August 1973 25p

studio sound

AND BROADCAST ENGINEERING

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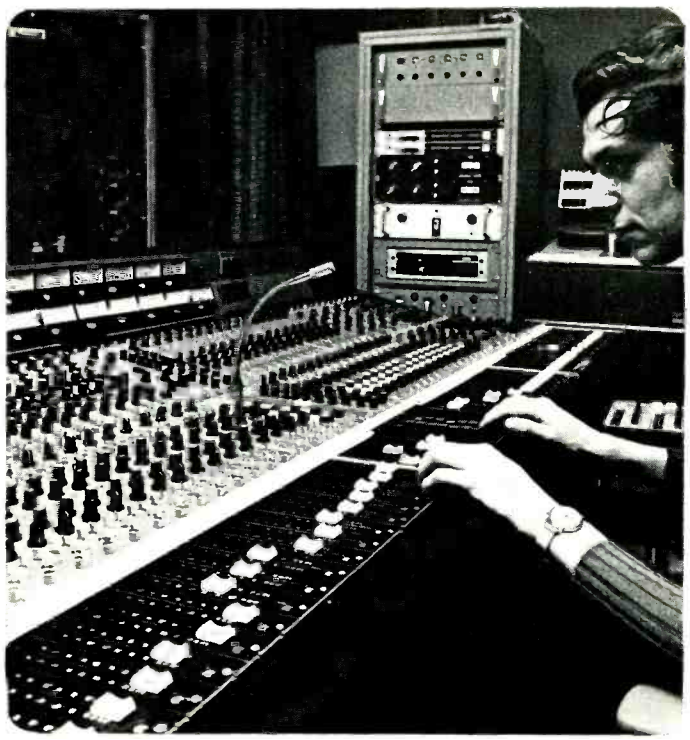

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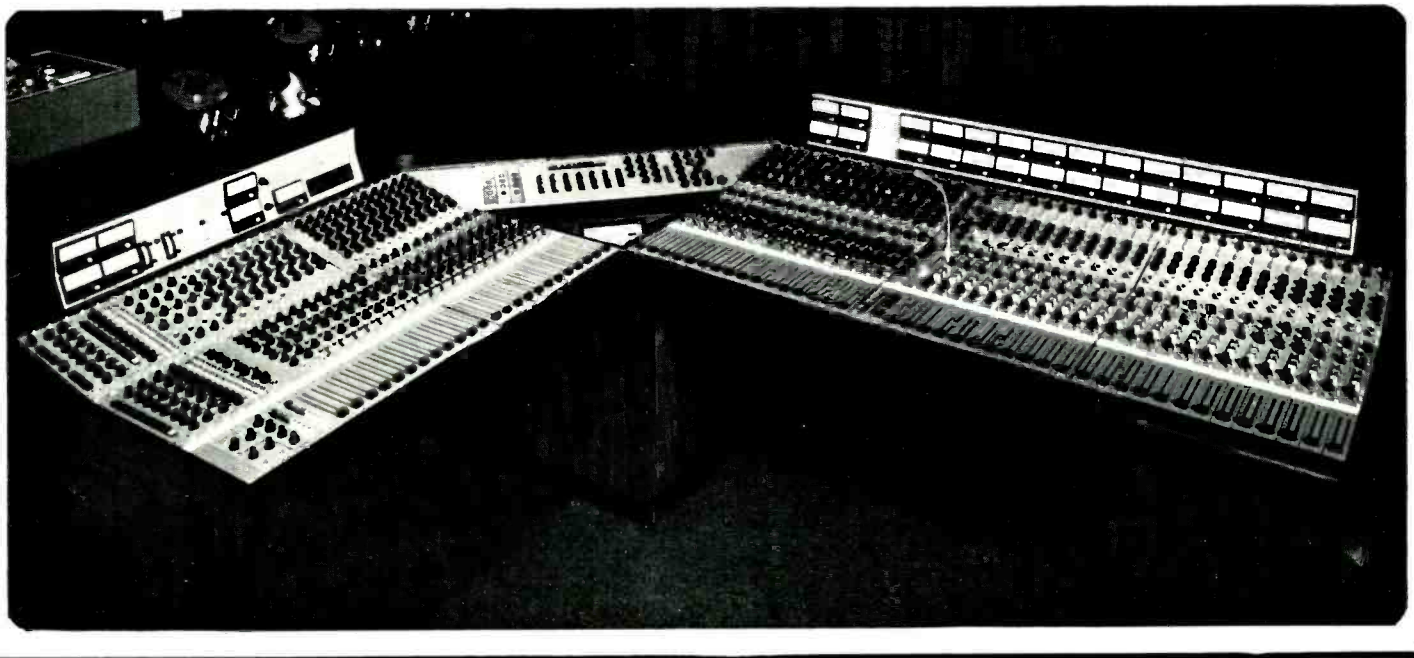

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CORRESPONDENCE AND ARTICLES

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

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

BINDERS

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

AUGUST 1973 VOLUME 15 NUMBER 8

THE ANNOUNCEMENT by the Conservative Government that Britain would in due course acquire a chain of independent radio stations had one immediate effect on the recording industry. It initiated the formation of several programme production studios specialising in the high art of disc jockeying. They offered not merely the services of a disc jockey and his gramophone; a few went further and declared their willingness to train future jockeys in the fine detail of cueing, jesting and ad-lib linking. The already high unemployment among disc jockeys was presumably attributed to their lack of style though little improvement in jockeying standards has been noticed since the training studios commenced operations.

A much healthier trend in the radio arts has been apparent in recent months, again triggered by the prospect of commercial radio. We are seeing the formation of a new breed of recording studio primarily handling speech and catering for a new market in syndicated audio programmes. The material facilities required to produce documentaries and dramatic productions are much less elaborate than those offered by conventional music studios. Essential kit comprises two or three tape machines, a couple of portables for interviews and locality effects, a small mixer, a few microphones, and a very quiet and very dead studio.

It has long been part of studio folklore that plain speech is uncommonly difficult to record. Consistency is considered a problem, not least because voice characteristics can vary as wildly as the local pollen count. In practice, however, the greatest difficulty is noise contributed by the local mixer. Equipment standards in most music studios are reasonably high but so too are signal levels. The minimum signal-to-noise ratio acceptable for high level Pop is nowhere near satisfactory for speech, bearing in mind that a major proportion of most speech sequences is silence. Since noise and distortion are contributed in every progressive stage of a mixing chain, it is clear that for any given standard of mixer design a simple system offers better overall quality than any one channel of an elaborate music console.

The one missing facility is talent. If commercial radio breeds a new generation of scriptwriters and programme producers, it may yet prove worth its cost to the consumer. BBC radio standards at their best are very high, particularly in the sphere of news presentation. But the endless panel games, the down (why down?) your ways, the thin colourless odourless Monday morning magazines, present a vacuum for commercial enterprise. Let's hope the enterprise exists.

SUBSCRIPTIONS

STUDIO SOUND, *published monthly, enables engineers and studio management to keep abreast of new technical and commercial developments in electronic communication. The journal is available without charge to all persons actively engaged in the sound recording, broadcasting and cinematographic industries. It is also circulated by paid subscription to manufacturing companies and individuals interested in these industries. Annual subscription rates are £3 (UK) or £3.30 ($8 or equivalent) overseas.*
STUDIO SOUND *is published on the 14th of the preceding month unless that date falls on a Sunday, when it appears on the Saturday.*

COVER PICTURE

Section of the Richmond 1224 theatre sound console, to be reviewed in our September issue.

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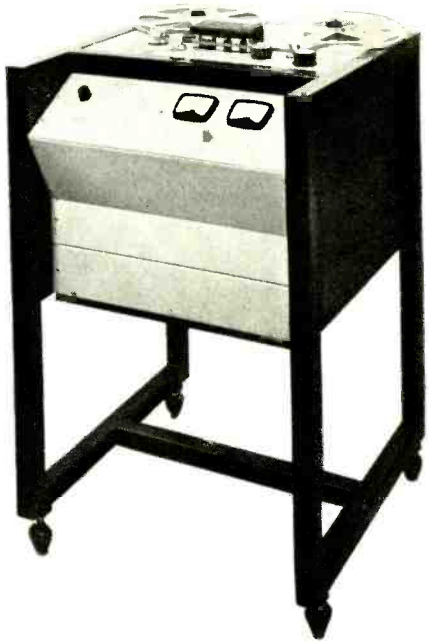

Illustrated:
NEW STEREO CONSOLE with Precision Cast Tape Deck, Ferrite Heads, Plug in Headblock, Electronic Servo Tape Tension, Full Remote Control, Switchable NAB-CCIR, Modular Electronics.

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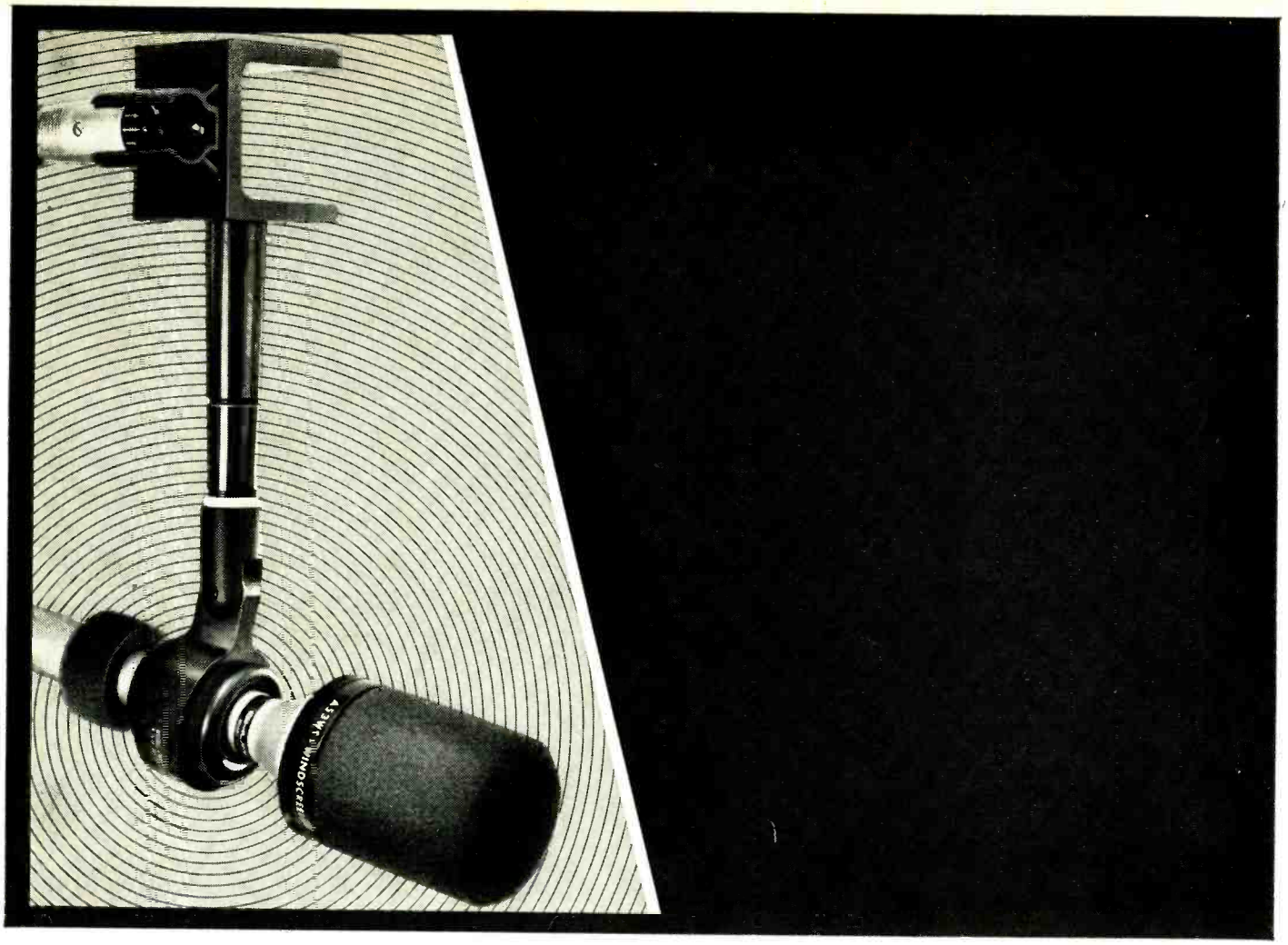

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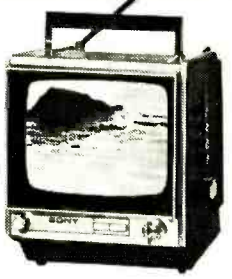

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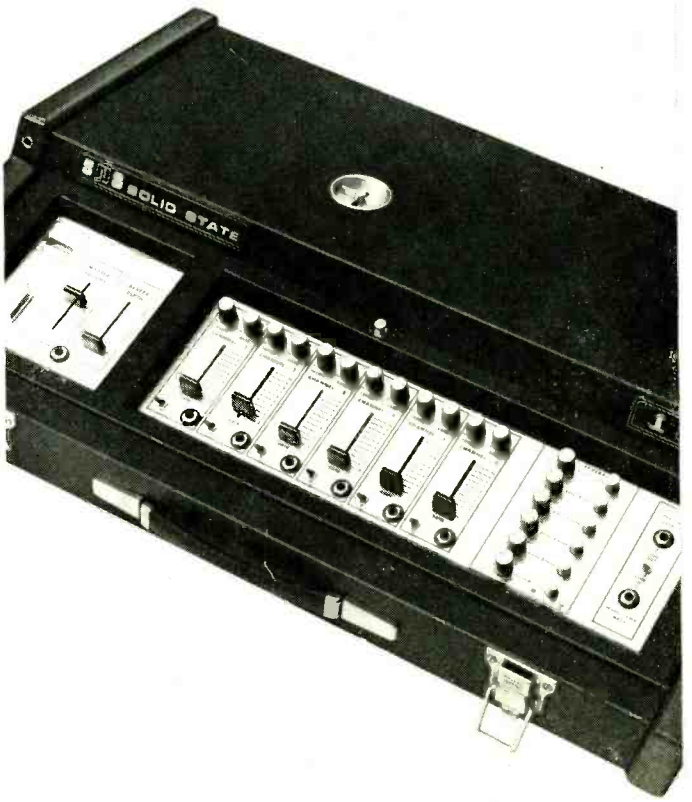

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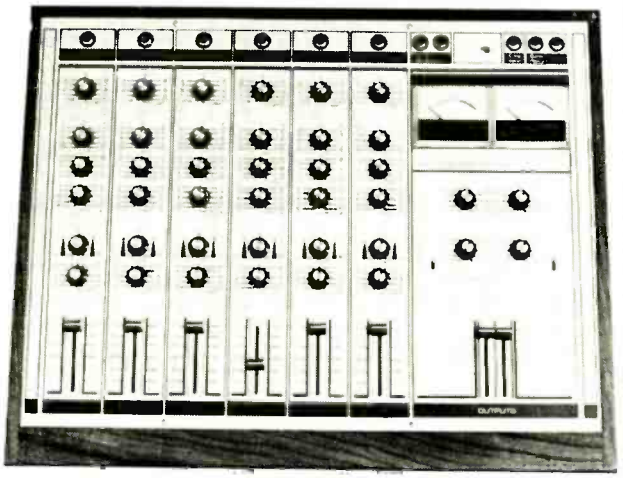

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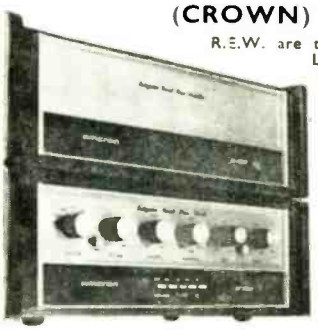

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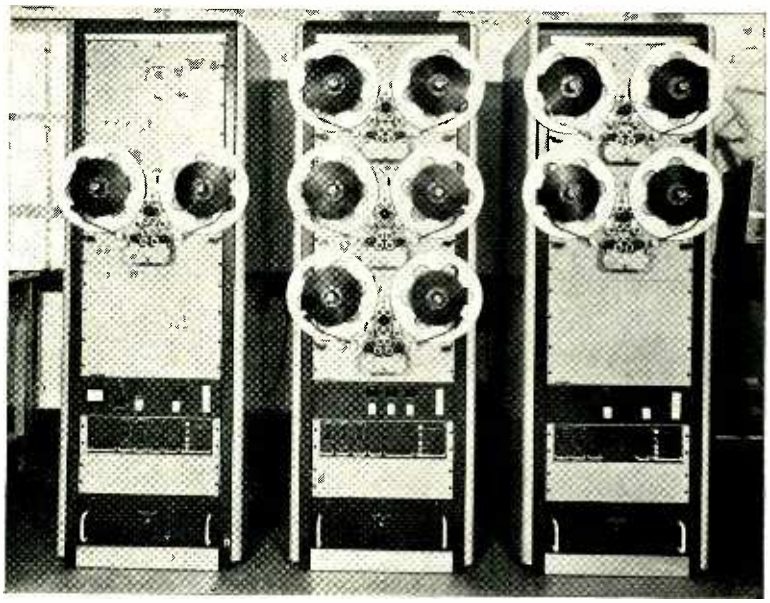

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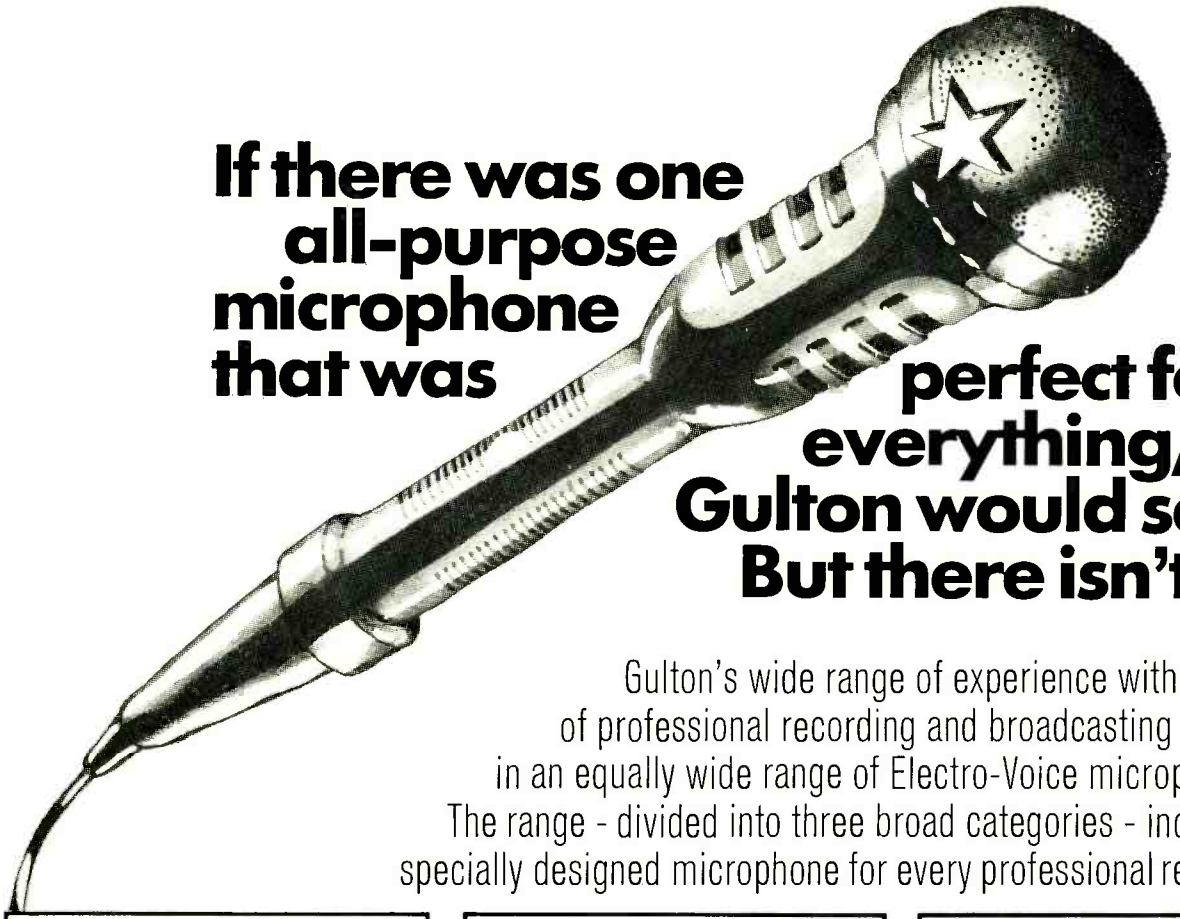

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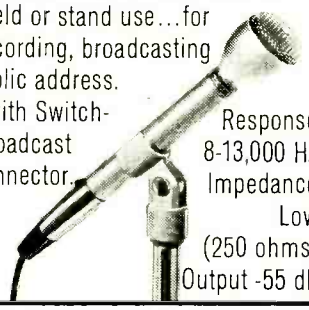

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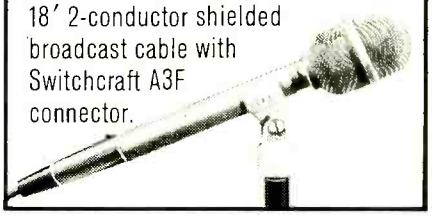

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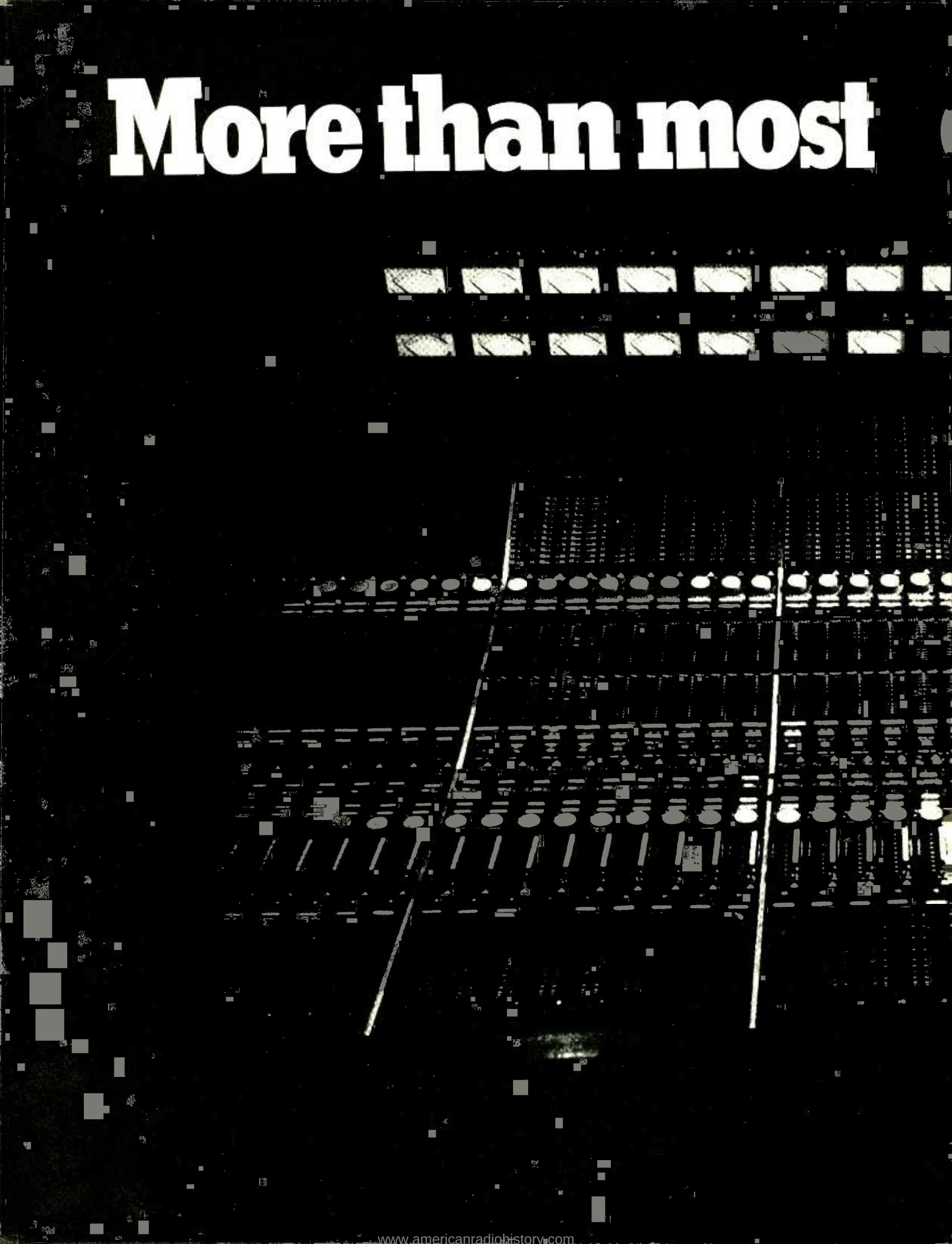
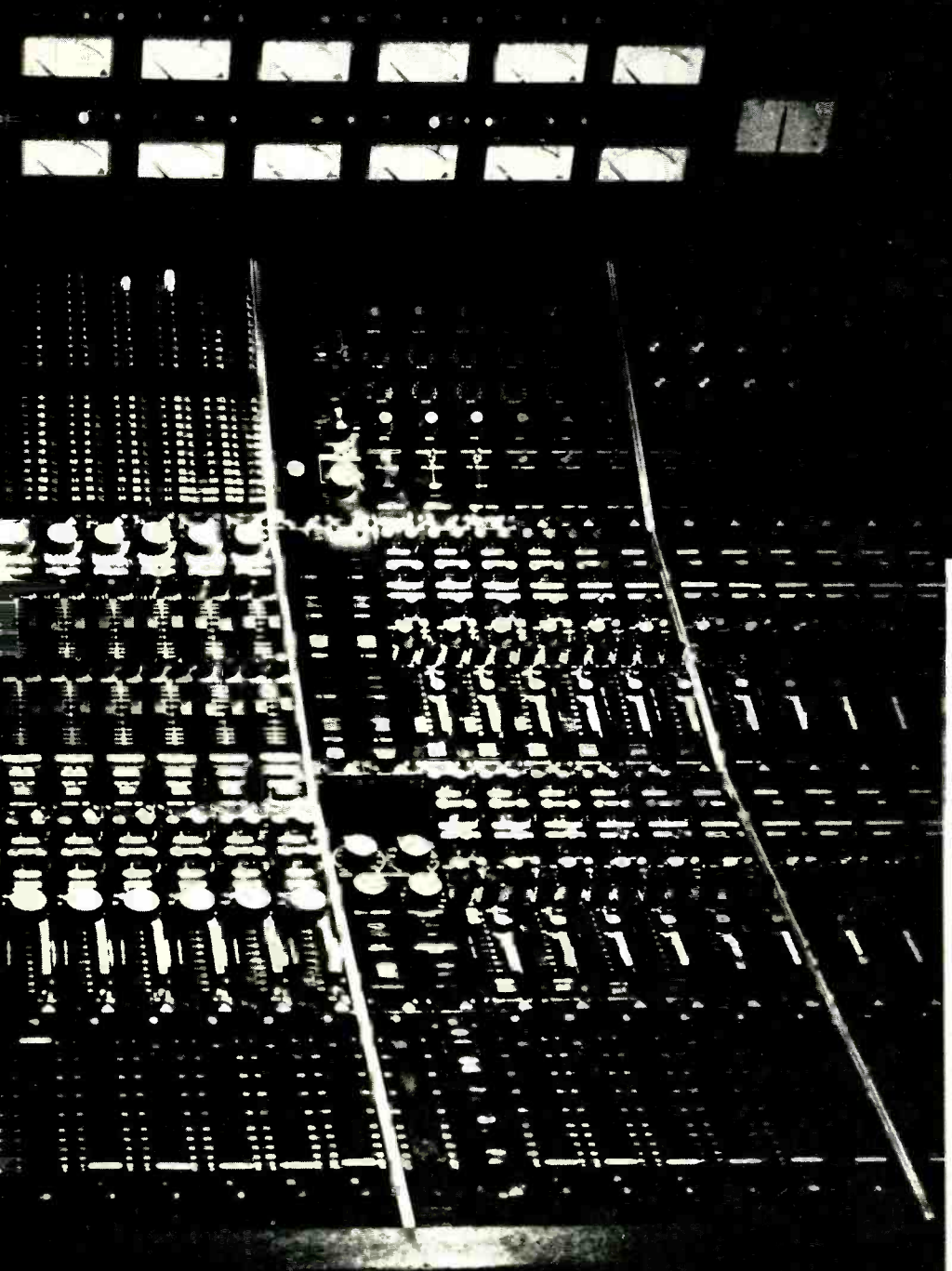


guys can handle.



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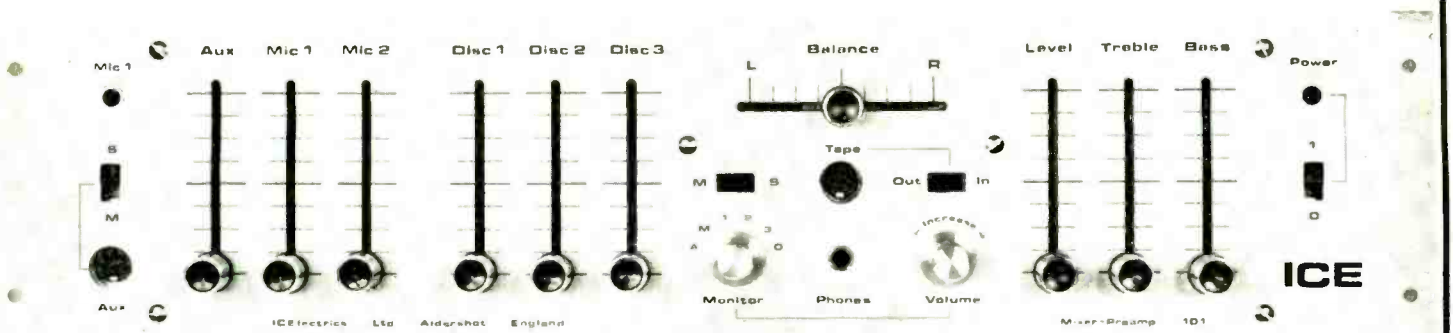

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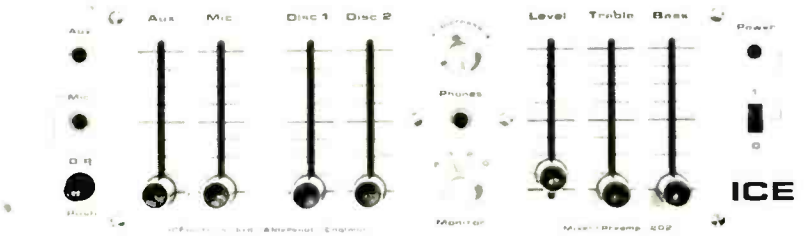

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The M 69 is an unusually sensitive microphone with outstanding cardioid characteristics. It makes high-quality transcription possible even under acoustically unfavourable conditions. The well-balanced response curve of the microphone maintains the highest fidelity in the reproduction of speech and music. Version SM with VOICE-OFF-MUSIC switch.

Specifications:

Frequency Response: 50-16000 Hz. Output Level at 1 kHz: (0 dbm ≙ 1 mW per 10 µbar) 0.24 mV/µbar (—50 dbm) Polar Pattern: Cardioid Output Impedance: 200 ohms. Connections: 3-pin plug T 32621+3=200 ohms, 2=ground. Dimensions: 6.7" x 0.9"ø, head 1.7"ø Also available with Cannon connector XLR-3-50T

M 88 N

Dynamic Moving Coil Microphone

With hypercardioid characteristics and unusually high sensitivity. Due to its very good front to back ratio it is less subject to feedback and provides excellent discrimination against unwanted sound. It is used by broadcasting and TV-studios, recording artists, bands and instrumentalists.

Specifications:

Frequency Response: 30-20000 Hz. Output Level at 1 kHz: (0 dbm ≙ 1 mW per 10 µbar) 0.25 mV/µbar (—50 dbm). Polar Pattern: Hypercardioid. Output Impedance: 200 ohms. Connections 3-pin plug T3262 1+3= 200 ohms, 2=ground. Dimensions: 6.5" x 0.9", head 1.9"ø.

Also available with Cannon plug XLR-30-50 T (M 88 N (C))

M 260 M 260 SM

Dynamic Unidirectional Ribbon Microphone

The M 260 is especially suited for speech and music reproduction. It has excellent transmission qualities. The dampening effect backwards is almost constant over the whole frequency range.
Version SM with 3 position Voice-Off-Music switch.

Specifications:

Frequency Response: 50-18000 Hz. Output Level at 1 kHz: (0 dbm ≙ 1 mW per 10 µbar) 0.09 mV/µbar (—58 dbm). Polar Pattern: Hypercardioid. Output Impedance 200 ohms. Connections: 3-pin plug T 3262 1+3= 200 ohms, 2=ground. Dimensions: 6.5" x 0.9", head 1.7"ø. Also available with Cannon connector XLR-3 50T

M 500 N

Dynamic Unidirectional Ribbon Microphone

A ribbon microphone designed for capturing the full intensity of modern music while suppressing undesirable side effects such as popping, breath noise and hissing. Flat frequency response, high sensitivity and excellent front-to-back ratio are the distinguishing features of this new BEYER-DYNAMIC PRODUCT.

Specifications:

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M 160

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By using the double ribbon principle the highest possible reproduction quality of music and speech is guaranteed. Non-linear distortions are imperceptible.

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STUDIO MICROPHONES

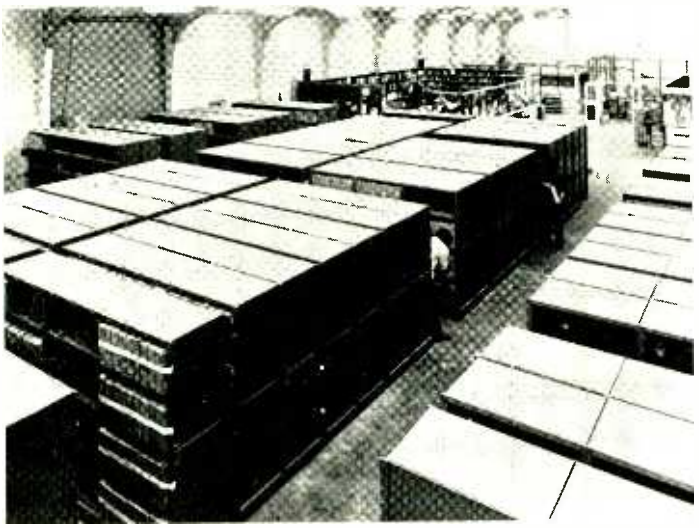
IBA Shareholdings

THE IBA have allotted the shareholdings in local radio stations to interested groups. In most cases the local press have a bigger share of the equity in local radio than had been anticipated.

The Birmingham *Post and Mail* have ten per cent of the voting, and 15 per cent of the non-voting, shares of the Birmingham radio station; the *Manchester Evening News* and *Lancashire Journal* have 11 per cent of ordinary, and 11 per cent of redeemable preference, shares; in the Glasgow area the *Evening Citizen* have ten per cent, George Outram eight per cent, the Scottish *Daily Record* and *Sunday Mail* 6.5 per cent and Scottish and Universal Newspapers four per cent of the voting shares. The figures for non-voting shares are 15, eight, 6.5 and four per cent.

The Associated Newspaper group, owning the London *Evening News*, have been allowed 16 per cent of London Broadcasting, the news station. Home Counties Newspapers and Dimbleby newspapers each have 0.47 per cent. Fifteen per cent of Capital Radio is owned by Local News of London, a consortium of 22 London newspaper publishers. The group also own 23 per cent of the unsecured loan stock, of which Beaverbrook Newspapers, owners of the *Evening Standard*, have 23 per cent and the *Observer* have 11.5 per cent. These last two each own 8.5 per cent of the ordinary shares.

According to the *Financial Times*, the largest shareholding apart from that of Mr Barclay Barclay-White, the dentist who started Capital Radio, is that of Charterhouse Securities who have a fifth of the equity of London Broadcasting. 'Otherwise holdings tend to be relatively small whether by individuals or companies. The only cases where one holder has stakes in more than one company are those of Mr David Jacobs who has a small stake in Capital Radio and in the Manchester station, and the Automobile Association with five per cent of the voting stock in Birmingham, one per cent of Radio Clyde, and three per cent of London Broadcasting.'



Island expand

ISLAND RECORD'S turnover increased by almost a third last year and they have made their third move in four years to a 1,100 m² distribution centre in Brentford. The Dexion group have just installed four more blocks of mobile shelving at the centre, giving storage space for an extra 300,000 or more records. The new installation comprises two blocks 2.7m deep and two more 3.7m deep. In Island's order-picking area, records and cartridges are stored on static Impex shelving 2.4m high. There are plans to build a raised storage area above the new mobile installation.

Mr Martin Higham of Dexion has asked us to point out that a recent news item which mentioned the EMI production and distribution centre at Hayes may have given a false impression that Dexion's press release about the plant had been erroneous. 'Your comments imply that we had sent a press release detailing the successful commissioning of the new centre when, in reality, EMI were experiencing a number of problems. I feel I ought to point out that the production function and the distribution function are two separate operations and that none of the problems you mention are allied to the Dexion-designed distribution centre which is, to our knowledge, operating successfully'.

New BASF tape

BASF ARE now making a double play version of *LPR35LH*. They claim that the new tape, *DPR26LH*, gives better signal-to-noise ratio and higher output than those available using normal oxides. Both tapes have an anti-static matt backing which BASF say 'ensures uniform winding of tape on to reel'. They say that the tape will be of most benefit to those who use machines which accept large reels, since it is on these that uneven winding of conventional tapes causes overlapping, which in turn may cause damage. *DPR26LH* will be available on 18, 22 and 27 cm spools at £5.60, £8.25 and £10.94.

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

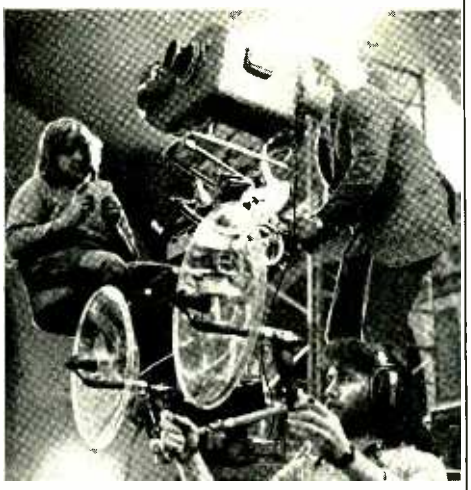
Pentagon eight-track duplicator

PENTAGON ARE now making what they describe as 'a new low cost' 6.25 mm reel-to-reel duplicating system for eight track cartridges. The duplicator, *Series 2800*, has modular plug-in solid state electronics, and fully automated operation for reel-to-reel duplication. Master transports are available in either 6.25 mm or 25 mm tape configurations. Eight-track programmes may be copied directly on to

pancakes for later loading to cartridges or, if preferred, duplication directly to cartridge hubs to eliminate the loading procedure.
Agents: Avcom Systems Ltd, Newton Works, Stanlake Mews, London W12 7HA.

AEG Hayden

THE MANAGING director of Hayden Laboratories, Mr K E Owens, has pointed out that a news item in our June issue, in which we said that all AEG's products would be now handled by Hayden, was incorrect. Hayden Laboratories have in fact assumed responsibility for the marketing of professional studio tape recorders marketed by AEG-Telefunken, Konstanz, Western Germany, and for tape duplicating and cassette loading equipment manufactured by AEG-Telefunken SIpA, Milan, Italy'.



The *Dan Gibson* parabolic microphone manufactured by R & D Systems (Canada) Ltd, one of ten exhibitors on the Ontario Government stand at Internavex '73. The exhibition will be held at Olympia from July 16 through 20.

Bonochord profits

BONOCHORD'S AFTER-TAX profits for 1972 were over 42 per cent above those for 1971. The pre-tax profit was £483,000 and the after-tax figure £209,000. The group's turnover was £5,450, an increase of nearly 16 per cent on that of 1971. The chairman of Bonochord, Mr Robin Rigby, said in a statement that profits throughout the group, which includes Rupert Neve and Livingston Hire, had been 'well spread, not only between the three main activities of the group's business [sound, electronics and instrument hire] but also between United Kingdom and overseas operations. It is expected that in 1973 more than half of the group's earnings will accrue from activities outside the field of hearing aids while overseas interests, excluding UK exports, should account for approximately one third of the profit of the group.'

The 'overseas interests' which Mr Rigby mentioned are the highly successful Viennatone group, and the rest of that part of the statement would seem to indicate that Bonochord expect good results from their more recent acquisitions, particularly Livingston Hire and Neve. Neve, whose profit record before the takeover left plenty to be desired, seem then to have benefited greatly from the takeover. The local press at Melbourne in Cambridgeshire has been running a series of personnel ads in recent weeks which indicate that Neve have been taking on production staff.

Bonochord announced at the same time that there would be a dividend of nearly 10 per cent and that the nominal value of each ordinary share would be increased from 5p to 10p a share, to be funded by £1,791,000 from the share premium account.

BASF prospects

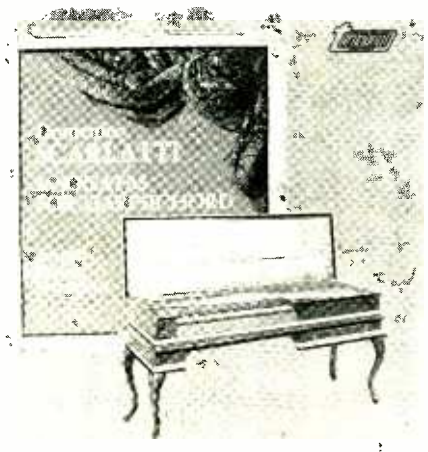
BASF HELD their annual meeting on June 20. In the directors' report, BASF said that they had been affected adversely by inflation and by increases in costs. 'Overall the prospects for business in 1973 remain uncertain. We are particularly concerned with the trend to persistent cost increases which will exceed potential productivity gains, and also with continued inflation'. They added that, if BASF were to expand their business throughout the world, they would need to have the benefit of a durable new international monetary system.

World sales from the BASF groups had increased by 12.4 per cent in 1973 compared with 5.4 per cent in the previous year. The BASF group here means any and all companies in which BASF hold 50 per cent or more of the equity.

No men only

NO VACANCIES for BBC posts will be advertised as for men only in future. Mr Maurice Tinswood, the corporation's personnel director, said that the BBC would also try to ensure that women were not kept out of senior management posts and that women would begin to take jobs they had not held until now. The announcement came after pressure from women's organisations had forced the board of management to order an enquiry into alleged discrimination against women. The BBC employed 15,913 men and 8,944 women at the end of March, 1972.

Spot the boob:



LETTERS

RAC modules

Dear Sir, I would like to thank John Fisher for his review of our RAC modules in the June issue of STUDIO SOUND. It was a very fair assessment of them but as is inevitable in such reviews there has been some progress since the modules were supplied for test and I would be glad of this opportunity to bring your readers up to date.

Two general points. We now use better quality SRPB boards with the result that most of our customers do not find it worth while to pay the extra for the fibreglass ones. Also, we have now found a source of enclosed presets at a very good price so we hope to do away with the skeleton type shortly.

There was some criticism of our *PAI.1* module in the review: the unit sent for test used a GE ic which is rated at 2W. As this ic is no longer made, we have redesigned the unit round the *TAA621* which is rated at 3W so that we now have a unit which is interchangeable with that tested but with a better all round performance.

In addition to the further units in the *T* range giving presence and notch filter facilities, which were briefly mentioned in the review, we now have an *MA2* range of medium and high level virtual earth amplifiers available. We are shortly bringing out oscillator and limiter/compressor units.

Yours faithfully, Martin Bennett, Rugby Automation Consultants, 19 Freemantle Road, Bilton, Rugby, Warwickshire.

Studio employment conditions

Dear Sir, The Editorial in your April issue was welcome but remarkably inaccurate. Firstly, I am the Chairman of the APRS not its President. Secondly, if you had personally attended the inaugural meeting of the Guild of Sound Recording Engineers, I am sure you would not have been so misinformed as to its aims, which are primarily concerned with the exchange of technical information with a view to the raising of standards of recording in this country and at the same time, add status to British engineers. Similarly, if you were more aware of the conditions which pertain in recording studios, you would know that engineers, by and large, enjoy what they do—and receive good pay into the bargain: clearly reasons for the overwhelming number of applicants for posts.

Your reference to 'jobs for the boys' is ludicrous—particularly when you consider the low average age of both engineers and management. For many, it is their first job with little or no family responsibilities to weigh them down and it is no hardship for them to leave. Nepotism has little or no place in studios.

Notwithstanding the difficulty in finding perfection in this imperfect world, our comparatively young industry is a healthy and robust embryo, not at present in need of Union help or guidance. May I suggest that you do all you can to encourage ventures like the Guild and the APRS by giving them your honest and informed support.

Yours faithfully, Jacques Levy, 6 Carlisle Mansions, Carlisle Place, London SW1.

The views expressed in April produced a fair measure of support though, for obvious reasons, respondents did not wish to be identified in print.—**Ed.**

Radio studio acoustics

Dear Sir, Couldn't agree more with your Editorial in the June 1973 issue about Latinesque over-written drivel. Folk want facts and it might be better, at least for a bit, to insist on Anglo-Saxon in the audio industry. That would quickly have identified the examples you quoted as being either nonsense or nearly useless.

About local radio stations (BBC Radio Blackburn: same issue), I would like to say a few words as I designed all of them.

1. It's not true to say that Blackburn, or any other local radio station for that matter, was built to normal talks studio standards. I was presented initially with 20 quite different locations, many of them totally unsuitable, together with a building programme which made it impossible to treat them individually—as they should have been. Furthermore, a cost figure was set for the work which couldn't in any circumstances cover what was required for talks studio acoustic design. I therefore had to think fairly quickly and invented modular absorbers, which were factory produced and used in *all* local radio stations. There was no time to have them tested: the whole design was based on hunch and calculation on some rather obscure research by Keith Geddes who had worked in the BBC Research Department in the late Fifties. I calculated that the devices I invented would absorb over 90 per cent of incident sound energy at frequencies above about 90 to 100 Hz. I'm happy to say they did, but a progressive bass cut was needed in the electronic circuit below this frequency. Not an afterthought: I expected it. Anyway it turned out all right although everyone was holding their breath until the final tests.

I have subsequently refined these devices. They are now in use in over half the major radio, recording and tv studios in the UK and many others in Europe.

2. The stroboscopic effect Douglas Oakley mentions is, as he says, due to the squarish wave illumination. The point here is that, if you move your eyes across exactly 50 black dots (or holes in this case) per second, on a light background in this type of illumination, all the dots (or holes) disappear entirely. They suddenly reappear at the instant your eyes move at a different speed. I can't describe the visual effect adequately, one would have to experience it, but it's very disturbing: on two occasions new-readers passed out (which Douglas Oakley euphemised into 'fell asleep'). If the absorbers are dark in colour there's no such experience because the contrast is less sharp and an admixture of tungsten lighting helps. We normally use a fabric cover now so the problem no longer exists. It was pretty serious at the time and I was interested to be reminded of it.

Yours faithfully, Sandy Brown, Sandy Brown Associates, Architects & Acousticians, 12 Conway Street, London W1P 5HP.

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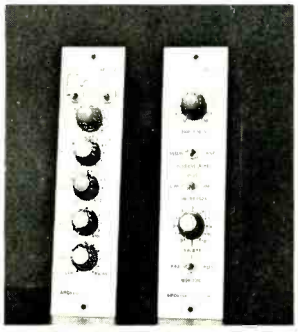

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Both channels will deliver continuously more than 100 watts into a 4 ohm load or 70 watts into an 8 ohm load.

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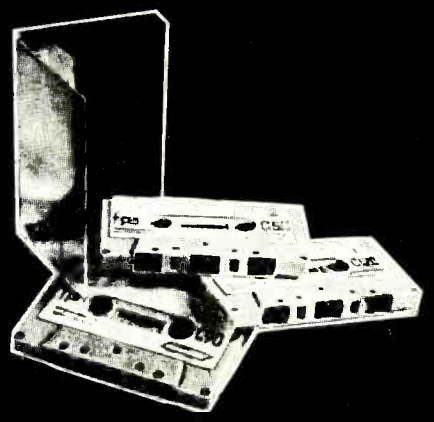

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Designing an automated mixing console

PART TWO

M. S. CURTIS

The basic requirements of an automatic audio reduction chain having already been outlined by Clive Green (November issue), M. S. Curtis progresses to the various methods of executing a practical system.

When square wave pulses are replayed on an audio recorder, the results are far from square. However, all that is required is a pulse of some form. The 'audio' output from the control track is, therefore, fed first to a threshold detector (noise immunity) and a pulse shaper. The former being an operational amplifier and the latter a Schmitt Trigger. The resulting output is fed first to a pulse length (8 ms) detector (usually a couple of monostables) to detect the 'sample start' pulse. Until this pulse is detected, the pulse input (to the decoding system) is inhibited and the demultiplexer static. When the pulse is detected, a monostable (of full cycle length—about 500 ms in this case) is triggered to enable the pulse input. The demultiplexer counters are reset and so is the Hamming Error latching bistable. The next pulse to be detected (by a 1.5 ms pulse length detector) is the first 'data start' pulse. This pulse triggers a 6 ms monostable which enables the serial input of a 12-bit register. It also triggers a triggerable clock generator (based upon an ic timer). This clock is an important part of the system. It is used to clock the data bits into the register. If it is out of sync with the data bits, the results will be nonsense. For slow speeds, as in this example, the circuitry is not too critical and highly stable ic triggerable timer/astables can be used. For higher speeds of operation more elaborate circuits are necessary. Of course this technique of timing means that the tape speed cannot be varied appreciably while the control system is in use. (The speeding up to raise a voice two tones will cause a system lockup. For this sort of work, it is essential to use a second track carrying the simple clock pulses for synchronisation.)

Once the register is loaded, and the 6 ms period over, gates are opened to dump the register contents into the Hamming decoder. The decoder will validate the data block. If two or more bits are incorrect, then an 'error' pulse will set a latch bistable to close the output gates and stop the demultiplexer counter. The system is then effectively static until the the next 'sample start' pulse. Normally the validated eight bits of data will be converted to an analogue voltage by the d/a converter. This voltage will be presented to whichever channel has been opened by the demultiplexer.

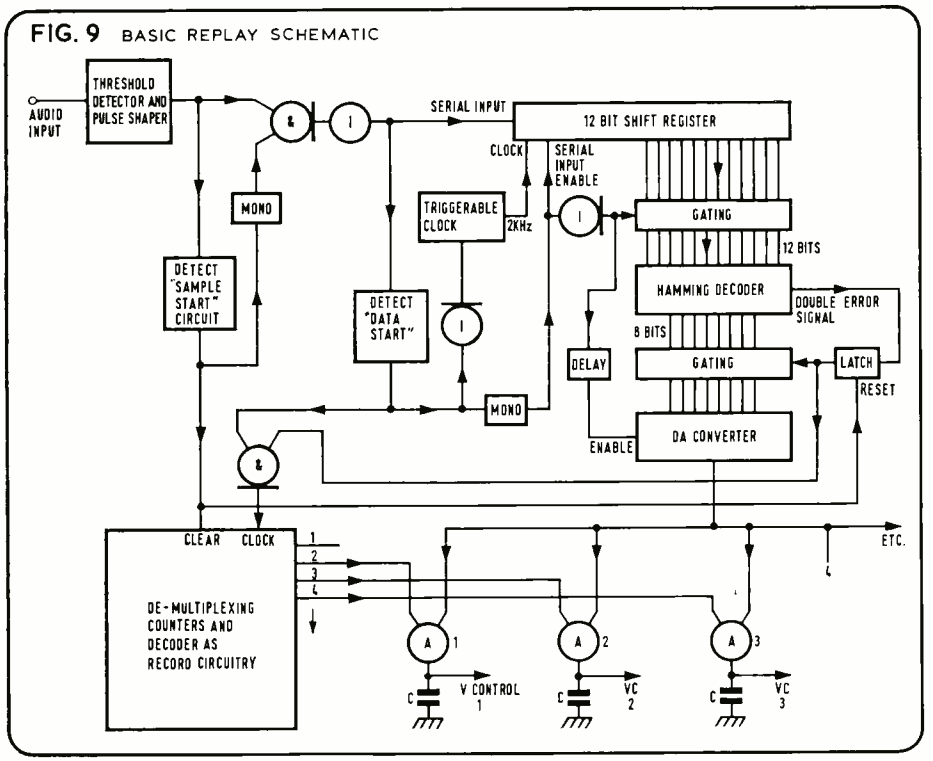
Meanwhile the first 'data start' pulse also locked the first four-bit counter in the demultiplexer, thereby (via a decoder) enabling channel one. However, there is no wired connection. Channel one is opened by the decoded count of two, and channel Two by the count of three, etc. This is because the analogue output cannot be available until all of the data block has been processed. Thus the sampling cycle is offset by one cycle. The shift of 8 ms is insignificant. Thus channel 63 is opened during cycle 64 which was used to generate 'sample start' on the record side of the system.

The demultiplexer is straightforward, being virtually identical to the multiplexer. The mosfet gates feed sample-and-hold circuits which in practice are small value capacitors across the very high input impedance of the fader vca. Thus we have the basic elements of a memory system. At this stage, however, no facility has been included for updating the memory.

Updating

The first major problem is: how can the memorised 'score' of some faders be updated without losing the original score of the remaining channels. A major constraint is that no changes or modifications be necessary on the multitrack recorder. Unfortunately this constraint dictates that two tracks are necessary. The control data is read from, say, track

FIG. 9 BASIC REPLAY SCHEMATIC



seven, decoded into the mixer, and any necessary updating performed and the modified data is recorded and written onto, say, track eight. At the next pass, track eight is read and revised data is written back onto track seven. All that is required to accomplish this is a simple bistable switching arrangement. I am still trying for a simple practical method of achieving the same ends using just one track. No doubt someone will find a way but it has evaded me so far.

The updating can be achieved in two ways. The eight-bit digital code can be re-Hamming encoded and then rewritten with new data being inserted during the relevant sampling cycles. This will require decoding networks to identify the correct sampling cycle relevant to a particular channel (that is being updated), in order to switch the source of the digital data block (from tape to a/d system) during that cycle. It will still be necessary for all data to go through the Hamming process in order to prevent data being progressively corrupted and so eventually lost. This method of updating is preferable and the circuitry is simple though repetitious.

The alternative method is theoretically dubious but, again, works well enough in practice. This is to sample normally the control voltage fed to the vca and to reprocess it except when updating, whereupon the line is switched to the voltage fed manual fader. The fader system is shown in **fig. 10.** The main disadvantage is that the small tolerances causing slight changes between the original fader position and the memorised position will add up over a number of rewrites so that eventually the memorised score will differ appreciably from the original. Only good design work will overcome this difficulty. It is worth trying as the circuitry is obviously vastly simpler and significantly less expensive.

FIG. 10

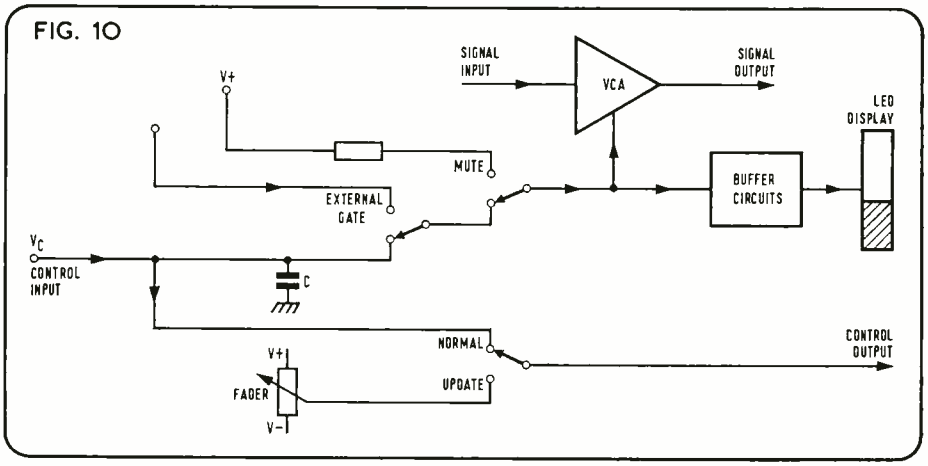
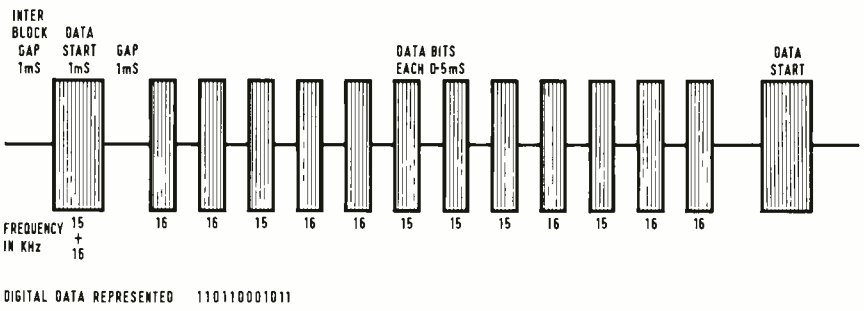


FIG. 11



System expansion

The system specification can be vastly improved by recalculating the timing. In the example, 1 ms has been allowed for a/d conversion and Hamming encoding. This is generous by many orders. The clock rate can be increased and thus the 'frequency' of the recorded data bits, and the sampling time. The latter change means that each channel can be sampled more often or, alternatively, more channels can be sampled. The number of channels can be increased by adding more counters, decoders and analogue gates to the multiplexer and the demultiplexer. A typical specification that can be easily achieved is:

Number of channels: 128
Updating rate: once every 500 ms per channel
Bandwidth required: less than 8 kHz

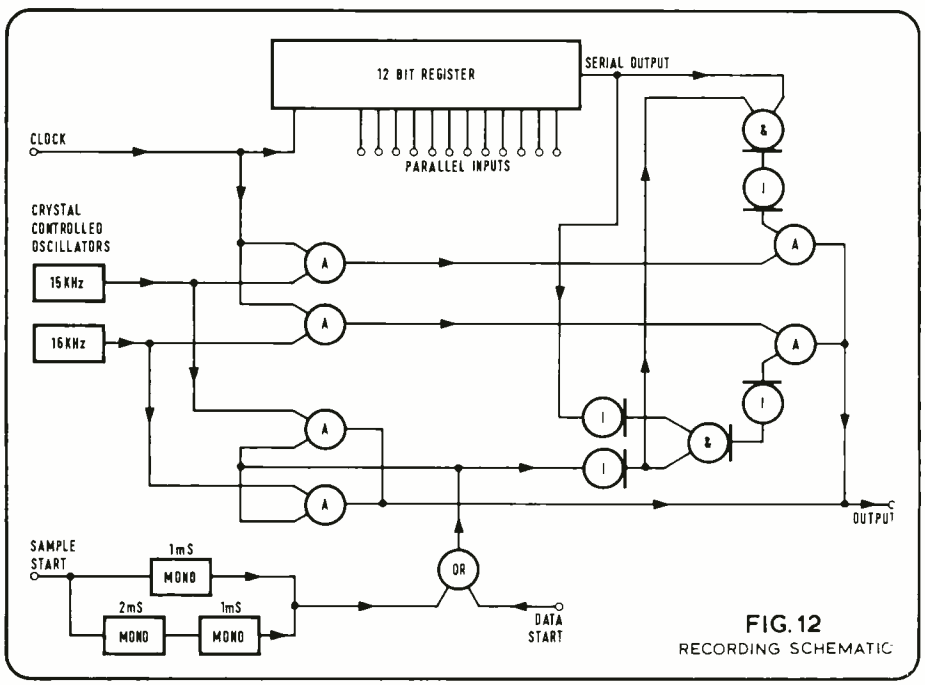


FIG. 12
RECORDING SCHEMATIC

Accuracy

The accuracy of the system (and hence the system-to-system compatibility) is dependent upon three main factors:

(1) Linearity and consistency of the vcas.
(2) Accuracy of the a/d and d/a circuitry.
(3) The resolution (i.e. number of bits) on the conversion.

Factor (2) presents no problem with the very good d/a-a/d circuits now easily available.

Factor (3) with eight-bit resolution limits each discrete step to 0.39 per cent or about 0.25 dB worst case in practical terms.

Factor (1) is the biggest problem. With typical devices, the linearity is within 1 dB over a 60 dB range. However, it is possible to trim most devices to give greater linearity over part of the range and poorer linearity over the remainder. Such a combination can be more useful when the vca is employed as a fader.

26 ▶

The typical specification then becomes: 0 to −40 dB ±0.3 dB, 0 to −60 dB ±2 dB. Thus it can be seen that the accuracy of such a system would be comparable with that of existing mixing desk components and therefore acceptable.

SYSTEM TWO

This system was developed to try and overcome the problems created by the lack of a timing track and therefore the difficulty of synchronising the reading of the data with the writing. It is a comparatively slow system and can only accommodate a limited number of channels. However, its slowness makes it a good system for the inexperienced to experiment with and, indeed, its performance will be adequate for those studios only wanting to automate a small number of channels. Furthermore, it is identical in a large part to the previous system and thus can be uprated when desired.

The novelty of this system is the use of bursts of audio tones instead of digital data bits. We can use, say, 16 kHz to represent a digital 'one' and 15 kHz to represent a digital 'zero'. Also we can use the presence of both frequencies simultaneously to represent the 'data start' signal and, perhaps, use the presence of the 'data start' signal twice in rapid succession to represent the 'sample start' signal. Firstly we must define some performance figures. The speed of the system will be set by the frequency decoders in the replay circuitry. Two types of decoders can be used: ringing oscillators which 'fire' when triggered by the right frequency, and ic detectors. The ics are easier to build and set up and are also cheaper. A typical device needs about eight complete cycles of the correct frequency to trigger. Thus the minimum burst time of the 15 kHz signal will be about 0.5 ms. Also another 0.5 ms pause and, say, 1 ms for the start signal and, another 1 ms inter-block gap, and we have a period of 14 ms for a 12-bit data block. If we continue with a channel updating rate of 500 ms, we limit ourselves to about 34 channels.

The basic adaptations of the original system diagrams are shown in **fig. 12** and **13**. The 'record' circuitry includes a number of analogue gates. Ideally these should be a compound shunt-series fet arrangement, though a simple one-transistor switch will work but with much higher leakage and hence crosstalk.

A few words of explanation on the replay system. Each frequency detector will give a 'one' output when that frequency is detected. Thus, when both are detected, a 'data start' output is obtained—unless inhibited. Also, if a two-bit counter can count two of these 'both frequencies' pulses within 5 ms, then a 'sample start' clock is generated. This clock will then enable the 'data start' clock line, via a mono-

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FIG. 13 REPLAY SCHEMATIC

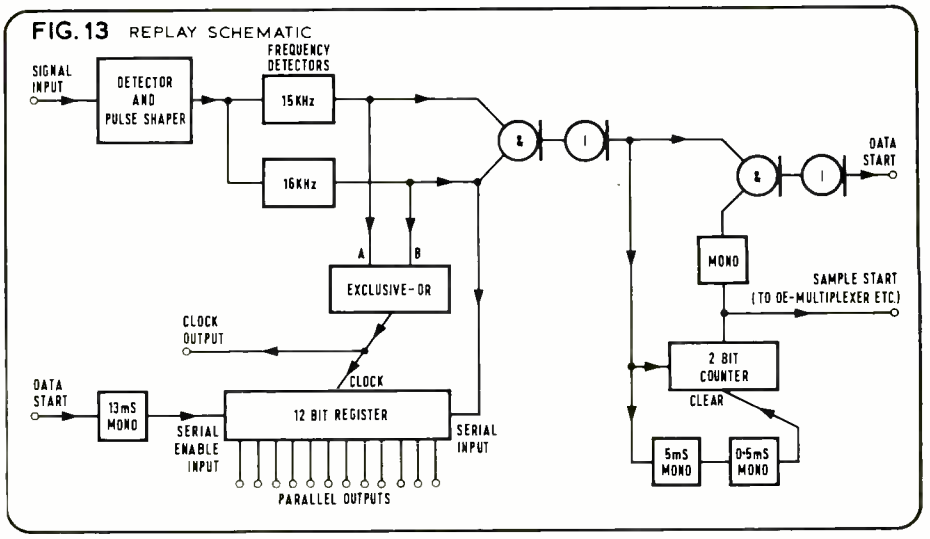
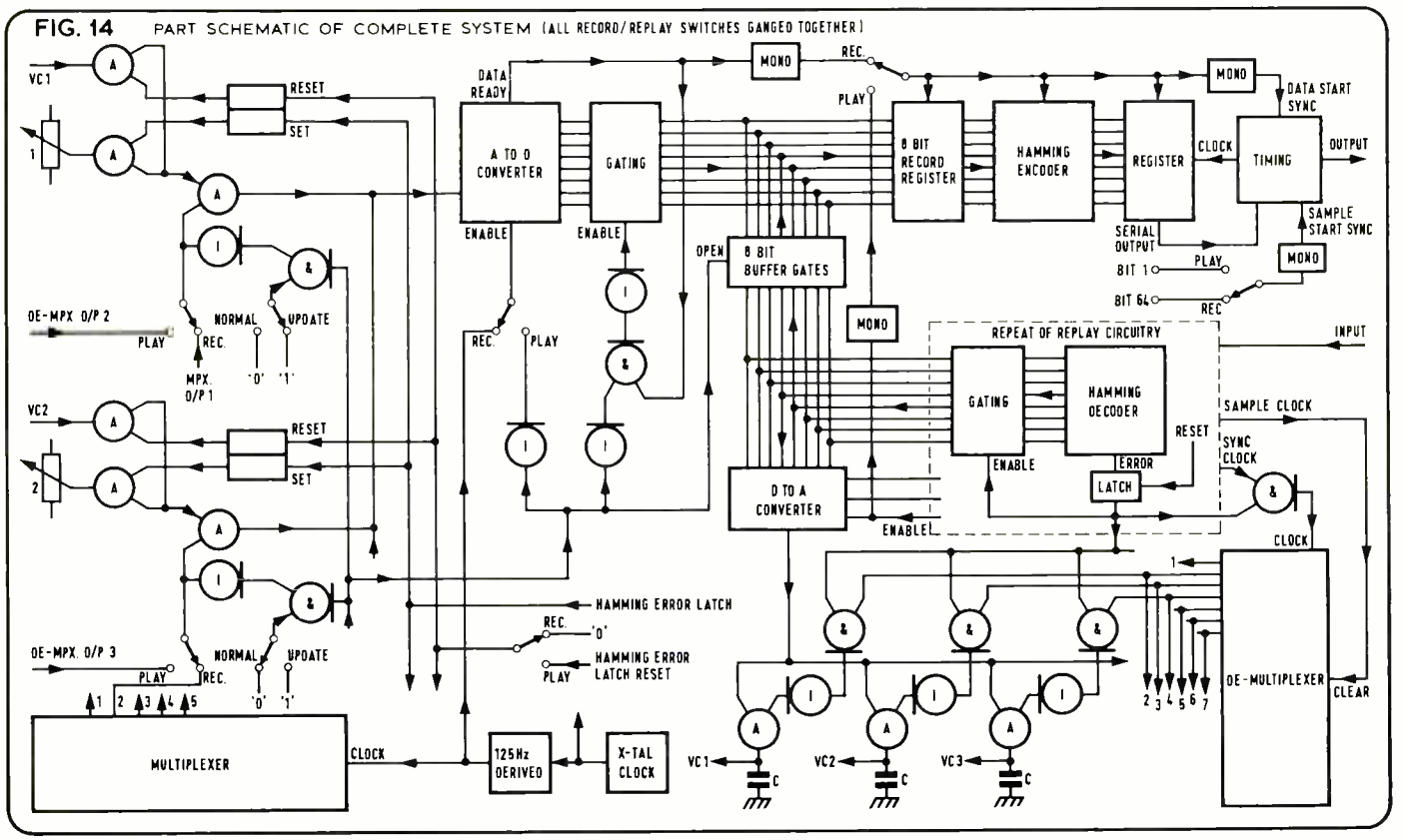


FIG. 14 PART SCHEMATIC OF COMPLETE SYSTEM (ALL RECORD/REPLAY SWITCHES GANGED TOGETHER)



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stable, for the cycle length time. The two detector outputs are also gated by an 'exclusive or' circuit whose truth table is:

Inputs A	Inputs B	Output
0	0	0
0	1	1
1	0	1
1	1	0

Thus an output is obtained only when one frequency alone is detected. Thus we can generate a clock in sync with the input data signals. This clock is used to clock in the 16 kHz detector's outputs into the register (as this detector output will be a 'one' for a data 'one' and 'zero' for a data 'zero').

As it stands, the system can only be expanded by increasing the two frequencies. A top limit of 16 kHz was chosen as this is within the flat response range of all professional recorders. However, 20 kHz and 18 kHz can be used to increase the number of channels to about 40.

Conclusions

This article has outlined some ideas and techniques of automated mixing. It is a completely new field and one in which some very elaborate and purposeful equipment is going to be made. The suggested systems only cover the bare necessities and numerous improvements are possible. For instance, it can be arranged that error detection only inhibits the corrupt block, rather than all the blocks in that cycle.

Most of all, there can be improvements in the recording techniques. The suggested system uses the nrz (non-return to zero) technique. In other words the square wave pulse is recorded directly as a square pulse. In practice, of course, the band-pass characteristics of the record electronics cause the recorded pulse almost to resemble a sine wave. In the appendix, alternative recording techniques are mentioned. Their use, however, will require some changes to the original system logic.

Fig. 14 shows an approach to a complete system, incorporating updating and correcting facilities. This system would be in the 'record' mode for the first writing of a fader score, thereafter in the 'replay' mode.

There are many other approaches to automated mixing and these should be considered for their worth. A completely different system of incredible simplicity is outlined in the Appendix. As shown, this system has no error or splice protection nor can any estimate of its accuracy be given, but it is worthy of investigation. The results so far achieved may lead to this system becoming the basis for any final design.

APPENDIX

Fig. 15 shows a typical analogue fet switch package and **fig. 16** the related recording techniques.

The nrz recording technique is acceptable at low bit rates although some pulse shaping is required upon replay unless the recording system has a response to dc and has good phase linearity. As the bit rate rises, problems occur with pulse-to-pulse jitter or timing error introduced by the recorder.

The bi-phase (or double frequency) technique has a transition every clock period and it is thus possible subsequently to extract a clock upon replay, thereby overcoming the problem of timing.

The Miller Encoding technique reduces the

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FIG. 17 AN ALTERNATIVE MEMORY SYSTEM

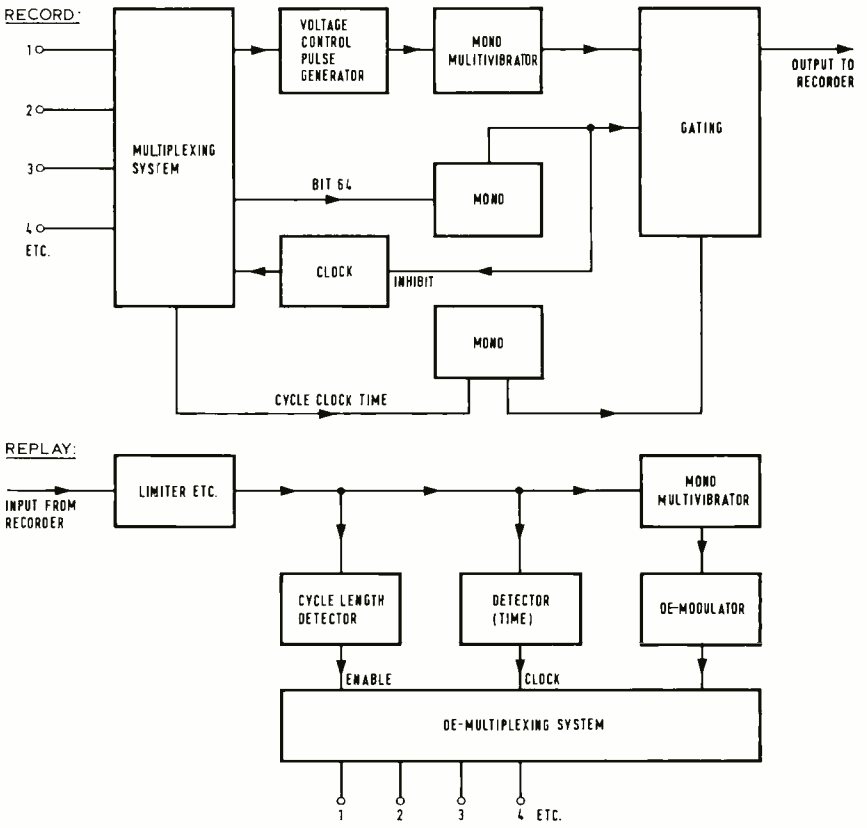


FIG. 15 TYPICAL ANALOGUE FET SWITCH PACKAGE

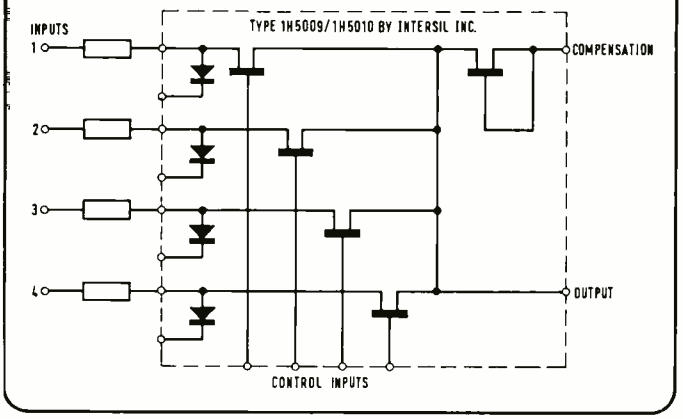
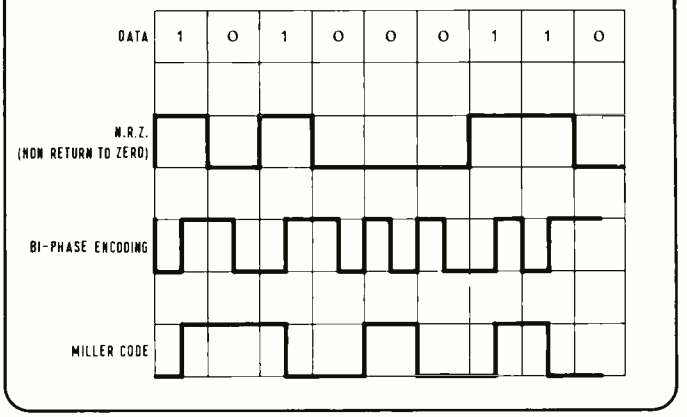
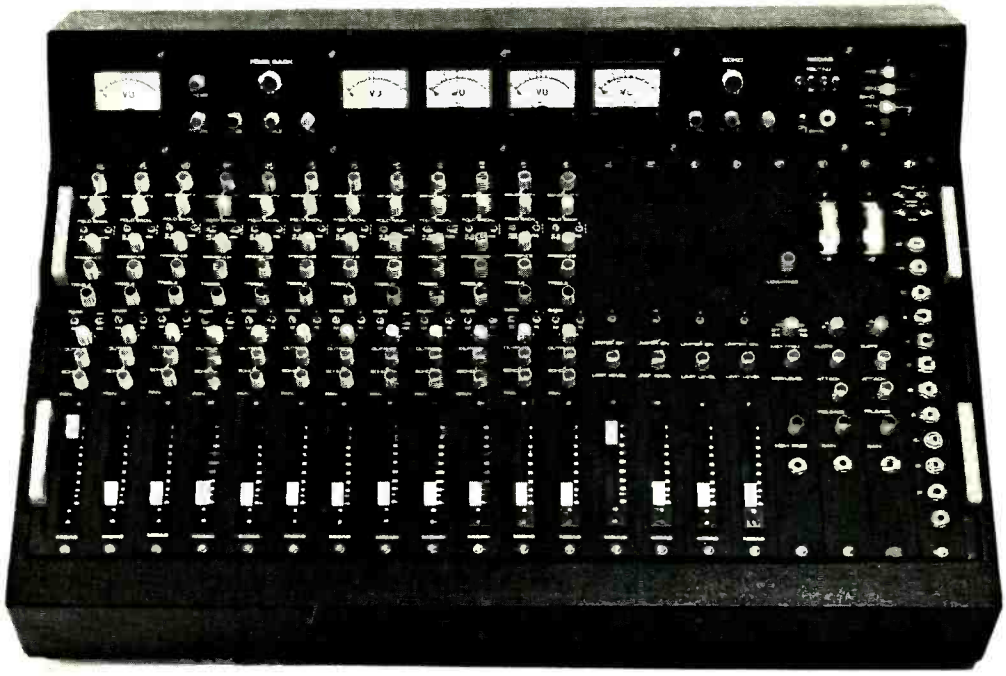


FIG. 16 RECORDING TECHNIQUES



midas modular mixer system



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DIARY

By John Dwyer

IT SURPRISES me how many studios are opening at the moment, although if commercial radio won't be a licence to print money for the radio contractors it might prove profitable for studios who offer the right facilities. None of us knows yet, though, what those facilities will prove to be. Later on in this column it will become apparent that the commercial contractors themselves are no slugs when it comes to providing their own facilities.

At any rate, this month I bring news of four new music studios opening around now. Three of them, Kingsway Recorders, SARM and Weir, are taking over premises previously used as studios and the fourth, Scorpio, is a new studio at the base of the Euston Tower office block.

Kingsway Recorders are in the basement of the Civil Aviation Authority's building in Kingsway, just opposite Holborn underground station. The studio was originally owned by De Lane Lea, and it will be no surprise that the new management—managing director Martin Birch, and directors Louis Austin and Terry Yeadon—are also ex- De Lane Lea. The backing has been provided by Deep Purple lead singer Ian Gillan.

The studio wasn't finished when I went to have a look at it but they were just over the hassle of having an air conditioning plant put in. There are two air conditioning systems: one was already installed in the control room and they put in the other at a cost of £4,000. Apart from such major items as that, the directors are fitting the place out themselves, and when I went into the control room Terry Yeadon was putting up one of those weighty but flimsy-looking acoustic tiles.

Terry told me they had created a great deal of rubbish. They had already filled three large skips and were about to fill another. I asked if any of the old recording gear has proved of any use and he said that most of it was very old: 'some of it was 12 or 13 years old and the newest equipment was four years old. What was here was basic eight track—no pan or anything like that . . . We put most of the equipment on the market. We kept the EMT plate and connected it for stereo and remote; the Ampex four track; and two Ampex stereo machines. Anything else we sold it or threw it away.'

The desk hadn't yet arrived—they expect delivery by late July—but Terry told me it was being built by Raindirk Ltd. Raindirk is the name of the company formed by Ron Pender and Cyril Jones, who left Sound Techniques last January. Ron was senior sales engineer and Cyril was works manager. Raindirk's headquarters are at Downham Market, in Norfolk.

The Kingsway Recorders desk is a 24 channel 16 track desk with separate mixing outputs. There will be space for another six inputs. 'The monitoring arrangement allows simple transfer from standard operation to remix or overdub condition interlocking the tape machines with the monitor modes and Dolby functions'. The desk, having 28 monitor units, is capable of full 24 track operation.

The desk is divided into seven sections: producer's section and jack bay; 24 monitor amplifiers with 16 main group faders below; 16 channel amplifiers; four remix outputs with monitors; a remote control section; 14 more channel amps (only eight have been fitted); and an auxiliary panel for additional eq, echo returns and so on. The microphone/channel amplifier has full equalisation—high pass and low pass filters at various frequencies and at 18 dB/oct; bass and treble lift and cut; separate mid-range controls each giving boosts and cuts at six frequencies.

There are four echo sends, and three auxiliary feeds each with a level control and pre/off/post fader switch. Channel routing is accomplished by two rows of 14 pushbuttons of which the upper eight in each column select the signal routing (odd numbers left, even numbers right) the next four per column give full panning on the remix outputs and the lower two in each column select insert, pan, direct output, and phase reverse.

There are many other facilities including a slate facility which allows talkback to go onto tape; standard monitoring facilities; and full remoting. The remotes for three tape machines are in the mixer's centre next to the remix outputs and have interlock on all functions, 24 safe/sync/ready switches, a master safe switch, 24 Dolby in/out switches and two push-buttons for remix and multitrack tape machine Dolby tone.

Elsewhere there are eight master gain controls for the auxiliaries: five for echo send and three for aux send with a rotary switch which monitors the echo sends, aux sends and disc outputs by muting those apart from the one selected. This rotary has an off position.

Finally, two rotary switches select monitor modes, allowing mixing of the monitor signals and selection to various loudspeaker systems. The monitoring also has full headphone facilities, separately controlled.

Solo detail

An interesting detail of the desk is that the solo button is not the usual pushbutton but a bias and lock toggle switch: switched one way it is biased back to the centre position for quick listens to one channel and if pushed in the other direction it will lock like any other toggle switch and keep the solo in.

Other equipment at the studio includes two Crown *D150* for the monitors and Quad *303* amps for the playback, foldback and echo send to the chamber. They have a 24 track Studer on order, a stereo Studer with a full track erase head, an Ampex four track, two old Ampex two track machines I've already mentioned and an EMI *TR90* mono machine which will be used for editing, tape finding and the like. For echo they have an EMT *140* stereo plate with remote control and an EMT *240* plate is on order. They also have an echo room. Ian Gillan has seen a new device in the States which he has bought, and Terry told me they might buy a Grampian spring.

They have four Universal Audio Limiters, an Altec *436* compressor, and a Fairchild *666* compressor. Under the desk will be a rack with eight *360* Dolby units in it: 'This means there will be no need to jack up for an ordinary stereo mix. *M* range Dolby units will be considered as part of the 24 track machine, and there will be no long leads to and from the machine and there will be no need to go through the jack bay'.

I asked Terry what his thoughts were about quad recording: 'Well, quad would be great if everyone could decide what they were using'. He went on to say that they had allowed for it and that there would eventually be four speakers in the control room.

For those who don't know the layout of the Kingsway studio there is a main section roughly 10m by 10m with another smaller room opening on to the larger one. There is no dividing wall between the two but there is an acoustically treated air duct which comes about 0.5m down from the ceiling.

The control room is off the smaller section of the studio. There are 30 mic lines from the studio to the mixer. Two more mic lines would be coming out of the echo room into the studio on a patch panel. There are four tie lines from studio to the mixer jack bay.

Kingsway have not yet decided what speakers to put in the control room. There will be a couple of Mickey Mouse speakers in the desk and two *Maxims* for domestic monitoring but they had conducted tests on a number of speakers for main monitoring and had yet to make up their minds. Terry said it was probable, though, that they would settle for Tannoy *Golds* in cabinets they would build themselves.

Like Central Sound, Kingsway seem to be very pleased with Roger Pick's work on their piano, a 50 year old Steinway which eventually cost them around £1,000.

It seems that many of the customers who used to use De Lane Lea's studios in the old days have shown interest in returning.

Terry told me that parking was no problem since there were a lot of parking meters about the place, an NCP car park at the London Theatre and another at Holborn. Gear can be unloaded from the garage at the back directly into the studio.

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DIARY

Ron Carran mixes an eight track tape at Minot Studios in White Plains, New York.

Kingsway have not yet fixed session rates.

Barry Ainsworth and Gary Lyons took over the old City of London sound studios in January of this year and since then they have been doing a similar tear-down-and-put-back-up job as that at Kingsway. On one occasion, Gary Lyons told me, they had been knocking walls down in the early hours of the morning when a passing gendarme took an interest in the proceedings and made them do some explaining. Presumably he thought they were lifting bricks.

But the most important thing about **SARM**'s studio in Osborn Street, just off Whitechapel, is that it is 24 track—now. Barry told me when I went there that it was this country's first 24 track studio—a dodgy claim for me to print unless I leave the words in the mouth of its author, but I hadn't heard of any other 24 track studios opening before theirs did.

The 24 track machine is an MCI, though the other machines—one four track, three two tracks—are Ampex. The desk is a modified Triad *B* range desk with eight groups switchable to any four positions. The 24 tracks can be recorded simultaneously. The line-in for mixdowns is automatic.

Wisely they've also bought the MCI auto-locate unit for the 24 track machine. They've also got a Dolby *M16* unit, Westrex compressors, and Marconi limiters. The monitoring is on Tannoy *Reds* in Lockwood cabinets driven by Quad *50E* amplifiers.

Barry and Gary started Sound and Recording Mobile when they left Command. They began by going round every publisher they could find asking for work. This commendable approach rewarded them with tape copying, record cutting and freelance engineering work, much of it in association with Pye. They recorded Planxty before that group became popular, and pa work such as *Jesus Christ Superstar* and the Richard Harris English tour. They used the Granada and Pye mobiles for big sessions and their own gear for smaller jobs. But they decided they needed a studio of their own and looked for a backer: 'We found someone interested in what we were doing and he helped us finance the project'.

As far as the studio itself goes the acoustics can be altered by hard/soft acoustic screens and by drawing curtains across part of the studio. The ceiling and the floor are floating and there are good heavy sound doors at the end of the studio. The floor is wood over concrete with a fibreglass membrane between.

The mics are the usual Neumanns and AKGs with one or two STCs. The cans are AKG. Foldback on speakers is through two large Wharfedales. For echo they have an EMT stereo plate, a Grampian *Ambiophonic* unit and a spring device which Barry made himself.

There are 20 mic lines from the studio but two mic points in parallel on each. Thus the two studio connecting panels each hold 20 mic points, as well as two foldback points, a talk-back and a loudspeaker point.

The layout of the studio was changed by making the old control room part of the studio and building the new control room into a part of the studio at the other end. This gave them a lot more room to move in the control room. The only part of the studio they left untouched was the vocal booth. The lighting is on tracks and connected to dimmers. The studio takes up to about 24 musicians.

The tape copying room, which is also the control room for the small studio two, is about 3m by 4m. The two Ampex tape decks are built into a desk here with a jackfield nearby and a Dolby *301*. There is also a Bell & Howell cartridge machine. The self-built desk is a ten channel desk with full eq, foldback and so on. The speakers here are by Living Audio. Barry told me they were the Japanese equivalent of the small JBL at about one-third the price. They will handle 50W each.

Studio Two is really a vocal booth next to the control room of the main studio. The jack panel in the tape copying control room across the passage connects the booth with the tape copying room, and can also connect the booth with the studio onmic lines through control room one.

Teeth at SARM

SARM have had the usual teething problems in setting up the studio but I imagine that these will be sorted out by the time they open officially. At any rate they don't appear to be so serious as to stop SARM from being busy; Gary Lyons gave me a long list of sessions they'd been holding in mid-June. They have done four children's albums for MFP; Dart Records have brought in Richmond and Incredible Hog; B & C have made a Kelly Ann single for their Mooncrest label; Carole Bell has come in for Bell Records; The Swinging Blue Jeans are alive and well and starting an album, Gary says; Arnold Martin and Morrow have come in to record backing tracks for Joe Brown, Rescue Company Number One and Butterscotch singles; Ember Records brought in P J Proby reductions; Phil Coulter produced some Birds Eye jingles and Stigwoods did an album of their musical *Jam*.

The rates are reasonable at £30 an hour for 24 track and £26 an hour for 16 track. Other rates are £22 for 8 track, £20 for two and four track in studio One and £6 an hour for stereo in studio two—no overtime charged.

Scorpio Studios are a 16 track outfit in the Euston Tower Centre. By what I am assured is a coincidence they're just under the studios of Capital Radio—see further on. The studios are run by Aidan Day, former Radio One producer and the engineers are George Peckham and Claude Harper. As I mentioned in the June issue I went round to see Scorpio before they had finished the work and it looked impressive even then. When I went back two months later it looked even better.

The studio was designed by Broadcasting & Sound Consultants and installation and testing were carried out by an associated company, Shone Sound Ltd. BSC tell me that the work took 16 weeks from the time the first brick was laid to when the studio was handed over to Scorpio. BSC are run by Norman Bone, former president of the APAE, and HS Bishop AMIEE.

Scorpio was their first major project, they tell me, after leaving the BBC, where they had each worked for 37 years. They were both engaged on the planning, design and construction of the 20 BBC local radio stations.

BSC specialise in sound reinforcement systems, but they say they take on anything from the smallest public address installation to a complete radio station, anywhere in the country. To judge by the number of phone calls we get asking for the names of acoustic engineers they should not find themselves short of work.

Anyway, to get back to Scorpio. The studio measures about 9.8m by 7.3m and is about 3.2m high. The vocal or drum booth inside the studio is about 2.75m by 2.1m and 2.4m high. The control room is 6.7m by 6.1m. Norman Bone tells me that because the site was near a busy traffic junction which was responsible for a 90 dBA noise level during rush hours, all the external walls had to be 'of triple-skin design' with one wall 23 cm thick.

The wall between control room and studio was similarly built and the method of construction seems to have been successful, for I could hear no significant traffic noise inside the building. Norman's measurements showed an ambient noise level in the technical areas of less than 25 dBA on first tests before the final acoustic changes had been made, after which it was 22 dBA. The sound insulation between control room and studio was 80 dBA at 1 kHz. The control room window has three panes of glass of different thicknesses. It measures 3.04m x 1.2m and in combination with the Cadac desk's being on a 30 cm high raised dais there is a good view of the whole studio.

Boxes around the technical areas provide 26 microphone sockets as well as talkback, foldback and playback facilities, headphone listening, ring main tie lines and conductor's rostrum (?) tape machine inputs and gramophone outlets. Four foldback circuits are available for musicians to choose from and each of the ten headphone boxes has a level control.

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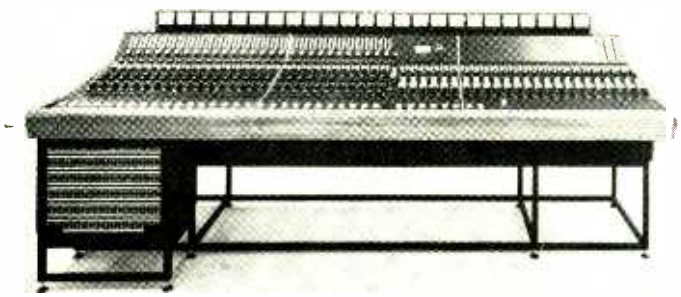
SARM HAVE JUST CONSOLED THEMSELVES.



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DIARY

There are 22 AKG mics of various types and 25 mic stands including a number of small boom arms. Separate technical and domestic ring mains are provided throughout the studio and technical areas and there are Shone-designed mains isolating transformers in the studio.

The wiring, I am told, has been put in 'specially designed microphone skirting' well away from the mains wiring. Norman says that every piece of wire and equipment was phase tested before it was put in, which meant making about 2,000 tests. None of the air ducting is visible, but the air is changed 15 times an hour in the studio and 25 times in the control room. There are six full height and six half height acoustic portable screens available in the studio.

I won't go into the acoustic treatment in great detail, although I should mention the ceiling since the studio is in the bottom of a tower block. The walls were treated with 450 acoustic modules of two types 'as currently used by most major broadcasting authorities.' The ceiling is made of three layers of insulation with large air spaces between each. Each layer was covered with a 25 mm layer of plaster and the absorber modules used for the walls were used on top of that. The final reverb time of the studio is about 0.24s from 300 Hz to 8 kHz, according to Norman Bone. It rises to 0.3s at 200 Hz and 0.4 at 80 Hz. 'The singer/drum booth is even better and the result is a very clean sound, complete absence of bass boom and wonderful separation between musicians'. Many of them have already commented on this and they like it.

'We could not agree more with what Mr Veale of Acoustic Consultants said (ASE Rotterdam report, July issue) about control rooms except that we think the same remarks should apply to studios as well, ie they should be inert and not add any non-linear modification to the sound within that room. Incidentally the control room acoustics follow very closely those of the studio . . .' The desk as I have said, is a Cadac. It is wired for 24 inputs though at the moment it is only equipped for 20. The speakers too are Cadac monitors which give a sound level of 108 dBA at 3.05m. There are three Ferrograph *S1* speakers available for foldback, talkback and playback and these are mounted on amplifier plinths and can be moved around the studio as required. The 16/8 track machine and the three two tracks are all by Ampex.

I will give more information about the Cadac desk in a future diary. The rates at Scorpio compare well with similar studios. They charge £32 an hour for recording and £28 an hour for reduction.

The smallest of this month's new studios, though none the worse for that, is **Weir** studios, in Broadhurst Gardens near Finchley Road station. They held an opening reception in mid-June. As it happens I remember these premises very well as they were the first studios I visited after I joined STUDIO SOUND. What is now Weir studios was then under different management, and we won't go into that now either. I'll give a fuller report on Weir next month.

Things are hotting up on the 24 track scene with news that **AIR** have bought a 3M 24 track machine which will be in full use on July 16, Dave Harries told me. The first session was held in mid-June when they did a 24 track rough mix for an American tv film. The tracks were made at two Emerson Lake & Palmer concerts, one in Milan and one in Rome. The reduction was to tape and film with 23 music tracks and a sync track. Dave Harries tells me there were 'no problems'. The mix was a straight mix to picture. The tapes had been encoded and were decoded with the DBX noise reduction system.

The thought that AIR would be the first of the bigger independents to go 24 track has been around the business for some time. Now that they have, let battle commence.

Other AIR news: I just had to get a gander at their new reception desk; as I mentioned in June, the way AIR described it made it seem less of a reception desk than a barricade. Perhaps it was all those bomb hoaxes. When I got there I found that the carpenters had come back in and cut a chunk off the top to let the receptionists get a better view of the customers and vice versa.

They have also installed, on the wall behind the desk, a teeny-proof indicator. You can't read what's written on it in wax pencil unless the Perspex board is lit from behind. This way clients won't have their presence in the studio betrayed to marauding fans.

AIR's Bill Barringer, star of stage, screen and the Dolby *M16* Brochure, has told me that they had been working on a film called *How To Seduce A Woman* for Hollywood's Synchro films, but denied that the film was made as a party political broadcast. A Canadian group called Tobias have been in for Triumvirate; Mike Sherman came in to mix with engineer John Hunter; and at the beginning of June Donald Swann recorded a performance in studio One with an audience.

Wings man Denny Laine has come far since he trolled around our local youth club circuit many years ago with the Diplomats. He has just recorded a solo album at AIR engineered by Geoff Emerick. The Casuals were produced by Peter Sullivan for AIR's own production company with Denny Bridges balancing; Gary Herd came in with engineer Alan Harris; John Middleton engineered some Family sessions and an album by Rupert Hine, also involved with the *Colditz Story* I mentioned in May.

Geoff Emerick also worked with Tirnanog and Cockney Rebel during the month, and Roger Greenaway came in with Reg (It-wasn't-me-at-the-airport-either) Presley to do solo work. Another lead singer, Bryan Ferry, was prised away from his band to do solo work, again engineered by John Middleton. Air seem to be doing well—they're already taking bookings for January—and when I was there one of the staff remarked that they had done nearly all the work for that week's *Top of the Pops*.

Capital Radio, London. The London general entertainment station have finally appointed a programme controller; Ruth Leon had to withdraw her acceptance of the post because, for personal reasons, she felt she could not leave Washington.

Her successor is Michael Bukht, 31, whose appointment was announced on June 5. Until his appointment Mr Bukht was acting editor of current affairs special projects for BBC tv. He was responsible for editing all the Apollo moonshot programmes as well as *The Great Debate* on the common market and the excellent Ulster debates.

He joined the Beeb in 1963 from Kings College, London as a script editor and producer in the radio drama department and later moved to the *Tonight* and *24 Hours* team. In 1967 to 69 he was director of programmes for the Jamaica Broadcasting Corporation, so he has some experience of commercial radio.

Capital are building a suite of studios at the Euston Tower Centre, near Thames Television. David Whittle Associates are the consultants for the work and have ordered five Neve desks, I am told. Among the studios will be two presentation studios and an eight track music studio.

Finally, while we're on the subject, why do the commercial radio bods seem to find the word 'commercial' so offensive. They persist in calling themselves 'independent'. Independent of what? of whom? Conversely, who or what has enslaved the alternative to commercial radio, our own dear BBC? Are not the BBC independent of advertisers?

AUTOMATED MIXING

number of transitions per data bit (and hence the apparent bit rate). This form of coding has the advantages of nrz and bi-phase without the disadvantages. The system frequency response and timing accuracy become less important and again a clock can be derived from the replayed data. **Fig. 17** shows a suitable alternative memory system.

As in the other systems, the analogue signals are multiplexed and thus each signal in turn controls a voltage controlled pulse generator. Thus the frequency of the output pulses is dependent upon the input voltage. The pulses trigger a monostable multivibrator to produce a stream of pulses at constant amplitude and duration but of variable frequency. This pulse stream is shaped into an ac waveform by the effectively bandpass frequency response of the recorder amplifiers. Thus the analogue voltages have pulse frequency modulated the tape.

Upon replay, the recorder output waveform is limited, to remove noise, and used to trigger another monostable multivibrator (identical to the record one) to produce a well defined pulse train similar to the original. This pulse train is then de-modulated (usually by a series of low-pass filter systems) to give an analogue signal which can be de-multiplexed.

It is necessary to have a gap of defined length between each block to generate a replay clock and also a starter block of greater but defined length to identify the start of the cycle.

The required tape recorder bandwidth is low and relatively simple circuitry is employed.

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BROADCASTING

HOSPITAL SOUND RELAY

By Adrian Hope

ALL BUT the shortest-term hospital patients eventually contract the same disease. Boredom. It strikes as soon as the patient has half recovered from whatever he had in the first place and there are two schools of thought about its effects. Some say boredom delays recovery. Others say it speeds recovery by giving the patient the will to get out of the hospital.

Whatever the truth, nobody is going to dispute that a stay in hospital is by definition going to be tedious. And hospital radio is a positive attempt at providing entertainment for the patients.

Most hospitals have fairly low quality headsets (or sometimes acoustic tube connection to a wall mounted transducer) by each bed with a selector switch which pipes out a couple of BBC radio stations and possibly tv sound. More and more hospitals are now providing an extra 'spot on the dial' for an internal programme source. Michael Binstock of 3CN (of which more later) recently gave me a guided tour of hospital radio activities in the North London area.

On the way to his own home studio, Binstock explained to me how, in some cities, hospital radio is run on highly organised lines comparable to BBC local stations. In Manchester, for instance, around 50 hospitals are linked by landline to a central studio run partly by full-time and partly by voluntary staff and which puts out talks and music programmes for what must be a reasonably large audience. Something similar happens in Southampton but in London there is no such central organisation. London hospitals with their own programme facilities operate under circumstances that vary widely from hospital to hospital. What results is a great deal of inter-station rivalry and inevitably an abundance of mini-politics. I even saw this myself, being involved in what appeared to be a totally pointless moody from one soul who felt (rightly or wrongly, I cannot say) he should have been consulted in advance, then steadfastly shouldered his chip for long enough to remind me of the old football crowd shout 'Forget the ball and get on with the game'.

Clearly, running separate stations at each hospital is economically unsound; especially as money is always in short supply. Equipment has to be made or scrounged (most firms give a very hefty discount to genuine hospital stations) and all time is given free. There are no pre-release records forthcoming from the record companies but how can there be with stations dotted over the London area and no official body to organise a centralised library of discs?

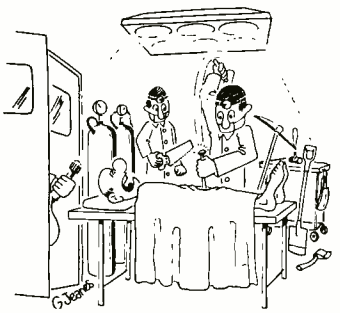
Attempts to put things on a more organised basis have been thwarted by problems such as the Post Office charges for an equalised landline: installation costs plus around £3 per kilometre annual rental. While the hospitals generally accept that an internal radio station is therapeutically valuable, they have little or no money to spare for subsidising it and figures in the order of £50 a year are often all that is forthcoming. Space is also inevitably at a premium because wards and operating theatres clearly take precedence over studio space. So the studio is usually tucked away in a remote corner of an unwanted building.

The studios are manned by voluntary workers with varying degrees of ability but with apparently limitless enthusiasm. At one station that I visited, the studio was in a drafty wooden hut staffed by a Youth Voluntary Service (average age round about 16) and had obviously been put together more or less on a shoestring. But the programmes were going out and I wish I'd had a chance like that at 16 to learn the hard and proper way how to use tape and equipment.

At the nearby Royal National Orthopaedic Hospital, Brockley Hill, Stanmore, Radio Brockley operates from a much more elaborate studio in what was once a waiting room. The studio staff are much older (mid-twenties or thereabouts) and have their eye on expanding into the room next door. Radio Brockley runs on two Vortexion recorders, a couple of Goldring Lenco grams, a Jason tuner, some Reslo microphones, a mixer with VUs and again, the essential ingredient, boundless enthusiasm. While I was there they were running a radio 'bingo' session for the wards and were up against stiff competition from television (The Royal Variety Performance featuring Bruce Forsyth, HM The Queen and Tommy Cooper).

Stations like the two I saw operate two or three nights a week from about 19.00 to 21.30. Apart from bingo, the programmes include regular dj music off discs (requests collected the week before from the wards), news programmes, pre-recorded interviews and general interest material.

It is in this latter pre-recorded area that 3CN are particularly active. Together, Ira Coleman, Ashley Leboff, Colin Southern and Michael Binstock have formed 3CN (Closed Circuit Communications Network). Again on a completely voluntary and non-paid basis, they are building up a library of pre-recorded tapes for use by hospitals in the London area.



I saw the library list and it was certainly impressive. I also heard some of the tapes, including equally impressive interviews with leading musicians like Ronnie Scott, Stan Getz, and Humphrey Lyttelton, recorded on location with a Uher. Usually the 3CN interviewer edits out his own questions and leaves the musician talking, the only interruption being recorded music illustrations of what they are talking about. Hardly a new technique but well tried and probably one of the best ways of getting inside the mind of the subject. Other tapes available through 3CN are a wide variety of music selections, original short story readings, and excerpts from comedy programmes. 3CN make no charge for their tapes, provided they are only used in hospital stations, and the various official bodies waive all royalty and performing right requirements for hospital use.

The 3CN team are obviously moving into this area on a much more purposeful level than the stations themselves—although that is not to say the stations are ham. For instance timing has to be accurate, and is, because of the need to join up with Radio Two. Radio Brockley even have their own tape of the Radio Two cueing jingle for use when the BBC timing strays.

Clearly the amount of time 3CN dedicate to this hobby is massive. Almost every night of the week and almost every weekend are taken up with taping. They had recently, for instance, taken a Uher to London Airport and interviewed virtually everyone in sight who worked there. The programme was intended for a local hospital which suffers particularly from aircraft noise and it seemed a good idea to find out for the long-suffering patients semething about the planes that were roaring over their heads.

3CN have a way of persuading BBC disc jockeys (including Pater Latham, Bob Holness and Keith Skues) to do the occasional taped programme. Because their programmes are passed round from hospital to hospital, there is more chance of persuading a busy professional disc jockey to give his time. This is obviously where the isolationist attitude of the individual hospital stations breaks down. Inter-station rivalry may in theory encourage a high standard of performance but it means in practice that no material is shared. Which is absurd, bearing in mind the slim chances of a patient hearing the same programmes twice by virtue of being in two different hospitals at the wrong times.

For anyone interested, the address of the 3CN Voluntary Service for Hospitals is c/o 10 Kenyington Place, Harrow, Middlesex.

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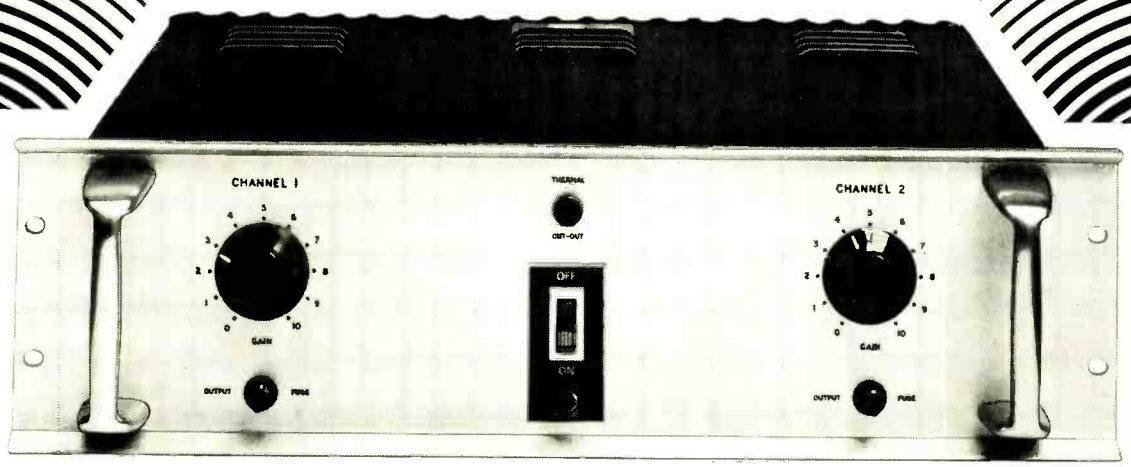
SOUND SYSTEMS AND ELECTRONICS

MONITOR



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Power Bandwidth:– 5Hz to 40KHz at rated output.
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Total Distortion:– 0.05% at 1KHz; 200mW to rated output.
Noise:– –100dB.

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TORONTO SOUND

By Steven Vaughan

AS THIS IS the first of my articles on Canadian studios, it will probably be helpful to the reader if I explain a little about the recording industry in Canada. As with the British market, the biggest outlet for recorded music is radio and in Toronto alone there are at least ten radio stations, all of which are on the air 20 hours minimum a day. Some of these stations play out-and-out Pop all day, while others specialise in different types of music. The one thing all stations have in common is that, up until 1970, most of the music played was American produce with a liberal sprinkling of British material. Very few Canadian records ever got off the ground in Canada or anywhere else for that matter and, in 1971, the Canadian Radio and Television Commission decided to do something about this situation. I asked Terry Brown, managing director of Toronto Sound Studios, to explain what the CRTC action was.

'On January 1, 1971, the CRTC put rulings together which called for 30 per cent of the product being played on Canadian am radio stations to be Canadian in one of four categories. It had to be either a Canadian artist, Canadian produced, Canadian music or Canadian lyrics. In 1972 the ruling was upgraded so that a record had to have two of these points to qualify as Canadian content. What this has done is to force the Canadian stations to broadcast Canadian material whereas, before the ruling, Canadian produce was being ignored to a large extent.'

Needless to say, I couldn't begin to cover everything that has been affected by the CRTC rulings but Terry assured me that business in his studio had been boosted quite considerably to the extent that on most days the studio is in use for a full 24 hours.

SV Let's talk about your studio now. What are the dimensions of the studio and control room?

TB The studio is about 7 x 9m and the control room 7m square. The control room is a wedge shape, the ceiling being higher at the front than at the back. We have built up the floor at the back of the control rooms with risers and people can sit up there and see what is going on without getting in the way of the engineer.

SV What about the acoustic treatment in the studio?

TB The studio is very dead, in common with a lot of British Rock studios. This differs from the other studios in town in that North American studios in general seem to be more live.

SV The fact that you are an Englishman who worked in British studios would have some bearing on the way in which this studio was treated. I see that your mixing console is English also.

TB It's a Cadac console which has been really good to us. We've had no problems at all since we put it in. There are 20 inputs and 16 out. In fact it is a converted eight track desk and I've found it works really well. The equalisation is quite standard. There is 12 dB lift and cut at 10 kHz and lift and cut at four mid-range frequencies: 1.4 kHz, 2.6 kHz, 4 kHz and 5 kHz. We've altered the bottom end slightly and it now has a lift of 40 Hz and a cut at 80 Hz. We have also added extra 300 Hz, 750 Hz, 7 kHz and 15 kHz equalisation modules. We have 20 of these and they will be selectable one per channel.

SV How about tape machines?

TB We have a full complement of Ampex machines. There is a 16 track *MM1000*, an eight track *MM1000*, two *AG440* stereos and one *AG440* mono which is equipped with a sync pulse head. We find that especially useful for commercials because it means a 60s commercial will stay 60s long! We have just installed a complete Dolby *A* system for 16 track and stereo. Until recently we had been living on our reputation as the quietest studio in town. We still have that reputation but, as we got busier, we found ourselves mixing tapes from other studios and eventually it became necessary to standardise with them. I'm glad we now have them because it means we are quieter than ever.

SV What sort of tape do you use?

TB Scotch *206* modulated at +7 dB.

SV I imagine that must help your reputation also. It's been my experience that *206* is the quietest tape around. What about your monitoring system? The speakers you are using are new to me.

TB They are EPI speakers which we drive with SAE *Mk 3A* amplifiers. The model speaker we use is the *201A* and we have eight of them, driven in pairs, to give us the power we need. Of each pair, one is on the floor below the control room window and the other above. I'm very pleased with the speakers. They are made by an American company and each cabinet contains 2 x 200 mm woofers and 2 x 25 mm tweeters. Basically the design is pretty standard except that they are very highly damped and the transient response is far above any other speaker on the market. The rise and fall time of the speaker is instantaneous and the combination of all these things results in a speaker with a very flat response and very clean sound indeed.

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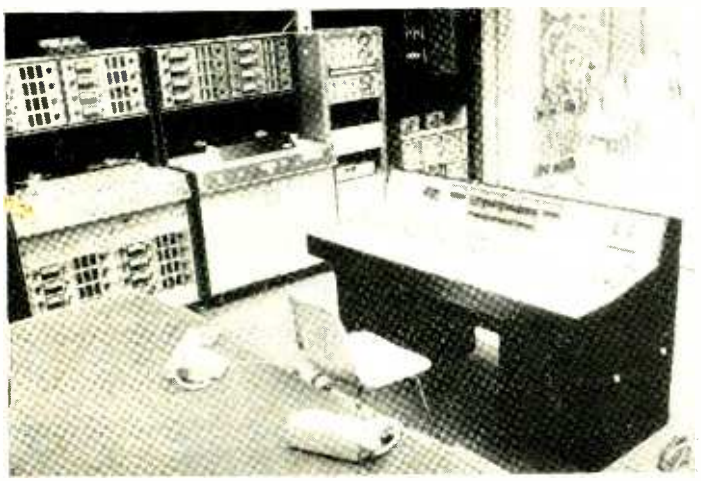

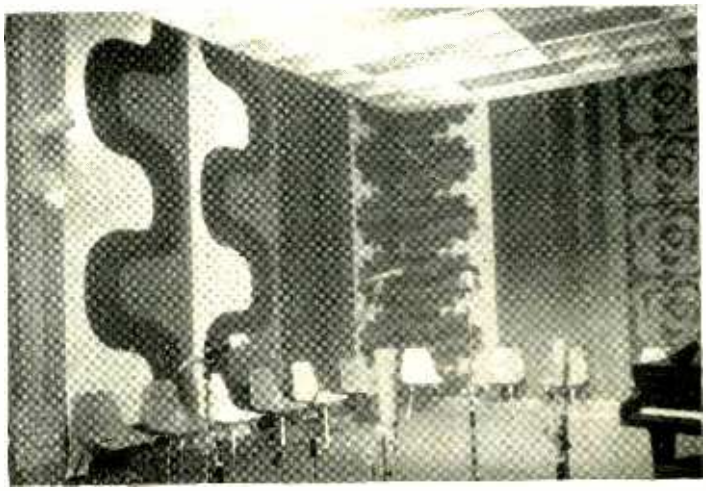

Left: Control room showing Cadac desk.
Right: Origination studio.

PHONOGRAM, LONDON

By John Dwyer

What is now the Phonogram studio opened as the Philips studio in August 1956. At that time it had an eight input mono console with simple equalisation and limiting. In 1958 this console was rebuilt for stereo recording and, in succeeding years, altered again to allow recording on four track tape machines.

In the early sixties the studio began to be used more and more for pop music. Tom Stephenson, studio manager at Phonogram, explained what had happened: 'The groups have made a tremendous impression on music. When the groups came they cut across conventional recording ideas. They brought in multitrack recording and composed with it. Multitrack recording is not just putting other instruments on other tracks, the way of using it is an artistic thing'.

It seemed to Phonogram—then Philips—that most of the available recording studios could not provide the separation necessary for multitrack recording. Phonogram say they were one of the first studios to change the acoustics in the studio and the control room to improve pop recordings; they reduced the reverberation time in the studio to 0.3s and that in the control room to 0.15s.

Having improved the acoustics, Phonogram electronics and recording engineers then prepared a specification for a new recording console. Phonogram tell me that this was the first major studio console to be built by Rupert Neve and that the facilities on it became standard in most London studios.

After these changes had been made Phonogram attracted artists like Dusty Springfield, Cleo Laine, Sandy Shaw, Vicky Carr, Manfred Mann, The Walker Brothers, The Move, ELO, Rod McKuen, Jose Feliciano, Kenny Ball, Humphrey Lyttelton, Benny Goodman, Sir John Gielgud, Robert Stephens and Maggie Smith.

As the list suggests, and as Phonogram's manager, Tom Stephenson, confirmed, the studio has been used for everything from Pop through light orchestral, film music and jingles to Shakespeare plays. Sandy Shaw made her first record there and The Move have been recording there for three years. Roy Wood's Wizzard also work in the studio regularly.

As I mentioned in a recent 'Diary', the studio is booked solid mainly because of the support of Phonogram's own artists. As the studio manager said: 'If artists are getting what they want it gets around. The main point is that our recording console is there mainly so that engineers, artists and producers can work together to achieve best results'.

To return to the story, at the beginning of 1971 Phonogram decided that they needed a new console. Tom Stephenson thought this would be a good opportunity to form a working team with engineers in the Polygram group and thrash out ideas for a mixer which would form a standard pattern for all the other studios in the group. In doing so they could use all the resources of Polygram to make sure that the mixer would be the best available; the Polygram group consists of Phonogram International in Baarn, Holland, and Polydor International in Hamburg, both with subsidiaries throughout Europe.

The talks between the various branches of Phonogram about the mixer aimed to produce a design that would anticipate as many demands as possible. 'Particular attention was paid to flexibility, logical layout and simplicity of operation, especially the latter, as ergonomics, colour coding etc were aimed at a single operator control of the vast array of facilities.' Ron Godwyn, senior electronics engineer, expanded this point: 'The layout is an important feature. The design was laid out here and agreed by our colleagues in Holland. For example, the engineers want to see the text in low-lighting conditions. and they need the rows of controls distinctly colour-coded and positioned in order of priority.

'Our specification, based on our experience and with some brilliant electronics development by Mick Moriarty, one of our electronics engineers, formed the basis for a detailed discussion with our colleagues in Polygram project engineering departments in Baarn and Hanover who were already well into the development of a successful solid state switching technique and practical voltage controlled amplifiers. Other projects in hand at that time included a digital automatic mixdown processor, memstore channel routing and a miniature quadraphonic pan pot. The whole mixer was manufactured by the Phonogram International Project Engineering department, Baarn, Holland, in approximately six months and installed in London on September 8 1972'.

The desk arrived on August 31 and was installed and checked out in a week.There was no time to arrange test sessions with musicians so the engineers started working with the desk on the opening Monday. However, Phonogram tell me that the layout and facilities were so familiar to the engineers that they had no problems.

What makes the desk rather special is that Polygram engineers have been able to use a device in the microphone amp channel which is described as a major breakthrough in circuit design. It is a rather special thin film class B operational amplifier which is used throughout the channel and is only 18 by 21 mm. Because

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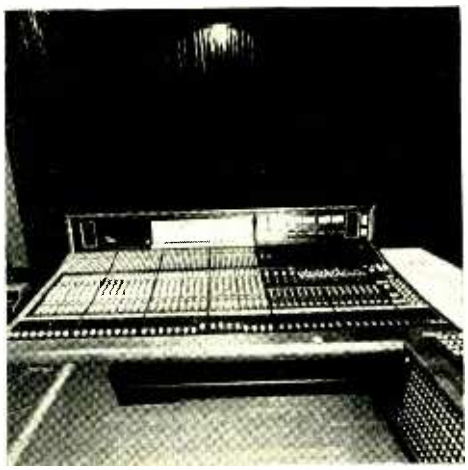
Left to right: Phonogram studio, mixing desk and tape room.



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Tape speeds (3): $3\frac{3}{4}/7\frac{1}{2}/15$ ips; or $7\frac{1}{2}/15/30$ ips. Plug-in head assembly. Electronic speed change. Cast aluminium deck—1" thick. Sel-sync. Cannon inputs, optional balanced or unbalanced. Balanced line outputs. Built-in tone oscillator—700 Hz or 10 KHz. VU meter reads input, output, or bias current. Equalisation and bias controls on front panel. Headphone output.

Stereo version: **£879***
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Console: Optional extra.
DP4050 Cassette Copier: **£2077***

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the device is so small, each microphone channel is only 40 mm wide.

The desk has 32 channels and 16 outputs. Eight of the channels can be switched as submasters. On the microphone channel they have managed to include the following:

Mute button.

Solo button. Any number can be pressed at once and the facility also applies to the monitor, reverberation and foldback channels. The switching is solid state.

Sensitivity control. 6 dB steps. Microphone sensitivity −82 to −22 dBm then, switched to line, −12 to +12 dBm. A vernier control is built into the control knob to give a ± 3 dB continuous variation.

Phase reversal switch.

Equaliser bypass switch.

Equaliser section.

Phonogram regard this section as a special feature and say that it has some departures from current practice. All the equalisaton curves, for example, maintain their slope no matter what the amplitude of the boost or cut.

To arrive at the parameters involved in the high and low frequency sections they built model circuits and then evaluated them by putting them into the studio and assessing how they matched up to what proved necessary in working conditions. The Holland team had developed a very flexible 'presence' boost and cut circuit which had variable bandwidth control. The entire equalisation occupies only 21 cm of panel space. No inductors are used and 'every element of the circuitry has been tested and approved under working conditions'.

Each of the three sections of the equaliser section—low, middle and high frequency—has two control knobs, and four of these are dual concentric types. Phonogram emphasise that all of the frequency selection controls are continuously variable.

The low frequency section comprises a high pass filter with a slope of 24 dB per octave which can be placed at any frequency between 20 Hz and 380 Hz and a continuously variable shelf boost or cut control giving ±12 dB with frequency control variable between 35 and 350 Hz.

The midfrequency section comprises a ±20 dB continuously variable boost and cut control; a frequency control for the above which is continuously variable on two ranges: between 50 Hz and 2.5 kHz and between 240 Hz and 12 kHz; and a constant amplitude bandwidth control which is continuously variable between 0.25 and three octaves.

The high frequency section comprises a 12 dB per octave low pass filter continuously variable between 2 and 20 kHz and a ±12 dB shelf boost or cut control continuously variable between 2 and 8 kHz.

The use of these controls either separately or in combination would certainly seem to be very comprehensive, and Phonogram say 'apart from the more obvious uses of the above curves . . . several extras become available with the presence control switched to negative and narrow bandwidth, such as wah-wah and phasing effects, sibilant filter and even guitar hum filter'.

Pan pot with centre detent (click-stop) and in/out switch.

Pre and post insertion point switches.

Four echo send level controls and pre or post fader switch.

Four foldback level controls. Four separate echo and foldback signals can be sent simultaneously from each channel to the four reverberation and foldback groups.

That completes the microphone module.

The desk outputs consists of 16 voltage controlled amplifiers. Each of these has an individual level control which Phonogram say provides 60 dB of adjustment. In addition there are two master faders to over-ride these controls and fade out all 16 channels.

An extra input to each of the voltage controlled amplifiers is wired to the mixer's patch panel. This input, called the modulation input, can be used to modulate the amplifiers' gain with signals from any other voltage source, be it a function generator, a voice track or a synthesiser element. An obvious future application for this facility is its use for automated mixdown.

About 24 and 32 track, Phonogram's philosophy is that the technical facilities are there to meet the creative needs of producers and artists. 'We are prepared for any eventuality, but we must also be aware of the increased capital cost and return on the investment. At the moment we are watching developments very carefully.'

Channel routing is accomplished by Phonogram-designed electronic switching boards. This system is also used for all other signal routing including echo returns, solo button switching and all the complex monitor switching.

The selector pushbuttons handle only a dc control voltage. They are not illuminated but show a mechanical colour change when pressed. 'This obviates all the problems associated with illuminated buttons and saves 884 lamps.' Not to mention additional complications in the power supply.

'Unipot'

The monitor mixer measures 35 by 55 mm. Each of its 16 channels has a conductive plastic fader, mute and solo buttons, four echo send controls and a quadpot. The latter, known to Phonogram as a Unipot, say Phonogram, gives 'complete freedom of localisation of sound sources within the 360° quadraphonic picture'. The unit was developed by Polygram at Hanover. A switch allows the Unipot to be used as a stereo left to right pan-pot for normal monitoring use. Four more Unipots are provided for placing echo return signals; each feeds an output buss which has its own master fader and VU meter. Phase indicators and correct-level buttons are used to check that the quadraphonic and stereo signals are compatible. The monitor mixer can be used to record a simultaneous quad or stereo mix.

Selection of the various monitoring modes is achieved by a Phonogram-designed logic control system. Thus the engineer can instantly select 16, eight or four track; stereo, reduction or quadraphonic operation. Two a/b buttons on the Monitor Function panel then give the engineer direct or playback monitoring of any mode selected.

For metering, Phonogram eventually rejected a number of systems, including various forms of the now fashionable LED indicators, and decided to use a vertical flying spot light beam meter. They thought that this would give them the clearest level indication with the least eye strain. Thus they have put 16 of these units, with a VU scale, into housing 71 cm long which presents an angle of only 35° to the engineer between one end of the housing and the other. The meters are in circuit after both the a/b switching I mentioned earlier and the logic switching, so that the two meters closest to the engineer, 15 and 16, can be used for stereo, and so on. A stereo peak-reading meter of the same type is placed next to the VUs and is used to monitor the console's stereo outputs during final reductions. In the same main panel area are the meters for the six plug-in compressors.

The console has a number of interesting extras. Phonogram have built a 10W stereo set into the desk for domestic standard monitoring and for communications between one

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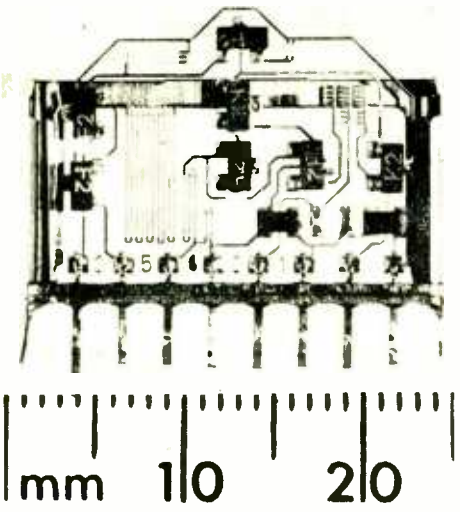
Left: Class B op-amp used in each microphone input channel.
Right: Right-hand mixer section showing cassette machine.



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MODEL 10-4 Modular Mixing desk

The ITA 10-4 is designed to meet the current and foreseeable requirements of the creative Studio Engineer. With the introduction of OTARI and TEAC products, multi-track recorders have now come within the budget of the medium-sized studio. However, mixing desks have become more complicated, being customised to suit the individual engineer's requirements, with the result that no two desks are even similar and their complexity is tending towards unmanageable proportions. By virtue of their individuality such desks are soon rendered obsolete, a point often raised by bank managers and finance houses.

It is an established fact that between 50-80% of a mixer's cost is accountable for labour, thus perpetuating the enormous expense incurred when purchasing a studio mixer. Since the basic configurations of all mixers are similar, ITA decided to analyse the demands of dozens of recording engineers in order to establish the various requirements in order of priority. Once all the information was collated, a very distinct pattern emerged, making it easy to lay down the specification of the ideal mixer.

Since the number one priority was cost, we submitted the specification to a number of electronic manufacturers who were asked for quotations of identical mixers on a quantity basis. The quality of the components was specified as being comparable with mixers costing over £900. An analysis of the spares list proves that 98% of the component costs were by British or European manufacturers, thereby making it possible to maintain tight control over the quality of the finished product. The meters were to be Ernest Turner, the mic-transformers by Gardners, the panels stove-enamelled, etc., etc. The resulting tenders proved that production-line techniques would bring earlier prohibitively priced mixers to the reach of the medium-sized studio with delivery times down to within seven days.

Immediate Delivery. Model 10-4 Mixer: £562*

*Prices exclude VAT. Credit facilities available

PHONOGRAM

part of the studio and another. More interesting is the cassette recorder which they have mounted in the desk and which is connected to the monitoring system. The facility this provides, whereby a producer can take home and play a rough mix of the day's work, is very popular, I am told. The patch panel is unusual in that it uses Tuchel connectors instead of the more common GPO jacks, and the jack cords are elastic; another example of Dutch ingenuity. The bay provides access to all parts of the mixer and allows what Phonogram call 'a few tricks'; for example, an equaliser on an unused channel can be used elsewhere. As far as the console's trim is concerned, I should mention that the dashboard's genuine leather, and I kid you not.

About the circuits of the mixer itself a couple of other points are noteworthy. All multipole unit and cable connectors are gold-plated AMP type with wires crimped, not soldered, which Phonogram say gives 'better long term reliability'. Pins, with wires attached, can be repositioned in the holder at any time. The system uses transformers at the microphone inputs and main outputs but is assymmetrical everywhere else.

There is a built-in signal generator and all 32 channels are provided with phantom power. Elapsed time is indicated on a built-in digital display and there is a remote display in the machine room. Both displays are of the light-emitting diode type.

Another interesting thing about the desk is the way it is supported. Two metal beams are cantilevered out at right angles from a massively constructed corner unit. Both the main desk section and ancillary section at right angles to it have a hollow square section tube running through them which allows them to slide onto the beams. The total weight is about 1 tonne supported without legs at the ends. Phonogram measured the displacement when two of their engineers sat on one end and it was about 1 cm.

Phonogram have one studio and a maze of offices, workshops and reception areas. When I was shown into the reduction room, I asked whether the studio used Dolbys and, if not, would they consider using them? I was told that they had two sets of Dolbys for dealing with tapes from other studios and that they were considering using Dolbys on multitrack recording mainly to satisfy the needs of clients. This had become also a commercial issue as Dolbys were more or less becoming a standard in London studios.

I also asked why there were VUs and ppms on the desk and was told that the most suitable instrument is used for the particular job in hand.

'We use VUs to measure dynamic range and average level. We use the ppms at the reduction stage to observe fast peaks which may give cutting problems.'

The reduction room has an eight track Neve mixer which is used for reductions, copying and general work. Some reduction work is also done in the control room of the studio. As we went into the recording room Ron Godwyn said that connections to all the tape machines and equipment in Phonogram were centralised in this one room. They were plugged through by Tuchel connectors on the main patch bay.

Later Tom Stephenson talked about Phonogram's training policy: 'We believe in people having experience of all the jobs that have to be done. We do not engage tape operators as such but young men with the right background, temperament and personality to develop into recording engineers. All the engineers at Phonogram have been developed in this way. If everything was remote controlled they would be missing a vital part of their training'. Phonogram's three senior mixing engineers are Peter Olliff (also deputy studio manager) Roger Wake and Chris Harding.

Phonogram is a most impressive place. Particularly impressive is the amount of technical expertise the studio have available, both on and off the premises. The technical support comes from Ron Godwyn, Mick Moriarty, already mentioned for his development work on the console and who is always busily engaged on new developments, and Gary Moore, a specialist on tape machines. The studio also boast that they have 'the two best operators in town', Steve Brown and Stephen Lillywhite, not to mention Fred Beekman the studio porter.

TORONTO SOUND

SV They are very small compared with most studio monitors. What dimensions are they?

TB They are 700 mm long, 460 high and 280 deep. This is handy for us because our control room shape doesn't lend itself to putting in a conventional size speaker. We have a huge window 2m high and, as the desk faces into the studio, the only place the speakers could go was above and below the window. The EPIs are a perfect size for those locations.

SV What do you use for echo?

TB Two EMT stereo plates.

SV And limiters?

TB We use several of our own design limiters which work very well. They are the light dependent resistor variety. We also have two Pye compressors in the desk and four Universal Audio limiters in a rack.

SV What percentage of your business is taken up with groups?

TB I would say that around 80 per cent. When we first opened in November 1969, we were the only 16 track studio in Toronto and also the only studio really equipped to record groups competently. Naturally we have built up a good reputation for group recording and that includes *all* kinds of groups. I recently found out that, for the three months from July to September 1972, 45 per cent of the records in the Canadian charts were recorded here in this studio. Most of the remainder of our business is taken up with commercials.

SV Who are the other engineers?

Right: Control room viewed from studio.

TB Peter Houston has been with us since we opened up. Dave Slagter has also been here since the beginning but only started engineering in the past four months. We also have a maintenance engineer, Ivan Durov, who put the studio together in the first place and has kept it together ever since.

SV What plans do you have for studio expansion?

TB We've just completed a tape dubbing room and that's now in operation. This year we hope to be able to put in a mixdown room, which will have a voice-over studio adjacent. There will be enough room there to record small rhythm sections as well. Thinking further ahead to around 1975, we hope to build a bigger studio which will be about 10 x 10m with a bigger control room, a voice-over booth, and another lounge for musicians. We already have one lounge which we are in the middle of improving. We have a couple of rehearsal rooms where clients can rehearse with a piano. We need those especially while prerecording for tv shows, of which we do quite a few.

Toronto Sound are the most established studio in Toronto and at $100 an hour for 16 track it's nowhere near the most expensive. The atmosphere is friendly and helpful and the whole operation runs smoothly and efficiently. On top of this the sound is as good as their chart record indicates. With studios of this quality around, I'm sure that Canadian music is going to start being noticed around the world before too long.

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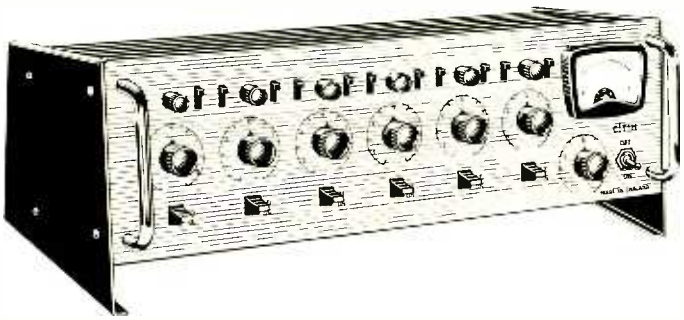

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VIDEO

By Roderick Snell

SHIBADEN 600

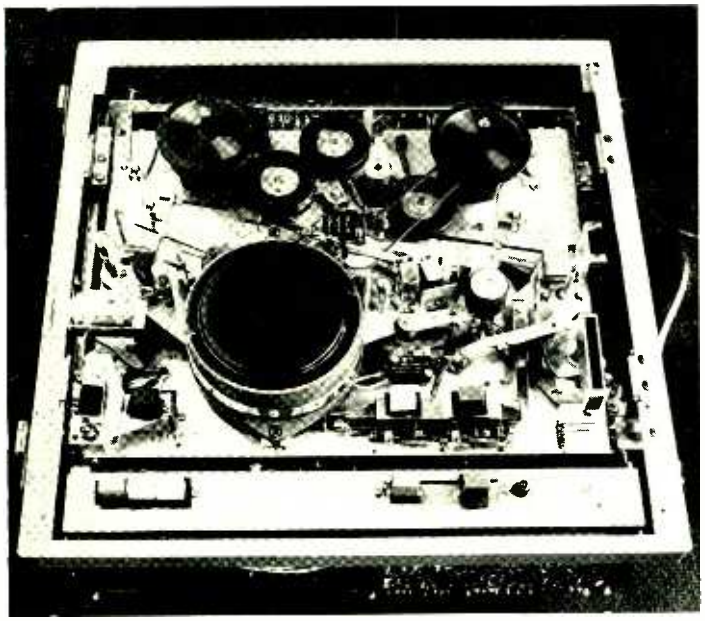

FIG. 1

SHIBADEN AGENTS: Shibaden UK, Lodge House, Lodge Road, Hendon, London NW4 4DQ.

THE SHIBADEN 600 series of monochrome and colour videotape recorders comprises four models using a 12.5 mm format conforming to the EIAJ/1 format, modified for CCIR 625 line use in accordance with Document Five of the EIAJ Technical Committee. The main difference between this and the NTSC specification is that linear tape speed is now 16.32 cm, playing time approximately 70 minutes, and horizontal resolution 240 lines.

The first 12.5 mm vtr available in Europe for 625 lines was the Shibaden *SV700E* which appeared here in 1967 (the Sony *CV2000* available at that time had only sufficient resolution for 405 line use). Since then, Shibaden's range of equipment has expanded to the point where they are now the second largest distributors of far-Eastern cctv equipment in Britain. Detailed improvements and the addition of battery portable, slow motion, and electronic edit versions kept their 12.5 mm vtr range up to date and it is to their credit that their original format was sufficiently advanced to remain competitive until this time.

A colour adaptor was developed for the American and Japanese markets but the decision to go over to the EIAJ/1 standard stopped the European version at the prototype stage.

Shibaden's new range of vtrs does not include a battery portable at the moment (although their *SV-7550* record-only system is listed for the 525 line standard) but the pressure for a CCIR version is not too great since both the Nivico (*Studio Sound* May 1973) and the new National battery portable record/replay systems are compatible.

The new range of machines is based on a different tape transport mechanism which has many differences from the *SV700* series, some resulting from the new format, others from design improvements.

Lighter weight

The most obvious change is a dramatic reduction in weight. The use of dc motors for driving the capstan and drum has reduced the power requirements from 95W for the *SV700* to only 55W. So, apart from the lighter motors, the power transformers smaller and the cooling fan and motor have been eliminated.

The single metal tape control lever of the *SV700*, which has since been adopted by most other 12.5 mm vtr manufacturers, has been retained here and is probably the best choice where one motor is used to drive both the tape reels and capstan and single-handed operation is needed. The drum, fixed heads and critical tape guides are all fitted to a rigid casting which lies on the usual pressed steel deck plate; this in turn is stiffened by an extruded aluminium frame which forms the outer edge of the deck and at the same time allows a simpler case to be used. Both carrying handle and bottom rubber feet are fitted to the metal frame and the case can be lifted off without disconnecting the power and signal leads, leaving the recorder standing on rubber feet for easy access (see figs. 1 and 2 which show the colour edit version). The weight reductions therefore result from improvements rather than engineering economies.

The top deck mechanism is simpler and probably more rugged than the earlier machines, using wider rubber pulleys and brake drums. The pay-off reel flutter filter now bears on the oxide side of the tape and operates a simple back-tension servo; this is an advance on the simple felt washer for back tension on the earlier machines, which sometimes caused compatibility problems.

Although smaller, the deck will still accommodate Shibaden's 19 cm spools. These larger reels make handling easier (as the tape does not spill out of a full reel) and, if extra tape is spliced on to the normal 730m length, a 95 minutes playing time is achieved without using thin tape.

Ferrite heads

The video heads are now ferrite, which should out-wear the metal types used in the *SV700* series by a factor of three or four. Ferrite heads were available for the *SV700* but, while giving the expected increase in life and good playback performance, were unable to saturate the tape so gave noisy recordings. This, incidentally, is why metal heads still have to be used on expensive broadcast vtrs.

Each video head has its own preamplifier and equaliser, their output selected by switching pulses derived from the control track. The changeover point is timed at seven lines before vertical blanking, in accordance with the EIAJ specification.

In the words of the poet who wrote the service manual: 'a noise limiter . . . functions to abate the visual noise to which the eyes of the human is most sensitive'. Like the system used in the Sony *CV2100*, the demodulated video is separated into two bands, centred about 500 kHz and threshold limiting (or the video equivalent of 'squelch') is applied to the higher frequency band. The system certainly works, as these machines had the lowest noise of any vtrs so far measured, but it may also reduce the resolution.

Apart from weight savings, the dc motor driven head drum has shortened run-up and lock-in times. The dc transport motor also uses a servo regulator, lending itself for use in variable slow motion without any increase in complexity (the slow motion version of the *SV700* series added about £80 to the cost). It also gives faster rewind times. The remaining advantage of the capstan servo is, of course, that the tape speed is independent of mains voltage or frequency; the recorder can be used on 50 or 60 Hz, or even low voltage supplies.

Finally, a mains locked interlaced sync pulse generator is included, enabling the vtr to be

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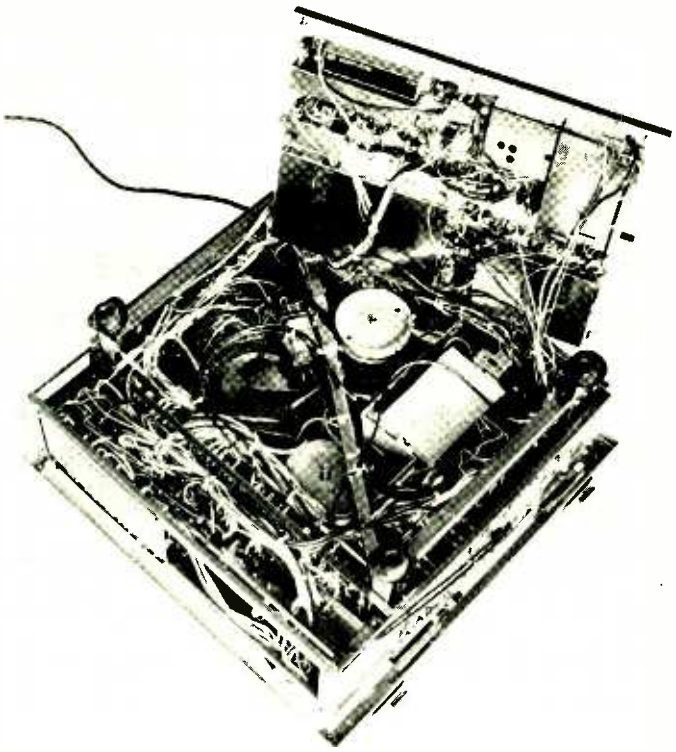

FIG. 2

used to drive low cost random interlaced cameras. Still frame and slow motion performance from random interlace cameras being very poor on all vtrs.

Power and signal connections now occupy an inset panel on the right side of the recorder: DIN for sound and UHF connectors for video inputs and outputs, together with the eight-pin combined socket for use with the EIAJ standard monitors available from Sony, Sanyo, Shibaden, Ikegami, etc. This panel also carries tracking and chroma level controls which, as they rarely need touching, have a preset position.

Lacing was slightly simplified in that the tape did not have to be manoeuvred around the flutter filter. The function selectors were rather stiff but otherwise the transport was smooth and silent when compared with the earlier 12.5 mm machines from Shibaden and others. Rewinding was rapid and the brakes gave very gentle handling of the tape. The time taken to rewind a 75-minute tape was now only two minutes 50 seconds.

The drum servo was very quick to synchronise. Whereas the earlier Sony and Shibaden recorders took between three and five seconds, these recorders were steady within 1.5s, giving cleaner starts and junctions to recordings.

Reproduced pictures seemed completely noise-free and had the increased stability and freedom from jitter that is common to this format. Monochrome recordings were made on Shibaden's own tape and looked particularly clean and stable, with adequate detail. Tests with cameras, off-air testcards and a sweep generator showed a video signal-to-noise ratio of 46 dB, a minimum of moire patterning, and good transients but the frequency response was −20 dB at 3 MHz with a limiting resolution of just over 250 lines. While this is within the EIAJ specification for CCIR systems of 240 lines, it is not as good as Shibaden's own claim of 280 lines but it is interesting that the subjective improvement resulting from the low noise and moire seemed to offset the reduction in sharpness when compared with the standard set by the *SV700EC*. Also, the wide margin in noise level (6 dB better than the 40 dB of the specification) made the recorders much less fussy about the grade and condition of the tapes used. For example, an old Shibaden tape rejected for dropout and consistent head clogging on an *SV700E* gave good results on the new recorder, with no clogging, reduced dropout and a noise level of −44 dB. With several other tapes, including extra-play and budget types, the noise was always better than −43 dB. High energy tapes from Sony and 3M gave noise levels of −49 and −48 dB respectively but this is beyond most people's requirements. For those wishing to use other makes of tape, it is worth pointing out that Shibaden's guarantees of performance and head life apply to machines used with their own tape.

Audio philosophy

The sound circuits seem to have been adjusted with the same philosophy: again the noise was better than specification at 46 dB (50 dB 'A' weighted) below the recorder's 0 VU mark, but the sound frequency response taken at 12 dB below 0 VU was −3 dB at 70 Hz and 8 kHz, referred to the level at 1 kHz. DIN weighted wow and flutter measured 0.13 per cent through most of the reel, rising to 0.16 per cent at the end.

Compatibility was checked with seven other machines of four makes, including 525 line models from the USA, and the tracking control only needed moving from its preset position on one sample.

The *SV610K* is the lightest of the 12.5 mm Japanese vtrs and its smooth functions probably give low tape wear. Short run-up times and improved servo stability make for neat starts and means that, for most users, the tracking control need never be touched. The ferrite heads can be expected to give upwards of 1,500 hours life and when maintenance is needed the construction makes this easy. Resolution may be low for some users but for most this will be offset by the very low video noise.

The *SV610KD* Electronic Edit version adds rather more to the cost of the basic machine than did the edit version of the *SV700EC* and, like that recorder, uses a capstan servo and split erase head to give the insert and assemble editing facilities that have always been the most often needed extra on studio and broadcast vtrs.

Capstan servo

The editing electronics consist of an accurate capstan servo capable of synchronising the recorder on playback to the field sync pulses of an incoming signal which could be a broadcast or camera source but more often is the playback from another vtr of 'takes' which are to be assembled to make a programme. After the first sequence has been copied on to the edit machine in the normal recording mode, this section is rewound and played back, simultaneously with the next insert required. The edit recorder is now switched into the 'assemble' mode (synchronising it with the playback machine) and the record button pressed at the instant chosen for the cut. There will now be a disturbance-free cut to the incoming 'take' and this way programmes can be built up from randomly recorded sequences.

In the 'insert' mode, a new sequence can be electronically spliced into an existing recording without disturbance at the beginning or end. The start of the insert is similar to an assemble edit described above but here the split erase head is switched to leave the control track intact. Then the operator must release the record button 2s before he wishes the insert to end. When this is done, the erase head turns off and the 2s delay allows the part of the video track lying between the erase head and the drum to be filled with the insert.

Improved editing

Some users of the earlier *SV700ED* found the process a little precarious. Some edits worked, others would not. One could not make inserts into a tape originating from another recorder and, if the programme source consisted of a replay from another vtr, the edit recorder's servo would not remain stable if this source was anything less than perfect. It was always easier to identify these problems than to devise a cure because they did not lie in the design of the *SV700ED* but in the lower standard of stability and cruder mixing equipment commonly found with users of 12.5 mm vtrs. Given the sort of signals that the more expensive 25 mm editing vtrs had to work with, the *SV700* worked as well.

It is pleasing to be able to report that the new EIAJ/1 format is more suitable for this

task than Shibaden's own. Problems of tracking and compatibility are reduced and this, together with the stability improvements in their new series of recorders, has all but eliminated these problems. The edit timing control, which needed critical adjustment on the *SV700ED*, can be left in its preset position for most editing jobs. This includes most tapes recorded on other machines and, using tapes from many sources, dozens of insert and assembly edits were done without difficulty.

Other vtrs offer various editing facilities, from the simple technique of switching to record during replay to the full insert and assemble features of the *SV610KD*. While this machine is marginally the most expensive, it is the only 12.5 mm vtr to give the same editing possibilities that are found in the vastly more expensive 25 and 50 mm studio machines. Finally, at 14.5 kg, it is still lighter than most non-edit machines.

Colour edits

The *SV620K* colour vtr was not tested as such but the *SV620KD* colour edit machine was used as it had the same colour electronics and allowed the colour performance on electronic edits to be assessed. The colour coding system used is basically the EIAJ 'M' type, designed for CCIR use, and is switchable between PAL and SECAM (SECAM coding being used in France, Belgium and the USSR). On PAL use, the colour information (centred at 4.3 MHz) is separated from the luminance signal and frequency converted to a 560 kHz carrier which is recorded as an amplitude modulation of the basic monochrome fm carrier, as in the Philips VCR (STUDIO SOUND March 1973). The playback decoding is more complex, however, in that these open reel recorders have stop-frame and slow motion facilities, requiring the colour carrier correction circuits to cover much wider frequency errors. In addition to the normal subcarrier phase corrector which compensates for jitter and other short-term errors, Shibaden have added a multiple of the line frequency with a signal divided down from a crystal-controlled 4.9 MHz sum components from the subcarrier regenerating circuit. These two signals are compared and the resulting error voltage used to drive a variable capacitance diode which retunes the phase corrector circuits. Thus the apc corrects line-by-line errors and the afc corrects the longer term changes resulting from changes in linear tape speed. All this makes the colour electronics quite complex (**fig. 2** shows the large colour board lifted off the chassis of the edit recorder) but does not prevent the system being compatible with the much simpler colour processing system used in the Ikegami *TVR-321E;* recordings interchange perfectly between these two.

Normal limitations

Off-air, live signals and electronically generated tests were tried and the normal limitations of all the lower cost open reel and cassette colour systems were evident but not obtrusive. The monochrome bandwidth reduced from about 3 to 2.5 MHz (i.e. 250 to 210 lines) and noise in fully saturated colours became evident if the control on the monitor was raised above

norm. The use of high energy tapes reduces this chroma noise and is obligatory in, for example, the Sony and Philips cassette systems. It can be used with the Shibaden recorders but the extra cost may not be thought worthwhile. One other effect was noted on the machine tested and that was a chroma registration error: fully saturated yellow sections of the picture were slightly displaced to the right.

Performance criteria for low bandwidth colour coding systems have not yet been established and they all fall short of broadcast standards. The recorder being tested gave excellent colour pictures which were as good on still frame, slow motion, and electronic edits.

The new deck mechanism and EIAJ/1 format have combined to produce a range of recorders that are easy to service, lighter than any of their competitors, yet certainly no less rugged. Problems of maintaining compatibility between machines have been greatly reduced and the models tested seemed less critical of the tape used. The format chosen opens up the possibility of using battery portables, special slow motion versions, remote control machines and, when they arrive, self-loading cartridges. Using Shibaden's own tape, at retail prices, colour recording cost only £8.65 per hour, with 75 minutes playing time. Most users will warrant some sort of discount on tape, making an economical system. All in all, the range is a worthwhile advance in the low-cost video recording scene.

Postscript: Shibaden engineers claim that they are now modifying the pre-emphasis circuits to bring the resolution up to the claimed 280 lines. In view of the wide margin in noise on the machines tested this seems sensible: a modified version will be reported on in the future.

VIDEO SUPPLEMENT

A special supplement devoted to television and video tape recording will be published in our September issue. This will include a survey of presently available vtrs and television cameras and a test report on the new Sony *U-Matic* video cassette recorder.

Constructing a quadraphonic capacitor microphone

PART FOUR

JOHN FISHER

FIG. 1 SIMPLIFIED CAPACITOR HEAD AMPLIFIER

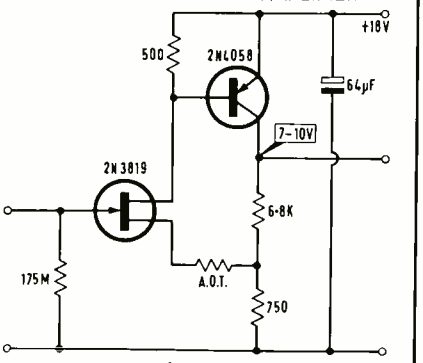

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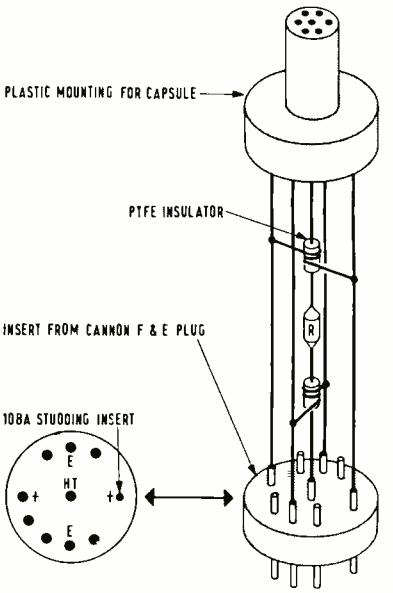
FIG. 2 BUSBAR ASSEMBLY



LINKS AND HT RESISTOR SHOWN, DECOUPLING CAPACITORS AND OTHER COMPONENTS OMITTED FOR CLARITY.

CONSTRUCTING AN intrument of this kind is something of an act of faith. By the time one has finished, even if all goes well, one has made a substantial outlay. At a very quick calculation, which is probably also a considerable under estimate at present prices since a number of the items emerged from the spares box or were bought for the project when it first began to take shape a long while ago, there would be no change from £50 for components and raw materials. Buying commercial capsules, the basic cost would have been at least double at these prices and possibly nearer £120. This also makes no allowance for very many hours of work, soothing flowers, and dinners out for a long-suffering wife to make up for short-tempered moments of despair, or inroads on the whisky bottle after dropping a capsule on a hard floor in the early hours of the morning. It also takes no account of using or borrowing machining facilities. I would be inclined to charge somebody quite a lot to build one of these microphones commercially.

Has it been worthwhile? Very simply the answer must be yes. Labour and time apart, two cheap professional cardioid capacitor mics would have cost more and been less flexible for stereo recording. An AKG C24 or similar variable polar diagram stereo microphone, even second-hand, would have cost considerably more. Neither would have provided the option of a quadraphonic output. I have no doubt that the commercial alternatives would have certain advantages over this one but the recordings I have heard made with the instrument so far suggest that its performance is very satisfactory for many purposes. While I do not imagine for one moment I shall abandon my miniature back-to-back cardioids altogether, because of their small size and inconspicuous shape, I anticipate many situations when the new microphone will give a sound preferable to that obtainable using the smaller microphones. The noise level is very satisfactory and the frequency and polar responses seem acceptable.

So much for two-channel stereo. Half the point in building the microphone was to investigate and record quadraphonic signals using as nearly coincident a set of capsules as possible. Having started comparatively recently in this field, I am not sure that I can really offer any valid conclusions but my impressions may be of interest particularly as applied to recording with this microphone.

Firstly, my impression is that the transition from good stereo to good quadraphony is rather more marked than the transition from mono to stereo, certainly than the transition from two speaker mono to stereo. I am concerned here entirely with reproducing sound as heard in a concert hall, church or outdoor environment, rather than with discrete instrument-in-every-speaker quad or stereo. The latter I find good for a giggle when it's a synthesiser and possibly an interesting new experience but not one I wish to be subjected to in every recording. I am concerned with reproducing the most realistic sound of the kind one would hope to hear from the best seat at a musical performance, preferring to err on the side of realism rather than idealism.

If I appear to be overstating the difference, perhaps I may add two things. First, this has also been the reaction of a number of non-technical but musical listeners; my wife in particular, had caused me some concern in the early days of our acquaintance through her obvious lack of appreciation of the superior sound of my stereo equipment compared with her mono record grinder. She was instantly enthusiastic over the playback of the first experimental quadraphonic recording, without knowing that this was appropriate reaction. The improvement in realism is certainly very striking when things are properly set up.

My second point is in a sense rather negative. On consideration, I wonder whether it is worth the extra expense to go quadraphonic. I have no doubt it is a step nearer ideal reproduction. I suspect however that it is wise to tread with caution in the present state of the art, since I anticipate many changes to come, possibly including a general realisation that adequate information for flat surround via discrete channels can be provided by three channels. I fear the main two channel systems are an

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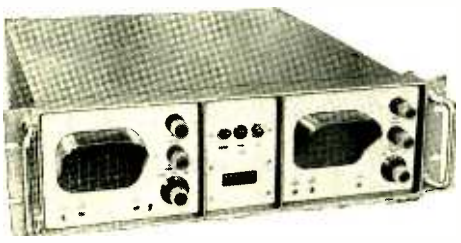

Airtech Mo100

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MO100 monitor oscilloscope

Display system: 10 cm double gun crt has a common X deflection system and pda operating at an overall voltage of 3.2 kV. The P31 medium short persistence screen is fitted with a green filter and a visor hood is used to improve viewing in brightly illuminated areas. The minimum screen area is 5 cm x 8 cm for each trace with a minimum overlap of 4 cm. Removable graticule provided, marked in 1 cm squares. Alternative markings can be supplied.
Vertical deflection system: two Y amplifiers, each with independent preset gain control. The bandwidth of each Y amplifier is 10 Hz to 500 kHz (-3 dB). At the maximum gain position the sensitivity is 200 mV/cm. The minimum sensitivity is 2V/cm.
Input impedence: not less than 10k ohms at 10 kHz and not less than 1k ohms at 500 kHz.
Time base: 20 ms/cm and 10 μs/cm.
Power unit: 100 to 130 or 210 to 150V, 40 to 60 Hz ac supply. The total consumption for two indicator units is 50 VA.
Dimensions: 483 x 133 x 495 mm.
Weight: 15 kg.
Price: On application.

BRADLEY

Bradley Electronics Ltd, Electral House, Neasden Lane, London NW10.
Phone: 01 450 7811

200

The model 200 mainframe houses the cathode ray tube, the main X and Y amplifiers and the power supplies. It has been designed to take a range of plug-in modules of which the 201Y amplifier and the 201Y amplifier and the 211 timebases are the first. The mainframe Y amplifier has a bandwidth from dc to greater than 100 MHz and the X amplifier from dc to 4MHz. The front panel carries the display and trigger mode controls and those for focus and brilliance. A number of Y1/Y2 display modes are provided. These are: Y1 only Y2 only; Y1/Y2 alternate; Y1/Y2 chop (500 kHz) and Y1 and Y2 add. High intensity 8 x 10 cm rectangular faced single gun, mesh pda tube with 13 kV accelerating voltage.
Graticule: 8 x 10 cm on internal graticule variable edge illumination. Detachable grey natural density filter. Provision for standard camera adaptor to take Shackman *A7*.
Power supply: 100 to 125V or 200 to 250V, single phase 48 to 60 Hz. Consumption 120 VA.
Impedance: 1M ohms shunted by 18 pF.
Bandwidth: dc to 4 MHz with 8 cm pp deflection.
Warning lights: indicates when time/division control is off cal, and when X10 expansion is in use.
System price: £595.

3100

General: 8 x 10 cm rectangular faced internal graticule crt, single gun, mesh pda tube, with 10 kV overall accelerating voltage, P31 phosphor standard, other phosphors on request.
Beam finder: overrides brightness and limits vertlcal and horizontal deflection to bring bright and bright trace on the crt face.
Input impedance: 1M ohm in parallel with 25 pF.
Main timebase: 0.2 μs/div to 0.5 s/div in 20 calibrated steps of 1, 2, 5 sequence. A variable control covers between the steps and extends the range to least 1.25 s/div. Warning light indicates uncalibrated setting.

4100

Vertical deflection: two channels having dc to at least 75 MHz, rise time 5 ns, from a 25 ohm source. 5 mV/div to V/div in nine steps with 1, 2, 5 sequence. A variable gain control covers between the steps and increases the range to greater than 5 V/div. Vertical deflection magnifies by a factor of five, increasing maximum sensitivity to 1 mV/div with bandwidth of 20 MHz.
Input impedance: 1M ohms (±2%) in parallel with approx 20 pF.
Horizontal amplifier: 6 MHz bandwidth. 20 mV/div when using x ten magnification.
Power requirements: quick change line voltage selector covers voltages between 100V to 125V and 250V (48 to 440 Hz). Consumption 80 VA at 50 Hz.

BWD (Australia)

Agents: Racal Instruments Ltd, Duke Street, Windsor, Berkshire, SL4 ISB
Phone: 95 69811

509B

Bandwidth: dc to 7 MHz (-3 dB) referred to 4 cm deflection at 50 kHz.
Input inpedance: 1M ohms and 40 pF constant.
Timebase: 1 μs to 1 s/cm in six decade steps with 12-1 vernier between each step.
Horizontal sensitivity: 600 mV to 6.5 V/cm.
General: Crt 13 cm diameter flat-faced *5UPIF* operating at 1.6 kV eht. P1 medium persistence phosphor standard. P7 long persistence available as an option. Fitted with detachable graticule/filter and four hole camera mounting.
Power requirements: 85 to 135V and 190 to 265V, 50 to 60 Hz 30W.
Dimensions: 24 x 19 x 42 cm.
Weight: 7 kg.
Price: £125.

539

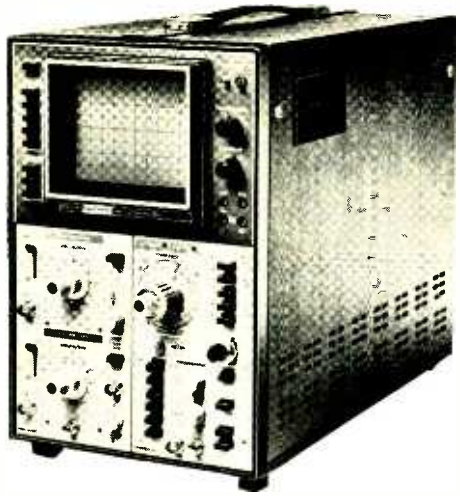
Vertical sensitivity: 10 mV to 50 V/cm in 12 calibrated steps.
Input impedance: 1M ohms and 40 pF constant.
Display: channel A and B alternate or chopped, channel B only.
Time base: 1 us to 0.5 s/cm in 18 calibrated steps of 1, 2, 5, 10 sequence +5.1 vernier extending range to 2.5. s/cm.
Horizontal sensitivity: 70 mV to approx 10V/cm continuously variable.
General: Crt flat faced with 8 x 10 cm viewing area operating at 3 kV eht. Fitted with cm graticule on green light filter for high intensity maximum contrast display. P31 phosphor normally supplied, P7 available to order.
Power requirements: 30W approx 90V to 135V in three ranges, 190V to 265V in three ranges. 50 to 60 Hz.
Dimensions: 24 x 19 x 42 cm.
Weight: 7 kg.
Price: £199.

COSSOR

Cossor Electronics, The Pinnacles, Elizabeth Way, Harlow, Essex.
Phone: 027 96 26862

CDU150

Sensitivity: 5 mV/cm to 20 V/cm in 12 steps with 1, 2, 5 sequence. A variable gain control covers between the steps and increases the range to 50 V/cm.
Display modes: channel one, channel two, channel one and two alternate sweeps, chopped (chopping frequency 500 kHz), channels one and two added (invert facility both channels).
Horizontal amplifier: sensitivities of 100 mV/cm, 200 mV/cm, 500 mV/cm, 1V cm and 5V cm. Accuracy ±3°. Input impedance 1M ohms (±1°) shunted by 25 pF. Bandwidth: dc -3 MHz. (-3d B).
Cathode ray tube: 8 x 10 cm. Rectangular faced, single gun mesh post deflation acceleration tube



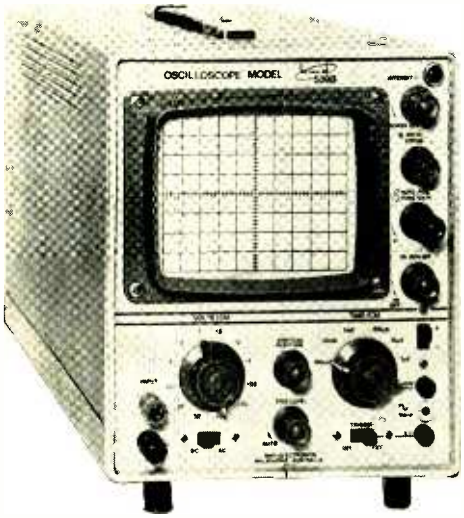
Bradley 200

with 12kV overall accelerating potential. P31 phosphor standard. Long persistence phosphor available.
Power requirements: 100 to 120V ±6% or 200 to 250V ±6% 45 to 440 Hz consumption 110 VA.
Dimensions: 260 x 260 x 410 mm.
Weight: 12.7 kg.
Price: £473.

CRC
Manufacturers: Constructions Radio-electroniques et Electroniques du Centre (France) (Subsidiary of Schlumbrger). Agents: Solartron Electronic Group Ltd, Farnborough, Hampshire.
Phone: 0252 44433

OCT588A

Type: D13450 crt, rectangular single gun mesh pda, 13.5 kV eht.
Display area: 6 x 10 cm.
Vertical amplifier: 150 MHz bandwidth. 0.15 V/cm sensitivity.
Horizontal bandwidth: more than 10 MHz sensitivity: 0.3 V/cm.
Power requirements: 105 to 115 to 127 to 220V to 240V ±10% (50 to 400 Hz), approx 220 VA with plug-in units.
Dimensions: 223 x 590 x 403 mm.
Weight: 22 kg.
Price: £775 + VAT.



BWD 509B

OCT590/592

Vertical bandwidth: (-3 dB): 250 MHz, with H/5901 preampl fier.
Sensitivity: 10 mV & 20 mV/div up to 200 MHz, 50, 100, 200, 500 mV & 1 V/div up to 250 MHz.
Timebase: 0.02 µs/cm to 1 s/cm in 24 calibrated ranges in 1, 2, 5 sequence.
Horizontal sensitivity: 100 mV/cm to 1 V/cm calibrated with continuously variable control.
Power requirements (592): 110 to 127, 220 to 240V ±10% 50 Hz, 350 VA.
Dimensions: 410 x 300 x 650 mm.
Weight: 32 kg.
Price: £2,020 + VAT.
Dual trace sampling oscilloscopes.
Three basic sampling modules are available which plug in to the 70 MHz OCT587A (or 587AR) and 150 MHz OCT588A (or 588AR) real time oscilloscope main frames. The sampling units are double width 58 series plug-ins which fit into the space normally occupied by both vertical and horizontal 58 series plug ins. Separate data sheets fully describe the bench (a) and 483 mm rack mounting (ar) main frames and the 18 real time 58 series plug in units. The OCT587A mainframe gives a 10 x 8 cm display with internal graticule and 15 kV eht while the OCT588A has a display of 10 x 6 cm internal graticule and the same eht.

BWD 539

OCT587A and AR

Crt: type D14160, standard phosphors P2 and P11, 15 kV eht.
Display area: 10 x 8 cm.
Vertical amplifier: 70 MHz bandwidth, 0.15 V/cm sensitivity.
Horizontal amplifier: 15 MHz bandwidth, 0.3 V/cm sensitivity.
Power requirements: 11 to 127V or 220 to 240V 50 to 400 Hz.
Price: £680.

OCT588A and AR

Crt D13450 phosphor standard, persistence 40 µs to 10% normal intensity, 13 kV eht.
Display area: 10 x 6cm.
Graticule: internal with variable illumination
Eht: 13 kV.
Vertical amplifier: 150 MHz bandwidth, 0.15 V/cm sensitivity.

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Horizontal amplifier: 10 MHz bandwidth, 0.3 V/cm sensitivity.
Power requirements: 105 to 240V ± 10% 50 to 400 Hz.
Price: £837.

OCT749R

Bandwidth: (-3 dB) dc to 750 kHz.
Input impedance: 1M ohm in parallel with 40 pF.
Crt: 18 cm diameter flat faced, 3 kV eht, 14 x 14 cm graticule.
Power requirements: 110 to 127V, 220 to 240V, 50 Hz.
Dimensions: 311 x 450 x 600 mm.
Weight: 24 kg.
Price: £1293 + VAT.

DYNAMCO

Manufacturers: Dynamco (a division of Electronic Flometers Ltd), Central Way, Walworth, Andover, Hampshire, SP10 5BY.
Phone: 0264 65961/8

71 series

This comprises the 7118 dual channel amplifier, the 7130 display unit and the 7103 delayed sweep timebase.

72 series

The series comprises the 7212 dual channel amplifier the 7200 display unit, the 7202 gated delay timebase, and the 7201 timebase module.

Drift: ±0.5 cm/h short term stability 0.1 cm.
Line identification 'cross-wire' bright-up strobe on raster X1 shows line selection and position of start of expanded display. Line delay one triggers from leading edge of line sync. Line delay two triggers from trailing edge of line sync.
Cathode ray tube display: 12.7 cm rectangular face place mesh screened pda.
Spot size: 0.4 mm nominal.
Tube linearity: 2% over centre 8 cm.
Phosphors: P31 (gh) as standard. Others including P2 (gp), P7 (gm) and P11 (be) available to special order.

GRUNDIG

Grundig (GB) Ltd, Newlands Park, London SE26 5NQ.
Phone: 01 778 2211

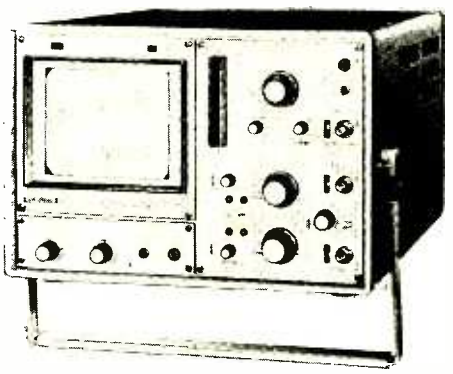
G10/13Z battery/mains

A twin channel oscilloscope suited for data processing, colour television or stereo engineering. It has a bandwidth from dc to 10 MHz and the smallest deflection coefficient is 2 mV/cm. A selector switch allows the following input signal selections: (1) channel a only, (2) channel b only, (3) a & b addition of both signals, (4) a-b (5) chopper operation—100 kHz switching triggered by channel a (6) alternate—triggered by channel a (7) alternate—trigger signal derived independently from input signals. The ac/dc input changeover switch also has a position to display the zero or reference line.

Vertical sensitivity: 2 mV/cm.
Mains consumption: 110V or 220V, 50 VA
Battery operation: 21.5 to 32V, 1.5A
Dimensions: 432 x 305 x 203 mm
Weight: 9.5 kg.
Price: £277·61.

Heath *10102*

Heath *10105*



Grundig *G10/13Z*

HEATH

Heath (Gloucester) Ltd, Bristol Road, Gloucester, GL2 6EE.
Phone: 0452 29451

OS2

Vertical sensitivity: 100 mV rms/cm.
Input impedance: 3.3M ohms shunted by 20 pF
Horizontal sensitivity: 100 mV rms/cm
Input impedance: 10M ohms shunted by 20 pF.
Valve complement: 1-ECF80, 4-12AU7, 1-12AX7, 1-EZ80, 1-3RP1 crt medium persistence, green trace.
Power requirements: 200 to 250V, 40 to 60 Hz ac 40W.
Dimensions: 130 x 188 x 305 mm.
Weight: 4.43 kg.
Price: £49.

1018

Vertical sensitivity; 30 mV pp/cm at 1 kHz.
Input impedance: in x 1 attenuator position, 2.9M ohms shunted by 21 pF. In x 10 and x 100 positions, 3.4M ohms shunted by 12 pF.
Horizontal sensitivity: 150 mV pp cm at 1 kHz.
Input impedance: 30M ohms shunted by 31 pF.
Time base generator: 10 Hz to 500 kHz in five steps. Provision for intensity modulation by removing an access panel at the rear of cabinet.
Power requirements: 200 to 250V 40 to 60 Hz, 80W fused
Overall dimensions: 220 x 356 x 432 mm.
Weight: 10.4 kg.
Price: £59·50.

10102

Vertical sensitivity: 30 mV pp.
Rise time: 80 ns.
Attenuator: three position, compensated, X1, X10, X100.
Horizontal sensitivity: 0.1 V/cm.
Sweep generator: 10 Hz to 500 kHz in five ranges.
Power requirements: 110 to 130 or 220 to 260V ac 50/60 Hz 70W.
Dimensions: 324 x 235 x 413 mm.
Weight: 12.2 kg.
Price: £74.

10103

Vertical sensitivity: 50 mV/cm.
Horizontal sensitivity: 0.25 V/cm (uncalibrated).
Time base: seven decade steps, 100 ms to 100 ns/cm, ± 5%
Power requirements: 110 to 130 or 220 to 260V, 50/60 Hz 35W.
Dimensions: 324 x 235 x 413 mm.
Weight: 11.9 kg.
Price: £120.

10105

Sensitivity: 0.05 V/cm, ac or dc
Time base: triggered with 18 calibrated rates: 0.2 us/cm to 100 ms/cm in a 1, 2, 5 sequence, ± 3%. Continuously variable (uncalibrated) within the same range.
Power requirements: 105 to 125V ac or 210 to 250V ac, 50/60 Hz, 60W.
Dimensions: 270 x 315 x 381 mm.
Weight: 12.7 kg.
Price: £235.

HEWLETT PACKARD

Manufacturers: Hewlett Packard (USA) Agents: Hewlett Packard Ltd, 224 Bath Road, Slough, Bucks. SL1 4DS.

1700

Magnified sweep speed: 10 ns/div (except 1710A, for which mss is 2 ns/div)
Battery capability: all models in the series except 1710A

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Calibrated display size: 6 x 10 cm (except 1702A and 1703A storage or variable persistence scopes, for which the size is 6 x 10 divisions, where one division is 0.85 cm).

1200 series

This series ncludes the 1200, 1201, 1202, 1205, 1206, 1215 and 1217 models All of these except the last two, which operate from dc to 7 MHs, will handle up to 500 kHz. They are all available either in rack or bench model form. All have differential inputs, external horizontal input, dc coupled axis, and sweep speeds from 1 us to 5s per division. The first three have deflection factors on the horizontal amplifiers of 0.1 mV/div to 20 V/div, whereas the rest operate from 5 mV to 20 V/div. All are two beam except the 1202 and 1206. The 1201 is a variable persistence and storage scope.

140 series

Operates up to 20 MHz, has variable persistence and storage, time division reflectometry and 12.4 GHz sampling, and a deflection factor of 10 uV/div.

180 system

The basic unit measures up to 100 MHz. There are nine mainframes, eight vertical plug-ins, seven and imebase plug-ins in the series. Not all are compatible.

MARCONI
Marconi Instruments Ltd, St Albans, Hertfordshire.
Phone: 56 59292

TF2204

Two versions available: one for mains and external battery and the other for mains or internal rechargeable battery.
Bandwidth: up to 20 MHz depending on sensitivity range. 5 MHz minimum.
Display area: 10 x 8 cm.
Internal graticule: provided as standard in 1 cm and 2 mm divisions.
Battery operation: Deac type 5M6 rechargeable, 24V.
Weight: 11.5 kg.
Dimensions: 255 x 225 x 355 mm.

NOMBREX
Nombrex (1969) Ltd, Exmouth, Devon
Phone: 03 952 3525.

Model 46

Sweep speeds (four ranges): 10 ms/cm 1 ms/cm, 100 us/cm, 10 us/cm.
X amplifier: 3 dB bandwidth dc to 1 MHz.
Deflection sensitivity: 1 V/cm.
Cathode ray tube: 5 x 5 cm. Green phosphor.
Medium persistence: external intensity modulation.
Power requirements: 220 to 240V 50 to 60 Hz. 40W. Fuse 750 mA.
Dimensions: 240 x 140 x 190 mm.
Weight: 3.18 kg.
Price: £59.65 + VAT.

PHILIPS
Manufacturers: Pye Unicam Ltd, Philips Electronic Instrument Department, York Street, Cambridge, CB1 2PX.
Phone: 0223 58866

Some 20 oscilloscopes at prices ranging from £137.05 (10 MHz double beam) to £1,705 (PM 3253), a 50 MHz/2 mV or 5 MHz/200 uV dual trace with delayed timebase, variable persistence and storage and multiplier facilities. Brief specifications quoted for some of the more representative models applicable to studio use.

PM3400

Vertical sensitivity: 1 mV/cm.
Horizontal sweep speeds: 1 ns/cm to 20 us/cm.
Crt: 10 x 8 cm, dual trace.
Power requirements: 100 to 145V or 200 to 260V, 50 Hz to 400 Hz.
Dimensions: 245 x 340 x 535 mm.
Price: £1,095 + VAT.

PM3379 microwave spectrum analyser.

Display dynamic range: 60 dB.
Sensitivity: -92 dBm.
Sweep speeds: 50 ns/cm – 1s/cm.
Crt size: 10 x 6 cm.
Power requirements: 100 to 145V and 200 to 260V, 40 Hz to 60 Hz.
Dimensions: 370 x 285 x 560 mm.
Weight: 25 kg
Price: £1150 + VAT.

PM3200

Sensitivity: 2 mV/div.
Sweep speeds: 0.1 us/div to 0.5 s/div in 21 steps.
Display: single beam.
Crt size: 10 cm.
Power requirements: 100 to 250V and 200 to 250V ac 22/30V dc.
Dimensions: 175 x 210 x 330 mm.
Weight: 5.3 kg.
Price: £135 + VAT.

A100

Display area: 8 x 10 cm.
Graticule: variable illumination, 10 mm squares, 2 mm divisions on major axes. Dotted lines at 10% and 90% (for measurement of pulse rise times).
Phosphor: GH (P31) (Green) medium short persistence) standard. Others also available.
Power requirements: 100 to 125V or 200 to 250V, 48 to 60 Hz.
Dimensions: (bench) 267 x 223 x 409 mm.
Weight: 12.5 kg.

RACAL
Racal Instruments Ltd, Duke Street, Windsor, Berkshire S14 1SB
Phone: 95 69811

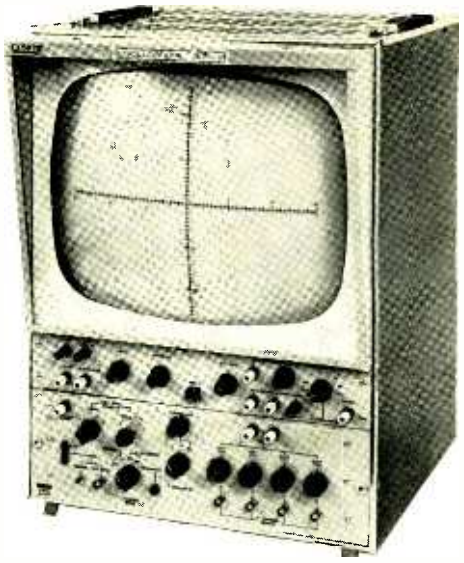
383.2

Screen area: 23 x 33 cm.
Z modulation: 100% modulation of intensity requires 20 to 30V p-p at 20 Hz to 100 kHz. A negative signalextinguishes the trace.
Vertical sensitivity: 100 mV/cm.
Horizontal sensitivity: 100 mV/cm.
Dimensions: 584 x 432 x 483 mm.
Weight: 38 kg.

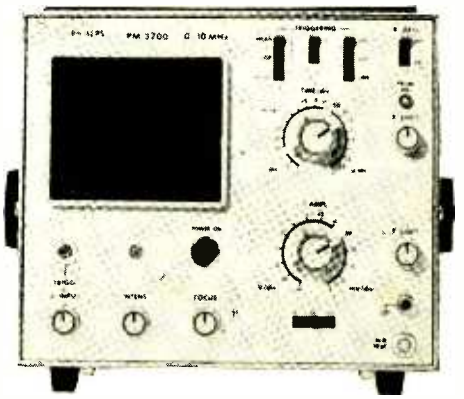
SCOPEX
Scopex Instruments Ltd, Pixmore Industrial Estate, Pixmore Avenue, Letchworth, Hertfordshire SG6 IJJ
Phone: 046 26 72771

4D10

Vertical sensitivity: 10 mV/cm to 50 V/cm (12 calibrated ranges).
Horizontal sensitivity: 1 V/cm (200 mV/cm magnified).
Display size: graticule ruled 6 cm 3.8 cm.
Power requirement: 210 to 250V, 40 to 60 Hz 25 VA.
Dimensions: 153 x 312 x 350 mm.
Weight: 7.71 kg.



Racal *383.2*



Philips *PM3200*

Marconi *TF2204*

Ambient operating temperature: + 40°C.
Price: £98 + VAT.

Vertical sensitivity: 10 mV/cm to 50 V/cm (12 calibrated ranges).
Input impedance: 1M ohms ± 2% and 27 pF.
Operating modes: channel A only. Alternate between channels chopped between channels (approx 100 kHz).
Sweep speeds: 200 ns/cm to 200 ns/cm (19 calibrated ranges)
Horizontal sensitivity: 1 V/cm (200 mV/cm on x 5).
Input impedance: 1M ohms and 15 pF.
Display: pda mesh operating at 6 kV, P31 phosphor standard, P7 long resistence crt phosphor also available.
Graticule: 8 x 6 cm.
Power requirements: 210 to 250V 40 to 60 Hz 35 VA, 105 to 125V ac 40 to 60 Hz 35 VA.
Dimensions: 153 x 312 x 435 mm.
Ambient operating temperature: + 40° C.
Price: £175 + VAT.

SE
SE Laboratories (Eng) Ltd, North Feltham Trading Estate, Feltham, Middlesex.
Phone: 01 890 1166 (sales); 01 890 5876 (works)

Range of oscilloscope chassis and plug-in modules, arranged according to bandwidth. A dual channel adaptor (HZ 36) is also available to convert any single beam oscilloscope to double beam.

EM102D main frame, **EM505** module

Display area: 10 x 6 cm, double trace.
Input impedence: 1M ohms 35 pF.
Time base range: 0.5s to 20 ns/cm.
Battery operation: 11 to 16V.
Weight: 12.7 kg.
Dimensions: 181 x 356 x 470 mm.
Price: £410 + VAT.

HM207

Input impedance: 1M ohms 40 pf.
Time base range: 0.5s to 2 ns/cm.
Weight: 5 kg.
Dimensions: 203 x 160 x 240 mm.
Price: £79+VAT.

EM102D main frame, **EM515** module

Display area: 10 x 6 cm, dual trace.
Input impedance: 1M ohms 35 pF.
Time base range: 0.5s to 20 ns/cm.
Battery operation: 11 to 16V.
Weight: 12.7 kg.
Dimensions: 181 x 356 x 470 mm.
Price: £360 + VAT.

SM111 main frame, NATO and commercial.
Display area: 10 x 8 cm, dual trace.
Input impedance: 1M ohms 35 pF.
Time base range: 2.5s to 40 ns/cm.
Battery operation: 20 to 30V.
Weight: 11.5 kg.
Dimensions: 254 x 254 x 355 mm.
Price: £270 + VAT.

EM102D main frame, **EM530** module

Display area: 10 x 6 cm, dual trace.
Input impedance: 1M ohms 35 pF.
Time base range: 0.5s to 20 ns/cm.
Battery operation: 11 to 16V.
Weight: 12.7 kg.
Dimensions: 181 x 356 x 470 mm.
Price: £385 + VAT.

SM113

Display area: 10 x 8 cm, dual trace.
Input impedance: 1M ohms 35 pF.
Time base range: 2.5s to 20 ns/cm.
Battery operation: 20 to 30V.
Weight: 11 kg.
Dimensions: 254 x 254 x 355 mm.
Price: £295 + VAT.

SM112 main frame, **SM554, SM602** module

Display area: 10 x 8 cm, four traces.
Input impedance: 1M ohms 23 pF.
Time base range: 3s to 5 ns/cm.
Weight: 16 kg.
Dimensions: 305 x 203 x 457 mm.
Price: £920 + VAT.

SM112 main frame, **SM599, SM602** module

Display area: 10 x 8 cm, dual trace.
Input impedance: 1M ohms 23 pF.
Time base range: 3s to 5 ns/cm.
Weight: 16 kg.
Dimensions: 305 x 203 x 457 mm.
Price: £850 + VAT.

SOLARTRON
Solartron Electronic Group Ltd (a division of Schlumberger), Farnborough, Hampshire.
Phone: 0252 44433

CD1740 system

Display area: 8 x 10 cm.
Z modulation: dc to 10 MHz.
Dimensions: 165 x 385 x 420 mm.
Weight: 13 kg.
Price: £165 (mainframe), £125 (dual vertical amplifier), £55 (single timebase) + VAT.

Serviscope Minor

Y amplifier response: dc to 30 kHz at 100 mV/div (-3 dB approx). Y sensitivity range: 100 mV/div to 50 V/div.
Input impedence: 1M ohm +30 pF.
Time base: 10 ms/div; 1 ms/div, and 100 us/div.
Power requirements: 200 to 250V, 50 Hz, 25W.
Dimensions: 248 x 162 x 145 mm.
Weight: 2.25 kg.
Price: £30 + VAT.

S51B

Y amplifier frequency response: dc to 3 MHz at 100 mV/cm (-3 dB approx). Y sensitivity: 100 mV/cm to 50 V/cm in nine steps.
Time base: 100 ms/cm to 1 us/cm in six steps.
Slowest speed: 1 s/cm on continuously variable.
Cathode ray tube: 13 cm flat faced pda tube operating at 3 kV overall.
Display area: 10 x 8 cm vertically.
A P31 phosphor is normally supplied, P7 long persistence also available.
Supplies: 90 to 130V, 200 to 240V, 50 to 400 Hz.
Power consumption: 58 VA.
Dimensions: 380 x 204 x 178 mm.
Weight: 7 kg.
Price: £70 + VAT.

TEKTRONIX
Manufacturers: Tektronix (USA)
Agents: Tektronix UK Ltd, Beaverton House, PO Box 69, Harpenden, Hertfordshire.
Phone: 058 27 61251

Tektronix make a range of oscilloscopes under their own name and that of Telequipment Ltd. The DM53A main frame is a storage unit supplied with a TD51 time base and an option of three amplifiers. The D83 main frame is £185 cheaper than the £450 DM53A and a delayed sweep time base, a dual trace Y amplifier or a high gain differential amplifier, can be selected for it.
Besides these two plug-in models there are 15

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other models in the Telequipment and Tektronic range which vary in price between £30 and £420. Outlines of representative models are quoted

DM53A

Sweep speeds: (at minimum X-expansion) 500 ns/cm to 5 s/cm in 22 calibrated steps with 1, 2, 5 sequence. A variable uncalibrated control provides continuous overlap between ranges and reduces the slowest speed to approximately 12 s/cm.
Cathode ray tube: direct view storage operating at 7 kV accelerating potential, dual beam. Viewing area 6 cm vertical by 10 cm horizontal.
Power requirements: 100 to 125V in 5V steps. 200 to 250V in 10V steps, 50 to 400 Hz, 200 VA.
Dimensions: 280 x 292 x 515 mm.
Weight: 24 kg.
Price: £450 + VAT.

D66

Input impedance: 1M ohms + 47 pF.
Bandwidth: dc to 1 MHz.
Sweep speeds: 23 calibrated sweep speeds from 100 ns/div to 2 s/div in a 1, 2, 5 sequence. Slowest speed 5 s/div continuously variable.
Cathode ray tube: 8 x 10 cm rectangular faced single gun mesh pda tube with 10 kV overall accelerating potential.
Power requirements: 100 to 125V in 5V steps. 200 to 250 in 10V steps, 48 to 400 Hz, 50 VA.
Dimensions: 240 x 210 x 370 mm.
Weight: 11.5 kg.
Price: £225 + VAT.

D65

See page 60

D75

Bandwidth: dc coupled dc to 50 MHz (-3 dB) ac coupled to Hz to 50 MHz (-3 dB).
Voltage measuring accuracy: ±3%.
Input impendance: 1M ohms +29 pF.
Sweep speeds A: 100 ns/div to 2 s/div in 23 calibrated steps 1, 2, 5 sequence.
Sweep speeds B: 100 ns/div to 1 s/div in 22 calibrated steps 1, 2, 5 sequence.
Cathode ray tube: 8 x 10 cm rectangular faced single gun mesh tube with 15 kV overall accelerating potential.
Power requirements: 100 to 125 in 5V steps. 200 to 250 in 10V steps, 40 to 400 Hz, 105 VA.
Dimensions: 136 x 380 x 470 mm.
Weight: 11.4 kg.
Price: £420 + VAT.

Z & I (USSR)
Agents: Z & I Aero Services, 44a Westbourne Grove, London W2 5SF.
Phone: 01 727 5641/2/3

C1-5

Display area: 50 x 50 mm.
Vertical amplifier: 10 MHz bandwidth, 100 kHz, for 25 mm sensitivity.
Horizontal sensitivity: (at 100 kHz for 25 mm display) 0.3V rms.
Free running sweep frequency range: 20 Hz to 200 kHz in nine ranges.
Power requirements: 127V and 220 to 250V 50 Hz and 115V 400 Hz.
Dimensions: 220 x 360 x 430 mm.
Weight: 18.2 kg.
Price: £39 + VAT.

Z & I *CI-16*

C1-16

Display area: 35 x 90 mm.
Time base: 50 Hz to 1 MHz.
Frequency of quartz crystal calibrator: 100 kHz.
Power inputs: 220 to 250V, 50 Hz.
Dimensions: 260 x 550 x 376 mm.
Price: £87 + VAT.

C1-19

Display size: 80 x 50 mm.
Vertical sensitivity: 5 mm/mV.
Time base: 100 ms to 10s per sweep.
Supply voltage: 115 to 240V ac.
Dimensions: 250 x 500 x 360 mm.
Price: £82 + VAT

C1-54

Image size: 9 x 4 cm.
Vertical sensitivity: 0.1 mm/mV.
Input impedance: 0.5M ohms shunted by 40 pF.
Time base, triggered, free-running, or one-shot: eight main ranges 0.1 us to 1 s/cm.
Internal crystal calibration: 100 kHz at 2 to 5 V rms.
Modulating voltage (from 20 Hz to 5 MHz): 1 to 30V rms.
Dimensions: 260 x 380 x 550 mm.
Price: £140 + VAT.

C1-49

Display size: 3.6 x 6 cm.
Vertical deflection: 0.6 mm/mV (10 mV/div).
Sweep duration: 15 steps from 0.04 us to 100 ms per div.
Power supplies: 115 to 230V 50 Hz, or 24V dc.
Dimensions: 170 x 223 x 430 mm.
Price: £98 + VAT.

C1-37

Working area of screen: 6 x 8 cm.
Image holding time: (instrument switched on) 30 minutes in the normal memory position, 15 minutes in the enhance position; (instrument switched off) 1 week.
Sweep time, 24 steps: 0.5 us/div to 25 s/div.
Power supplies: 200 to 240V 50 Hz.
Dimensions: 630 x 450 x 310 mm.
Price: £185 + VAT.

QUAD MICROPHONE

unfortunate diversion in the form in which they are presently being offered and that the fourth channel can usefully be employed to provide other information: possibly a height signal or a level control signal.

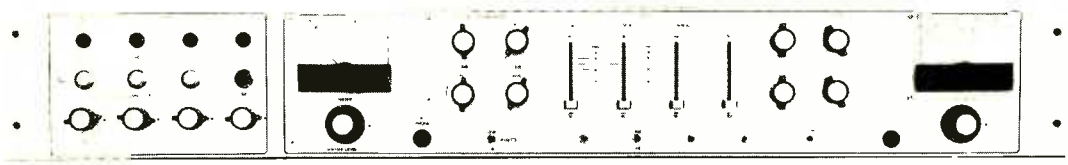
Quite apart from that, there is the expense. Even if one settles on one's own quadraphonic system, and hang the rest of the world, one must question whether the extra expense is justified. At a domestic level, I believe that for many people it may not be. Stereo already allows the brain to separate and analyse musical textures quite well and indeed some people get considerable enjoyment from mono. Is the marginal improvement, the recreation of concert hall ambience around one, worth the extra cost? Money no object, the answer is of course yes: but that is for the few with no mortgages to pay off, no family or social commitments, and perhaps no social conscience.

I see quadraphony as a tool to be used in much the same way as multitracking to allow the engineer greater flexibility, accepting the limitations of two or one channel reproduction. At its simplest this might mean adding some of the rear two channels sounds, in or out of phase, to the front two channels in order to control the amount of reverberation and the image width. This I have already tried and found useful in making stereo copies from parts of experimental quadraphonic recordings. It is hardly likely to be a popular view of quadraphony, particularly among the hardware merchants. I also feel strongly that, if there is an ethic left in the audio industry, quadraphony should not be hard-sold to a world that has many more pressing calls on its resources, or even to an affluent public at a stage when so much is in the melting pot and systems could become obsolete when they are hardly out of the shop. There is much enjoyment still to be had from stereo and from the occasional dose of reality from the concert hall.

Having said that little piece (you haven't heard me on ecology yet) one or two practical points to conclude. There is no need to describe the use of a variable polar diagram coincident stereo mic in these pages, which have seen much on the subject. But in recording quadraphonic signals, while cardioids set at 90° give quite a pleasing sound, the definition and separation are better in a hypercardioid mode. All the way to figure-of-eight gives a meaningless signal since the rear channels are then the front channels in antiphase.

A final point. Much of my listening has in fact been done with three rather than four channels, which has confirmed several suggestions that three channels contain enough information for reproduction of all sounds within one plane. Ideally one would use three cardioids or hyper-cardioids set at equal angles to record in this arrangement, or matrix from four to three channels. In fact very satisfactory results were obtained by simply paralleling the signal from the rear channels of the recording and feeding them to a single amplifier and speaker at the rear, or to a single amplifier and two spaced speakers at the rear, which created a better illusion. The three speaker setup seem to give a more restricted listening area, while four channels reproduced through four speakers seemed to give a larger listening area than for stereo with the front two channels reproduced through the front two speakers only—which appears to contradict a recent editorial [*Also contradicts our experience but you are allowed your opinion*!—**Ed.**]. Obviously there is room for some experiment, both with three and four channel systems.

CHYMES AUDIO ELECTRONIC



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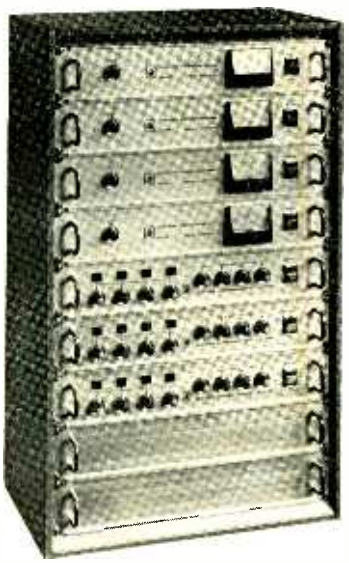

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TEKTRONIX D54 AND D65 OSCILLOSCOPES

By Hugh Ford

MANUFACTURERS' SPECIFICATION (D65 in italics) (*common)

VERTICAL AMPLIFIERS

Ac coupled bandwidth (—3 dB): 2 Hz to 10 MHz; *2 Hz to 15 MHz at 10 mV/division 2 Hz to 10 MHz at 1 mV/div.*

DC coupled bandwidtn (—3dB approx): Dc to 10 MHz; *dc to 15 MHz at 10 mV/division: dc to 10 MHz at 1 mV/div*

Rise time: 35 ns; *23 ns.*

Signal delay: None; *200 ns.*

Input attenuator: Twelve positions calibrated direct in volts per division giving sensitivities of 10 mV/division to 50V/division in 1-2-5 sequence. A variable uncalibrated control provides continuous variation between ranges and uncalibrated coverage up to 125 V/division. *A 2x10 gain switch extends the sensitivity to 1 mV/division.*

***Voltage measuring accuracy:** ±5%.

Input impedance: 1 Mohm+47 pF; *1M ohm+40 pF.*

***Input conditions:** Switched choice of dc or ac (via 0.1μF) coupling. A third position earths the input of the attenuator but not the input socket.

Operating modes: Channel 1, channel 2, channel 1 and 2 alternate sweep, channels 1 and 2 chopped at 100 kHz. *Channel 1, channel 2, channels 1 and 2 alternate sweep, channels 1 and 2 chopped at 80 kHz, channels 1 and 2 added algebraically, channel 2 inverted to provide a differential input. X-Y facility: channel 2 selected by timebase switch. Bandwidth dc to 1 MHz. Phase error less than 1° at 25 kHz.*

Time base: Sweep speeds from 200 ns/div to 2s/div in 22 calibrated steps with 1-2-5 sequence. *Sweep speeds from 100 ns/div to 2s/div in 23 calibrated steps with 1-2-5 sequence.*

***Time Measuring Accuracy:** ±5%.

***Trigger Modes:** Hf sync provides synchronisation of the time base from 1 MHz upwards. Tv sync triggers at line or frame rates. Slope either positive or negative. Sources: internal from either channel or external. Triggering: Automatic or trigger level control selects virtually any point on the leading edge of the input waveform. *Single sweep facility with lockout provided. A neon indicates when the time base is armed.*

Horizontal Amplifier: X expansion continuously variable up to approximately five screen diameters; *X5 magnifier operates over the full time base range.*

***Calibrator:** Line frequency square wave 500 mV ±2% peak to peak.

Cathode ray tube: 12.7 cm flat faced; 8 x 10 cm rectangular.

Z modulation: Input for perceptible modulation at average brightness 20V approx.

***Graticule illumination:** Front panel control varies intensity.

***Power Requirements:** 100 to 125 in 5V steps. 200 to 250 in 10V steps, 48 to 400 Hz. The instrument specifications apply over a 10% mains variation for the voltage step chosen.

Dimensions: 245 x 210 x 447 mm; *240 x 210 x 370 mm.*

Weight: 9 kg; *11.5 kg.*

Price: £160 (+VAT); *£195 (+VAT).*

Manufacturers: Tektronix UK Ltd, Beaverton House, PO Box 69, Harpenden, Hertfordshire.

PERHAPS ONE of the most versatile pieces of test gear in any well equipped workshop is the oscilloscope. Even the very cheapest oscilloscope will give some indication of voltage, frequency and distortion while a good specimen can give as accurate an indication of ac or dc voltage as many meters, over a far wider range of voltages, an indication of frequency within ±5 per cent which is often more than adequate for audio work.

A dual trace (sometimes double beam) oscilloscope has the further advantage of providing not only a direct comparison between output and input to a device but phase indication which is vital when aligning stereo equipment such as tape recorders.

When purchasing an oscilloscope, it is all too easy either to acquire an instrument which has to good a performance for the job in hand, with a consequent waste of money, or to buy too simple an instrument where the expenditure of only a few more pounds could provide many extra and useful facilities.

Perhaps those readers who are experienced in these matters will forgive me for explaining a few basic parameters but I am sure that there are many who will benefit from these comments.

One of the more fundamental oscilloscope parameters is the bandwidth of the Y deflection system which commonly refers to the point where the response is 3 dB down. First thoughts may indicate that a bandwidth of up to say 20 kHz will be adequate for audio frequency work but this is far from the case once consideration is given to the transient performance of amplifiers, the possibilities of spurious high frequency oscillations in equipment, the bias oscillators of tape recorders which may rely on square waves at several hundred kilohertz and, even worse, those pestilential high frequency pickup problems.

While many oscilloscope amplifiers may exhibit a useful indication at two or more times their cutoff frequency, it is to be strongly recommended that an amplifier bandwidth of at least 5 MHz be considered for normal purposes. Nowadays there is little difference in the price of good-sensitivity oscilloscopes with bandwidths up to about 15 MHz but above this the price rises rapidly and almost exponentially until one reaches the 500 MHz mark!

Naturally, as in other amplifiers, there is a gain/bandwidth limitation in oscilloscope amplifiers. Gains of 10 mV/cm are commonplace and just adequate for audio purposes but an overall sensitivity of 1 mV/cm can be very useful when one considers the output from magnetic pickups and tape heads, as well as moving coil microphones. The third important aspect of the Y amplifier systems is the low frequency performance; while ac coupled amplifiers will always perform down to a few Hertz, there are many advantages to be gained from dc coupling, one of the most important being the ability to measure dc potentials in the order of millivolts which are often critical in transistor circuitry.

One next comes to the choice between single trace or double trace oscilloscopes. In a single beam oscilloscope it is only possible to display one waveform and any required display of phase has to be accomplished by producing Lissajous figures by utilising the X and Y amplifiers. The result is not always easy to interpret, particularly when there is phase jutter as is common when using an oscilloscope to align the heads of multitrack tape recorders.

For such purposes a dual trace oscilloscope offers a great advantage as one can display two waveforms and directly compare their phase. There are three systems for producing dual traces in an oscilloscope, the first and original method being to use a twin gun display tube which has the advantage of giving a brighter trace than the other two methods. However, it

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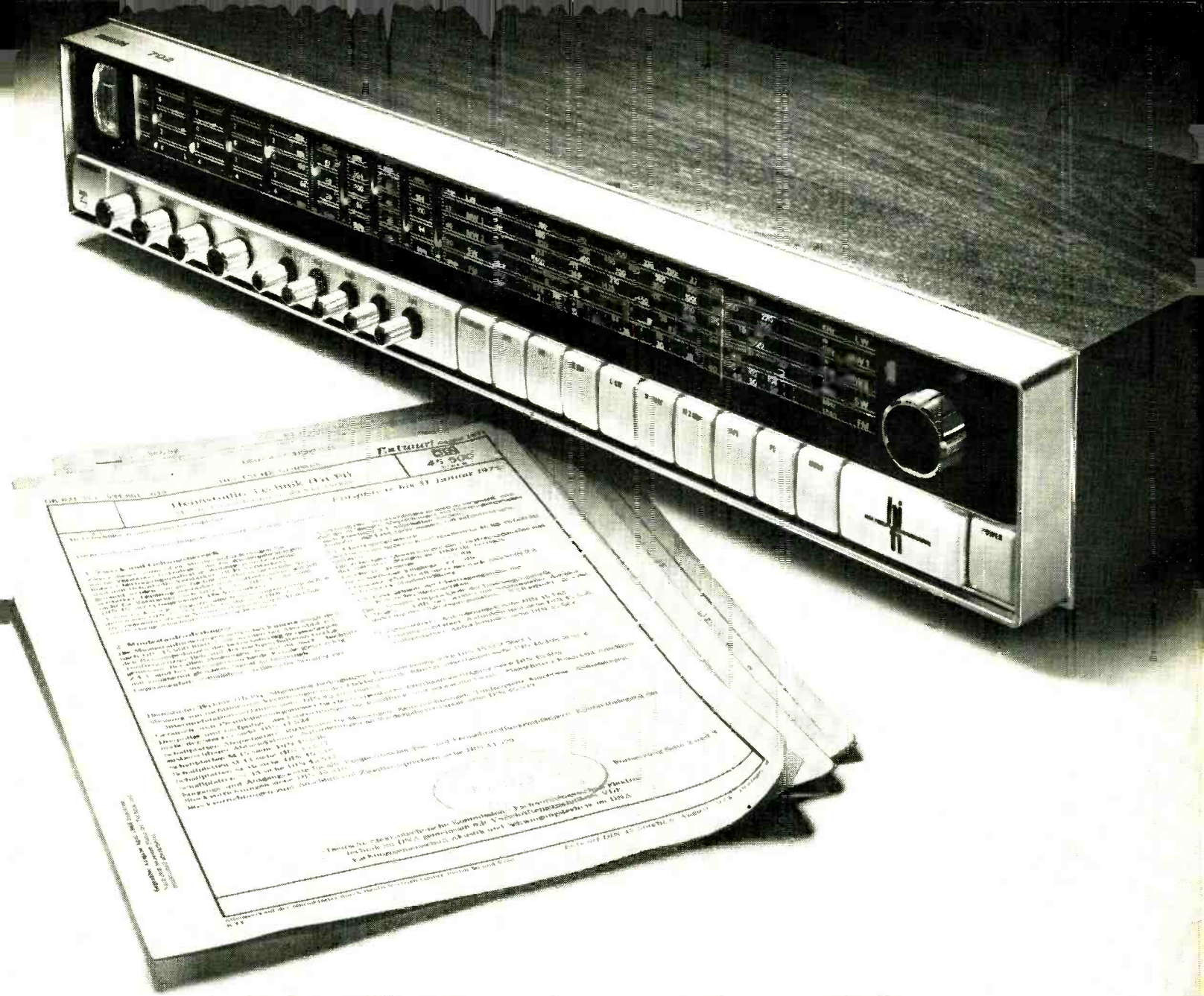

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Illuminated indication enables you to check volume, bass, treble, balance and the five pre-set station settings at a glance.

Facilities are provided for connecting magneto-dynamic pickup, ceramic pickup, tape or cassette recorder, loudspeaker enclosures and headphones. A microphone may also be plugged in, so that you can use the RH702 for low-level Public Address.

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is more expensive and offers little advantage for the examination of lower periodicity waveforms such as those encountered in the field of audio.

The other two methods employ a single gun display tube and switch between the two inputs while adding a dc offset so that either trace may be shifted in the Y axis. If the switching frequency is high compared with the frequency of the waveform being examined, the display will appear to the eye as two separate displays. However, once the display frequency approaches the switching frequency the two individual displays break-up and this is the limitation of the high frequency switching technique.

The third method is to switch between inputs on alternate sweeps of the timebase. This overcomes the disadvantage of the high frequency switching method but has its own limitation because the two traces are not by any means simultaneous which results in excessive flicker when low frequency displays are examined and the possibility of being deceived by simultaneous events. Furthermore, single sweep operation of the oscilloscope timebase is impossible with this system if dual traces are required. A combination of the switching method and alternate trace method offers a good compromise for the price to be paid for genuine dual beam operation and is completely adequate for audio work.

Another important consideration of Y amplifiers is the decision between single ended inputs and differential inputs. With a single ended input it is only possible to display potentials between a single point and earth. But with differential inputs it is possible to display potentials between two points which may have an ac voltage to earth, such as mains hum. While differential inputs are ideal, they are expensive and not very often required—one of the oscilloscopes reviewed here has a rather clever alternative which, while it does not give very good 'common mode rejection', is likely to be a good compromise.

Having dealt with the more basic parameters of the Y amplifier system, I will now turn to the X amplifier and timebase. Personally I make very little use of an X amplifier on its own count and almost entirely use it in conjunction with a timebase. However, it is of great advantage if the X amplifier has shift controls which are fine enough to make aligning of the display with the graticule an easy task and if it has an X gain control which does not shift the display from the centre of the graticule.

Much more important is the performance of the timebase, and in particular its ability to lock on to complex waveforms without undue knob twiddling. This is the downfall of so many cheap oscilloscopes when they encounter anything but a sinewave.

If the timebase has good locking abilities, single shot facilities are perhaps unnecessary, even for tone burst testing of amplifiers, and timebase linearity is also of little importance for audio work. Time base speed ranges for some reason always seem to exceed the performance of oscilloscopes in that either they have capabilities of running so fast that the trace is practically invisible, or they have slow sweep speeds which are completely unusable with the type of cathode ray tube incorporated. This is of course reasonable if the oscilloscope manufacturer offers alternative cathode ray tubes of long persistence but that is not often the case.

The foregoing considerations formed the basis of the choice of oscilloscopes for this review, which I required to have dual trace facilities with a minimum Y amplifier bandwidth of 10 MHz and minimum Y sensitivity of 10 mV/cm. Calibration accuracy of both the Y amplifiers and the timebase I required to be better than ±5 per cent.

The two Telequipment models reviewed form an interesting comparison in that they offer substantially different performances with a relatively small difference in price. Both these instruments will meet the requirements for studio work and must not be confused with cheap oscilloscopes which only offer the often rather dubious facility for displaying waveforms. Such instruments are suitable for schools and for tracing catastrophic equipment faults; they have no place in any self respecting laboratory.

As the physical layout of the two instruments is very similar, it is easiest to describe the two instruments together from this point of view but the measured performance and facilities will be described separately as it is here that the instruments differ.

The rear panel of both instruments incorporates a multiway mains voltage selector and the mains input fuse, both of which are very clearly labelled, including fuse ratings for high and low voltage mains supplies. There is also the Z modulation input and its associated earth connection, both of which accept standard banana plugs. The remaining back panel facility is the mains connection which is a plug-in lead on the more expensive *D65* and a fixed mains lead on the *D54*.

Panel layout

Front panel layout is such that the display tube is mounted in the top left hand corner, with the two amplifiers underneath, and the timebase controls to the right of the instrument. The layout of amplifier controls is extremely clear with the input sockets on the left, and, proceeding to the right, the input slide switch which selects either ac or dc coupling or alternatively earths the amplifier input. Next the rotary input attenuator switch which is coaxially mounted with the variable attenuator control and has in the case of *D65* a distinct mechanical latching when set to the 'calibrate' position in which the attenuator switch calibrations apply. In the case of the *D65* model, the knob of this variable control is pushed in to select a times 10 gain function.

Proceeding further to the right there is the vertical shift potentiometer and the amplifier on/off pushbutton. However, in the case of the channel two amplifier in the *D65* the vertical shift control is coaxially mounted with a normal/invert pushbutton switch which is used when differential input facilities are required, or if phase reversal is required for any other purposes.

Tucked between the vertical amplifiers are the operating mode switches which in the cheaper type *D54* comprise a slide switch for selecting either alternate sweep or chop style dual trace operation and also two trigger selection buttons which select channel one, channel two, or alternate trace. In the *D65*, the slide switch is replaced by two pushbutton switches which select either chopping mode, alternate sweep, or presentation of the algebraic sum on the two inputs, which of course is converted into the algebraic difference between the two inputs when the channel two invert facility is used. Hence true differential operation.

The top right hand corner of both instruments is occupied by the 'brilliance' and 'focus' crt controls, being coaxially mounted as are the trace rotation control and the graticule illumination potentiometer which is combined with the mains on/off switch. Below these is the astigmatism control and, in the case of the *D65*, three pushbutton switches and a neon indicator which are used to select and display continuous sweep and single shot and to reset the timebase in single shot operation. Rather peculiarly the latter control arms the timebase when it is released, as opposed to the common practice of arming the timebase when it is pushed, which is a more convenient function. Next come the trigger level and timebase stability controls which are coaxial, and the X amplifier controls which comprise two coaxial potentiometers in the cheaper type *D54*. These act as X shift and variable gain with the calibrate position fully anticlockwise. In the *D65*, the coaxial potentiometers are 'find' and 'coarse' X shift: a thoughtful facility, together with a X5 gain switch which is operated by pulling out the knob.

The remaining rotary controls are the time per division switch which is coaxially mounted with a variable sweep speed control in the *D54* and *D65* but in the latter case pushing in this control connects the channel two amplifier to the X deflection system which is an excellent facility for producing Lissajous figures for precise phase comparison. Further pushbutton controls select the trigger mode with alternatives of 'normal', 'tv field', 'tv line' and 'hf', positive or negative edge, internal or external source. The more expensive *D65* also offers facilities for 'auto', 'ac' or 'dc' triggering. Finally the *D54* has banana sockets for external X input, timebase sawtooth output and a calibration waveform output, while the *D66* offers a rectangular wave gate output in addition to these.

It is quite amazing how some 40 or so controls can be packed into such a small panel space and remain clearly identified and easy to operate. After only ten minutes with the oscilloscope, I was quite at home with its operation and I found its light weight a tremendous advantage over earlier valved instruments.

The standard of construction of the instruments was high, with the overall finish being attractive but decidedly functional, but the front panel controls would be prone to damage in transit. The *D65* was fitted with clips alongside the front and rear panels which would indicate that protective covers may be available. Substantial carrying handles were fitted and the instruments are provided with let down feet for tilting the instruments to a good viewing angle.

Both instruments had good and variable

graticule illumination which gave sufficient range for visual examination and photography. The *D54* graticule was engraved with approximate 1 cm squares with intermediate markings on the X and Y axes while the *D56* had additional markings at 10 per cent and 90 per cent of the total Y deflection for rise time measurements. Fine traces were obtainable on both inputs, with negligible degradation towards the edges of the screens. While it is of little consequence for audio work, the green/blue phosphor incorporated in the *D56* gave superior brilliance to the green phosphor of the *D54* when fast edges were being examined. It proved possible to examine the fastest edge to which the *D56* will respond with a repetition rate of only 10 kHz.

Detailed examination of the D65

Initial examination was directed at the voltage measuring accuracy and frequency response of the Y amplifier systems, a 1 kHz sinewave was applied to the inputs of the two amplifiers and the input voltage set for five scale divisions deflection on each range. The resulting percentage errors are shown in **Fig. 1**, from which it will be seen that the measured performance is astoundingly better than the specified accuracy of ±5 per cent; however, operation of the X10 gain facility on channel one produced a worse case error of 3.6 per cent.

Abbreviated checks on the attenuators at 10 MHz did not produce any cause for concern, as was the case with high speed rectangular pulses. The frequency response of the amplifiers was measured at three gain settings: 100 mV/div, 10 mV/div and at the maximum sensitivity of 1 mV/div. The results of these measurements are shown in **Fig. 1** from which it is to be seen that the instrument is substantially to specification, offering a full 10 MHz bandwidth at some 1 mV/div sensitivity!

Common mode rejection when using the oscilloscope with channel two inverted and the Y amplifiers in the sum mode, that is using the instrument with the amplifiers connected as a differential amplifier, was in the order of 100:1 at audio frequencies falling to 100:4 at 1 MHz. This performance could be improved by careful adjustment of the variable Y gain controls and gives a quite acceptable performance for many purposes, while not really competing with true differential amplifiers.

FIG. 1
TEKTRONIX D65 ATTENUATOR ERROR AND VOLTAGE ERROR AT 1KHz

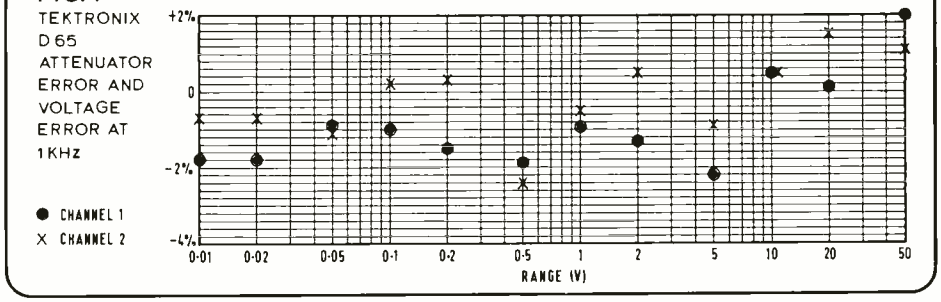
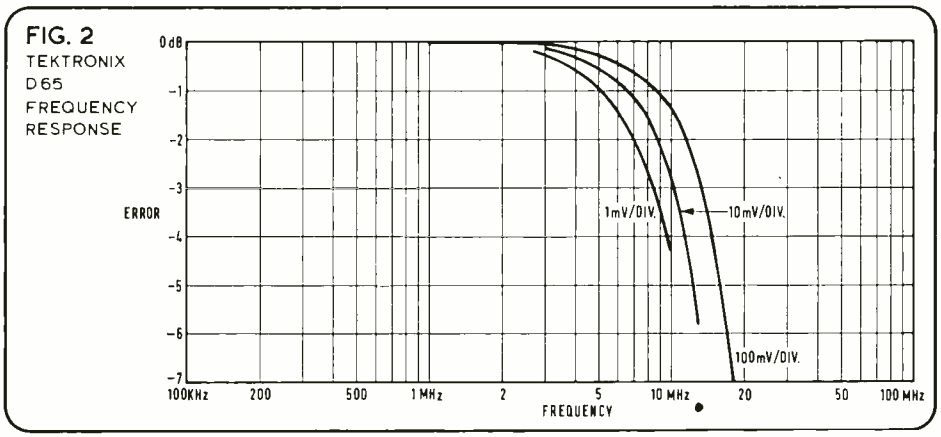


FIG. 2
TEKTRONIX D65 FREQUENCY RESPONSE



Certainly the performance is perfectly adequate for looking across balanced lines and will find many other applications.

As is the case with all cheap oscilloscopes and most medium priced instruments, the available Y shift is limited so that it is not possible to use displays of greater than about three screen diameters. However, distortion of the Y axis is very small up to this limit.

When using the Y amplifiers in the dc mode, drift is of course of paramount importance. Once the instrument had been warmed up, drift was small even at the maximum dc sensitivity of 1 mV/div provided that the incoming mains voltage was constant. Variation in mains voltage over the specified working limits of ±10 per cent did introduce some drift and also had a substantial effect upon the brilliance of the display.

The inbuilt delay in the Y amplifiers gave a delay of about 100 ns from the beginning of the trace to the leading edge of the waveform so it is assumed that the specified delay of 200 ns does not include the initiation time of the timebase. This is, however, a quite reasonable delay for all one requires is to be able to examine the leading edge of a waveform. On the subject of waveform leading edges, the measured rise time of the Y amplifiers was 26 ns. This disagrees with the publicity material which contains an error corrected in the full specification.

Input impedances were measured as 960k ohms and 44 pF for channel one; 996k ohms and 39.6 pF for channel two. This small difference is quite acceptable but could require the readjustment of divider probes when interchanging between channels.

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TEKTRONIX REVIEWS

I do not propose to go into details of the X input performance, except to point out that the facility by which the Y2 amplifier switches in as an X amplifier offers great advantages over the normal X input facilities. Not only does it give the advantage of an X amplifier with calibrated gain, as the calibration in the X direction is identical to that in the Y direction, but it also gives all the other facilities associated with the Y amplifiers except that the bandwidth is limited to 1 MHz. There is however a further facility which can be used in that a X sensitivity of some 200 μV per division can be achieved by utilising the Y2 amplifier at full gain in combination with the X5 facility of the X amplifier. As might be expected, this amount of amplification has limited bandwidth and suffers from a degree of noise which does not exist in the normal modes of operation.

Turning to the timebase itself, I am not including any chart of time calibration accuracies because there was no measurable error on about half the timebase ranges. On all ranges slower than 1 μs/div the calibration was within +2 per cent and on the two fastest ranges the error was +4 per cent and +3 per cent, both of which are better than specification. No further errors were observed when the X5 expansion facility was switched in. Timebase linearity was excellent on all ranges, as was distortion of the X axis.

Triggering facilities all functioned satisfactorily with a minimum of knob twiddling to lock the timebase, the dc trigger facility being particularly useful for locking to complex waveforms. The internal trigger sensitivity was so good that the timebase would lock to waveforms of only 1 mm display amplitude and, once a sensible size of display was selected, the timebase jitter was minimal.

Detailed examination of the D54

The *D54* was put through the same paces as the more expensive *D65*, initial examination again being directed at the voltage measuring accuracy and frequency response of the Y amplifiers. **Fig. 3** shows that the attenuator accuracy at 1 kHz is far better than specification, and no excessive errors were noted at higher frequencies. The only slight irritation with the attenuators was that it was easy to operate the variable attenuator accidentally when changing ranges of the switched control. Unlike the *D65*, the *D54* does not have click stops on the variable control.

The frequency response of the Y amplifiers is also within specification, as shown in **Fig. 4**, and in fact a usable response extends right up to 50 MHz and above. It should be particularly noted that the frequency response is almost unaffected by the attenuator setting, as is the rise time of 40 ns.

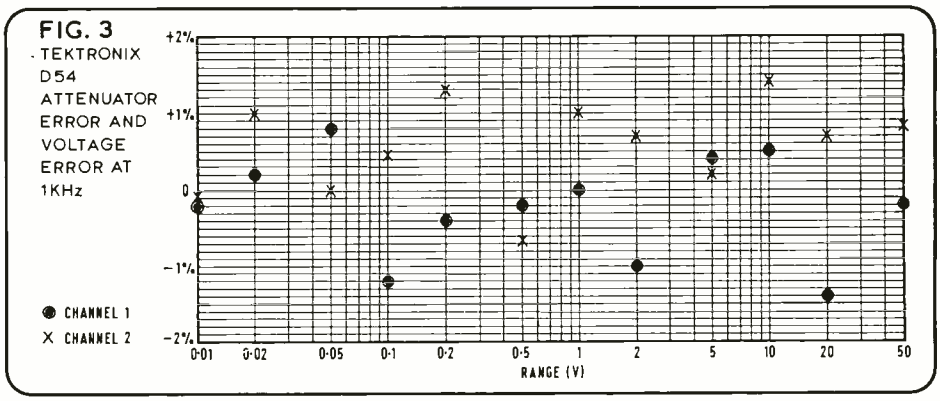
Triggering facilities were virtually identical to those in the type *D65*, with the exception that dc triggering is not included. As with the *D65* instrument, the triggering performance was excellent.

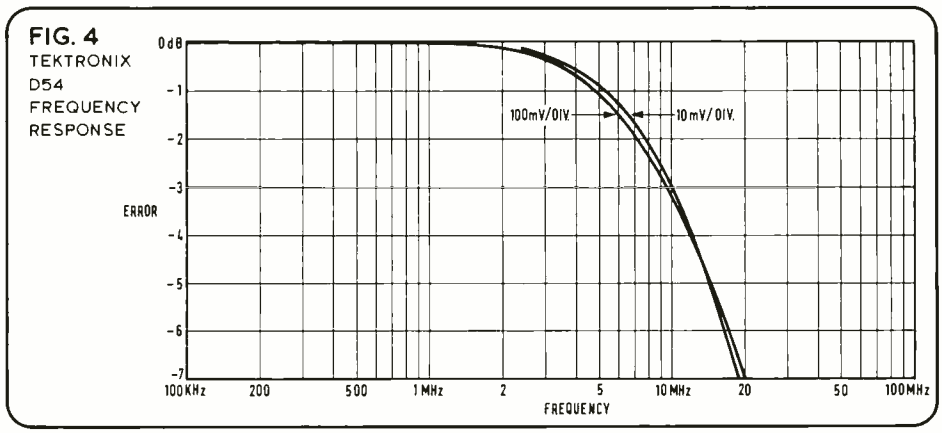
Both these oscilloscopes met their specifications in every respect, and in many respects far exceeded their specified performance. Clean and practical layouts were incorporated and the instruments were easy to operate, even without referring to the copious instruction and maintenance manuals which are supplied.

Undoubtedly either instrument will meet the requirements for the design and maintenance of studio audio equipment, including the possibility of working on digital electronics which must soon appear in professional audio equipment.

While the Telequipment *D54* represents good value at £160 the number of extra and unusua features included in the *D65* make it an un usually versatile tool which can have little competition at its price tag of £195.

H. D. Ford





Classified Advertisements

Advertisements for this section must be pre-paid. The rate is **7p** per word, minimum **70p.** Box Nos. **20p** extra. Semi-display rates on application. Copy and remittance for advertisements in **SEPTEMBER 1973** issue must reach these offices by **16th JULY 1973** addressed to: The Advertisement Manager, **Studio Sound,** Link House, Dingwall Avenue, Croydon CR9 2TA.
NOTE: Advertisement copy must be clearly printed in block capitals or typewritten.
Replies to Box Nos. should be addressed to the Advertisement Manager, Studio Sound, Link House, Dingwall Avenue, Croydon CR9 2TA, and the Box No. quoted on the outside of the envelope. The district after Box No. indicates its locality.

APPOINTMENTS VACANT

BBC tv
FILM DEPARTMENT

requires

ASSISTANT FILM RECORDISTS

To operate recording and reproduction equipment in sound transfer and dubbing areas. Practical experience of film sound transfer and/or dubbing recording methods and techniques, and an understanding of the use of sound in film production essential. Salary: £1,674 x £93 to £2,139 p.a.
Candidates who do not meet the full requirements of the advertisement may be considered for appointment as Trainee Assistant Film Recordists at a salary of £1,446 p.a. with promotion to Assistant Film Recordist upon satisfactory completion of a one year training period. For this applicants should be aged 18 to 28 with GCE 'O' level standard of education, have some knowledge of basic electronic theory and be able to show evidence of a practical interest in recording. Based: Ealing or Shepherds Bush.

Write or telephone now for application form (enclosing addressed foolscap envelope and quoting reference 73.G.724) to Appointments Department, BBC, London, W1A 1AA. Tel. 01-580 4468 Ext. 4619

BBC tv

★**Sound-effects** librarian required in modern tape library, London W.2. Duties mainly playing tapes to and advising customers, who are mostly film and TV sound-editors. A.C.T.T. member preferred. Ring Peter Musgrave or John Hales 01-727 9801.

★**Experienced** audio test engineer required for expanding audio manufacturers. Age 20-25. Salary negotiable. Apply Mr. I. D. Taylor, Allen and Heath Ltd., Pembroke House, Campsbourne Road, London N.8. 01-340 3291.

★**Young man** wanted by rapidly expanding tape company for copying master tapes (Revox equipment), checking quality new masters and subsequent cassettes and cartridges, also looking after master tape library. Knowledge of handling tape (splicing, editing, etc.) also a good musical ear essential. Some basic electronic knowledge an advantage. Write in first instance with full details (in confidence) of present employment and experience to date to: Mr. Maurice Mindel, Managing Director, Arrowtabs Limited, Humber Road, London NW2 6EP.

STUDIO FACILITIES

★**County Recording Service.** Stereo and Mono masters, 12″ vinyl pressings.
★**Mobile recording** van. Live sessions. Stereo. Anywhere. Mobitrack, 01-892 9599.

Roger Squire
DJ Studios
The best facilities in town for making Audition Tapes, Jingles, Programmes and Sound Commercials. For further information telephone
01-722 8111

STUDIO FACILITIES cont.

YOUR TAPES TO DISC
Records made to order—7″ from £1.50 12″ from £4.00. 4-day postal service. Vinyl pressings, sleeves, labels. Tax-free for schools, etc. We cut records for many Recording Studios, etc, and use the same equipment for you: NEUMANN Disc Cutting Lathes—Mono and Stereo systems. Professional tape machines with Ferrite playback heads, Dolby A and B systems, 200W Amplifiers, Lockwood monitors, Teletronix/Ortofon Limiters. Send SAE for photo leaflet.
DEROY STUDIOS (1948)
Hawk Street, CARNFORTH, Lancs. Tel. 2273

★**County Recording Service.** 7″ vinyl discs pressed on our own plant.
★**Fanfare Records.** Tape - disc pressings, demo's, masters, any quantity. Studio/mobile. Neumann disc cutter. S.A.E. brochure. 1 Broomfield Close, Rydes Hill, Guildford. Telephone 0483 61684.

mjb recording and transcription service
Vinyl pressings and acetate demodiscs. Limiting, compression and equalisation facilities; high undistorted cutting levels with feedback cutter heads. Booklet available.
ST. MICHAEL'S, SHINFIELD ROAD, SHINFIELD GREEN, READING, BERKS.
Reading (0734) 84487 Member A.P.R.S.

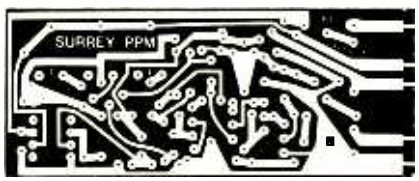
★**County Recording Service.** Stereo and Mono discs from your tape.
★**J & B Recordings.** Tape to disc—latest high level disc cutting, all speeds. Mastering pressings, studio, mobile. 14 Willows Avenue, Morden, Surrey. MITcham 9952.

CASSETTE COPYING
PROFESSIONAL HIGH-SPEED SERVICE
Competitive prices for small or large runs. Full Studio facilities for production of master tapes. Rate card with full details on request.
STUDIO REPUBLIC SERVICES
01-868 5555

★**County Recording Service.** Top quality, reasonable price, quick delivery. Tel. Bracknell 4935. London Road, Binfield, Bracknell, Berks. RG12 5BS.

COMPACT CASSETTES
PROFESSIONAL HIGH-SPEED DUPLICATION
Dolby B—compression and equalisation available—competitive prices on small runs—full productions undertaken—music and language specialists.
Contact Chris Sands
AUDIO EDUCATION COMPANY
01-723 6635

FOR SALE—TRADE



Drive circuit for 1mA L.H. zero meters, 35 x 80mm.

C.W.O. further 5% less	2 off	4 off	10 off
Complete kit	£8·00	£7·60	£7·20 £6·80
Built and aligned	£12·00	£11·40	£10·80 £10·20

Ernest Turner PPM meters, scaled −22 to +4 OR 1 to 7. Type 642, 71 x 56mm £9·90; Type 643, 102 x 79mm £11·77.

SURREY ELECTRONICS
24 High Street, Merstham, Surrey

★**Professional tape** only 45p. 1200ft. Agfa on hubs, no joins (p. and p. one box 25p, each additional box 10p). We handle 99% of all s/h professional recording equipment. Send for list. Jackson Studios, Rickmansworth, Herts.
★**Tame those dB's** . . . Plug in professional quality FET compressor module £15.50. For the 'slick operator' . . . 'Voice over' module £15.50. S.A.E. details. Cathedral Sound SS, "Fourways," Morris Lane, Halsall, Lancs. L39 8SX.

★**Lancashire.** Tandberg, Ferrograph, Tape Recorders, etc. Plus over 10,000 high fidelity systems. After-sales service. Holdings, Photo-Audio Centre, 39-41 Mincing Lane, Blackburn BBA 2AF. Tel. 59595/6.

★**Revox A77** 1102 Mk III, boxed, £198. Tel. Wokingham (0734) 781970.

★**Response 10 channel** transportable stereo-mixer with built-in HH amplifiers for monitoring and foldback. Tape machines, pre- and post-group, foldback and echo send selectable on monitoring speakers, foldback speakers and headphones and on to meters. Echo send faders have pan-pots—as each tape machine can take either echo send or mixer output, for track working is possible, with push-button channel selection for overdubbing or mixdown. Many extra facilities. £900 o.n.o. 579-6376, after 4.30.

★**Nagra IVS** complete with batteries, case and PSU, £750. Two Sennheiser Mk H405 mikes, £82 each. Grampian 636 reverb £32. Phone Bury St. Edmunds 3232.

FOR SALE—PRIVATE

★**Allen & Heath** 10 channel stereo mixer. All facilities including limiters. Revox A77 high speed sel-sync suitcase model. Six AKG and Calrec mics. All 5 months old and used only 3 times. Details: Carlisle 35907 after 6 p.m.

WANTED

★**Lee Electronics.** The Tape Recorder and Hi-Fi Specialists wish to purchase good quality Tape and Hi-Fi equipment for cash. 400 Edgware Road, W.2. Phone PAD 5521.

MISCELLANEOUS

★**Tape and Cassette Recorder Repairs** by Specialists. The Tape Recorder Centre, 82 High Holborn, London, W.C.1.

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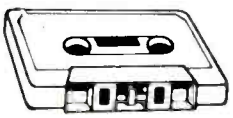

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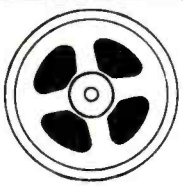

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5¾	900′	40p	1200′	55p	1800′	80p
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EMPTY SPOOLS 5″ 10p, 5¾ 11p, 7″ 12p. P/P 20p

WALKERS (S) 16 Woodthorpe Road, Ashford, Mdx. 52136

Sensitive, Reliable and Unattached

Sounds too good to be true.

That's what you get when you fall in love with RESLO radio microphones. RESLO radio microphones leave you free to move around, free to engage your audience properly, without restriction of movement. Yet the same RESLO quality sound is there to back you up.

Reliability is all part of the purchase too.

If the thing ever goes wrong you know where to find us – at Romford, near London, with a service department that's second to none.

We could name-drop a lot of big-timers who rely on RESLO radio mikes to keep in touch with their audiences, but you'd probably prefer to prove it yourself.

So if you want to be heard loud and clear, or sweet and soft, take a good look at the range of RESLO radio mikes before your next gig.

Better still clip the coupon attached below and we'll send you a brochure right now.

RESLO

Spring Gardens,
London Road,
ROMFORD, RM7 9LJ.
Tel: Romford 61926

It all sounds too good to be true.

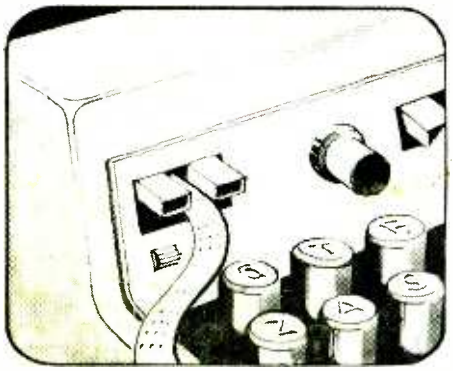
I'd like to find out about RESLO radio mikes ☐ I want to see the rest of the RESLO range also ☐

Name.....

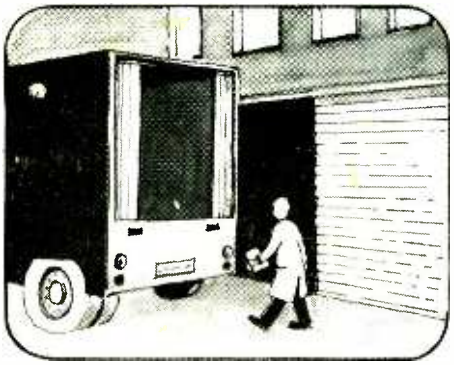
Address.....

.....

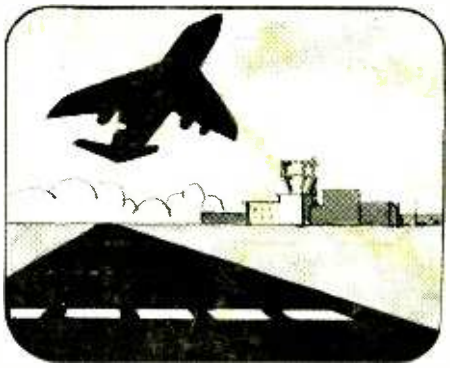
Neve Storyboard



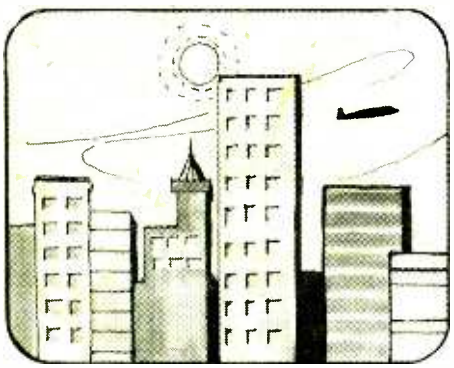
SFX: Telex machine.
Customer wishes to order 24 channel music recording console to be in Montreal by Monday.
Message received by Neve previous Tuesday .....



Neve S24/8/16 console delivered to U.K. packers Thursday.....



Delivered to London Airport Friday.



Arrives Montreal 1pm Saturday.

Powered up in studio fully tested 6 pm same afternoon .....

In use for live F/M broadcast 10.30pm Saturday (same evening).
MVO: 'Who said Monday?'

Neve

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Hertfordshire SG8 6AU,
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telex 81381
cables Neve Cambridge

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