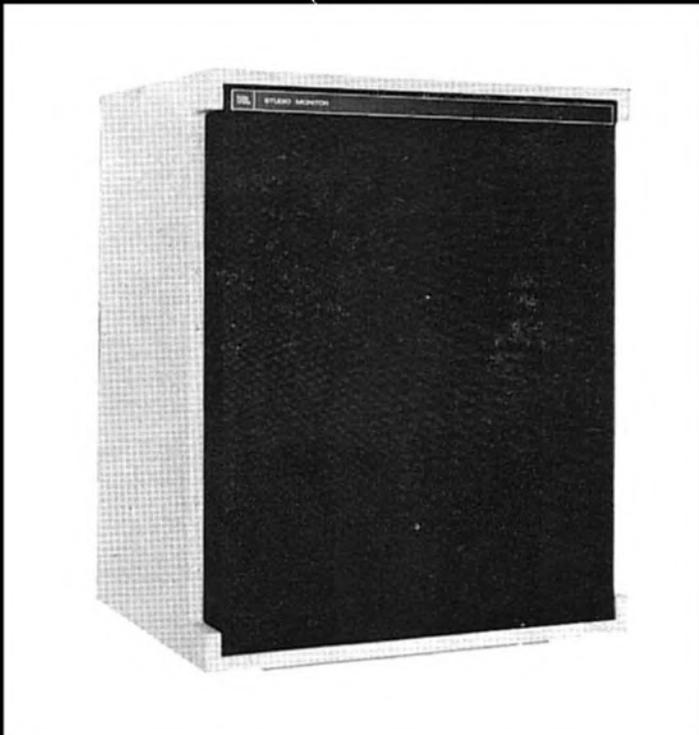
booth is provided for overdubbing. In the studio, recent sessions have included albums by Shirley Bassey, Petula Clark, Jack Wild, and Gentle Giant. Dr Moog has also been in demonstrating his synthesiser to interested members of the music and recording industries. Advision report that business is currently as good as ever.

Gary Levy's Spot Studios will have a new desk working by June. Designed by studio staff, it is being built by Rosser Electronics of Swansea, who produce equipment under contract for NATO and for many TV companies. I understand that several new ideas are to be incorporated in the mixer and I hope to give details of these at a later date. This month, Len Black has been producing masters for the Belgian company Ronnex, featuring pop singer John Wooley, a chart topper in Belgium. The Frank White group has been laying down heavy rock tracks for Rama Records under the production of Roger Watson, and Mark Sutton has been producing a stereo recording for composer Dennis Stoll. The line up here was one flute doubling alto flute, an oboe doubling cor anglais (alto oboe), a harp, and a string quartet. With producer Don Paul, Julie Covington has been putting down tracks for EMI, and Paul Lynton produced for the new group, Puckle's Blend. For Gem Productions, composer and arranger Mike Leander produced sessions consisting mainly of percussion instruments—conga drums, maracas, tymps, vibes, swallow flute, and 12 string acoustic guitar. Spot have also recorded some film tracks for Pete Brown and Piblockto, which is an Eskimo name for something. Other work includes a Dubliners single, produced by Phil Coulter for EMI, and the start of a Kenneth Connor album for Avenue Recordings, produced by George Watkins. This features Elizabethan music, the tracks on side one containing harpsichord, acoustic guitar and flute. Side two had not been started at the time of writing. From all this it can be gathered that, following their fairly quiet period after Christmas, business is once again booming at Spot Studios.

IBC, never short of work, have had their Studio Two closed down for re-equipping. A new mixer is being built by studio staff, and they await delivery of a 16 track 3M MM1000. In Studio One, Dave Mackay has been producing the Mixtures, Manfred Mann, the New Seekers, and Quartette. Mike Claydon engineered a Pedlars session produced by Phil Smith and finished off the Graham Bonnet album for A and M Records. Barry Ryan has also been in to do a single, engineered by Bryan Stott. Future bookings include 16 consecutive nights with the Bee Gees.

AIR's list of artists in their studios is as impressive as ever: Stan Getz, Kenny Rogers, (continued on page 221)

JBL MODEL 4320 STUDIO MONITOR



Model 4320 specifications

Power capacity: 60 watts RMS, 120 watts program

Crossover frequency: 800 Hz

Nominal impedance: Designed to operate from 8 to 16 ohms. (Minimum impedance is approx. 12.5 ohms at 175 Hz.)

Dispersion: 45° x 120°

Frequency response: ±3 dB 40 to 15,000 Hz

EIA sensitivity: 48 dB (30 feet with 1 milliwatt input)

NOTE: Unlike many "theatre type" loudspeakers whose sensitivity peaks in the mid-range, the JBL studio monitor exhibits substantially the same sensitivity through the full range of audible frequencies. Measured sensitivity below 500 Hz or above 2000 Hz may be considerably greater than that of other systems with higher EIA sensitivity ratings.

Finish: Textured grey with charcoal grille fabric

Dimensions: 30" x 23½" wide x 20" deep

Weight: 86 lb.

Professional two way loudspeaker components:
15" long-excursion low frequency driver and
horn-loaded high frequency
assembly with acoustic lens.

Smooth response, uniform spatial distribution,
and high power-handling capacity.

Computer designed crossover network with 12dB
per octave attenuation and adjustable high
frequency intensity.

Rigidly constructed enclosure provides optimum
acoustic loading for the loudspeaker components
yet is modest in size. 120 watt power capability.

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T. Rex, Badfinger, Procul Harem, Barry Ryan, the Pipkins, and many others. Sir Laurence Olivier has been doing more Bible reading for Argo Records, and Young and Renshaw have been in with producer Roger Greenaway. Toni Visconti is busy producing a Strawbs album with engineer Bill Price, and Roger Cook is about to produce a single for Ringo and Twiggy.

Recorded Sound's broadcast activities continue with DJs Cash and Vance doing programmes for Radio Monte Carlo. The Fantastics have been in and Maurice Gibb has been producing sessions for Richard Harris and Lulu. In the reduction room, Atomic Rooster have been mixing tracks recorded several months ago. The studio's new 24 channel 16 track Neve desk and 3Ms 16 track recorder (with Dolbys) will be in operation at any time now.

Squire Sound, the recently opened DJ studio, is making progress and bookings are on the increase. The demonstration tape made by Chris Grant and Nicky B. Horne for 77 WABC New York, was apparently well received and they were asked to make another which, they hope, will secure them a £350 per show contract. Linguist DJ Peter Gooch has been making demonstration programmes in Italian, French, and English for a company called Euradius. The studio's director, Roger Squire, tells me that London entertainment agencies have a growing interest in selling prerecorded programmes overseas, and Euradius are specially geared for this kind of business.

Roger's small studio, as I said last month, is capable of producing first class material and I was amazed when he told me that he is unable to join the APRS. He contacted them with a genuine desire to run his studio in a professional manner and gave the secretary details about the sort of work he would be doing. He was led to believe that full membership would be granted, but heard nothing until five weeks later when an APRS committee member, Mr Vetter, arrived unannounced on his doorstep. Roger had the impression that the concept of a

disc jockey studio made Mr V. cringe and he was later told that his studio was not acceptable for membership because 'his end product was not records'. This is remarkable considering the interest originally shown, and hardly worthy of an association professing to represent professional people. After talking to the APRS secretary, Roger commented, 'I suddenly realised that quite a lot of the committee were very old and very entrenched in the past. A DJ studio reeked of perversion to them. It was an aggravation to talk to someone who does not know what 1971 is about. Everyone has to move with the times'. I agree with this and feel that, if the APRS are unwilling to represent studios specialising in producing radio programmes, they are making a mistake. Jacques Levy, the APRS chairman, once told me that the association 'hope eventually to spread their name far and wide as the one focal point to whom anyone can turn'. He also criticised studios who did not join the association as being short sighted.

From the United States comes news of Fame Recording Studios at Muscle Shoals, Alabama. Studio manager Jerry Masters reports that Liza Minelli and The Wire Band have been recording a single with producer, Rex Kramer. Fame's Studio A is temporarily out of action as it is undergoing modifications in order to provide better recording facilities.

Also down south, at College Park, Georgia, are Southside Sound Studios, where Gina Hill recently made a soul hit, *Rich Man's Toy* for Lou-Neita Records. Also in the works are more soul sessions with Tee Fletcher and the Scott Brothers, folk with Deborah Emerson and Kitchen, and a new rock opera by Mike Patron. Studio president and chief engineer Johnny Duncan has made a number of tapes by his staff group, Red Beans and Rice, and in addition the studio is handling the sound for a new country music TV show from Backyard Productions.

In Nashville, Tennessee, the Metropolitan

Music Company's Mercury Custom Recording Studio has been 'busy recording for several major artists. The photograph of their control room, reproduced here, shows it to be rather like a typical London set-up. The 20 channel 16 track console is by Bushnell Electronics of Los Angeles, California, and four Altec speakers are provided for monitoring. Tape machines, from right to left, are a 16 track Ampex MM1000, and Scully eight track, four track and two track. Standard hourly rates are £42 for 16 track recording and £23 for mono or two track. Sixteen track reduction is £31 per hour, and all prices are subject to a surcharge for overtime, weekend and holiday working.

By way of comparison, Sound Ideas Studio of New York City charge £46 for 16 track recording but only £10 per hour for mono or two track. A feature of this studio is that the microphones for rhythm instruments are left set up in the studio at all times, so that a group can go into the studio and quickly get a quality consistent with that obtained previously.

The Record Plant Recording Studios in New York are spending just over £100 000 rebuilding their premises, and the Plant's west coast branch in Los Angeles, California, is adding a third studio after a successful year in operation. Details of these will be given next month.

Also in California, the Custom Fidelity Company of Hollywood, who handle every aspect of production from studio work to the pressing and shipping of the final product, announce that they have a new digitally controlled disc mastering facility. This utilises a Neumann VMS-70 lathe and an SX-68 cutting system, the latter controlled by digital integrated circuits. They are now fully set up for quadrasonic work, and can make two channel disc masters direct from four channel master tapes, thus saving a generation of tape transfer.

Finally, news comes from Cinelume Productions of Montreal Canada of their contract awarded by ITV London for French language dubbing of the British-made science fiction series, *UFO*. When completed, the show will have a potential audience of over 100 million viewers. It will be seen across Canada on CBC's French network, and also in French speaking countries around the world.

MCRS control room, Tennessee



MONITOR LOUDSPEAKERS

In the context of loudspeakers, 'monitor' is but one of a family of meaningless denominations which includes 'professional', 'studio', 'quality-checking', and that sad old abbreviation 'hi-fi'. All have become so debased that any attempt to compile a list of loudspeakers suitable for use in recording studios must necessarily be arbitrary. Several types are therefore included in this survey. A number of loudspeakers are represented simply because they are too large, too expensive and too powerful for domestic use. Others are included because, while basically suitable for domestic use, they are either used for, or in our opinion suitable for, studio monitoring.

There is little doubt that the popularity of some otherwise poor loudspeakers is enhanced by their ability to withstand comparatively high power levels. While we think the term 'monitor' inappropriate to such designs, they must be included if only because they are in very wide use.

CADAC

Name: Studio Monitor System
Frequency response: Equalised to suit location
Recommended amplifier: Internal
Dimensions: 1474 x 788 x 483 mm
Price: £810 (pair)
Manufacturer: Cadac (London) Ltd, Stansted, Essex

CALREC/IMF

Name: Monitor
Frequency range: 30 Hz to 20 kHz
Nominal impedance (400 Hz): 8 ohms
Drive units: One (Tannoy)
Maximum recommended amplifier power: 50 W programme
Input connections: Terminals
Average conversion efficiency: 4%
Dimensions: 1 220 x 450 x 508 mm
Weight: 60 kg
Price: £180 (approximate)
Distributor: Calder Recordings Ltd, Regent Street, Hebden Bridge, Yorkshire

IMF

Name: Professional Studio
Frequency response: 25 Hz to 20 kHz ± 4 dB
Nominal impedance (400 Hz): 8 ohms
Drive units: Four
Maximum recommended amplifier power: 60 W
Input connections: Terminals
Average conversion efficiency: 5 W for 90 dB
Dimensions: 915 x 356 x 381 mm
Weight: 30 kg
Price: £97.50
Delivery time: Six weeks
Manufacturer: Transmission Electronics Ltd, 495-499 Oxford Road, Reading, Berkshire

Name: Professional Monitor
Frequency response: 17 Hz to 20 kHz ± 4 dB
Nominal impedance (400 Hz): 8 ohms
Drive units: Four
Maximum recommended amplifier power: 100 W programme
Input connections: Terminals
Average conversion efficiency: 5 W for 90 dB
Dimensions: 1 220 x 450 x 500 mm
Weight: 60 kg
Price: from £155
Delivery time: Six weeks
Manufacturer: As above

KEF

Name: LS5/1A
Frequency range: 35 Hz to 15 kHz
Nominal impedance: 25 ohms
Drive units: HF and 380 mm LF
Input connections: Cannon XLR-3
Dimensions: 840 x 430 x 480 mm
Weight: 37 kg
Price: £155
Manufacturer: KEF Electronics Ltd, Tovil, Maidstone, Kent.

Name: LS5/5
Frequency range: 35 Hz to 15 kHz
Nominal impedance: 8 or 25 ohms
Drive units: 305 mm LF, 204 mm MF and 35 mm HF
Input connections: Cannon XLR-3
Dimensions: 680 x 360 x 440 mm
Weight: 40 kg
Delivery: Not sold in small quantities
Manufacturer: As above

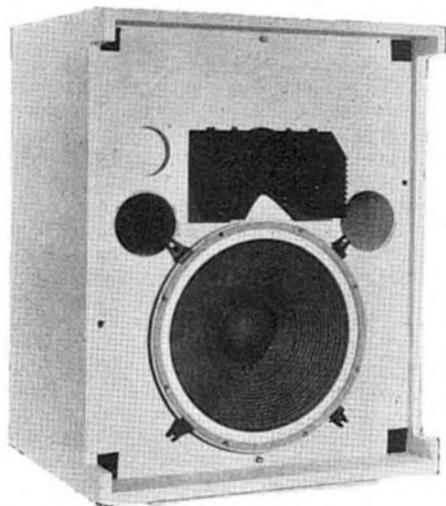
KLEIN & HUMMEL

Name: OY
Frequency response: 40 Hz to 16 kHz ± 2 dB
Input impedance: 4.7 K (balanced and floating)
Input sensitivity: -6 dBm minimum
Recommended amplifier: Internal 30 W
Input connections: Tuchel T 3262

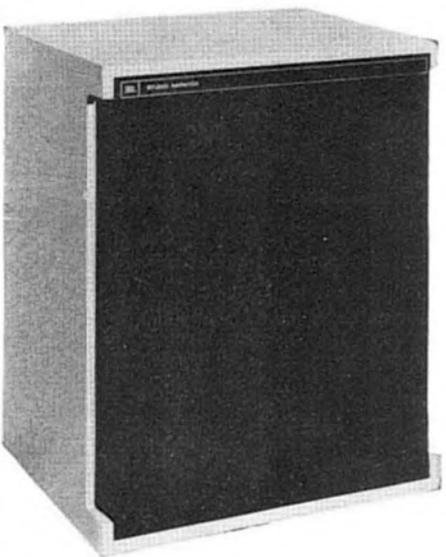
Dimensions: 480 x 310 x 230
Weight: 20 kg
Price: £195
Delivery: ex-stock
Distributor: F. W. O. Bauch, 49 Theobald Street, Boreham Wood, Hertfordshire

J B LANSING

Name: 4320
Frequency response: 40 Hz to 15 kHz ± 3 dB
Nominal impedance (175 Hz): 12.5 ohms



Drive units: Two
Maximum recommended amplifier power: 60 W RMS, 120 W programme
Dimensions: 762 x 610 x 508 mm
Weight: 20 kg



MONITOR LOUDSPEAKERS SURVEYED

Price: £277 (retail)

Distributor: Feldon Recording Ltd, 126 Great Portland Street, London W1N 5PH

Name: 4310

Frequency response: 30 Hz to 15 kHz ± 5 dB

Nominal impedance (400 Hz): 8 ohms

Drive units: Three

Maximum recommended amplifier power: 50 W programme

Dimensions: 610 x 360 x 305 mm

Price: £120 (retail)

Distributor: As above

LOCKWOOD

Name: Major

Frequency range: 30 Hz to 20 kHz

Nominal impedance: 8 or 15 ohms (Tannoy unit) or 16 ohms (Altec 604E)

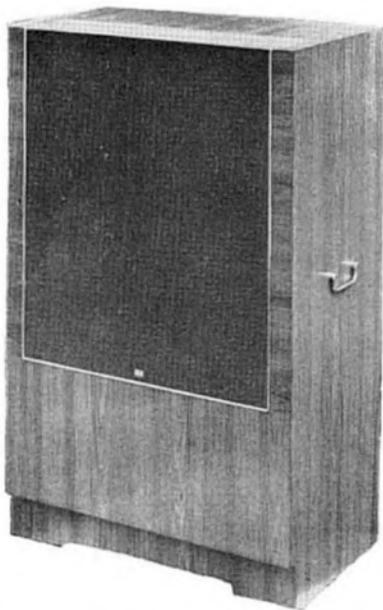
Maximum recommended amplifier power: 50 W programme

Input connections: To order

Dimensions: 1 144 x 712 x 450 mm

Weight: 45 kg (66 kg with Quad 50E internal amplifier)

Price: £152 (£242 with internal Quad 50E)



Manufacturer: Lockwood & Co. (Woodworkers) Ltd, 63 Lowlands Road, Harrow, Middlesex.

Name: Universal

Specification: Ceiling or wall mounting versions of 'Major'. Similar price and performance

QUAD

Name: Electrostatic

Frequency range: 45 Hz to 18 kHz

Nominal impedance (40 Hz to 8 kHz): 30 to 15 ohms



Drive units: Five

Recommended amplifier: Quad 303

Dimensions: 680 x 788 x 280 mm

Weight: 16 kg

Price: £66

Manufacturer: Acoustical Manufacturing Company Ltd, Huntingdon

RADFORD

Name: Studio 12

Frequency range: 45 Hz to 25 kHz

Nominal impedance (400 Hz): 8 ohms

Drive units: Four

Maximum recommended amplifier power: 50 W

Dimensions: 1 150 x 432 x 381 mm

Weight: 50 kg

Price: £100

Manufacturer: Radford Acoustics Ltd., Ashton Vale Road, Bristol BS3 2HZ

ROGERS

Name: BBC Studio Loudspeaker

Frequency range: 45 Hz to 25 kHz

Nominal impedance (400 Hz): 8, 15 or 25 ohms

Drive units: Three

Maximum recommended amplifier power: 25 W

Dimensions: 305 x 305 x 635 mm

Price: £87.50

Delivery time: Commencing early June

Manufacturer: Rogers Developments (Electronics) Ltd, 4/14 Barmeston Road, Catford, London S.E.6.

SPENDOR

Name: BC1

Frequency range: 45 Hz to 25 kHz (60 Hz to 14 kHz ± 3 dB)

Nominal impedance (400 Hz): 9 ohms

Drive units: Three

Maximum recommended amplifier power: 8 W

RMS continuous, 20 W programme

Recommended amplifier: Spendor S.209

Input connections: Terminals

Dimensions: 630 x 300 x 300 mm

Weight: 13 kg

Price: £59

Manufacturer: Spendor Audio Systems, 3 Station Approach, Redhill, Surrey

TANNOY

Name: Corner GRF

Frequency response: 30 Hz to 20 kHz ± 3 dB

Drive units: One (380 mm Monitor Gold)

Maximum recommended amplifier power: 50 W programme

Average conversion efficiency: 10%

Dimensions: 1 070 x 483 x 600 mm



Price: £127.75

Manufacturer: Tannoy Products Ltd, West Norwood, London S.E.27

TELEFUNKEN

Name: 086

Frequency response: 80 Hz to 12.5 kHz ± 1.5 dB

Drive units: Three 13 cm, two 10 cm

Recommended amplifier: Internal

Dimensions: 480 x 315 x 165 mm

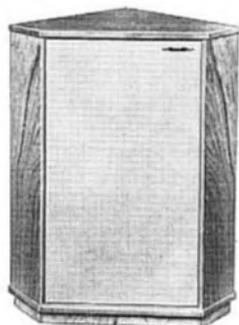
Weight: 12 kg

Price: £175

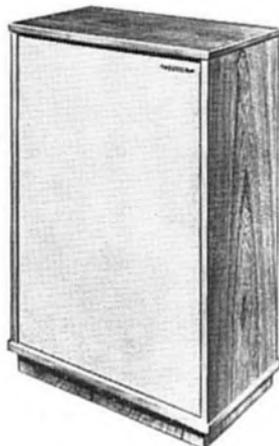
Distributor: AEG (Great Britain) Ltd, AEG House, Chichester Rents, Chancery Lane, London W.C.2.



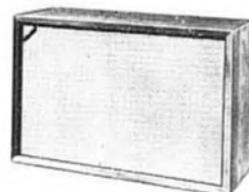
The majority of Recording and T.V. Studios use **TANNOY** monitors-the same units provide professional standards in the home



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corner-mounting
fitted with 12" or
15" Dual
Concentric.
Height 2' 9"
Width 2' 1"
Front to rear
corner 1' 4 $\frac{1}{2}$ "*



*"Lancaster"
free-standing
fitted with 12" or
15" Dual
Concentric.
Height 2' 9 $\frac{1}{2}$ "
Width 1' 9 $\frac{1}{2}$ "
Depth 1' 0 $\frac{1}{2}$ "*



*"III LZ" Mk. II,
Aperiodic
enclosure with
III LZ unit.
Height 1' 3"
Width 1' 11"
Depth 9 $\frac{1}{2}$ "*

and this is where you hear them!

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 F. Cave Ltd., 5 Bridge Street, Richmond, Surrey. 01-948/1441
 Chew & Osborne Ltd., 148 High Street, Epping, Essex. 375/4242
 Complete Audio Systems, 32 Grove Road, Eastbourne, Sussex. 0323/27362
 Francis of Streatham, 169-173 Streatham High Rd., S.W.16. 01-769/0466 & 0192
 Goulden & Curry Ltd., Little Mount Sion, Tunbridge Wells. 0892/30151
 C. C. Goodwin Ltd., 7 The Broadway, London N.22. 888/0077-8
 Hamilton Electronics, 33 London Road, Southampton. 0703/28622
 Holdings of Blackburn Ltd., 39-41 Mincing Lane, Blackburn, Lancs. 0254/59595
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 Lanes Radio Ltd., 94 Church Road, Hove, Sussex. 0273/738517
 Largs of Holborn, 76-77 High Holborn, London W.C.1. 01-242 2626
 Laskys Radio Ltd., 42-45 Tottenham Court Rd., London W.1. 01-580 2573
 Alan Laurensens & Co., Bell St., Reigate, Surrey. 74-46494
 Lind Air Optronics (18) Ltd., 18. Tottenham Court Rd., London W.1. 01-637 1601

Modern Electrics (Retail) Ltd., 120 Shaftesbury Avenue, London W.1. 01-836 7587 or 01-437 9692
 Musicraft Hi-Fi Centre, 63 High St., Hounslow, Middlesex. 570-4640 (01)
 H. Plumb & Son, Dicconson Street, Wigan, Lancashire. 0942/44442
 R. E. W. Charing Cross Road, 146 Charing Cross Rd., London W.C.2. 01-836 3365
 R. E. W. Earlsfield, 66/68 Upper Tooting Road, London S.W.17. 01-672 9175 or 01-672 4471
 Sheffield Sound Centre, 101 Elleleshall Road, Sheffield 11. 0742/23365
 Sound Incorporated Ltd., 5 Waterloo Road, Epsom, Surrey.
 Sound Incorporated Ltd., 114 Broadway, Wimbledon, London S.W.19. 01-542 7455
 Surbiton Park Radio Ltd., 48-50 Surbiton Road, Kingston-upon-Thames, Surrey. 01-546-5549
 Surrey Sound Equipment Ltd., Royal Oak Centre, Purley, Surrey CR2-2BG 01-668 4800
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 Telesonic Ltd., 92 Tottenham Court Road, London W.1. 01-636 8177
 Titan Tapes, 88 High Street, Edgeware, Middlesex. 01-952 3238
 University Audio, 1 and 2 Peas Hill, Cambridge. 0223/54237

Your favourite dealer may not be on this list — so phone him first!



All cabinets are fitted with Monitor Gold Loudspeakers



NORWOOD ROAD,
WEST NORWOOD,
LONDON, S.E.27.
01-670 1131

A Stereo Capacitor Microphone

Part Three

Final Tests

THE batteries for the power supply are a 9 V PP9, as used in larger portable radios, and two miniature 22.5 V Ever Ready batteries. The 9 V supply and the small 45 V supply are in series to provide the capsule polarising voltage. Both supplies are decoupled inside the microphone case. The batteries and sockets are mounted in an Eddystone die-cast alloy box, labelled with Dymo tape.

Two five-pin DIN sockets are provided for connecting two microphones to the common power supply, and two DIN three-pin sockets provide isolated outputs for DC. The coupling capacitors and leak resistors are wired between the tags of the appropriate socket pairs. A small resistor is in series with each output so that the emitter-follower is not damaged if the output is shorted or fed into too low an impedance. The mike can feed 600 ohms but the level is adequate to feed a high impedance microphone input.

The Eddystone box provides a strong and

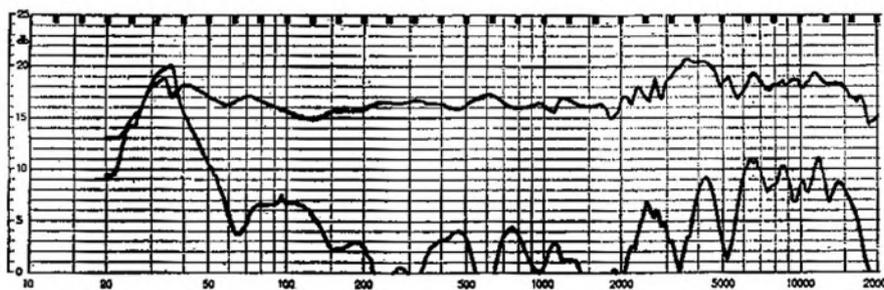
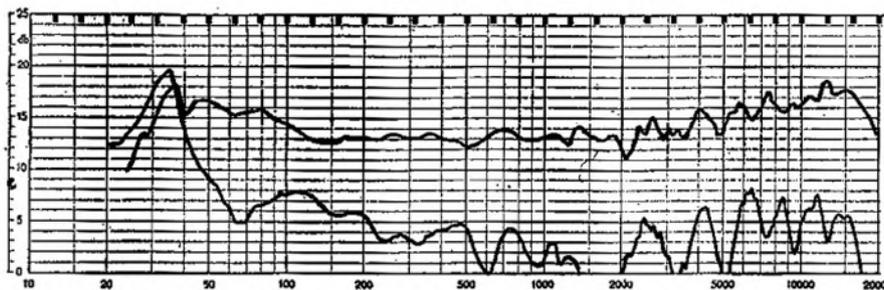
simple casing for the power supply. Though slightly expensive, it is well worth using. The batteries are prevented from flopping around by being tightly packed with foam plastic.

After building the microphone and balancing the outputs as necessary, there comes the agonising moment of truth when one starts listening to the results! Speech tests with several voices—inevitably including walking round the microphone while talking to see what stereo effect is produced—were most encouraging. There were no obvious resonances and popping did not occur unless one talked loudly very close to the microphone, within centimetres of the case. Not to be recommended since the capsule gets very noisy if the gap between diaphragm and centre plate becomes damp. There appeared to be very little coloration, suggesting that the diaphragm was well damped, as it should be, and that the case did not contribute too much in the way of objection-

able resonances. By comparison with a Lustraphone stereo ribbon and a pair of Film Industries ribbons, the signal-to-noise ratio was appreciably better and the sound quality comparable.

It was not easy to decide a preference between the microphones in terms of frequency response; there are subtle differences between all three. The different polar diagrams and how far one is off axis add to the difficulty assessing quality. Suffice it to say that with the capsules made for the author, the results were pleasing and the signal-to-noise ratio an improvement on anything obtainable with other mikes under practical conditions with the quietest amplifiers available. The output level also meant that the mike could directly feed the low level input of a Brenell, Revox or similar machine, without matching transformers.

Listening tests with a wide range of material,
(continued overleaf)



and direct comparisons with known good microphones, confirmed that the capsule design would give pleasing results in mono and stereo. The microphone gave a very good account of the author's Dolmetsch *Octavina* spinet, and of guitar, piano, singing and organ, with good clarity. The microphone was lent out for independent trial at a recording of the Fairfax Consort, and was well received. The width of the stereo image was not as good as anticipated, partly because the microphone had in any case to be placed further back from the singers than would be the ideal with back-to-back cardioids, but the sound was clear and the acoustic well captured. Noise performance was better than would have been possible with the Lustraphone, and the image width restriction was not felt to be serious.

The prototype has demonstrated satisfactorily that a single capsule mike can give very acceptable stereo and that the capsule design published in *Hi-Fi News* is suitable. No doubt an AKG *C12* capsule would give slightly better results.

Through the kind offices of a friend, measurements were made on one of the capsules mounted in its case. The results of measurement on axis and at 180° for each half of the capsule are shown on the B & K curves (1 vertical division = 1 dB). The on-axis response can be reasonably smooth and comparable with commercial cardioid designs. The curves were produced under dead-room

conditions using tone, and are therefore not as smoothed-out as the curves using one-third octave bands of noise to get round reflection problems. In terms of smoothness of response and its continuation to high frequencies, the microphone is considered very satisfactory. The front-to-back ratio of each cardioid, and hence the channel separation, could be somewhat better by comparison with the best commercial designs though it is better than many so-called cardioid moving-coil microphones where the separation and polar diagrams are highly frequency dependent.

The curves must be ignored below about 150 Hz, due to the finite size of the measuring room and the impossibility of eliminating all reflections at low frequencies. Regarding the noise performance of the microphone, the signal-to-noise ratio obtained was found to be better than given by an AKG *C12* (valve) microphone, comparable with the *C12A* (nuvistor) version, and about 4 dB worse than the *C451*. It was considerably better than anything obtainable with the ribbon microphones previously mentioned.

Small but significant

The small but significant differences between the two response curves illustrate the importance of making the two halves of the microphone absolutely identical (in the one illustrated, there was a 10% capacitance difference between halves). In practice, the slight plateau around 5 kHz on one side and the difference in front-to-back ratio of the two halves is barely detectable and of no consequence. The dips

in the 180° curves would extend a little further were it not for mechanical restraints on the automatic pen.

In addition to being used as a back-to-back stereo cardioid, the unit can be used as a mono figure-of-8 design by subtraction of the cardioids. Provided the two half capsules are similar and the sensitivity of each channel adjusted to be equal, the result is a good figure-of-8 polar diagram. A pair of stereo cardioids can then be crossed to give a crossed figure-of-8 pair. Using a mixer with phase switches on the input, the outputs from the two halves of the stereo mike can be mixed in-phase to give polar diagrams from cardioid to omni, or mixed out of phase to give polar diagrams from cardioid to figure-of-8. Effectively, one then has a remotely variable polar diagram microphone.

I understand that supplies of the Welwyn glass encapsulated high value resistors are running short at Proops of Tottenham Court Road, where they were obtained. From the manufacturers, they cost £2.75 or so in small quantities. I understand that Calder Recordings Ltd, Regent Street, Hebden Bridge, Yorks, may be able to supply 200 M LAB LHR resistors at 50p each. These would be suitable, and readers having difficulties might contact this firm explaining their needs.

I would like to express my thanks to friends whose practical help and suggestions had a great bearing on the final design, to John Penty for his help, and in particular to A. W. Fisher for producing all the metal work and the moulds for the capsule shields.

KLEIN & HUMMEL monitor speaker model 0Y

— a superior instrument designed for the professional

4-speaker system driven
by two built-in solid state
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Room and position matching
by two 4-step switches (3 dB steps)

Its small size permits highest-quality
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STUDIO DIRECTORY

A two

ASSOCIATED INDEPENDENT RECORDINGS (AIR)

Address: 214 Oxford Street, London W.1.

Telephone: 01-637 2758

Directors: George Martin, Ron Richards, John Burgess, Peter Sullivan

Studio Manager: Keith Slaughter

Engineers: Jack Clegg, Bill Price, John Punter, Alan Harris

General Information: AIR was formed in 1965 by a group of the most experienced independent record producers in the country. They originally hired studios when required but now have their own modern premises at Oxford Circus.

Studio One: 18 x 12 m, 6 m high, accommodates up to 70 musicians. Microphones by AKG and Neumann. Screen for film projection.

Studio Two: About 12 x 11 m and 6 m high, it can hold up to 35 musicians.

Studio Three: 4.5 m square and 3 m high—suitable for small groups and for overdubbing. This studio has no control room of its own and is normally used in conjunction with the adjacent Studio Two, or with the tape reduction room.

Control Room One: 9 x 5.5 m, 3 m high. Neve desk with 24 input channels and 16 outputs, Neve limiters and compressors, EMT echo plates and one echo chamber. Tape recording equipment consists of two 16 track 3Ms, three eight track Scullys, and Studer four track, stereo and mono machines. Dolbys are used unless clients specify otherwise. The monitoring speakers are Tannoy Gold mounted in cabinets designed by David Harries. CCTV has been installed to link this room with the other control areas.

Control Room Two: 7.5 x 5.5 m, 2.5 m high. The mixer is identical to that in Studio One and the recording and echo facilities are shared.

Reduction Room: 5 x 3.5 m, 3 m high. The Neve mixer and other facilities are identical to those in the control room.

Film Facilities: Projection room for Studio One containing 35 mm and 16 mm equipment. The film dubbing theatre is equipped with Philips projectors and a Neve desk. Albrecht magnetic film recorders can be used in the control rooms or in the theatre.

Music Services: Experienced producers are available for all kinds of music. Musical instruments normally available include Steinway Grand and Bolin pianos, Hammond C³ organ, celeste, electric harpsichord, electric piano, various percussion instruments, and a Moog Synthesizer.

Catering: Canteen serving light refreshment, and a vending machine.

Parking: No private facilities.

Hourly Rates (Tape):

Studio One:

Recording, mono or two track	£25
Recording, four or eight track	£27
Recording, 16 track	£35

Studio Two:

Recording, mono or two track	£20
Recording, four or eight track	£25
Recording, 16 track	£32

Studio Three used with Studio Two:

Studio Two rates plus extra charge of	£2
---------------------------------------	----

Studio Three and Reduction Room:

Recording, up to eight track	£20
Recording, 16 track	£25
Reduction, from up to eight track	£18
Reduction, from 16 track	£25
Copying, mono/stereo	£10
Copying, multitrack	£20
Editing	£8

Tape Charges (per NAB reel):

6-25 mm	£5
25 mm	£16
50 mm	£25

Hourly Rates (Film):

Studio One:

Mono or Multitrack	£25
Labour charge for normal crew of 5	£10

Studio Two (16 mm only):

Mono or Multitrack	£20
Labour charge for normal crew of 5	£10

Dubbing Theatre (excluding labour charges):

Mono post sync, effects, dubbing	£16
Stereo post sync, effects, dubbing	£20

Other Charges:

Steinway, Bechstein and jangle box piano available free. Fender-Rhodes electric piano for hire at £6.30 for three hours (minimum), and Hammond organ at £10.50 for three hours (minimum). The hire of other instruments can be arranged by the studio. The Moog Synthesizer is available at £10 per hour up to a maximum of £75 for a day's use.

Overtime rates for tape work are 20% from 18-00 to 24-00 and throughout Saturdays. After midnight and throughout Sundays and Bank Holidays the additional charge is 25%. For film work, overtime rates are negotiable according to crew requirements. Cancellations within 24 hours are charged at 100%, and between 24 hours and four days the charge is 50%.



George Martin (left) and Bill Price at an AIR desk

AUDIO SYSTEMS

Address: 421 The Hyde, Edgware Road, London N.W.9.

Telephone: 01-205 3803

Directors: Cyril Collick, Malcolm Stewart

Studio Manager: Cyril Collick

Engineers: Malcolm Stewart, Cyril Collick, Tommy Meyers, Peter King, Norman Brown, Trevor Carless.

General Information: Audio Systems is a film recording company specialising in location sound for feature films and the associated post production work. Limited studio tape recording facilities are available.

Studio: 12 x 6 m, 5 m high, accommodates up to ten musicians and is equipped as a film theatre. There is a 4.5 m high separation booth measuring 3 m square. Microphones are by Neumann and AKG.

Control Room: 5 x 3 m, 5 m high, containing an RCA mixer with ten input channels and three

outputs. In addition there is a transportable 12-channel four track mixer by Alice Electronics which can be used inside or on location. Alice have also supplied the limiters. Compressors are by RCA, and reverb is obtained from a Gramplan spring unit. Tape recording equipment consists of stereo BTR4 EMIs and Nagra machines with sync facilities. For monitoring, a pair of Quad amplifiers feeds Goodmans loudspeakers.

Film facilities: When used for film previews, the theatre seats 30 people. Film recording and projection equipment, 35 mm and 16 mm, is by RCA, and operates on the rollback system.

The company is also equipped for 35 mm and 16 mm optical transfers, while camera work and editing can be carried out by the associated companies, International Cine Products, and Film Editing Services.

Music Services: None provided by Audio Systems but various facilities including the cutting of demo discs available from Mrs Collick's music publishing company, Magus Music.

Mobile Recording: Fully equipped for location film recording.

Catering: Drinks available.

Parking: No problem.

Hourly Rates (Tape):

Recording (all sizes)	£10
Editing	£5
Copying	£5

Hourly Rates (Film):

Recording	£10
Dubbing	£15

Transfer Rates (per metre):

Magnetic, 35 mm or 16 mm	5p
Optical, 35 mm	5½p
Optical, 16 mm	5p

Other Charges: Cancellation fees are applicable during busy periods.

AUDIO TRANSCRIPTIONS

Address: 177 Torrington Road, London S.E.6.

Telephone: 01-698 4519

Proprietor: Geoffrey Terry

Engineers: Reg Blackmoor, Mike Wilds.

General Information: Geoffrey Terry started the business about 10 years ago, and has been at his present premises nearly three years. Being an orchestral manager and concert agent, he tends to specialise in recording orchestral works at concert halls all over England.

Studio: 9 x 6 m, 3 m high, capable of holding about a dozen musicians. Microphones are by AKG and STC.

Control Room: 3.5 x 3 m, 2.5 m high. The mixer, which has 16 inputs and two outputs, is home built. Monitoring is provided by a pair of Spondor combined speaker/amplifiers. For recording, there are ½ and ¼ track stereo Tandberg machines.

Disc Cutting: An MSS mono disc cutter is used.

Mobile Recordings: The same equipment is used for mobile and studio work.

Catering: Yes.

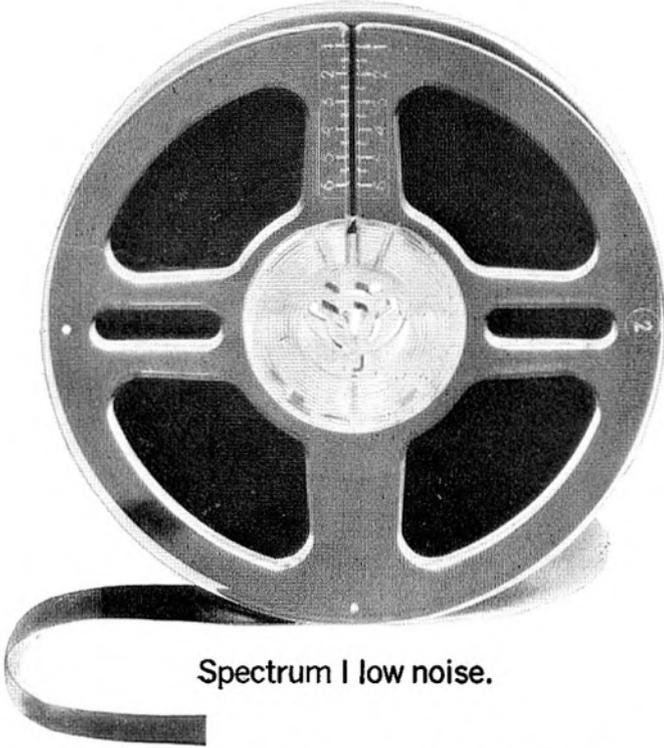
Parking: No problem.

Rates:

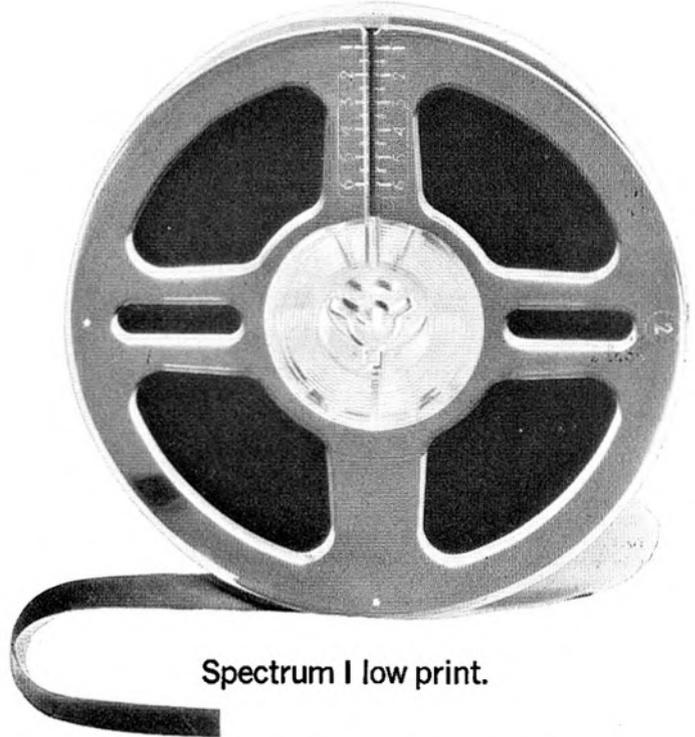
Studio recording per hour	£5
Disc cutting—per double-sided 30.5 cm LP	£5

Other Charges: All other charges are individually assessed according to the type of work and its complexity, the number of discs required, and other factors.

Pray silence for Spectrum I.



Spectrum I low noise.



Spectrum I low print.

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

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

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

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

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

You'll notice they're black.

The colour is caused by an oxide process designed to reduce static and

The new 4dB plus tapes from Zonal.

improve conductivity.

Base scratching (which causes debris) and dust attraction are reduced.

And you won't detect any head-clogging or dropouts as a result.

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Try breaking it.

Low noise is coated on a tough polyester base, insensitive to temperature and humidity changes.

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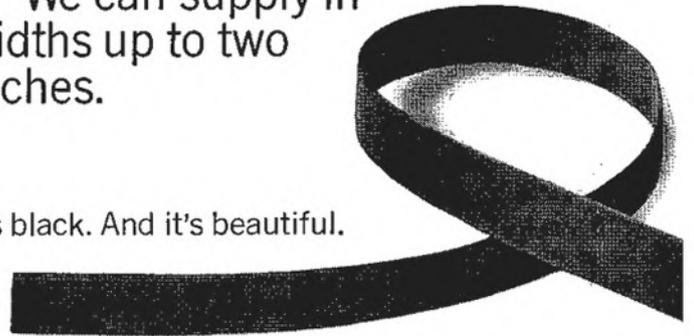
And distortions during storage will not develop due to pack settling.

If you're worried about batch

to batch consistency, we've only had a .001 rejection out of the last 500 million feet of tape produced.

We can supply in widths up to two inches.

It's black. And it's beautiful.



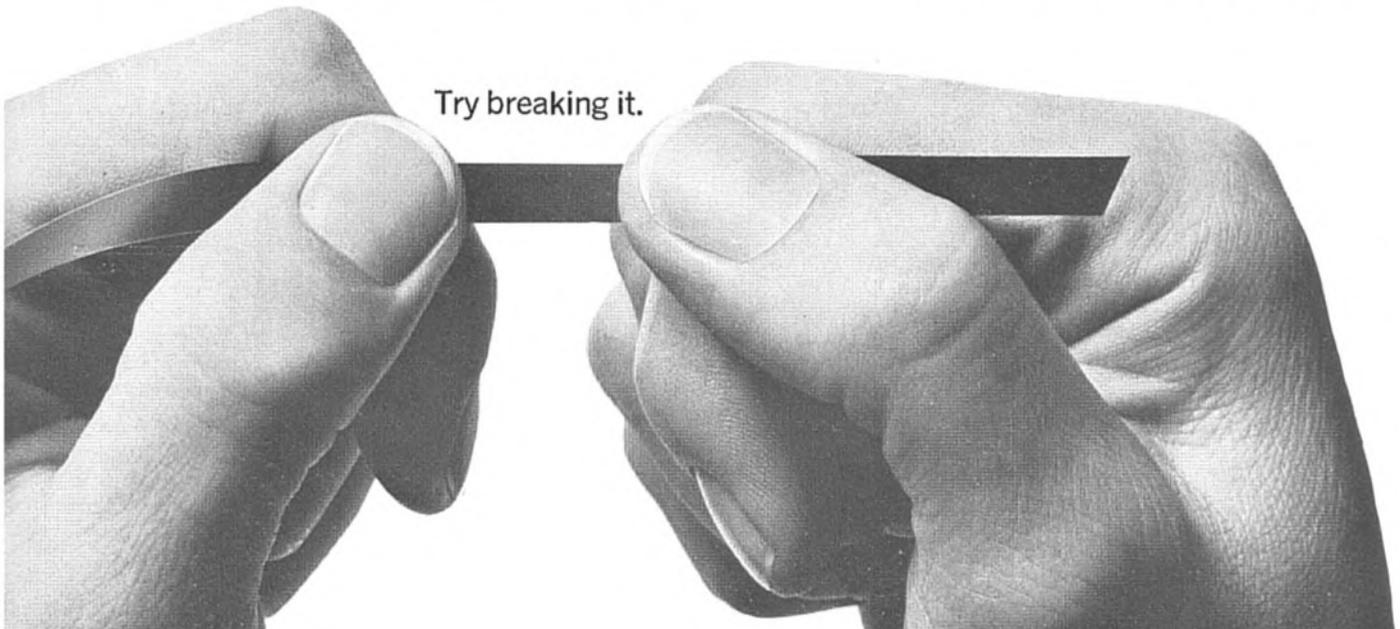
Ring Tony Pitter for any technical information.

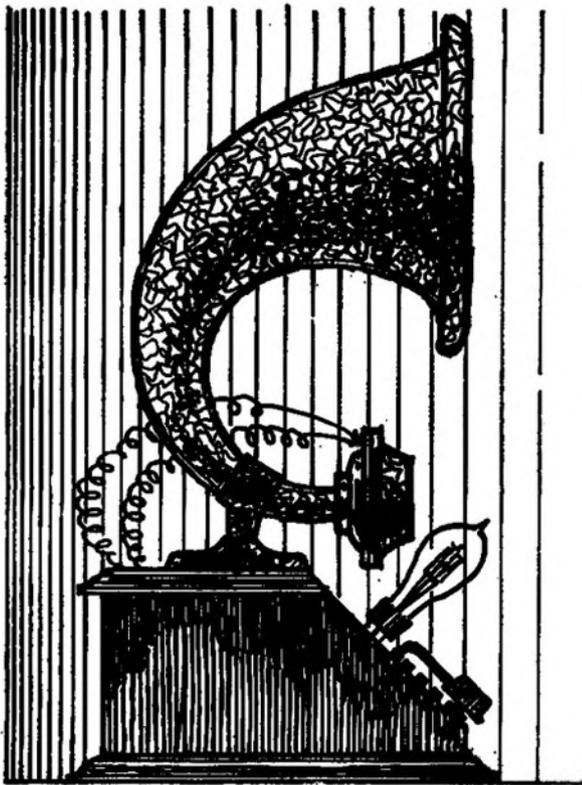
The number is Redhill 64706. He'll tell you why Spectrum I is years ahead of its time.

 **ILFORD ZONAL**
Spectrum I tapes

(All the better to hear you with).

Try breaking it.





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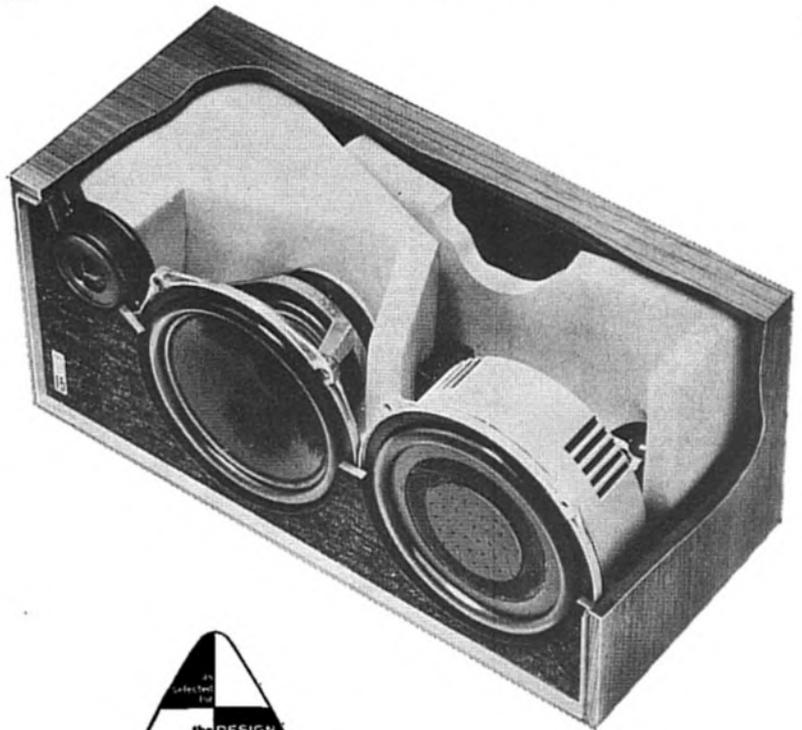
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Name

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THERE is not much point in devoting a full page to the circuit of the stereo Uher (the 4200 $\frac{1}{2}$ -track) or 4400 $\frac{1}{2}$ -track). Just as its appearance conforms very closely to the original design, so its circuit is largely a straightforward duplication.

If this was a review, I should feel inclined to criticise one or two points about the selection of stereo functions. It is only possible, for example, to monitor the left channel through the internal loudspeaker. If you want to monitor the right-hand channel, then you must take off the sound (via headphones, preferably) from the RH loudspeaker socket. It would have been very handy to have the kind of universal left-right switching that even quite inexpensive stereo tape recorders enjoy nowadays.

Full mono stereo operation is denied us, also, during recording operations. Although we are able to parallel replay from the left channel, recording mono on the right channel is not possible unless the left channel is also in recording mode.

Depressing both selector buttons brings both channels into operation for normal stereo. Using the machine with both buttons out allows you to replay the left channel through both outputs. Selecting either track shunts that head winding to the left amplifier channel; while recording, the appropriate track is routed via the left amplifier while the right amplifier is used for monitoring. This affects the choice of connections and can be a little confusing if you do not know about it. I therefore propose to tabulate the pin connections, comparing the mono and stereo versions where a similar sequence of pins is used.

One of the most annoying faults the service engineer gets is that of run-down—sometimes leaking and corrosive—cells in portable tape recorders. The Uher 4000 series takes a 7.5 V series of HP2 cells, or a storage cell or charger/



UHER 4200L

BY H. W. HELLYER

mains unit. When the lead-acid block Z212 or the nickel-cadmium accumulator Z214 is inserted in the battery container section, a push-button is depressed and a switch closes. This push-button (see fig. 1) lies between the curved walls of separate cells. Fitting the accumulator puts the power through to pin 6 of the remote socket and then, via the on/off switch, to the zener diode and filter circuits. In fact, the extra switching of the stereo models makes it difficult to describe this circuitry by using switch numbers. In the 4000L, the battery switch is K9; in the 4200/4400 it becomes K5. The circuit, however, is generally the same.

Thus, inserting the accessories plug still opens the K10 or K6 (stereo models) switch (the connection to pin 6) so that the charger circuit or the mains supply unit can come into action.

Earlier, I made reference to corroded batteries. Too often, rechargeable cells are allowed to fall off until attempts to recharge

them fail. A machine is brought to us, faulty. We operate it on a bench supply, cure the smaller troubles, and clean it up. A minor job, you may say. But the fuss made when we replace the rather expensive accumulator because the owner has allowed it to deteriorate without its necessary occasional recharge is far beyond the worth of our modest profit.

The moral? Never allow a rechargeable cell to stagnate. As a corollary, never leave batteries in an unused tape recorder. If you own an Uher, do not make the mistake of upgrading it by using the later type of mains unit, the Z124. Really, it is easy to remember the combination: the nickel cadmium accumulator is designated Z214 and its charger/power supply is the Z124. The earlier types, with which we have had so much trouble, were the Z212 lead-acid sort, and they could only be used for limited periods and stored for a short while unless fully charged. Bosch recommend recharging every three months. I would have said this is a conservative estimate. If you have the correct mains unit, this can be left connected for a trickle charge, and if one watches for the green light, ('on' for charging, 'off' for charged), there should be no problem except that of the cut-out failing—and we have already dealt with this possibility.

On this subject, it is worth noting that the Z124 mains unit does not operate in quite the same way. Its light stays on all the time. As the nickel-cadmium battery, with which it is intended to be used, can hardly be damaged by overcharging, this is no problem either. Moreover, the shelf life is incomparably better than that of the lead-acid, and it is possible, though not desirable for practical reasons, to store the Z214 battery in a discharged condition.

There are other significant differences between the mono and stereo versions in the Uher 4000L range. The output transistors have been improved now by using an AC 187/188

(continued on page 233)

FIG. 1 The nipple that actuates the battery switch when an accumulator is inserted.

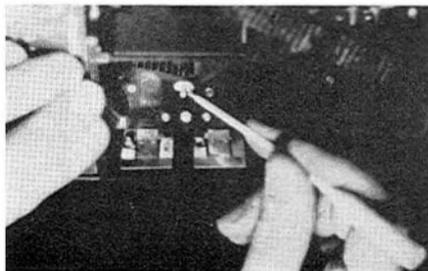


FIG. 2 The switches on the rear of the two level controls are vulnerable items. Easy enough to get at but not so simple to change.

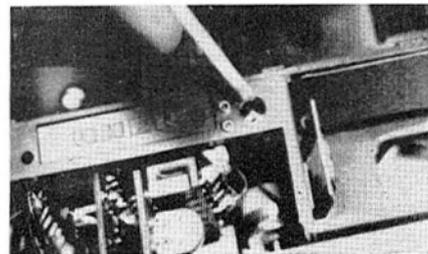
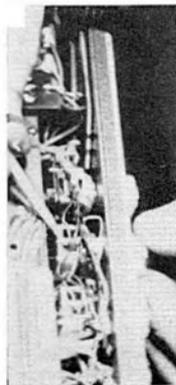
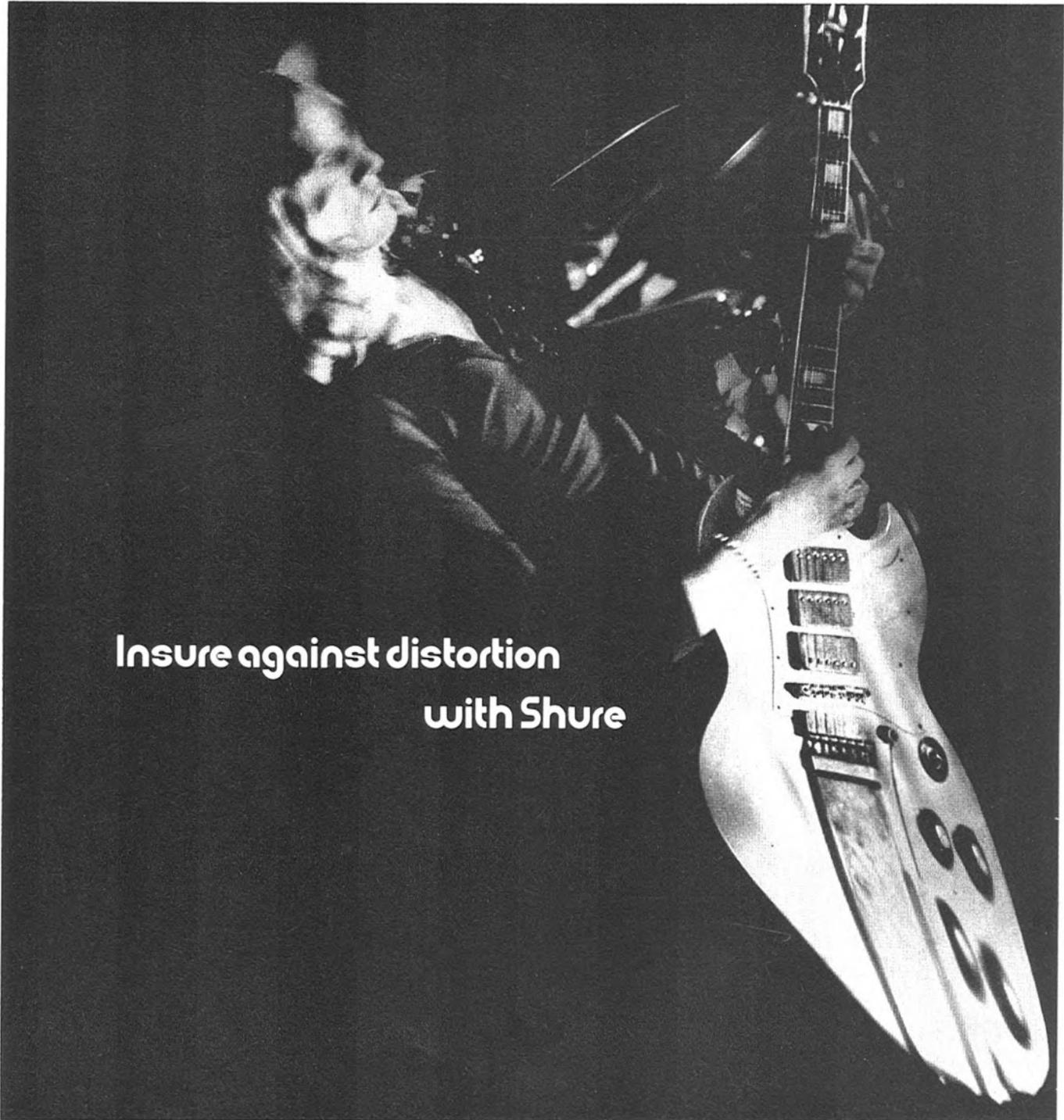


FIG. 3 Battery check adjustment preset, adjacent to the single cell container, brings RH meter to black/red division on 4.8 V



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FIG. 4 Adjustments crop up in the most unlikely places!

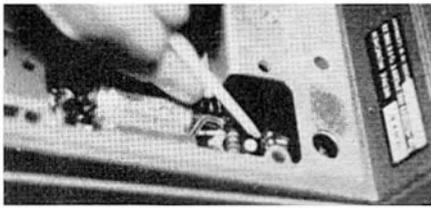
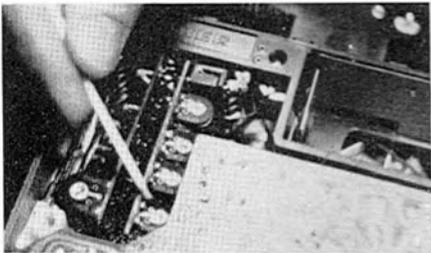


FIG. 5 Output stage balancing. Four presets instead of two, reading (bottom to top): R91, R93 (RH channel), R90, R92 (LH channel). Adjust R90/91 for sinewave symmetry and R92/3 for minimum crossover.



the possibility of beating with the strong third harmonic of the multiplex pilot tone but, as Bristol is as yet cheated of stereo radio (all stand and cry 'Shame'), the problem has not arisen.

Head alignment was omitted from our previous spiel, simply because this dissertation on the $\frac{1}{2}$ and $\frac{1}{4}$ -track stereo versions of the 4000 series was the most convenient spot to combine all the necessary information.

In their service manuals, Uher give overlap distances for judgement of the position of the head gaps relative to the tape. Even when you remove the head cover and the piece across the top of the pressure arm (which is now also extended to cover the head gate slot) it is still difficult to view the heads from a sufficiently horizontal position to judge head gap alignment. This is sheer bad design. In any tape recorder that dares to call itself professional, there should be easy access to the whole head gate assembly. So, for that matter, should bias and equalising adjustments be made easy for the user, not just the engineer.

For head alignment, where the facing is easily visible, I have always found the preliminaries very much curtailed by the help of a Bang & Olufsen transparent and engraved tape. Once the heads are roughly checked for position, a swift run-through with a white-noise alignment tape, track three erased, enables one to set up record and play heads in double-quick time. It is only a small matter,

play heads should always be made by the grub-screws under the head plate, and not by attempting to set the azimuth screws. The latter is done by adjustment of the longer screw, to the right of the record/play head; the left-hand screw is spring-loaded. The erase head height and azimuth alignment are fixed and can be used as a datum. Again, the $\frac{1}{2}$ -track model is easy, needing only a check on symmetry, and adjustment of the sprung guides, which are screw-slotted. If only the head cover and front shield are removed, I find it easier to set the left guide roughly, load tape and stretch tightly across, then shine a bright light down to the erase head facing and adjust the right guide until a visual level is obtained. You can just see the top of the gap section cutting the edge of the tape. Then use the guides as a datum for the record/play head. I keep a piece of quadruple play tape (by courtesy of Kodak) for head alignment and guide verticality checks. It runs through sweetly and its curvature, once more illuminated by a bright light, reveals any variation from vertical in guides or contoured heads. Remember, when adjusting, that the tape always tends to run to the point of greatest pressure—a useful point also when judging erratic pressure rollers.

What other differences must we note? One omission: the shorting or muting switch, a sliding contact actuated by the clutch mechanism, is not in the stereo models. One change: the frequency of the oscillator, affected by the direct loading of erase head windings, is lower in the $\frac{1}{2}$ -track models. The record/play switch is quite differently mounted in the stereo models—the sliding contacts make on two blades when the switch is neutralised. First contact blade of the LH channel must be engaged; first blade of the RH channel is free and second blade engaged.

Electrically, there are some different readings to be obtained, and the two tables of equalising figures for all four speeds, for record and replay, are given in the appendix to this article. It need not be stressed that both channels should be checked and should be within 1 dB of each other through the range. The only other figure differing from the 4000L series is that of residual noise; 3.5 mV instead of 3 mV.

Plug	Pins	4000	4200/4400	Remarks
Microphone	3/2 4/5	Single Remote control	Two single Remote control	Unbalanced Pin 4 common to Pin 4 of remote control socket
Radio/Phono	1/2	Via K511	Left channel stereo via K541 lead	Pins 4 and 5 are not used in the mono, 4000L version
	4/2	—	Right channel stereo via K541 lead	
	3/2	Mono gram	Left channel gram	High impedance
	4/2	—	Right channel radio	
	5/2	—	Right channel gram	
Loudspeaker	3/2	Line out	Left line out	Replay
	5/2	—	Right line out	Replay
Loudspeaker		Mono	Stereo	To suit 4 ohms loudspeaker or 75-400 ohms headphones. Switched.
Remote control	6-pin DIN	Suitable for power pack, Z124 (Z114 with earlier models and with lead-acid cells Z212) suitable for remote stop/start control. See previous notes on connections and refer to 4000L diagram.		

	19 cm/s	9.5 cm/s	19 cm/s	9.5 cm/s
40 Hz	19 dB	18 dB	6 dB	6 dB
60	19	18	4	4
100	18	17	2	2
200	14	13	0	0
500	6	5	0	0
1 kHz	0	0	0	0
2	-4	-3	0	0
3	-6	-4	0.5	1
4	-7	-4	1.5	2
5	-8	-4	2	3
6	-8	-4	3	4
8	-7	-2	4	7
10	-7	0	6	9
12	-6	3	8	12
14	-5	7	9	14
16	-4	10	10	16
18	-2	10	12	16
20	0	9	14	13

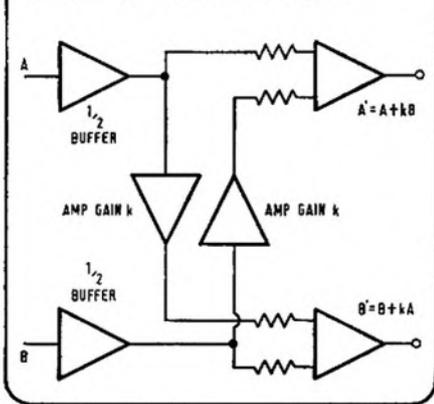
pair instead of the AC 176/153 combination of the mono models. This has meant very slight but quite important changes in the bias and feedback arrangements of and to the BC 214 driver.

The oscillator, too, has undergone a little alteration. Having to feed a pair of erase heads and provide bias for two recording heads, it was necessary to alter the circuit very slightly. Principal difference that affects us is the method of bias feed and the substitution of variable preset capacitors for the R4 resistor previously mentioned. The oscillator frequency is 60 kHz for the $\frac{1}{2}$ -track model, 10 kHz higher for the $\frac{1}{4}$ -track version. I am a bit bothered by

then, to record on fresh tape, check final details, and align the erase head.

As with many rather larger machines, the initial setting should be of reference levels, i.e., the head guides. The tape should be loaded and run through so that on any functional winding the tape clears the flanges of the reels. On the later models, the first visual check after this is that the top of the erase head gap comes level with the edge of the tape. The two-track stereo model is easy, of course: one needs only ensure that the upper and lower edges of the head gaps are equidistant. The $\frac{1}{4}$ -track models need to be judged by their upper tracks alone. Vertical alignment of the record/

FIG. 89 STEREO WIDTH CONTROL



a high quality mixer

PART 12 LAST THINGS

It seems a long way from Part One a year ago, but I hope that along the route I have kept my readers and provided something of interest. This part is positively the last!

We begin with the correction of errors; only two have come to light. In fig. 50, the low impedance earphone amplifier, R1, should be 470 K and not 47 K as shown. On page 81 in the February issue, the formula for the frequency dip in the band rejection circuit should of course be $f = \frac{1}{2\pi\sqrt{LC}}$.

Last month the main topic was the answering of readers' questions. Lack of space prevented all but the most common or interesting being answered. One question which has occurred many times and was omitted from last month is the problem of achieving separation controls on stereo mixers, and I propose to spend the opening paragraphs outlining methods of producing image width controls.

There is often the necessity to process further recorded or transmitted signals to improve or modify the separation of stereo signals. In stereo broadcasting, the transmitting authority has always to consider the monophonic listener, so that the stereo signal has to be compatible. This often leads to the signal being somewhat narrow. The other extreme occurs in some pop recordings where the signals are either entirely left or right, creating the hole-in-the-middle effect, which was very common in the discovery days of stereo. No doubt we can expect a further dose in four channel! Stereo signals L and R can be reprocessed to give sum and difference signals $L+R$ and $L-R$; $L+R$ is the compatible mono signal, and $L-R$ carries the directional information. Increasing the $L-R$ component thus increases the stereo effect, and reducing it will eventually lead to mono when $L=R$.

Circuitry to achieve this is straightforward, and can be adapted from the normal mixer circuits. (Another source of ideas is the article by A. Roberts in the December 1969 *Wireless World*.) Fig. 89 shows one possible though complicated solution which serves to illustrate the point. Signals from the A channel are taken via an amplifier of gain k and added to the B channel, and similarly B channel information is added to the A channel, to produce two new channel signals of A' and B' .

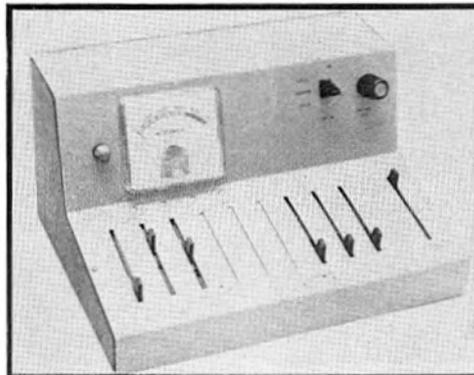


FIG. 91

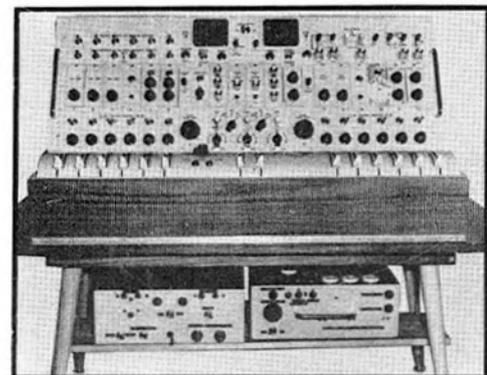


FIG. 96

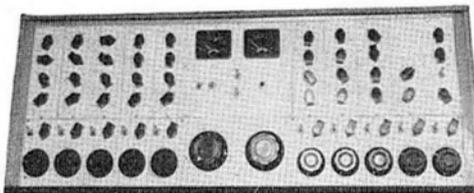


FIG. 93

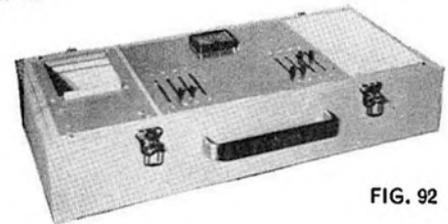
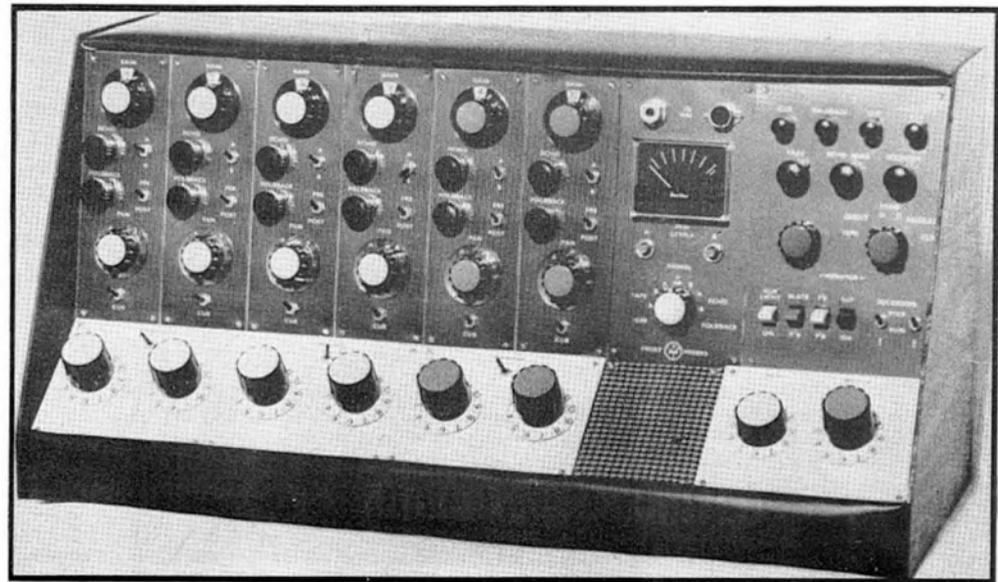


FIG. 92

FIG. 94



a high quality mixer

PART 12 LAST THINGS

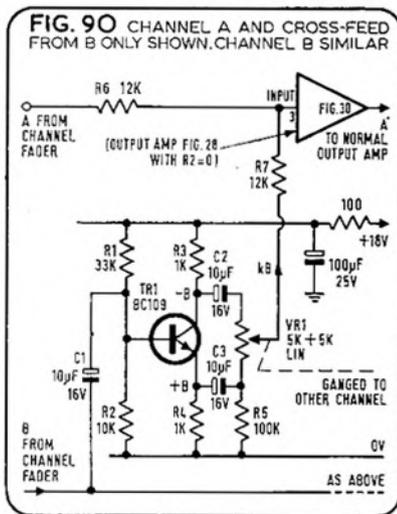
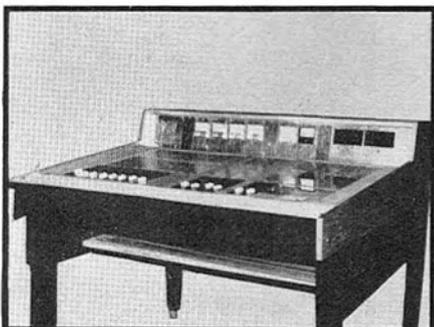


FIG. 95



FIG. 97



Then, $A^1 = A + kB$,
and $B^1 = B + kA$.

Thus the new sum signal is $A^1 + B^1$ or $(A + B)(1 + k)$, and the difference signal $A^1 - B^1$ or $(A - B)(1 - k)$.

If k is positive, then the image width is reduced. When $k=1$, then the sum signal is $2(A + B)$ and the difference signal is zero—that is, mono.

If k is negative, then the sum signal is reduced and the difference signal is increased, so increasing the separation. With k equal to -1 , there is no mono component. The circuit in the article referred to is an elegant, simple solution; another version is given in fig. 90. The amplifier stage provides signals of B and $-B$ at the emitter and collector, respectively, of the transistor, so that the electrical centre of the potentiometer RV1 has equal proportions of B and $-B$, i.e. zero signal or $k=0$. Thus the A^1 signal is purely A , the normal input. As the slider moves towards the collector, then the output moves towards $-B$ or $k = -1$.

The main purpose in this final article is to give some examples of some of the mixers which have been built around the world. These have varied from simple four input channel mono mixers to 24 input 8 output versions for use in multichannel applications. Figs. 91-97 show some of the more interesting among the many about which I have been told.

Fig. 91 shows a very simple mono mixer, using Stomag (Bauch) faders (now no longer available) which was built for a theatre group in Bishop's Stortford. There were three microphone channels and three high level inputs for tape and two record players. The design allowed for a further three microphone channels to be added as funds permitted. The metering is of the VU type, using a normal microammeter which is cheaper than the true instrument but has much inferior dynamic properties.

Fig. 92 shows a truly portable stereo mixer, built into a suitcase. Stomag faders again, used by John Gwillam of Ferny Creek, Australia. The photograph was taken towards the end of the construction; the hole at the top left contains three input channel preamps (coupled to the first three faders) and a fourth position for a tone control circuit. The main channel fader is the fourth from the left. The righthand side is a mirror image of the left. The PPM is a single meter reading the greater level of either channel.

Fig. 93 shows one of the mixers used at Dero Sound Service of Carnforth, Lancashire, which was the subject of an article by Derek Marsh in the January 1969 issue of this journal. Each of the two groups has four inputs, which have large plug-in modules containing both microphone amplifier and tone control circuits. Full echo facilities are fitted, and separate meters are used for each channel. At present, Dero are constructing a second smaller mixer, for location work, to the new design.

Fig. 94 shows a mixer built by J. S. Frost of Harrogate to the new design. He has achieved a high standard of finish; I particularly like the 'Frost' symbol! There are six input modules and two outputs; each input channel has panpots. Mr Frost has ingeniously overcome one of the problems of rotary faders; each alternate

potentiometer is in fact a stereo type, and by using the 'transfer' switch the output of the left module of a pair is controlled by the second half of the stereo pot on the right module; thus one pot controls two channels. The keys provide facilities for cue light, talkback, slate, foldback, playback, and line-up tone (LUT). There are two internal low wattage power amplifiers which can drive small speakers, and a further IC amplifier to drive the cue loudspeaker which is in the lower panel. Again, a single PPM is used with full switching facilities.

D. A. Rance (Princes Risborough) favours the long low look (fig. 95), and again the result is quite pleasing. Six input channels are used feeding Preh faders; the plug-in amplifiers are connected behind a flap on top of the unit above the key switches. Eight of the microphone amplifiers are in this rack; six for the inputs and two used as group amplifiers (to standardise on tapes). Two balanced outputs are provided, and also outputs for PA, talkback and echo send. There are three tone control units (on the front panel) which can be switched to any of the input channels and also to the PA or echo chains. One interesting feature is that the talkback switching is arranged to use one of the input mike channels rather than using a separate amplifier; this is logical, since mike inputs and talkback are not required simultaneously.

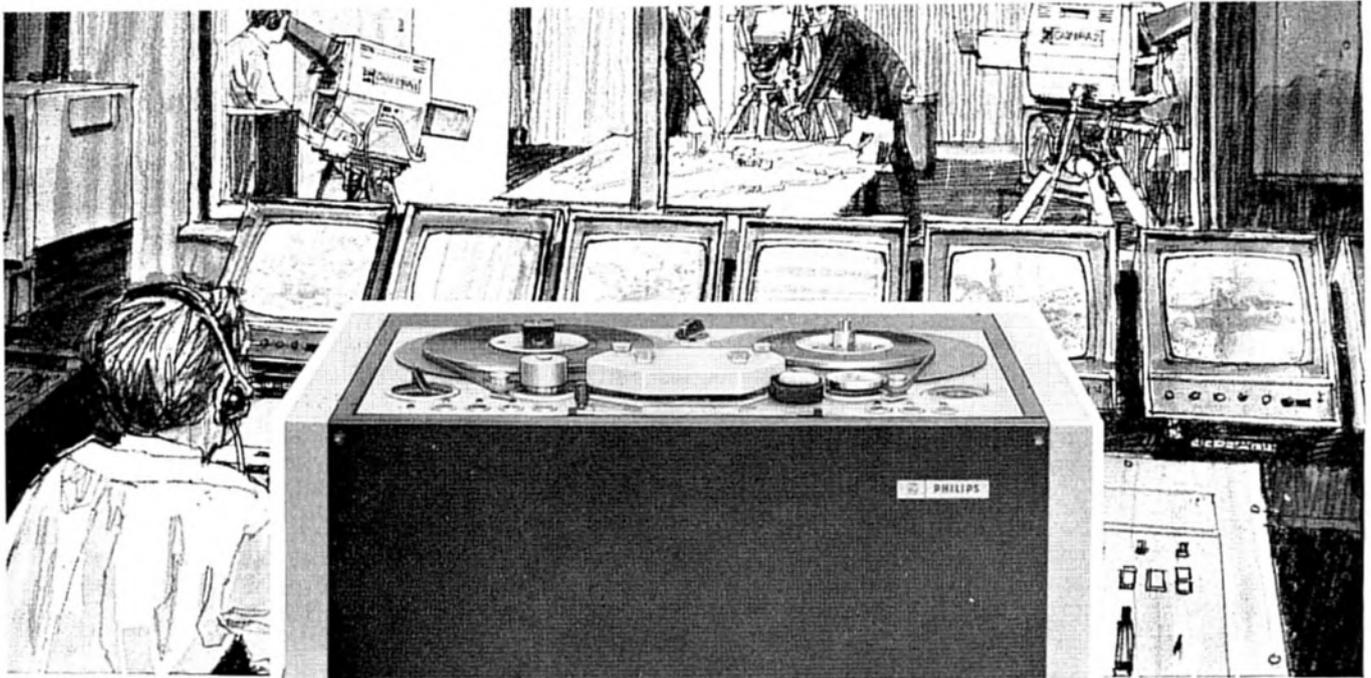
One of the largest stereo mixers I have heard about is shown in fig. 96, which was constructed over a period of years by H. P. Sprogoe, again of Australia. This is a twelve input desk, with two outputs, beautifully made and finished. The design followed the original articles almost exactly except for metering; independent channel PPMs were used as can be seen. Portability is obviously not this design's strong point but, for an amateur recording enthusiast (incidentally with no great knowledge of electronics, Mr Sprogoe was an oil executive), the result is most impressive. Two separate stereo 30 W amplifiers below the mixer feed studio and monitor room loudspeakers.

Last design

The last design that I have room to show is of an unfinished multichannel desk (fig. 97) a present under construction by Carl Nordstrand in Stockholm. There are 10 mike inputs, 10 high-level inputs, and four balanced outputs. There is also a full complement of monitor, echo, and foldback channels. Each input channel will be metered and provided with tone control stages. Penny and Giles faders are used throughout.

Unfortunately the postal dispute has prevented me from showing as many photographs of mixers built to the latest design as I would like; in any case many of these are very ambitious, with multichannel outputs (I know of three 16 output channel desks at present under construction) and thus take longer to plan and build. However, I hope these few examples will show what can be done, in the main by enthusiastic amateurs.

Finally, I must thank all those who have assisted in this project; the various photographers (Robin Gibson in particular), colleagues who have helped criticize and then test the many circuits, and not least the very many people who have written telling me of their problems and progress with the design.



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Above: Recorded Sound control room viewed from studio.

RECORDED Sound's premises in Bryans-ton Street, near Marble Arch, were taken over by George Pastell and his partner Alexander Dembenoitis in June 1968. Originally mono only, the studio was redesigned by Sandy Brown and refurbished to cope with eight track work. By the end of March, they will be equipped for 16 track working. After 23 years as a character actor, George Pastell went into the recording business at the suggestion of his wife Gloria George, one of the Ladybirds. Since then the business has expanded and has become George's chief occupation.

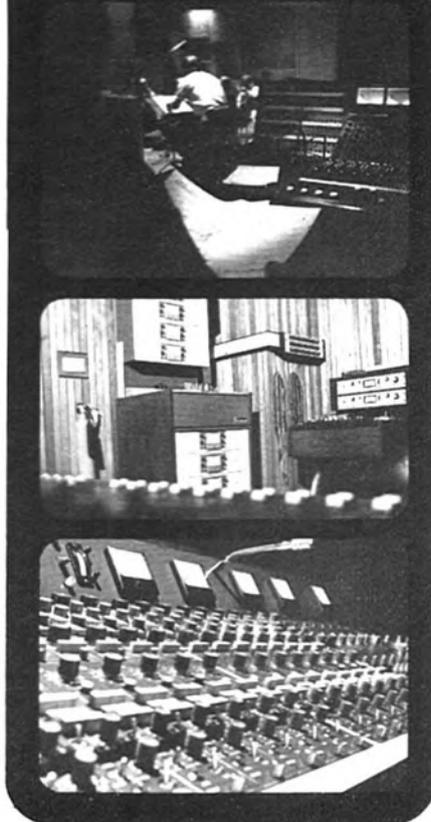
The studio measures 12 x 6 m, can take up to about 35 musicians, and has an adjoining separation booth. A large number of Neumann and AKG microphones are available, and the studio lighting can be varied from bright white (for session musicians) to dim red (for groups whose main concern is to be put into the right mood rather than to be able to read sheet music). The control room is on the small size, measuring about 3.5 x 3 m. Like the studio, it is well-equipped and comfortably furnished.

The control desk, a 20 channel eight track Neve, is positioned so that the engineer can see the studio through the viewing window on his left. Behind him are the recorders and in front, either side of the door, Cadac monitoring speakers fed by Audix 80 W amplifiers. Tape machines used at the studio are eight track 3Ms, four track and stereo Scullys, and four track, stereo and mono Studers. The 16 track machine soon to be installed is a 3M and it will be used in conjunction with a 24 channel 16 track Neve mixer which is on order at the time of writing.

In the reduction room is a 16 channel mixer again by Neve. As can be seen from the illustrations, these are typical Neve desks, comprehensive and smart in appearance. The echo facilities, which are shared between the desks,

around the studios Recorded Sound

by Keith
Wicks



Below (top to bottom):
Producer's view of studio.
Eight track 3M and (right) stereo Scully.
Close-up of 20 input Neve desk.

consist of four EMT plates, two stereo and two mono.

Studio personnel include chief electronics engineer David Hawkins, and recording engineers Mike Weighell, Gerald Chevin, and Eric David Holand. During my visit to Recorded Sound, Gerald Chevin (who I had previously encountered in his Advision days) was engineering some eight track work. This featured four session musicians laying down tracks for a New Generation record to be issued on Polydor. In the control room during the recording were about six of the singers, Gerald Chevin and producer Tony Palmer at the desk, and a tape operator and myself in the background. Bearing in mind the small size of the control room, it says a lot for the layout of the place that it did not seem overcrowded, although obviously one could not move around too much. As in many other control rooms, a space in front of the desk is used to accommodate artists and to keep them out of the way of the engineer and tape operator. One small criticism I have is that the limited free desk space made it necessary for the producer to spread his sheet music over some of the mixer controls. This did not apparently inconvenience the engineer in this case, but in some circumstances could be a disadvantage. These days, with so many channels, tracks, and their associated controls, the problems of space availability and ergonomics are becoming increasingly difficult for everyone.

Although there are no disc cutting facilities on the premises, the usual services can be arranged for clients. Since the rates for tape recording were about to be revised at the time of writing, there is little point in quoting any figures at the moment, but it is hoped to include the new rates in the Studio Directory in due course.

Recorded Sound are, in my opinion, one of the better medium sized studios.

FILM SOUND TECHNIQUE

THIS article deals with music prerecording and the selection of equipment to be used for the production recording of the film *Fiddler on the Roof*.

On a large production there is often a need for purpose built equipment and events proved 'Fiddler' to be no exception. The Mirisch Production Company appointed David Hildyard as sound mixer and his first task was to co-ordinate and provide the various technical requirements. In his discussions with the production company, the possibility of two track playback arose. One track carrying the vocal and the other the orchestra, with a view to being able to control the balance according to the artists' requirements, and the nature of a particular shot. It might be necessary to boost the vocal to assist in achieving lip sync or, in the case of the dance routines, give added emphasis to the orchestra. The alternative is to make several mono versions, each with a different balance, though this means a loss of flexibility as decisions on balance have to be made long before actual shooting conditions are encountered.

As 6.25 mm tape is the normal standard for production recording, the obvious choice for playback is also 6.25 mm tape. The problem was to obtain a two track machine with the ability to sync lock as it is necessary to maintain frame by frame sync between the resulting action and the original 35 mm music tracks, as they would be used in the final dubbing. The Nagra *Neopilot* system allows this as, when the playback tapes are made from the 35 mm magnetic masters, the previously mentioned sync pulse is also recorded. This pulse is played back and compared with the pulse derived from the camera drive system. Slight variations in the camera speed are faithfully followed by the playback Nagra and its reproduced sync pulse is kept locked in frequency to the camera sync pulse.

The long awaited stereo Nagra was not available (and is still not) and the Stellavox, though found at exhibitions for some time past, could not be obtained in time for acceptance tests.

David Hildyard chose then to modify a Nagra 4L for two track playback, so Jim Willis (a freelance sound mixer and engineer) and Fred Hughesdon of Location Sound Facilities

Ltd (the company who were to supply the sound recording equipment) set about the design and construction. The original erase and neopilot heads were retained and the mono recording and reproducing heads were replaced with two track ones supplied and fitted by Branch & Appleby of Harrow. The extra electronics could not all be housed within the body of the machine so part of the Track Two playback amplifier and its line sending amp were housed in a separate die cast box with an independent battery supply. The second record amplifier and playback preamp were fitted inside the machine in the space normally occupied by the crystal oscillator and radio receiver.

Tests proved the system to be feasible, the crosstalk and signal-to-noise ratio being acceptable, despite the reduced track width and the proximity of the sync tracks. At this time I joined the team which included Pat Haigham, who I must thank for supplying the basis of the text on the equipment development stages. He was working on the ancillary equipment, cables, remote control and all those odd things that don't seem much till you try to deal with them. I was to go on the picture as maintenance engineer in place of Jim Willis who was off to Spain to mix another production. Pat Heigham was to be sound camera operator (a rather poetic film industry term from the days of optical recording) and the boom operator was John Stevenson. My first job was to build a second two track Nagra 4L and make final modifications to them both.

Further problems of the playback system concerned the selection of suitable power amplifiers and associated loudspeakers, the matter being complicated by the fact that most locations would not have AC mains supply. All equipment had to be battery powered. The number of loudspeakers in use at any time might vary between one and six, being dictated by the size of set to be covered. 100 V line source column loudspeakers were chosen in view of their shape and size; all the sound equipment, including a Fisher mike boom, camera drive and batteries, were to be carried in one small truck. Re-entrant horns are the more usual type of loudspeakers to be found on playback sets, but the columns

combined rather better quality with the directional property necessary to project over some distance.

The power supply most convenient for the power amplifier was 24 V DC as the Panavision cameras were to be run from a three-phase rotary converter powered by two 12 V car batteries so 24 V DC would always be available. An amplifier possessing several useful features such as four channel mixer with slider faders, full tone controls, and the ability to combine with one or more other units, was tested but rejected as it required 36 V for full output. However the Grampian 662 amplifier was found to be happy with a supply of 24 V and two were modified to accept the line outputs from the Nagra. These were fed to the amplifier via a four-pin XLR wired to two of the four inputs of the power amplifier's built-in mixer, thus allowing the PA balance to be adjusted as required. The fourth pin on the XLR was used to feed +24 V for remote control relays, a limited system being employed. This gave control of (a) the playback machine stop/start, muting the loudspeakers in the stop mode, (b) mute only (machine running), (c) dim, the dim being variable for each track.

David Hildyard had also found that the script demanded the recording of dialogue spoken over prerecorded music. The normal method would be to play back the music on a loudspeaker and record the dialogue for use as a guide track to be replaced at a later date with a recording made 'clean' of the music so that two entirely separate components are available at the dubbing stage. His philosophy is to record as near 100% usable sound as possible, in this case clear of all extraneous noise including the music from which the artist would take his metre. An induction loop system was made up with modified hearing aids as receivers. As the camera never lies, the type chosen were those which go behind the ear. The sound is fed in along a clear plastic to a moulding made to fit the individual artist's ear. Tests with a large loop in the workshop at Location Sound proved the system and a final test was done with artists at Pinewood studios with a loop about 20 m in diameter. Good results were obtained anywhere within the loop and up to 2 m outside it.

Part Two Selecting Equipment

by Tim Blackham

The main sound equipment that was taken to the Yugoslavia location was as follows:

RECORDERS Two stereo and one mono Nagra 4L; one mono Nagra 3. All fitted with rechargeable batteries.

MIXERS One Nagra mixer, one Perfectone mixer.

CAMERA DRIVE One 750 VA three-phase rotary converter. Twelve 75 AH 12 V car batteries.

MICROPHONES Two Neumann U87, two Sennheiser 805, two Sennheiser 405, six Audio Ltd radio microphones.

MICROPHONE BOOMS Two Fisher booms, two poles.

CABLE 300 m microphone cable, 150 m loud-speaker cable, 100 m flex for 'silent playback loop', 100 m remote control cable, 250 m camera drive cable, plus interconnecting links etc.

SILENT PLAYBACK Two loop transformers (from 100 V line). Six loop receivers.

PA Two Grampian 662 power amplifiers, six column loudspeakers, two horn loudspeakers.

COMMUNICATIONS Six Pye Bantam walkie talkies, three Tannoy loud hailers.
Two 30 W GEC radiotelephone base stations.
One 10 W GEC Mobile radiotelephone.
Two 12 m masts for base stations.
One 12 m air-operated mast for mobile.

SPARES Tools, spares, test equipment, etc.

At the same time as these preparations, David Hildyard was sitting in on the music prerecording at Anvil Studios, Denham. *Fiddler on the Roof* is the third film musical for which Anvil have recorded the music since they installed their 24 input, eight output Neve desk. The others were the completion of *Oh What a Lovely War* (the Neve desk was brought into use while recording was under way on that production) and *Song Of Norway*. Eric

Tomlinson as usual was mixing and all the master recordings were made on 35 mm sprocketed tape. A 12.5 mm tape was also made but this was used for a fast check and would not be a source of any of the music to be used in the final sound track.

The 35 mm recorders used on the music recording stage at Anvil are RCA LM199, fitted with dual purpose mains sync/Sidsyn motors and fully adaptable to record one, three, four or six track to SMPTE standards. For this production, three track was the basis of all master music recordings. This is probably the most frequently used format for music work in film studios as the track area and position of Track One of a three track recording are the same as a mono standard track position and can therefore be handled on editing equipment designed for mono use only, if the Track One carries sufficient information for the editor.

Where possible the vocal recording was made at the same time as the orchestral recording with the artist in the vocal booth. The orchestra was recorded on one piece of 35 mm stock and the vocal on another, thus allowing freedom for the music editor Richard Carrath to make independent adjustments to either if necessary. The separation of vocal and orchestral is also necessary to allow the relative balance to be altered at the dubbing stage when the action is complete and the sound is being engineered to a final mix.

In some cases the Dolby system was used but only on vocals of a very wide dynamic range. To have all tracks Dolby treated would go beyond the limits of most studios since the number of tracks often gets very large.

After satisfactory takes had been made, a copy is taken if needed to make a vocal recording at a later session. If, as was often the case, the vocal was made at the same time, copies would be made for the editor and he would edit the chosen takes together, adding a click track. This is made up by punching holes in fully coated sprocketed magnetic tape and playing it back on an optical reproducer which produces a sharp click each time a hole passes over the photocell. The edited orchestra, vocal and cue clicks are then taken back from the cutting room and mixed in the dubbing room at Anvil from three machines running locked

together with the Selsyn system to form the playback mix. This was three track in the format, Track One orchestra, Track Two vocal and Track Three cue clicks.

These playback masters were then taken to Location Sound Facilities where Pat Heigham made the 6.25 mm playback tapes. The 35 mm playback master was reproduced on a Westrex machine feeding the two track Nagra 4L, a 50 Hz signal being simultaneously recorded from the mains supply driving the Westrex. The orchestra was recorded on Track One and the vocal on Track Two. The click track was combined on one version with the orchestra, on the second version with the vocal, and on a third version left out altogether. So it can be seen that probably the best playback system would be three track. At the same time as the playback tapes were being recorded, compact cassettes were made for the benefit of artists rehearsals, as in some cases up to six months would separate the prerecording and shooting of a number. In the past, artists have been provided with either acetate discs or 6.25 mm tape copies of their music for rehearsal. Compact cassettes offered the most convenient solution in view of the number of machines required to be issued, and the cassettes are less prone to damage or accidental crasure than 6.25 mm tape. Acetate discs are easily damaged and have a short playing life. Facilities would not be available for cutting further copies on location, whereas it would be easy to run off another cassette copy at any time.

While all this was in progress, we were packing the equipment ready for shipment by road to Yugoslavia. First to go were the radios, so that the Yugoslav authorities could check that they were on the frequency allocated to us. The bulk of the sound equipment went about three weeks before shooting was to start, by road in the Citroen truck we would use as our equipment transporter. I went a day later by air to set up the communications link comprising two base stations, one at the production office and one at a covered set that had been built to provide a dry shooting area should the exterior shooting be washed out by rain. The mobile unit was to be fitted into the soundtrack to provide communications when we were on location away from the cover set.

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Fast forward and rewind time Within 1 min, 40 sec (1,200 ft. tape)

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Outputs Line output, output level (0.775 V), impedance 100k ohms, headphone impedance 8 ohms.

Dimensions 16½ in. (w) x 8½ in. (h) x 14½ in. (d).

Weight 22 lb. 8 oz.

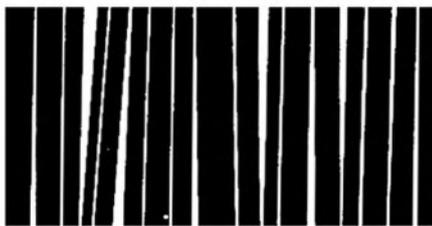
Accessories Empty reel R-7A, connecting cord RK-74 (2), head cleaning ribbon, reel caps, dust protector, non-skid pad (1 set), motor pulley, "SLH" sample tape.

Recommended optional accessories Telephone pick-up TP-4S, microphone ECM-21, F98 or equivalent (600 ohms), stereo headphone DR-4A, DR-5A, microphone mixer MX-6S, rec/PB connector cable RC-2, magnetic connecting cord RK-66.



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book reviews

THE TECHNIQUE OF THE SOUND STUDIO.

By Alec Nisbett. Second edition, revised and enlarged. 17 chapters, 559 pages, price £3.50.

AFTER five impressions of the first edition, this encyclopaedic book has been almost doubled in size to cover television sound techniques and such relatively modern audio topics as four channel sound. In the 17 chapters, the process of generating, processing and disseminating sound is covered in workmanlike detail and a very readable manner so that not only can the text be used as a reference source but also it can be dipped into for enjoyment. The whole philosophy of the book is outlined in the last chapter, where it is made clear that technique is subservient to programme—too often the reverse is true and the transfer of information is blurred.

The first chapter is an introduction to sound, starting with sound generating mechanisms, discussing frequency, wavelength and wave velocity and passing on to practical stereo and four channel reproducing systems. Subsequent chapters cover control of sound, planning sessions, studio design, microphones and balance engineering. The chapter on sound effects is excellent, with good descriptions of spot effects generation. Owners of Decca magnetic cartridges should not follow the advice given to spin records backwards under the stylus (to find cueing points) as this type of cartridge can be damaged by such treatment.

In a book of this size, errors have inevitably crept in. For example, in the mixer chapter, mention is made that most mixing modules having high output impedances to feed low input impedances in the next stages. As correctly stated elsewhere in the book, the reverse is the case. Another small point is that the right hand zero PPM went out of current BBC practice some years ago. A more serious error in the tape chapter concerns the implied statement that the difference in noise level between bulk erased tape and recorded tape is 20 dB, rather than 2 to 4 dB.

As expected from a BBC-trained engineer, the author comes down heavily on the side of the PPM, with which I agree, but in the process unjustly slates the VU meter. A studio-quality VU meter will only overshoot by 1 to 1½% when a pulse signal is applied (which is less than a PPM!), so that it does not 'peak to a much higher reading on programme than on a steady tone'. The glossary also states that the PPM is used by most recording companies in

the UK, which just isn't true. The two major record companies are divided, one with PPM and one with VU. The pop studios, with one exception, use VU meters, and the smaller independents again split.

The tape chapters, and particularly later ones on editing both film and tape, are good but again contain some errors. Notably, the record head gap is not directly related to the scanning loss phenomenon (where the replay head output drops to zero when its gap is an integral multiple of the recorded wavelength) since recording is achieved by the trailing edge. The size of the record gap determines the flux field, and hence flux penetration into the oxide. Most modern recorders, too, have a higher bias frequency than the 50 kHz mentioned. And surely, in this decade, detailed mention should have been made of the Dolby noise reduction system which is now used by every major recording company in the world and is just becoming available in modified form to the home user. Some space should have been devoted to an explanation of the system, either in these chapters or, less logically, in the comprehensive chapter on gain controls, compressors and limiters. Even the BBC now has multichannel machines which introduce serious noise problems.

Which brings me to my main and fundamental criticism. Although the book is subtitled radio, television, and recording, 98% is devoted to broadcasting. There is but slight reference to studios and techniques currently used in recording for disc, which I would venture occupies about as many engineers as in broadcasting sound, and this must be taken as an important omission. Multichannel recording is barely mentioned except as a means of producing four-channel sound. With 21 studios in the London area alone possessing 16-channel recorders, this is serious. If the title were changed to 'The Technique of the Sound Broadcasting Studio', my praise for the book would be unqualified. The rest of the material in this book outweighs this point, however, and it can be thoroughly recommended as a reference work and one which must teach even the professional quite a few new ideas. It may appear that this review dwells at length on the faults in the text; this must be so since this is an authoritative book, and the small number of criticisms should be taken as a compliment to the author's work. It is certainly a welcome addition to my bookshelf.

P. A. Lomas

SERVICING WITH THE OSCILLOSCOPE. By

Gordon J. King. 176 pages. Line and half-tone illustrations. Price £1.40. Published by Butterworth & Co Ltd, 88 Kingsway, London WC2.

THIS excellent book by Mr King is aimed at the service engineer and anyone else seriously interested in maintaining electronic equipment. Chapter One introduces the instrument—the Heathkit is used extensively as an example—and chapters nine and ten deal respectively with stereo multiplex waveforms and audio equipment testing. Otherwise most of the book is aimed at television servicing, particularly colour. Only part of the book is therefore of direct concern to audio engineers.

Even if it does not move you to doctor the guts of your own colour TV, it is likely to be of interest. A particular virtue is the large number of illustrations, particularly photographs of oscilloscope traces illustrating fault conditions in equipment.

The book covers a lot of ground in its 10 chapters, dealing concisely with topics under individual headings. Sometimes you may find it too concise if you are completely unfamiliar with a topic, as I occasionally did, and may need to look elsewhere for clarification and expansion. But to my mind that is infinitely better than padded out text and I think Mr King's target readers will have little to complain of. Television picture faults are also illustrated in appropriate cases (in monochrome) and adequate explanation is given of the principles of colour television and stereo multiplex. But I think it will be the illustrations and concise text that will make it a book for practical reference. It is very well written and the quality of presentation and printing match the high standard of the text.

J. H. Fisher

TAPE RECORDERS. By H. W. Hellyer. 239 pages.

Line and half-tone illustrations. Price £2.25. Published by Fountain Press, 46-47 Chancery Lane, London WC2.

ALMOST every reader of *Studio Sound* must be familiar with H. W. Hellyer's articles on servicing tape recorders, and with his attention to useful detail. The style and detail are present in this book, which meets the same high standards. There are one or two niggling faults which one regrets, but they do not seriously detract from the worth of the book. There is much to commend it—not least the profuse illustration; I have not actually counted the number of photographs and drawings, but I estimate that there must be well over 250 in a book of about 240 pages. The illustrations present graphically what many more words, even by Mr Hellyer, would not describe as clearly.

This is one of the Fountain Press 'Choosing and Using' series, a companion to John Earl's 'Tuners and Amplifiers'. ('Pickups and Loudspeakers' is to follow.) In 12 chapters, 'Tape Recorders' covers the history of tape recording and the development of tape mechanisms to the present day, the recording process; heads, magnetic losses and bias; the tape deck and motors; portable recorders; track systems, speeds and cassettes; microphones and mixers; special tape applications; tape and tape deck care; frequency correction, bias and alignment; servicing and measurements.

The photographs and line drawings illustrate just about every mechanical detail and variant that is representative of those encountered in tape mechanisms. Rather less detail is given to circuitry (though motor control circuits are dealt with), possibly because it is becoming increasingly difficult to produce a 'typical' circuit for a tape recorder. The final chapter is concerned with test gear and measurements, and with practical tips on servicing and service aids. In the course of the book there are useful tables of symbols, 'standard' DIN connections and pin numbers, and recording standards.

(continued on page 243)

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impressions

BY JOHN SHUTTLEWORTH

AS GOOD AS A CAPACITOR?

I RECENTLY attended two courses at Wansfell College in Essex, the first on audio generally and the second on recording in particular. I thoroughly recommend them; the accommodation and food are first class and the fees moderate. The lecturers have a wide experience and sound knowledge of their subjects. At both courses, the AKG *D202* microphone was praised by those who had used it and was used during the practical recording sessions, giving most impressive results.

For my own recordings I invariably use a *C24*, the best stereo capacitor microphone in the AKG range. At about £300 it is a good, if expensive, buy. It produces noticeably better recordings than any cheaper microphone I have heard. Some time after attending the Wansfell courses, I was told by an AKG agent that the *D202* was as good as a capacitor microphone so I decided to try a pair.

I had a recording session arranged for the following weekend when I was due to record two piano concertos, and had planned to use the *C24* into my Philips *Pro 20*. I also had available a Ferrograph *702H* and Revox *H77*. I had attempted to use the Revox on a previous occasion when a bowden cable had broken in the Philips. The recording had been made at Beckenham, quite near the Crystal Palace television mast, and I had picked up the television signal so clearly that my recording almost had a noise/signal ratio. After this I modified the input stage of the Revox (C. E. Hammond supplied the information and the bits) and purchased a pair of microphone transformers to convert 30 ohm balanced to high-Z unbalanced. I am now able to use the *C24* with the Revox without bother.

The *D202* microphones I borrowed were 200 ohms and, while they worked into the 30 ohm transformers, it was not giving them a fair chance. To ensure the correct frequency response they should look into at least 600 ohms.

The Ferrograph 7 should have helped here, but again it has unbalanced inputs. When I tried the microphone unbalanced I again picked up television signals, not as loud and clear as on the Revox on the previous occasion, as we were a little farther from the transmitter, but still bad enough.

Subsequent modification to the input stages with bits and information supplied by Ferrograph, and a pair of 600 ohm balanced to 600 ohm unbalanced microphone transformers has done the trick on the Ferrograph too. By the time this could be done, however, the piano concertos would be away at the pressing factory.

At this point I received a Nagra 4 to review and, as I had a session with a piano and wind quintet, I decided to make a mono recording with the *D202* and Nagra at the same time as the stereo one with the *C24* and Philips.

There were no troubles here. The Nagra had been supplied with a variety of microphone amplifiers and selecting the one suited to the *D202* was easy.

The performance of the *D202* into the Nagra was first class and in fact the recording of the piano quintet was better than the stereo version as I had achieved a better balance in mono.

While I was most impressed with the results at this session, I wanted to try the microphones on a wider range of music. Theoretically a capacitor microphone should be capable of a better transient response than a dynamic and I was anxious to hear how the *D202* would behave when a full percussion section was present.

A military band plus a full percussion department were rehearsing at Lewisham and the modified Ferrograph and two *D202* were taken along. The microphones were tried as a back-to-back sideways-facing pair of cardioids, suspended as near as possible over the conductor's head.

It was found inconvenient to suspend the microphones directly above the conductor and they were first tried just behind him. Monitoring on headphones gave the impression that the sound was a little distant. After the interval, the microphones were moved in front of the conductor, this giving a better sound on the headphones.

When the recording was played back using speakers, those made with the microphones behind the conductor were absolutely first class with good stereo placing and excellent balance and sound quality.

The recordings made with the microphones ahead of the conductor still gave a pleasant sound but there was a definite hole in the middle.

On both recordings the reproduction of the various instruments was clear and accurate, the piccolo and percussion were very well recorded, just lacking the final 'bite' that the *C24* would have captured.

The sound was certainly superior to many capacitor microphones I have heard, costing much more than the *D202*, and if I hadn't the

C24 I would certainly be happy with a pair of *D202* as a very much cheaper, but surprisingly close, substitute. They don't seem to have the 'edginess' I dislike so much on many of the cheaper capacitor microphones.

I must apologise to the AKG agent for my disbelief of his claims regarding the *D202* but I am not the only one to be caught out by the surprising properties of this microphone.

At the recording course I mentioned earlier, we were given demonstrations of various types of microphones, and warned that the manufacturer's description could not always be relied upon. At one stage a demonstration was arranged to show the properties of the 'noise cancelling' microphone used by commentators at sporting events. This is a ribbon microphone with a built-in bass attenuation circuit. It is used very close to the lips and is therefore not very sensitive. This, coupled with the steep bass cut, eliminates most of the background noise and compensates for the bass rise due to close talking.

The lecturer explained that manufacturers' ideas of cardioid characteristics had to be treated with caution. At certain frequencies it was surprising how much was picked up from the 'dead' side of a cardioid microphone.

To demonstrate this, and the excellent 'noise cancelling' effect of the other microphone, he made two speech recordings while sitting facing a loudspeaker about 50 cm away—one with the noise-cancelling microphone and one with a *D202* held dead side towards the speaker. During the recordings, loud music was played through the speaker at such a level that it was impossible to hear any of the speech.

On playback, it was found to everyone's amusement that the speech recorded on the *D202* was very clear, with reasonable background noise, and far better than that recorded with the 'noise cancelling' microphone.

I am reluctant to offer any encouragement to the multi-mike brigade but this microphone seems to me to be ideal for their purpose. It has a wide flat frequency response, virtually independent of pickup angle, a true cardioid characteristic and a built-in adjustable bass cut of up to 20 dB at 50 Hz. It is also robust and should be very suitable for recording 'pop'.

I hope to be able to review the *D202* more objectively in a future article but meanwhile, as you might guess, the pair I borrowed from AKG have not been sent back. I have now purchased them and expect to make good use of them during future recording sessions.

BOOK REVIEWS CONTINUED

Every now and again there are brief passages which suggest that the book may have been some while in preparation and, although the author gives the 'latest news' about chromium oxide and other low noise tapes (who started the move to quieter tapes seems to be a bit of a chicken and egg question, and not everyone will be happy with Mr Hellyer's order!) no mention is made of the domestic Dolby *B* noise reducing system which is an equally significant development at present.

In the review copy, which I take to be in final form, there is a sprinkling of typographical errors—megohms for MegaHerz, d.c. for DCI, response of moving coil microphones as going

up to 60 kHz, decimal point errors and the odd sentence that does not look as though it is what Mr Hellyer intended. However, there is hardly a book published in this field that does not have these and more, so there is little to be said, beyond a general plea to publishers to double-check such points, except that most of them are not seriously misleading. There are one or two places where the book conflicts with other informed opinion—the advantages of bismuth fillers in head gaps are discussed in the Miniflux manual reviewed in these pages recently and are dismissed, whereas Mr Hellyer presents them as significant; I can offer no judgement as to who is right.

Far better value than most of its kind I have read.

J. H. Fisher

SOUND 71

David Kirk reports
on the 1971 Association
of Public Address
Engineers' Exhibition

IF a public address equipment exhibition is judged by the standard of its own PA system, this year's was the best to date. Sound 71 was opened by Bob Danvers Walker on Tuesday March 16. The event was taped for posterity on a Philips VTR.

Public address, in exhibition if not in fact, is rapidly outgrowing the image of carbon microphones and tin loudspeakers. It is becoming, one way or another, sophisticated. In some respects, notably the specification of Carston's *DC300* amplifier, it exceeds all but the wildest claims made by the 'hi-fi' industry. Respectability emerges in the form of electronic music synthesisers on one stand, capacitor microphones on another, and another, and another. The BBC is In Attendance: Radio London transmitting live discussion programmes from its Sound 71 microstudio. And if that doesn't add up to respectability, KEF are exhibiting their loudspeakers. Correction; KF are exhibiting their loudspeakers.

For the first time in history, the APAE Exhibition opened with a waiting list of frustrated exhibitors for whom stand accommodation could not be found. This will probably be the last Camden Town Hall venue. Sound 72 may be held at the Bloomsbury Centre Hotel, providing an area four times larger than was available this year.

And so to the tour. **AKG** were one of the trio showing capacitor microphones. Their *C451* FET capacitor is now being used by several London and provincial theatres. Making its debut on this occasion was the *D160*, described as a high quality omnidirectional dynamic microphone for hand-held applications. Of particular interest to the PA trade was a compact paging unit, the *DST11*.

APAE sales, not to be overlooked, offered for sale a variety of publications and members' accoutrement, ranging from a 45 rpm APAE Test Disc (speech, tone, warble, pink and white noise) to an eminently useful 'Duty

Sound Engineer' badge on 51 x 35 mm blue plastic.

Astronic displayed for the first time three new items including the *A1888* Response Selector. This is designed as a tool for engineers involved in the installation of permanent sound reinforcement systems. Essentially a graphic equaliser, it is adjusted under test conditions to give optimum acoustic frequency response. An *A1781* modular unit is then ordered from Astronic, preset to the *A1888* readings, for insertion into the system.

On the same stand, *Series 1700* modules were claimed to be the most complete range of their kind yet produced. The series includes microphone, gram and line preamplifier, mixing and master gain modules. A relay system has been developed, allocating microphone priority on limited input networks. Finally, for the discotheque operator, Astronic are producing a twin turntable freestanding unit with internal/external source mixing.

Another exhibitor showing a graphic equaliser was **Audix**. Their 11-channel unit claims uniqueness in the form of a third-octave switch providing 12 dB cut or boost at 33 centre frequencies. Also introduced, a relatively inexpensive 16 W IC amplifier described as suitable for sound broadcasting. For situations when hand control is impractical, Audix are now producing a voice-operated intercom.

Beyer Dynamic (GB), southern agents for Calder Recordings, are now marketing a close-talk cardioid microphone, the *M411*, and the *M111* lavalier.

Carston Electronics displayed various amplifiers manufactured in the US by Crown. Largest of these is the *DC300*. Maximum output power of this unit is 340 W RMS per channel which explains the predominance of heat sink. Claimed power response is DC to 20 kHz \pm 1 dB, 150 W RMS into 8 ohms, with under 0.1% distortion. The amplifier is

short-circuit proof and comes complete with four spare mains fuses. We hope to review the unit shortly. Crown's *D150* power amplifier provides 90 W / 8 ohms continuous per channel at less than 0.1% distortion. Power bandwidth is 5 Hz to 20 kHz \pm 1 dB at 75 W / 8 ohms and carries a three year warranty.

New to the **Calrec** range wasn't the *CM 655* twin capsule noise-cancelling capacitor microphone. Not quite ready. The restyled *600* series was ready, however, and is being marketed in groups of one, two or four units with power supplies, cables and fittings. A remarkable innovation from this enterprising Yorkshire company is the *CM1000*, designed to accept screw-on cardioid (*CC 1051*) or omni (*CC 1002*) capsules. Calrec's first dynamic microphone is the *CM450*. Like the *1000* capacitors, this provides a balanced output.

Cass Electronics speciality is induction loop paging. The company's *Tele-Tracer* system provides 10, 50, 100, 400 or 1 000 channels of tone, tone and light, or tone and speed signalling to pocket receivers. Up to 16 separate calls can be made simultaneously in the larger TT systems. Talkback transmitters are also available.

The **Chymes Organisation** formed in 1970, exists to provide discotheque entertainment, PA, 16 mm cine projection, and wedding recordings, and also to sell domestic audio equipment. It is based in Wokingham, Berkshire.

CT11 Electronics displayed the *TM51/52* series of audio mixers on a range of mains/battery power amplifiers of up to 1 kW output power.

An impressive demonstration of chromasonics and colour wheel projection was experienced at the **D J Electronics** stand. The *DJ 30L*, retailing at £37.50, filters audio into bass, middle and treble channels. These are amplified independently and will each modulate 1 kW light groups, flashing in synchro-

nisation with the incoming programme. Model *DJ 40L* incorporates a microphone, overcoming the need for electrical links. Price is £56.25.

The *DJ Disco-Wheel*, at £50, is a colour wheel projector comparable in size to a domestic slide projector. Various pattern wheels are available, turned by a slow motor. Random effects may be obtained by inserting bubble wheels. New introductions were the *3000* three-channel light dimmer (£32.50 retail) and *DJ 1035* stereo discotheque preamplifier.

Eagle International are now marketing two low-price capacitor microphones, the omni *CO92* and cardioid *CO96*. A six-input stereo mixer was demonstrated, the *MPI2* incorporating sliding control.

Electronic Music Studios introduced themselves and the Synthi *VCS3* voltage controlled audio synthesiser for the first time to an APAE exhibition. Six *VCS3* units were demonstrated individually and linked. The term 'synthesiser' is increasingly being applied by manufacturers of instruments little more elaborate than conventional divider organs.

Visitors to the EMS stand saw for themselves the degree of evolution that has reduced the keyboard to a minor accessory in the chain of music creation. The patchboard linking facility renders the *VCS3* inherently more versatile than synthesisers using cord patching since any number of outputs may be connected (without external mixing) to any number of inputs. EMS synthesisers are advancing in complexity, the largest to date being the *Synthi-100*, a £6 500 system incorporating computer circuitry and a six track keyboard memory. At the other end of the scale, *Synthi A* at under £200.

Goldring represented Toa, manufacturer of PA amplifier microphones, horn and column loudspeakers, transistor megaphones and background music players. Toa's emergency wailing sirens created occasional discomfiture.

Grampian displayed two new amplifiers, providing 50 and 100 W RMS (rated to the four hour IEC specifications). Separate 100 V medium and low impedance terminals are provided.

KF Products (not to be confused) exhibited a

variety of wedge and column loudspeakers for factory and office PA.

Seven input channels, six with reverb, were featured on the *1210 AX* PA mixing console distributed by **Ling Dynamic System Ltd**, UK agents for Altec Lansing.

D. A. Lyons & Associates Ltd represent the French makers of Bouyer PA equipment, including a range of pressed steel column loudspeakers.

An eight-input *Music Master* mixer and an FET/IC FM tuner were shown by **Millbank Electronics**. The tuner may be preset or remote pushbutton tuned. The *Music Master* carries mike/line selectors and tone controls on each channel, and is self powered.

Keith Monks (Audio) centred their exhibit on the *Davenport* range of PA box, column and ceiling loudspeakers, through which Melodium microphones were demonstrated. The Melodium *C121* is described as a close talking unit and the *C133* as a very sharp cardioid.

'Power Transistors for Audio Amplifiers,' describing eight amplifiers in the 3 W to 50 W
(continued overleaf)



Above left: BBC Radio London microstudio and control room. Programmes were transferred by radio link to a mobile transmitter outside the hall.

Above right: DJ Electronics stand showing projected patterns and sound-controlled lighting.

Left: Six *VCS3* synthesizers on the EMS stand. A seventh is hiding in the corner. EMS are now producing a suitcase version of the £350 *VCS3* at about £200.

Left: Who else but AKG?

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SOUND 71 CONTINUED

category, was offered to visitors at the Mullard stand. These are based on their latest high dissipation homotaxial transistors.

The VTR which recorded the Danvers-Walker opening speech occupied the Philips stand, manned here by Pye Business Communications. The LDL 1000 is the cheapest of Philips' VTRs and is aimed at educational/industrial users. The PA benefit of CCTV was effectively demonstrated to our shorter brethren whose view of BDW was blocked by the standing audience.

BBC Radio London lived up to its claim that 'Londoners with something to say will always be welcome in its studios' by setting up a temporary studio and control room. Live discussion programmes were relayed through a transmitter situated in an estate car outside the hall.

Reslosound displayed for the first time a restyled and 'more versatile' version of their RB ribbon, the cardioid MRI. It will be interesting to see how this compares with its predecessor and with the new generation of low price capacitor microphones.

Horn-load loudspeakers for high level industrial applications were shown by Rola Celestion. Their speciality is the production of units capable of withstanding corrosive and explosive atmospheres.

Interest at the Shure stand centred on the VA 302C amplifier/control system and VA 300-S directional speaker columns. Anti-feedback circuits are employed, covering four ranges of the audio spectrum.

SNS Communication displayed a series of crystal-locked radio tuners designed for hotel and factory use.

The Private Communications Division of STC exhibited sound systems based on 35, 60 and 150 W modular amplifiers. A new range of matching PA microphones also made its debut.

Teletronics demonstrated the National three-channel CCTV system, using small lightweight cameras and intended for interoffice communication and general surveillance.

In addition to importing Renco (Italian) battery tape recorders, Trusound produce a 50 W industrial amplifier, the TA 50, and a matching range of TS1/100 loudspeakers.

Vitavox need little introduction as makers of robust microphones and loudspeakers. This year they celebrated their fourteenth anniversary, demonstrating the Bitone range of loudspeakers.

A virtue claimed by Vortexion for their 100 W silicon transistor amplifier is its ability to drive tape recorder motors when fed with an LF sine source. A convenient source of variable speed. The company is currently producing a BBC-type PPM system incorporating an FET rather than high value capacitors in the time constant circuit.

Finally Westrex. Slide faders, bass, treble and master gain controls and an output meter are incorporated in their new 30 and 100 W amplifiers. The company recently completed the installation of PA systems at the RAF Mildenhall Passenger Air Terminals, Dublin Airport and Leatherhead Catholic Church.

RECORDING STUDIO TECHNIQUES

PART SEVENTEEN—STANDARD LEVELS by Angus McKenzie

DURING the past month I have received many comments and queries about the compromise between low tape noise and low distortion. Several complaints have also been made about tapes produced at one studio not playing back properly at another, especially when they have been Dolby processed.

It is vitally important for every studio to employ test tapes of a known standard and, for the 320 pW/mm (32 mM/mm) found at the front of all BASF and Agfa full-track test tape, the playback of a 38 cm/s machine must be lined up such that the output is ± 8 dBm. The recording amplifier should then be set up so that, when ± 8 dBm is applied to the input of the machine, the tape replays at this level. Note that, in the event of the machine in question having a correctly calibrated VU meter, this meter will be above full scale deflection on these particular test tapes. For this reason, the 1 kHz azimuth level tone should represent approximately -6 VU. This level should correspond to -2 dBm out of the machine. Under these conditions 0 VU corresponds to $+4$ dBm.

Comparatively recently, the NAB standard level has been very carefully measured in the USA and found unfortunately to correspond with 185 pW/mm (not 200 pW/mm), this level in fact being 4.8 dB below the DIN level of German test tapes. The new Dolby A360 is calibrated so that the NAB mark is 4.8 dB below the DIN one, each mark being 0.4 dB different to the A301 marks. For the example quoted above, a Dolby noise reduction system should be ordered such that ± 8 dBm corresponds to the DIN mark. If it is required to record a higher peak level on the tape than the DIN level under these circumstances, then a higher level should be driven in to the Dolby. Under this system, it will not be possible to peak at more than approximately 9 dB or so higher than DIN level. Otherwise the Dolby system itself will start clipping, causing severe distortion. If such high levels are required, it is imperative that the tape recorder be checked to ensure that it can stand this very high level. I must make clear here that, when I refer to peak recording levels, I mean the precise real peak level that would be read by a perfect PPM, and not the peak levels normally seriously under-read by a VU meter.

Incidentally, I have known some PPMs to under-read by as much as 2 or 3 dB, particularly on speech.

With respect to the above example, control desk PPMs should be set so that they correspond

to the peak level at which it is required to record on the tape itself. As an example, they might choose to record peaking 510 pW/mm 4 dB above normal DIN level. The meter should then be set such that 6 on the scale corresponds to an output from the desk connected to the Dolby system of ± 12 dBm. In the case of VU meters it is probably safe to assume that it will under read about 6 dB on average, although this under reading can be as high as 10 dB, as explained in a previous article. For the same peak recording level, therefore, 0 VU should be set such as to correspond to a ± 6 dBm output from the desk. The temptation to drive the VU meter into the red under these circumstances should be avoided since this will result in the chosen peak recording level being exceeded, often severely.

If a noise reduction system is used, there is no point in peaking any higher than the mentioned levels, even on the highest output tapes. On many tapes it is advisable to set the levels 2 or even 4 dB lower. Adjusting 6 on my PPM to show -8 dBm, and setting up the equipment exactly as quoted above, I have kept mid-frequency distortion to well below 1% on master tapes, without high frequency compression. What is more, I can make copies from these masters, not only with low distortion but also with virtually no hiss introduced by the tape recording process. I was appalled to learn recently that a very well known and respected record company still peaks some of its masters at approximately the 5% distortion limit of the particular tape used, despite the fact that they are using Dolbys, I understand that, when they copy tapes, they de-process, drop the recording level by 3 dB, and then reprocess.

If a VU meter has to be used and it is required to peak at not more than DIN level, the VU meters should be set in such a way that 0 VU equals ± 4 dBm. Under these circumstances, the peak level on music read by the meter should not go more than -2 VU at most. If I appear to be repeating what I have said in other ways in this series it is because I am so frequently being asked to clarify these points; also because the use of Dolbys in many studios has been an excuse for not maintaining the equipment as well as it might be. Many very expensive machines are delivered to studios completely out of adjustment and are sometimes used in this condition—to the irritation of other studios handling the resultant tapes.

While the cost of 25 and 50 mm test tapes recorded at 38 cm/s is high, unreasonably so, it is very bad to try to copy such test tapes. Should the record head alignment of the machine used for copying be wrong, then replaying such a tape on another machine will cause the replay chains to be advanced too far to compensate for the loss in not picking up the entire recorded width of track. If the record head is correctly aligned to the replay head setting obtained with the dubious copy, the record amplifier will be set to give too low a recording level on the tape. Such a machine will therefore play correct tapes at too high a level in the replay Dolby, causing too much brilliance and decreased dynamic range. On the other hand, a recording made on the misaligned machine, played back at another studio, will appear to be lacking in brilliance and will appear to pump down in level in quiet passages. Alas I have heard the latter comment very frequently recently, and am convinced that some studios have set up their machines incorrectly.

All these troubles could be obviated by adhering strictly to the recommended procedure of putting a reference level (either new NAB or DIN levels) on every single track of a recording so that, in the event of misalignment, at least the studio playing back the tape has some reference to go on. In addition to this, since virtually all tapes now used at 38 cm/s will not cause 10 kHz squashing anywhere near as low as NAB level and rarely even at DIN level, at least the first reel of a session should carry 40 Hz, 1 kHz and 10 kHz tones of specified level. In this way the characteristic to which the tape has been recorded can immediately be ascertained on playback. I must apologise for appearing to preach to readers fully competent in these matters. I hope also that these remarks will not embarrass engineers who have not taken as much trouble as they might have done.

Many recordings subsequently transferred to disc or reduced at another studio have sounded poor only because the engineer trying to transfer them had no reference to go on. Many discs issued on the market show blatant examples of anything from incorrect Dolby levels to noise reduction not even being switched on in cutting.

Having explained the importance of reference levels, I would like to answer a particularly interesting comment on the alleged coloration

(continued overleaf)

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RECORDING STUDIO TECHNIQUES CONTINUED

by the Dolby system of reverberation in particular. I recently transferred a tape which had itself been Dolbyed, and which also had adequate reference levels, to a copy tape recorded at quite a high level repeating the recorded example both in its Dolbyed state, and un-Dolbyed. Although the music was generally fairly loud (the end of Berlioz' *Carnaval Romain Overture*) the hiss level on the un-Dolbyed copy was only very slightly noticeable. Nevertheless, less reverberation was noticeable on the un-Dolbyed copy than on the Dolbyed one, no audible difference being noticeable between the Dolbyed copy and the original. Several engineers have heard this comparison and all agree that the reverberation is in fact affected by *not* using the Dolby, the decay appearing to be shorter. It would therefore seem that a Dolbyed recording correctly set up is the only type that will fully show reverberation and the low end of the dynamic range to its best advantage. I have also noted that, even when normal tape hiss is inaudible, the tape hiss present can still affect the clarity of high frequency sounds, adding to them a slight modulation noise. I would like to quote an example of a Dolbyed piano recording that I made some months ago, of which I made an un-Dolbyed copy. The two tapes were played side by side to an engineer who was suspicious, if not critical, of the Dolby system. So that he would not be biased, he was told that the un-Dolbyed recording had been made at the same time as the Dolbyed one. It was obvious to him which was which but he preferred the hissy un-Dolbyed copy. He was in fact preferring an un-Dolbyed copy of the master. This comparison perhaps makes it clear that the un-Dolbyed tape hides low level reverberation. I have on countless occasions compared the live sound of a balance with a completely processed/deprocessed one being made at the time. Virtually no difference has been audible, provided the equipment has been correctly lined up.

I have often been asked what I consider to be a good standard for frequency response in studio tape equipment, and to what accuracy levels should be set. I have not had any trouble for a long time in setting up tape machines to an accuracy ± 1 dB, at least from 40 Hz to 15 kHz, and under experimental conditions have achieved ± 0.5 dB over the same frequency range. A response of ± 2 dB from 40 Hz to 150 Hz and ± 1 dB from 150 Hz to 15 kHz with respect to 1 kHz should be achievable in a good studio, although it is fairly easy to better these figures, particularly at the bass end. I also think that a gain accuracy of ± 1 dB at 1 kHz is reasonable although many studios work to better than this.

Dolby Laboratories have fitted oscillators into their *A 360* systems and, by pushing a button, this allows Dolby level to be recorded on the tape machine. A kit of parts will shortly be available to provide the same facility in *A 301* systems. Dolby Laboratories also point out that prerecorded tapes containing Ampex operating level of 185 pW are available from Ampex, obviating the need for constantly playing the main test tape.

equipment reviews

SPENDOR S.209 STEREO AMPLIFIER

MANUFACTURER'S SPECIFICATION. Transistor stereo power amplifier. **Input impedance:** 47 K in parallel with 10 pF. **Output impedance:** 0.25 ohm in series with 1600 μ F. **Voltage gain:** 29 dB. **Load resistance for maximum output:** Between 8 and 9 ohms inclusive. **Maximum output volts:** 38 V p-p, 15.5 V RMS. **Power output for 9 ohms load:** 20 W. **Input for maximum power:** 500 mV RMS. **Rating:** Continuous. **Efficiency at maximum power:** 72%. **Frequency response:** -1 dB at 20 Hz and 50 kHz. **Power response:** -1 dB at 24 Hz and 13 kHz. **Channel separation:** 66 dB, 20 Hz and 20 kHz. **Noise and hum:** -98 dB ref maximum output. **1 kHz distortion:** 0.03% at any level up to full power. **Mains input voltage:** 235 V \pm 7%. **Temperature range:** 0° to 40° C. **Price:** £32.50. **Manufacturer:** Spendor Audio Systems, 3 Station Approach, Redhill, Surrey (Tel. 71 63428)

THE Spendor amplifier was originally built as a mono unit for incorporating into their monitor speaker (reviewed in September 1970 *Studio Sound*), thus providing a compact monitoring system for studios. Because of the good reports about the amplifier, Spendor decided to manufacture cased versions of the stereo S.209 for sale as separate units. Certainly the package is attractive; the stereo unit is only 130 x 130 x 150 mm high, which is extremely compact. It encourages you to hide it behind the rest of the equipment and then forget it; its performance certainly allows you to do this. The outside of the case is finished in dark grey hammer paint except for the rear which is all black anodised fluted heat sink, and the front which is a pleasant light enamel. Inputs are on a four-way DIN socket, outputs on 4 mm banana sockets. All are clearly labelled. No power on-off switch is provided. A red neon shows when power is applied.

Being curious to see how the inside was arranged, I opened the case and found a well-built interior. All components are mounted on a fibreglass board (unlegended) with the stereo symmetry obvious. Two criticisms here. The DC fuse is almost inaccessible and replacement would require much fiddling with long-nose pliers and screwdriver should there ever be trouble. Since the circuit is electronically protected, trouble is perhaps unlikely but I did succeed in blowing the other fuse on the 240 V side of the transformer several times during full-power tests. This is a front-panel mounting unit so there was no problem in replacing that—except finding a replacement for the Type OO fuse used. The second criticism concerns the preset controls which are the skeleton type—seven in all. For an amplifier which is as good as this one, I would like to have seen rather better quality types used; for

TABLE 1 Measured performance (both channels driven simultaneously unless otherwise stated).

TEST	COMMENTS
Sensitivity for full output: 490 mV	Meets spec.
1 kHz power output: 20 W, 13.4 V into 9 ohms:	Meets spec.
12.25 W, 13.4 V into 5 ohms:	Meets spec.
Full power bandwidth (-1 dB): 32 Hz to 40 kHz	Spec: 20 Hz to 13 kHz.
Half power bandwidth (-1 dB): 30 Hz to 40 Hz	
Channel separation (one channel full power one channel shorted at input):	54 dB at all frequencies. Spec calls for 66 dB but 54 dB is adequate.
Hum and noise: Input short circuited: 90 dB below full output.	Spec calls for 98 dB; -85
Input open circuited: 85 dB below full output.	is inaudible, however.

TABLE 2 Distortion, 8 ohm load, both channels driven.

		2nd harmonic		3rd harmonic		total
		0.05	0.04	0.05	0.01	
1 kHz	1 mW	0.05	—	—	—	0.05
	10 mW	0.07	0.04	0.04	0.01	0.08
	100 mW	0.05	0.03	0.03	0.01	0.06
	1 W	0.04	0.01	0.01	0.01	0.04
	5 W	0.02	0.01	0.01	0.01	0.02
	10 W	0.01	0.04	0.04	0.01	0.04
10 kHz	1 mW	0.025	—	—	—	0.025
	10 mW	0.05	0.07	0.07	0.01	0.09
	100 mW	0.09	0.06	0.06	0.01	0.1
	1 W	0.13	0.035	0.035	0.01	0.14
	5 W	0.2	0.04	0.04	0.01	0.2
	10 W	0.28	0.06	0.06	0.01	0.28
40 Hz	1 W	0.08	0.06	0.06	0.01	0.1
	5 W	0.1	0.06	0.06	0.01	0.12
	10 W	0.1	0.05	0.05	0.01	0.11
	20 W	0.16	0.07	0.07	0.01	0.17

less than 50p extra, semi-sealed types could have been used. Let me say I met no trouble, nor would I expect any with a new amplifier, but as dust falls on the tracks, skeleton presets can become very touchy. Other components are of high quality, both the construction and workmanship are excellent.

There are six transistors in each power amplifier (with a further two in the fully-stabilised power supply). The first two are arranged as amplifiers with high gain. The output section consists of two complementary collector-coupled feedback pairs. With true complementary symmetry and matched output pairs, the crossover distortion can be made very low, and this is shown in the detailed measurements which are listed in Table 2. Special mention is made in the specification sheet of the care taken in the design to eliminate dis-

ortion at low signal amplitudes. Current limiting is applied to each output pair, and also in the power supply itself, operating instantly in the amplifier and with a slightly longer time constant in the power supply.

And so to the tests—first bench tests with instruments, and then listening tests with a variety of loudspeakers. The results are collated in Table 1. Spendor had supplied an input lead for making connection to the amplifier which was useful, especially as the input pin connections to the four-way DIN socket are not connected as you might expect from a guess based on the DIN notes. There is actually no standard for amplifiers. Since the installation instructions give full details of the proper connection, there is no problem. Sensitivity was almost exactly as stated, as was input impedance (which is never critical). Gain and maximum output were again on the nail. The power bandwidth was almost to specification.

Channel separation is more than adequate, as is the noise level. Under all situations noise is totally inaudible. The amplifier main input voltage is stated as 235 V \pm 7% and this was confirmed.

The distortion measurements were made with a Radford low-distortion oscillator and a Radiometer wave analyser, which allows the components of distortion to be isolated and so gives a better idea of the cause and nature of the distortions. Source distortion was less than 0.005%. For the more usually quoted harmonic figure, the formula $THD = \sqrt{d_2^2 + d_3^2 + d_4^2 + \dots}$ is used; fourth and higher harmonics were not present in quantities to affect the total distortion figure. The published figures were not met but departures were slight and of no real consequence in listening terms. Low power output distortions, usually produced by the crossover effect, were commendably low.

The safety of the amplifier was then tested by short circuiting the output, and this produced no significant rise in temperature or ill effects in the amplifier. (contd. on page 251)

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5"	1200'	2-16	1-60	1-45
5 1/2"	1800'	3-09	2-30	2-00
7"	2400'	3-83	2-85	2-50
5"	1800'	3-09	2-80	2-05
5 1/2"	2400'	3-82	2-85	2-50
7"	3600'	4-75	3-50	3-15

SCOTCH DYNARANGE LOW NOISE

	List Price	Cash Price	Cash Price	Cash Price
5"	600'	1-28	1-05	0-95
5 1/2"	900'	1-71	1-40	1-30
7"	1200'	2-17	1-80	1-65
5"	900'	1-79	1-40	1-25
5 1/2"	1200'	2-13	1-75	1-60
7"	1800'	3-00	2-50	2-25
8 1/2"	2400'	4-21	3-45	3-20

TAPE RECORDERS

	List Price	Cash Price	Special prices on application
Revox			
Tape Recorders			
Ferrograph 713	£188-50	£166-00	
Ferrograph 702	£207-35	£175-00	
Ferrograph 722	£242-54	£199-00	
Ferrograph 704	£207-35	£175-00	
Ferrograph 724	£242-54	£199-00	
Ferrograph Plastic Cover	£6-28 1/2	£5-77	
Grundig TK121	£54-78	£45-25	
Grundig TK141	£59-23	£50-00	
Grundig TK146	£68-14	£54-25	
Grundig TK124	£44-90	£36-50	
Grundig TK144	£49-95	£38-25	
Grundig TK149	£57-60	£44-25	
Akai 4000D 4 track	£89-95 1/2	£69-95	
Akai 1710L 4 track	£89-00	£69-95	
Akai X-5000L 4 track	£177-97 1/2	£155-00	
Akai X-5000W 4 track	£177-97 1/2	£155-00	
Akai M-10L 4 track, auto reverse etc.	£245-05	£199-00	
Tandberg			
Tape Recorders			
Teleton T-710 5" 2 speed	£34-75	£30-50	
Teleton SL40 5" reel Portable 2 track 2 speed	£38-00	£33-50	
Teleton FXB510D 7" Stereo deck 4 track 3 speed	£62-50	£49-95	
PHILIPS CASSETTES			
Philips N2202 ...	£29-90	£23-50	
Philips N2400 including speakers	£86-00	£75-65	

3"	400'	0-96	0-80	0-70
4"	600'	1-46	1-20	1-10
5"	1200'	2-39	2-00	1-75
5 1/2"	1800'	3-15	2-50	2-35
7"	2400'	4-45	3-60	3-25

EMI LOW NOISE ROUND PACK TAPE AT SPECIAL DISCOUNT PRICES

7"	1200'	1-00
5 1/2"	1200'	1-15
7"	1800'	1-50

BASF & PHILIPS CASSETTES

	6 or more only	10 or more
C30 (Philips only)	0-53	0-50
C60	0-76	0-65
C90	1-02	0-90
C120	1-52	1-20

SCOTCH DYNARANGE—LOW NOISE

	10 or more
C60	0-76
C90	1-02
C120	1-52

Philips N2400 ...	£68-00	£60-50
Philips N2401 including speakers	£99-00	£87-50
Philips N2602 Car Cassette Player	£42-00	£29-95

PHILIPS REEL TO REEL

Philips 4302 ...	£39-00	£29-95
Philips N4307 ...	£49-50	£42-50
Philips N4308 ...	£60-50	£51-95
Philips N4404 ...	£87-00	£71-25
Philips N4407 ...	£105-00	£90-10
Philips N4408 ...	£139-00	£119-30
Uher 4000L ...	£145-29	£125-00
Uher 4200 ...	£187-07	£160-00
Uher 440L ...	£187-07	£160-00
Truvox R44 ...	£42-50	£42-50
Crown CTR8750	£32-55	£24-95

8-TRACK STEREO

Akai CR80	£115-02	£101-25
Akai CR80D	£95-00	£83-60
Pioneer TP 83 8-track car stereo unit	£39-70	£33-20
Pioneer TP 85 8-track stereo unit with FM stereo radio	£84-25	£70-35

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PHILIPS EL3534 (S/4)	£60
BRENELL MK5M Series III (M/2)	£70
SONY TC260 (S/4)	£67
AKAI 1710 (S/4)	£63
TANDBERG 74 (S/4)	£50
VORTEXION WVA/4 (M/2)	£75
TANDBERG 62 (S/2)	£76
REVOX E36 (S/2)	£82
FERROGRAPH 4A/N (M/2)	£55
PHILIPS EL3536 (S/4)	£40
FERROGRAPH 622 (S/2)	£80
REPS R10 (M/2)	£40
BRENELL MK5 Series III (M/2)	£50
TELEFUNKEN M300 (BP/M/2)	£28
TELEFUNKEN 204E (S/4)	£70
AKAI X4 (BP/S/4)	£70
PHILIPS EL3301 (BP/M/2)	£15
SANYO 151 (BP/S/4)	£42

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SONY TC200 (S/4) ...	Our price	ONLY	£52
AKAI M9 (S/4) ...	Our price	ONLY	£98
SONY TC800 (BP/M/2) ...	Our price	ONLY	£47
VORTEXION WVB/4 (M/2) ...	Our price	ONLY	£53
TANDBERG 1241 (S/4) ...	Our price	ONLY	£72
REVOX 736 (S/4) ...	Our price	ONLY	£98
FERROGRAPH 5A/N (M/2) ...	Our price	ONLY	£56

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(HALF DAY THURSDAY)

SPENDOR AMPLIFIER REVIEW CONTINUED

Electrostatic loads were simulated with an 8 ohm load and $2\mu\text{F}$ in parallel, and the amplifier fed with square waves—with truly excellent results. At 1 kHz the overshoot produced was minimal, about 6%, and at 10 kHz it was only 12%, with two cycles of well-damped ringing. The amplifier is, as stated, unconditionally stable.

Finally the listening tests, which were performed with Leak Sandwich, KEF BBC monitor, and Quad Electrostatic speakers. Into all these loads it performed well, more than adequately for a typical living room. As usual

with the Quad, the loudspeaker overload point was heard clearly—that is, the speaker overloaded before the amplifier—which is as it should be. The KEF, being somewhat insensitive, did not produce too loud a sound, and this is not helped by the 15 ohm impedance of the speaker. Which leads me to the next point—this amplifier is aimed at studios rather than domestic users. In most studios, where 15 ohm loudspeakers are still in greater evidence than 8 ohm, the power output is insufficient unless very sensitive speakers are used—certainly the amplifier overload was evident on the KEF units. The conclusion is that the amplifier is an excellent design and can be recommended without reservation for the home and for the

smaller studio, but the larger studio should consider the match of its speakers to the amplifier. This is, however, a small criticism of a first-rate unit. I have the feeling that the specification sheet was written from the prototype, which can be a dangerous procedure. Production tolerances lead to variations, and this may be what has happened here where many test figures are outside specification. Even if the result is still excellent—as is the case here—there is perhaps a diminution in the feeling of confidence in the product which can be quite unjustified. Points for improvement? How about a supply socket for a pre-amplifier? The 40 V supply could provide a few milliamps for this. P. A. Lomas

field trials

BELL & HOWELL FILMOSOUND

MANUFACTURER'S SPECIFICATION. Super 8 cine system with lip-sync audio. Fully automatic pulse link between camera and recorder and between recorder and projector. **Camera:** Model 442, 16 f/s. **Price:** £97.87½. **Recorder:** 4.75 cm/s leaderless cassette. Separate audio and pulse tracks. **Price:** £50.98. **Projector:** Super 8, switchable to standard 8 mm. **Price:** £97.87½. **Distributor:** Bell & Howell Ltd, Alperton House, Bridgewater Road, Wembley, Middlesex HA0 1EG.

THE Bell & Howell *Filmosound*—comprising camera, tape recorder and projector—was developed to meet the need for a portable 8 mm lip-sync cine system.

Like several lip-sync systems used by the film and broadcasting industry, the *Filmosound* camera generates 'electronic sprockets' which are recorded on the tape carrying the related sounds, in this case on the bottom half of a cassette (fig. 1). These pulses can be heard by replaying the tape cassette upside down and resemble the sound of a purring cat.

On playback (fig. 2) the projector speed is controlled by the frequency of the recorded pulse, increasing where the camera (or tape) speed may have risen, and correspondingly falling. (This departs from normal industrial practice, where the projector is locked to 24 or 25 f/s. There the tape machine controls its own speed to maintain a constant playback pulse frequency.)

Any drift from sync across scene change points is compensated by a series of re-lock points occurring throughout the film, corresponding to the start of each programme sequence.

Each time film and tape are started, an optical mark is placed on the film by the camera. At the end of each scene, a short high-frequency

tone is recorded on the pulse track. The optical marks are visible, when the film is projected, as an occasional orange line on one side of the picture.

On playback, the tape machine is halted by each high-frequency tone and restarted by a signal from the projector, generated by the optical mark. A producer using this system must consequently allow for a break in sound across each scene change.

So much for theory. In practice your £51 recorder, £98 camera and £80 projector are attractively designed and, for their price (which obviously includes features not normally present in 8 mm cine equipment) quite sturdily made.

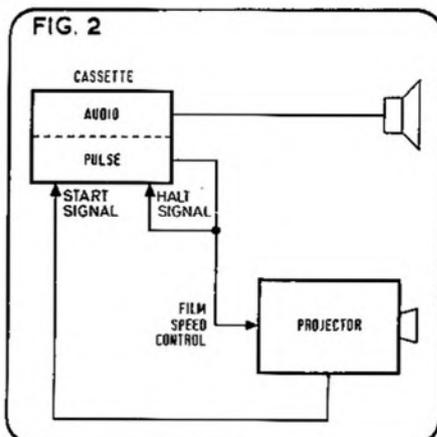
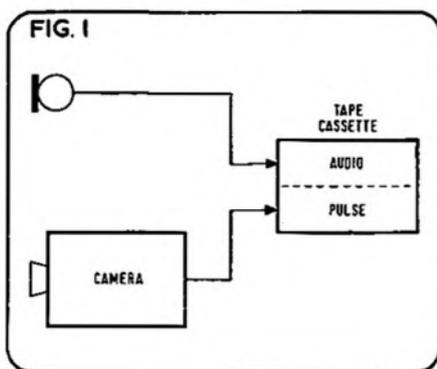
The recorder is controlled by five press-tabs: (left to right) eject, rewind, forward wind, play and stop. The forward wind tab cannot be locked down, though rewind can. A red record button shares a chrome panel with a very small meter. A single rotary control is fitted, governing record/play gain, and adjacent to this is a button controlling a light underneath the cassette. Most of the connecting sockets occupy the front panel (or top panel, when the recorder is used vertically). These comprise a group of three miniature jacks for the projector. One of the three is a dummy, used to prevent misconnection. Two further sockets and a slot connect with the camera, the slot accepting a metal tongue which over-rides the record inter-

lock. A slightly larger socket feeds an earpiece (invaluable when recording with this device) or external speaker. The manual/AGC switch is also situated here. Another socket connects with a remote on/off device, duplicated at the opposite end of the recorder beside the microphone input. Yet another socket accepts external power.

I have no complaints against the recorder (by cassette standards) but found the AGC less useful than it might have been. It brought stray noise roaring on to the audio track whenever a lull occurred in the sound. A shoulder case is supplied, with a separate compartment for the dynamic microphone and its 3 m cable. The bottom of the case is finished in an extremely coarse surface. A glove of similar material is supplied for the microphone. The two surfaces have a mutual hooking action and allow the microphone to be safely suspended beneath the recorder.

The 442 camera takes Super 8 mm cartridges costing £2 per four minute run. It is battery powered and incorporates a push button 'battery test' bulb which is at least better than nothing. A metal cover hinges up from the lens. The viewfinder is a through-the-lens reflex type, with a small amount of correction for individual

(continued overleaf)



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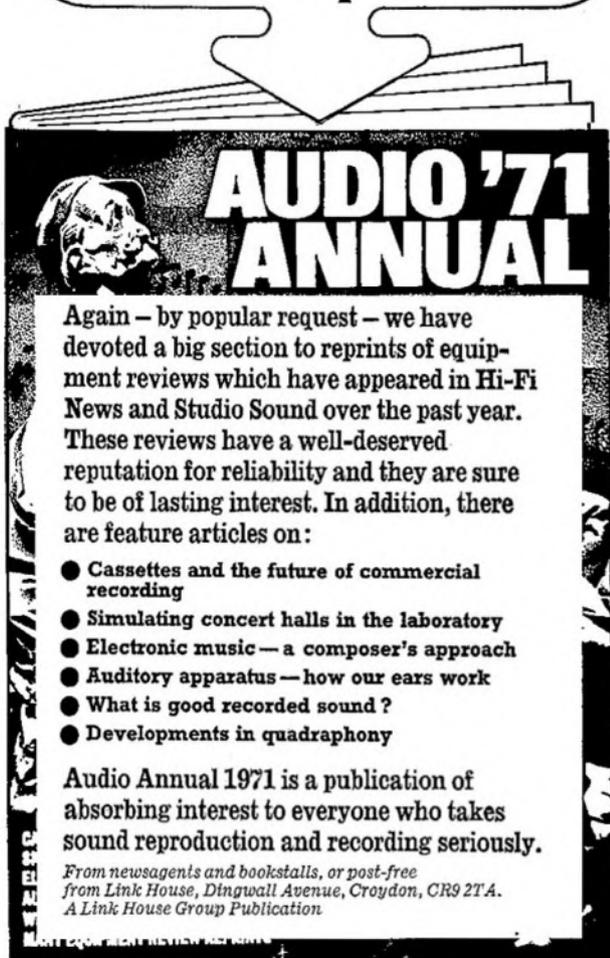
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AUDIO ANNUAL 1971

Produced by HI-FI NEWS and STUDIO SOUND

40p



**AUDIO '71
ANNUAL**

Again — by popular request — we have devoted a big section to reprints of equipment reviews which have appeared in Hi-Fi News and Studio Sound over the past year. These reviews have a well-deserved reputation for reliability and they are sure to be of lasting interest. In addition, there are feature articles on:

- Cassettes and the future of commercial recording
- Simulating concert halls in the laboratory
- Electronic music — a composer's approach
- Auditory apparatus — how our ears work
- What is good recorded sound?
- Developments in quadraphony

Audio Annual 1971 is a publication of absorbing interest to everyone who takes sound reproduction and recording seriously.

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LEAK Stereo 70, in teak case	75.00	59.50	
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*SINCLAIR 2000	25.00	21.00
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TELETON 210X FM		

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AKAI 6600	142.53	112.00
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ARENA 2400	90.30	72.00
ARENA 2600 Stereo AM/FM	111.30	94.00
ARENA 2700	105.00	85.00
ARENA T1500F	72.45	60.00
ARENA T9000	303.45	258.00
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ARMSTRONG 525	91.89	77.00
ARMSTRONG 526	104.71	87.00
GOODMANS 3000	77.73	53.00
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PHILIPS RH 790	139.00	112.00
PIONEER SX770 AM/FM	160.43	126.00
PIONEER SX990 AM/FM	194.74	150.00
PIONEER 440	111.10	89.00
*TELETON F2000	51.50	32.00
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TELETON 10ATI 150w RMS	160.00	109.00

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	Rec Price	Retail Price	Comet Price
TELETON TFS50	75.50	56.00	
*TELETON R.8000 with speakers	63.25	50.00	
TELETON CR55	120.00	95.00	
WHARFEDALE 100.1	149.00	119.00	

Starred items above take ceramic cartridges only. All others take both ceramic and magnetic cartridges.

All the above Tuners and Tuner/Amplifiers include MPX Stereo Decoder with the exception of Armstrong where decoder is extra as listed.

CARTRIDGES ALL MAKES STOCKED AT DISCOUNT PRICES

TURNABLES

GARRARD SP25 Mk.III fully wired with Goldring G800 Magnetic Cartridge. Complete with base, plinth and cover. Special Price	21.98	
GARRARD 2025 fully wired with Sonotone 9TA HC Cartridge, complete with base and cover Special price	15.50	
GOLDRING 705/P turntable, complete with Goldring G850 cartridge, base and cover	25.00	15.95

DUAL transcription 1219	60.40	50.00
DUAL 1209 transcription	42.62	35.00
GARRARD SP25 Mk.III	16.45	11.90
GARRARD SL65 B	21.25	15.90
GARRARD SL75 B	38.95	28.50
GARRARD SL95 B	53.27	38.50
GARRARD 401	38.07	29.50
GARRARD SL72 B	32.77	26.90
GARRARD 3500, with GKS Cartridge	17.23	12.90

Base and cover to fit GARRARD SP25, SL55, SL65B and 3500.	Special price 4.00	
GARRARD 40B...	13.84	10.97
GARRARD AP76	28.88	21.50
GOLDRING GL69 Mk.II	26.63	22.50
GOLDRING GL69 P Mk.II	35.14	29.50
GOLDRING GL75	36.41	33.90
GOLDRING GL75 P	46.94	41.90
GOLDRING Covers for 69P and 75P	4.21	3.50
GOLDRING C99—plinth and cover for G99	11.45	9.90
GOLDRING G99	26.00	23.90
GOODMANS 3025	37.74	26.90
McDONALD MP 60	15.75	12.25
McDONALD 610	20.00	15.90

Base and Cover for McDONALD MP60 and 610.	Special Price 4.50	
PHILIPS 228	20.00	17.00
PHILIPS GA 146	31.50	25.00
PHILIPS 217	33.00	28.00
PHILIPS 202 Electronic	69.00	57.50
PIONEER PL 12A with base and cover	49.93	37.95
PIONEER PL11	57.90	39.00
THORENS TX 25 cover	8.85	7.00
THORENS TD125	79.04	64.95
THORENS TD150A Mk.II	46.16	35.95
THORENS TD125AB	120.20	100.00
THORENS TD150AB Mk.II	49.96	42.95
THORENS TXII Cover...	4.43	3.95

PICKUP ARMS

GOLDRING Lenco L75	12.33	10.50
GOLDRING Lenco L69	9.29	7.00
SME 3009 with S2 Shell	34.47	28.00
SME 3012 with S2 Shell	36.71	31.50

SPEAKERS

ARENA HT 16	13.00	10.95
B & W Model 70	139.50	115.00
B & W DM3	63.00	53.00
B & W DMI	32.00	25.50
CELESTION Ditton 120	24.00	18.00
CELESTION Ditton 15	32.00	25.50
CELESTION Ditton 25	65.00	52.00
GOODMANS Minister	25.00	21.20
GOODMANS Magister	62.50	49.50
GOODMANS Maximo	20.39	16.75
GOODMANS Mezzo 3	34.00	26.50
GOODMANS Magnum K2	44.00	33.00
KEF Concord	43.50	33.00
KEF Concerto	53.50	42.00
KEF Cresta	22.17	18.00
KELETRON KN 500 4 speaker system (pair)	23.00	17.95
KELETRON KN 700 4 speaker system (pair)	27.50	21.95
KELETRON KN 1000 4 speaker system	19.25	14.95
KELETRON KN 1500 4 speaker system	24.75	19.95
KELETRON KN 2000 4 speaker system	28.75	21.95
LEAK 200	24.00	18.90
LEAK 300	32.50	23.95
LEAK 600	49.50	36.90
LOWTHER Acousta (with PM6)	45.50	38.50
LOWTHER Acousta (with PM7)	53.00	46.00
LOWTHER Ideal Baffle	35.50	30.00
METROSOUND HFS 10 (pair)	27.44	22.95
METROSOUND HFS 20	18.50	13.50
PHILIPS RH481...	11.00	9.25
PHILIPS RH482...	18.00	15.00
SINCLAIR Q16...	8.98	8.00
STE-MA 275 3 speaker system	23.10	15.00
WHARFEDALE Speakers		
Airedale	69.50	56.00
Denton	19.95	15.90
Super Linton	24.95	20.50
Melton	32.50	25.50
Dovedale 3	42.50	32.50
Rosedale	65.00	52.50
Triton (pair)	59.90	46.90
Unit 3 Speaker Kit	13.00	10.50
Unit 4 Speaker Kit	18.00	14.25
Unit 5 Speaker Kit	26.00	20.50

TAPE RECORDERS AND TAPE DECKS

AKAI X2000	190.00	159.95
AKAI X5000 W/L	177.98	140.00
AKAI 1800SD	199.42	167.00
AKAI 1710L	89.85	65.95
AKAI CR80 8-track stereo recorder...	115.03	99.95
AKAI CR80D 8-track stereo tape deck	95.00	79.95
AKAI 4000 4-track Stereo	124.90	99.95
AKAI 4000 D 4-track Stereo deck	89.96	69.95
BUSH Discassette DC70	21.95	16.95
FERGUSON 3252	101.80	82.95
FERGUSON 3245 Twin track...	37.05	29.95
FERROGRAPH 722	242.54	202.00
FERROGRAPH 724	242.54	202.00
FERROGRAPH 702/W 2-track tape deck	207.35	168.00
FERROGRAPH 704/W 4-track tape deck	207.35	168.00
GRUNDIG TK 121 (Twin track)	56.85	43.95
GRUNDIG TK 146 (4-track Auto)	68.14	53.95
GRUNDIG TK 149 4-track	57.63	47.95
PHILIPS 4407 4-track stereo recorder	110.00	89.95
PHILIPS 4500 4-track Stereo Tape Deck	126.00	98.95
PHILIPS 4408 4-track Stereo	139.00	109.00
TELETON FXB 510 D 4-track Stereo	62.50	47.95
TELETON TRC130 cassette, with VFH AM radio. Battery/mains twin motors	39.50	29.95
TELETON TC 110 Cassette, battery mains	27.50	19.95
TOSHIBA GT 840S	110.00	59.95
TOSHIBA GT 601v Twin Track	45.15	25.95
TOSHIBA 850 SA	94.00	59.95

COMET Hi-Fi DISCOUNT WAREHOUSES

Dept. SS Reservoir Road, Clough Road, Hull HU6 7QD. Tel. 407 906 and 407877

or Dept. SS 68A Armley Rd. (Artist St.) Leeds LS12 2EF. Tel. 32055 (5 lines)

or Dept. SS, Teesway, Portrack Lane, North Teesside Industrial Estate, Teesside, KTS18 2RH. Tel. 66132/65215

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