December 1971 25p

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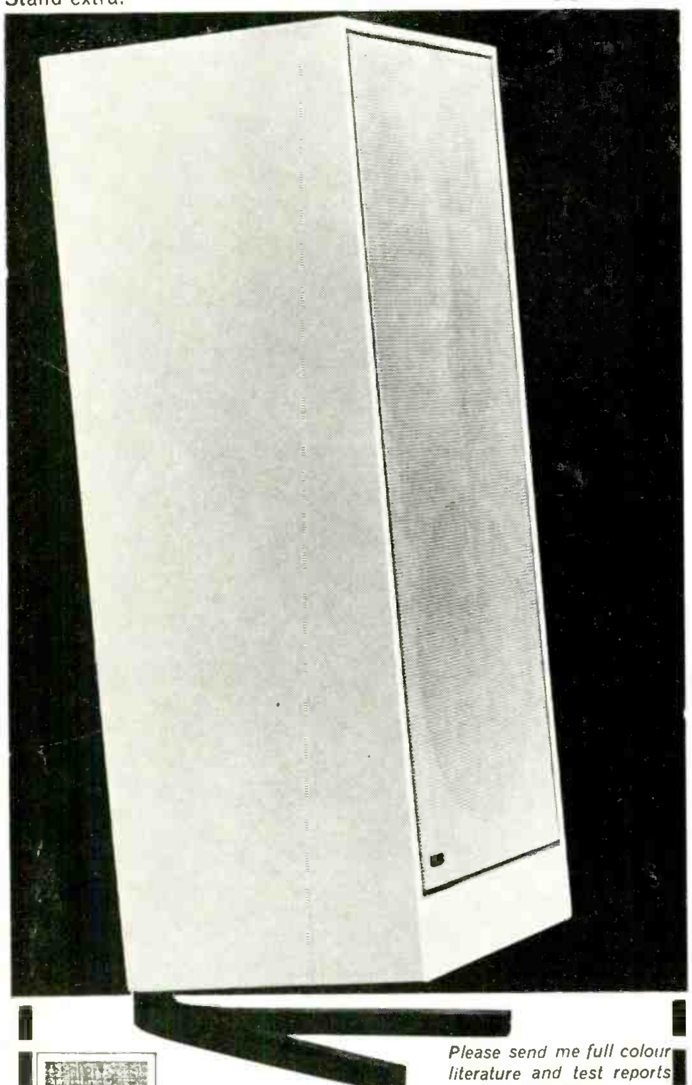

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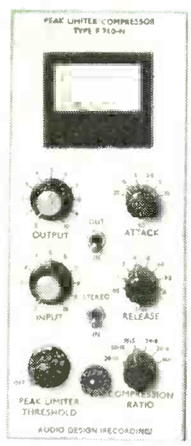

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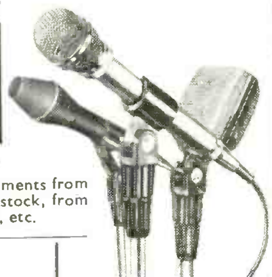

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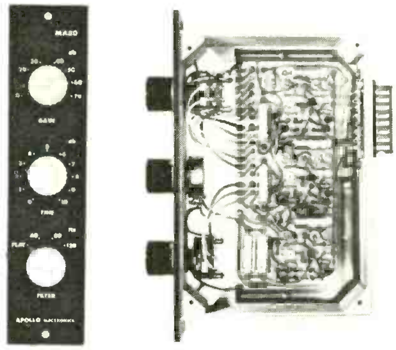

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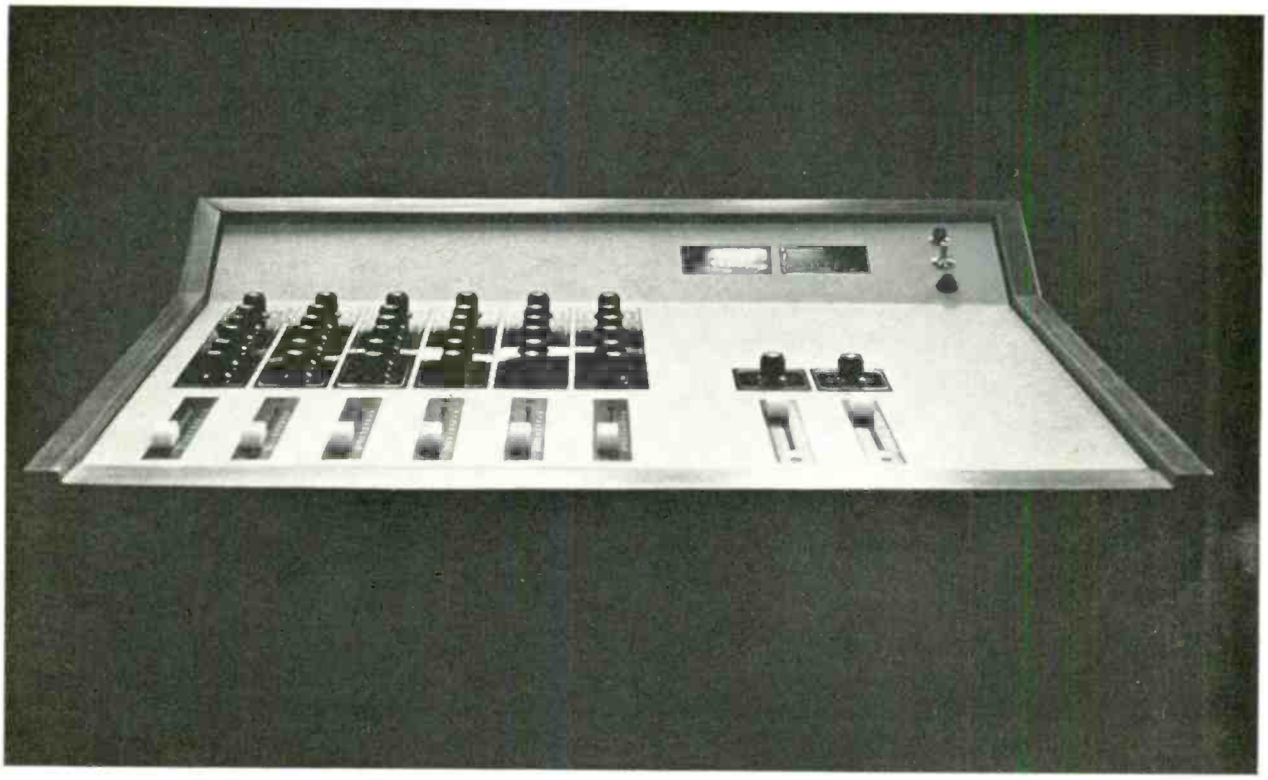

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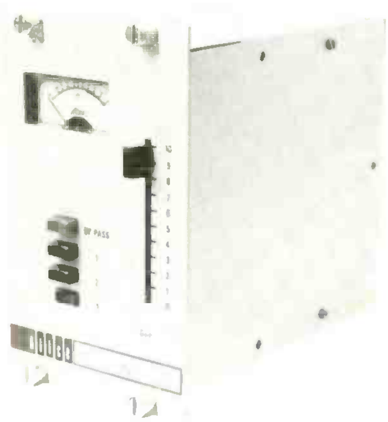

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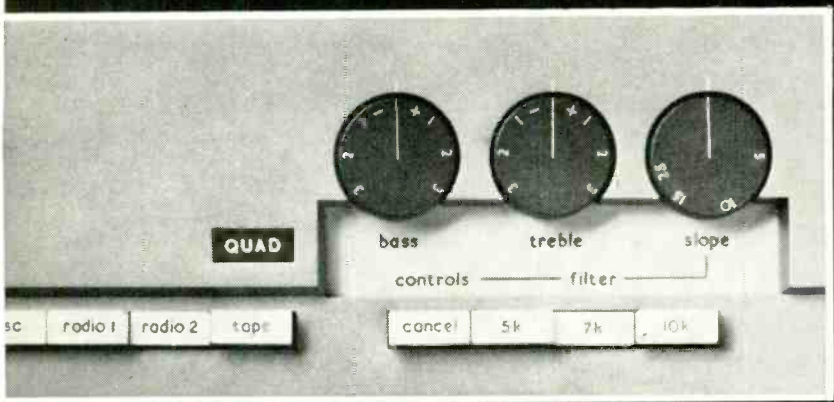

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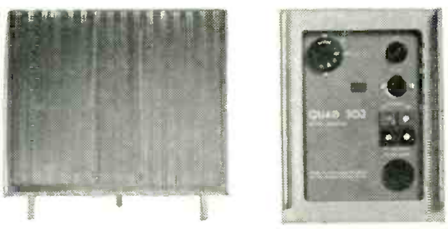

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studio sound
INCORPORATING TAPE RECORDER

DECEMBER 1971 VOLUME 13 NUMBER 12

EDITOR DAVID KIRK **CONSULTING EDITOR** JOHN CRABBE

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Editorial and Advertising Offices: LINK HOUSE, DINGWALL AVENUE, CROYDON CR9 2TA. Telephone: 01-686 2599

HOW DO YOU test a microphone? Come to that, how do you test anything? Usually by comparison with other microphones, other cars, other doughnuts, in the same price category. In this issue, Angus McKenzie has contributed what may be the most comprehensive comparison of studio microphones ever published. His tests leave only one major question unanswered: how do these units stand up to the buffeting of daily life?

Most one-man operators take particular care of their recording equipment; few can afford to do otherwise. But the apparatus put out by larger studios is vulnerable to accidents or mishandling. In this situation, robust dependability is of greater practical value than an impressive specification. A microphone submitted for examination to Tyne Tees Television has to survive a few falls before the staff will even consider using it. All very practical but try telling a reviewer to thump his precious *C24*. You are politely told where to go. Future microphone reviews, provided we can obtain the makers' authority, will include a standard shock test showing the effect of a specified fall on the measured performance. If a maker does not permit this (the equipment usually comes on loan so it is the supplier's prerogative), a note to that effect will be included in the review.

It is a general failing among reviewers—particularly of domestic hi-fi products—that routine bench tests are purveyed as complete reviews when in fact they omit all the practical problems facing the unfortunate buyer. Bench measurements are insufficient. You have to *use* a product to discover its weaknesses: the preselectors which break down after a month, the tuning dial that flips its loop, the fuses that blow on each climax, the yankee mains socket with a 50 kg grip.

In this journal, we have occasionally supplemented reviews with field trials intended purely to uncover handling problems. This has been unsatisfactory since much of the value of practical tests is lost when they are viewed in isolation from routine performance measurements. Future STUDIO SOUND reviews will be structured on a basis combining both aspects of equipment testing.

SUBSCRIPTION RATES

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

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Precis

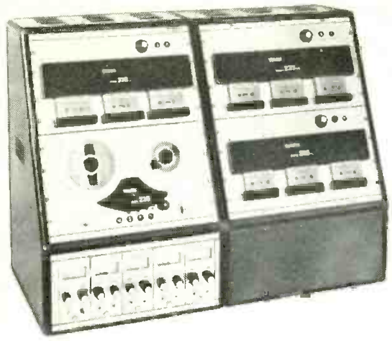
Letters

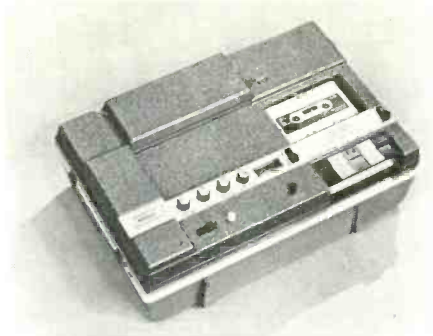
The Kellar review

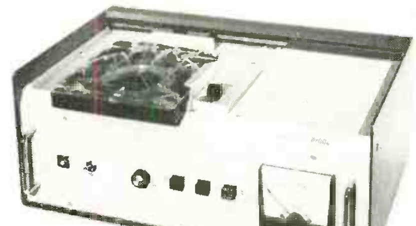
Dear Sir, I wish to call your attention to the considerable number of errors in method, errors of fact and mistaken assumptions published in the guise of a review of the Kellar KDB1 in the September issue of Studio Sound. The article is, in fact, so confusing a patchwork, and such ideas as it contains are so difficult to extract that a simple list of mistakes must suffice here. Except another by the same author, I cannot recall so unfair a treatment of a product submitted for review. It is also possible that the reviewer is actually quite fair, in which case it must then be assumed that he is equally incompetent.

1. In the second paragraph input level controls are mentioned, and their use is discussed later in the review. Having written these earlier parts of his manuscript, the author complains of the difficulty of using the unit because no such input level controls are provided. If the controls were in some way difficult to use in operation this is what should have been said.
2. Since the Wollensak recorder loaned did not affect the input level problems, as the reviewer pointed out, the introduction of the Dolby name is entirely gratuitous. The same, in fact, may be said of the repeated citation of the manufacturers whose amplifiers and loudspeakers are used. It is to be assumed that the reviewer is

(continued on page 616)







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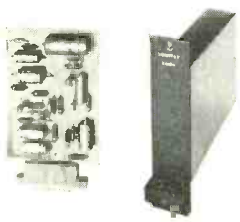

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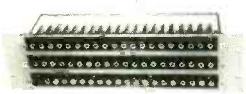

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employing test equipment and listening apparatus which have been thoroughly checked and are accurate in performance. Why, then, constantly provide us with these brand names?

3. It is not *assumed*, as the reviewer states, that 'the noise which really matters is generally confined to high frequencies'. This apparently innocent suggestion that an assumption has been made somewhere overlooks the fact that established standards of noise measurement exist in the form of DIN and NAB weighting networks. These standards are not the assumption of any individual or organization, and must be used to accurately measure noise reduction with any psycho acoustic significance. This ignorance is manifested again when the author announces a 5 dB reduction in noise by the use of the *KDB1* and measures wide band noise. It is also important for him to understand that almost all of the noise, i.e. high frequency noise, in a good tape recorder is due to the tape, while hum and flicker noise are removable by good circuit design.

4. After observing that 'high level signals are unaltered' the author later attempts to determine the distortion in the system at a high level, 4 kHz at −10 vu. As it happens there is about 1½ dB of noise reduction to be obtained under these conditions. However, testing under these conditions hardly discloses the facts of system operation other than distortion of the entire chain. In fact, the way in which the measurement was made, and the fact that the author finds it necessary to 'discover' an effect responsible for a null result of an experimental test would be amusing in a different context. There is no reason to assume that distortion has been observed, when so many other factors are involved.

5. A small point. In describing the set-up procedure, it is indicated that the Dolby level tape is supplemented by the use of a virgin tape. This is a bit of pedantic nonsense. We are quite happy to suggest that the blank tape used need not be virgin provided that it is clean.

6. Although the unit was tested with a three head tape recorder, it was not pointed out that the set-up procedure is in fact simpler and faster with such a machine than with a typical cassette recorder.

7. No line up tape is provided for 38 cm/s because the 19 cm/s tape supplied is usable at the high speed as well as at the lower speed of 9.5 cm/s. Again, at the very beginning of the review, had the author considered it, he would have found that Dolby level is defined as a level of magnetic flux on the tape and that this is independent of speed.

The first listening test described was done, we are told, 'with tone controls flat'. Despite the highly favourable comments about the Dolby system made by the reviewer with regard to this test, we are moved to ask whether any attempt was made to establish the system frequency response prior to judging the quality of the results. It is particularly important because of the observed lack of brightness, which could have been due to the loud-speakers, the tape recorder, or to the characteristics of the pickup cartridge used to play the discs. It is hardly of value to subsequently mention the brand of equipment used unless some reason for the choice of such equipment is given. It is even more mysterious to discover that the Sony recorder with which the test began was discarded without explanation and the Wollensak substituted. Since the Sony is available in the UK and the Wollensak is not, would not the Sony have provided a more relevant test? The reviewer states that attempts at measuring distortion 'fail to produce any evidence of increased distortion' except for a reading of 0.5 per cent under conditions which, the author fails to disclose, represents the highest distortion point of the Kellar circuit. The question is then raised, but typically left unanswered, as to whether the reviewer has discovered a 'Dolby B Achilles Heel'. The Dolby circuit itself can be designed to have arbitrarily low levels of distortion. On page 481 of the same issue of STUDIO SOUND, a more complex version of the same circuit—the Dolby Laboratories professional model *320*—is shown to have distortion 'lower than 0.01 per cent' under conditions similar to those in the review under discussion. So much for Achilles.

8. The author of the review has decided that 'properly set-up recorders at 19 cm/s should not need a Dolby for normal recording purposes'. This information will be of inestimable value to the hundreds of professional studios which have purchased thousands of units for use at even higher speeds than 19 cm/s. The further observation by the reviewer that the *KDB1* 'produced no audible effect at this speed' contradicts the evidence of many demonstrations and experiments carried out with all types of equipment. Incidentally among those arriving at opposite conclusions from the reviewer is the manufacturer of the tape recorder used in the test.

One can only wonder whether the reviewer would have considered it reasonable to make a piano recording and play that back at levels which were 'realistic', the term which he used to describe the listening levels he employed. There is hardly a tape which will not disclose an unpleasant background noise when the piano is reproduced on realistic levels that is, the levels which would be obtained with a piano in the listening room. Moreover, the excellent quality of the recorder used in the open reel tests is irrelevant, because the noise level obtained in most recordings is almost all due to the tape, not the recorder.

9. Why does the author perversely suggest that at 19 cm/s 'the Dolby might be of use in making multi-generation copies' if, as he immediately observes, 'it is difficult to imagine why anyone should choose to do his recordings in this way'.

10. The frequency response tests made on the Wollensak are only a test of the system, and tell us nothing about whether or not the Dolby System is operating properly.

11. The complete hypothetical distortion of 0.3 per cent which the reviewer calculates, would represent the level of −60 dB, well below the level of the tape noise. Without wishing to concede for a moment that the distortion exists, should it not have been pointed out that it is not only 'insignificant' and 'amply compensated' but also totally inaudible?

12. Although the meters on the *KDB1* were marked in vu units on early production, they were only intended for use in calibration and not for monitoring recording level. The comparisons to the meters on the recorders are therefore meaningless.

13. The reviewer once again gives us an expert listening panel to assist with his review, which in this case unanimously prefers non-Dolby recordings. This is later attributed to deviations of a few dBs at 20 or 30 dB below 0, these same deviations occurring mainly between 4 and 14 kHz. First, we should congratulate the anonymous panel on its remarkable hearing. But now that this unique preference has been discovered, was it also investigated at other speeds, with other equipment, and with other such astute listening panels? It is not only that the numerous other errors in the review shake one's confidence in the reviewer's ability to carry out such a test competently; it is also necessary to consider that it contradicts all previous experience in the use of the Dolby B system with properly operated equipment.

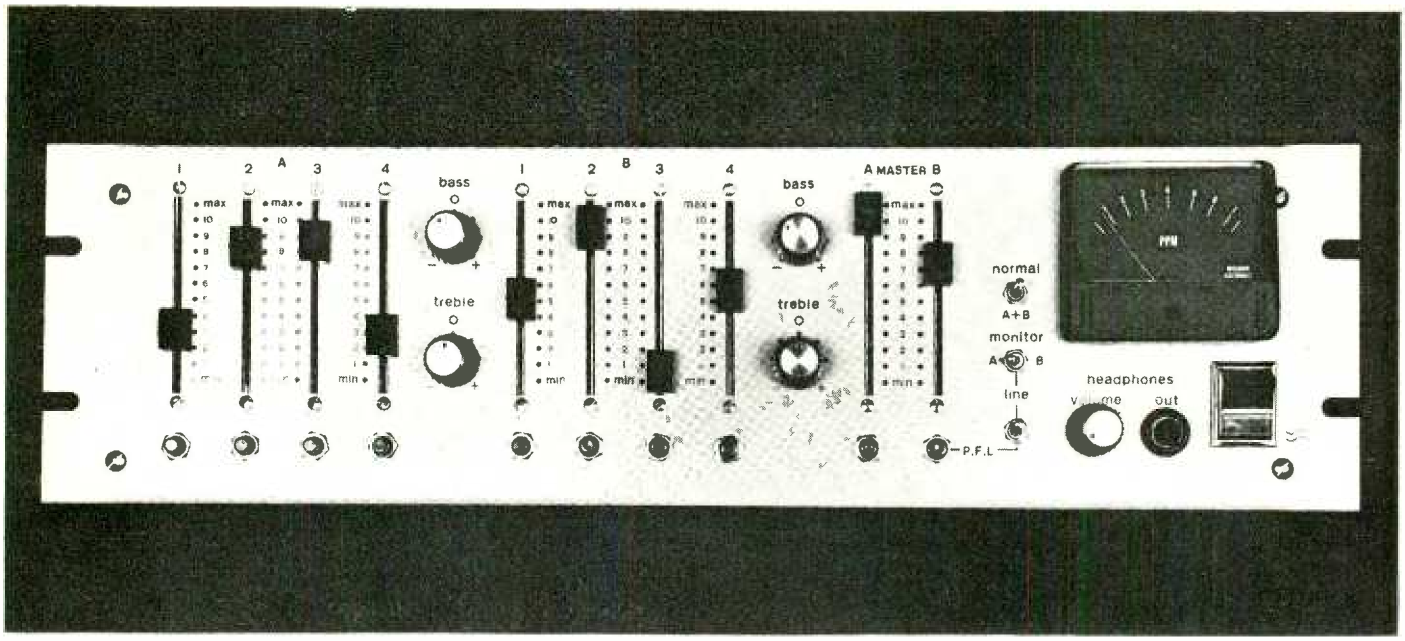
It may seem unusual to take a reviewer to task so strongly when he has written what is, after all, a favourable (if somewhat odd) review. However, it is from the publication in a journal as reputable as STUDIO SOUND that authority is loaned to those whose judgement must stand the strongest light of examination. Even allowing for the fact that everyone makes mistakes, the reviewer in question fails utterly to withstand such examination.

Yours faithfully, Sidney Larholt, Director, Kellar Electronics Ltd, 6 Byculllah Avenue, Middlesex.

I cannot understand why Mr Larholt's letter was written; the substance of my review was given to Kellar Electronics and Dolby Labs for their comments before publication and all his points could have been raised then. Kellar's only reaction at the time was that they thought the review very fair. [*Dolby commented on a number of details in the review but, due to an administrative error, several suggested changes were not made*—**Ed.**] *I will, however, attempt to satisfy Mr Larholt over some of his points.*

1. *It was pointed out in the review that the output from the Sony overloaded the inputs, and I assume that readers of this journal would be aware of the symptoms. I did* **not** *state that no input level controls were provided but suggested that, if attenuators such as those made up for use in the review were incorporated in the* KDB1, *the input controls provided would then be of use.*

(*continued on page 618*)



Audio Engineering for Professionals

Four years ago, only a handful of people had heard of the Millbank Electronics Group. Today, our equipment is operating in 25 countries and is specified by most major professional users of audio and communications equipment in the United Kingdom.

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The MCC Mark II illustrated above is an eight channel sound mixer employing linear motion faders arranged in two groups of four. Each group has associated bass and treble tone controls and a master fader. By the use of our plug in audio modules the following inputs may be obtained:

(a) Microphone, any impedance from 30 to 600 ohms.
(b) Linear unbalanced, any level from 20mV to 11 volts!
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Two 600 ohm floating balanced line outputs are provided and you can chose from either VU or PPM monitoring. Pre fade listen buttons are fitted to each channel and each group and a 2 Watt audio amplifier is provided for headphone or loudspeaker monitoring. There is even an output/input socket for external curve benders, etc., etc.

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Millbank Electronics Group,
Bellbrook Estate, Uckfield, England.
Tel: Uckfield 4166 (0825-4166)

2. *I don't know why the use of the Dolby name annoys Mr Larholt—the* KDB1 *is manufactured to a Dolby design under licence. I mention the other equipment used for listening tests so that readers can judge to some extent the standards by which the equipment is judged. The first listening tests were carried out on equipment which was considered a reasonable domestic 'budget' set up of the type for which it was felt the* KDB1 *might well be suited; the second with (arguably) the highest quality domestic system available. Since the* KDB1 *is designed for domestic use, it seemed to me that both these tests were valid and relevant.*
3. *The short paragraph devoted to the design philosophy and method of operation of the Dolby B system was taken direct from Dolby Labs literature on the subject and Mr Larholt should take the designers of his unit to task over this if he does not agree. I cannot see what DIN and NAB weighting networks have to do with this or whether hiss is due to tape or tape recorders. I can't recall raising any of these topics in my reviews though if the DIN and NAB weighting networks are not the assumption of any individual or organisation as Mr Larholt states I would be interested to hear how they were designed.*
4. *I thought I had made it clear in the review that doing this test the performance of a system without and then with the* KDB1 *was being measured and it is obviously important to determine whether the* KDB1 *has any effect at all levels—after all the signals pass through the unit even if they are high level. I can't comment on Mr Larholt's remark about 'my attempt to discover the effect responsible for a null result of an experimental test' except to say that this conjures up a fascinating picture; unless by 'null result' he means the definite preference of a number of experienced listeners to the non Dolbyed tape—in my view a very positive and relevant result even if puzzling.*

5/6. *Points taken, though I think we should assume readers of this journal would be fully aware of both these.*

7. *I was asked by Kellar not to test the unit at* 38 *cm/s as the licence for Dolby excluded its use professionally. The tape provided for lining up was not suitable for* 38 *cm/s because its length was so short that at that speed it ran off the spools before one had time to tweak the controls. These points did not seem relevant to the review so were not mentioned at the time.*

   I thought I made it clear in the review that most listeners thought the sound from the tape better than that from the disc, and that the fact that the latter was 'brighter' did not imply a 'lack of brightness' from the tape; these are Mr Larholt's words not mine.

   I thought I had made it clear that the 0.5 *per cent distortion was measured at* 1.5 *kHz,* −15 *dB, but regret that owing to an omission somewhere between my submission to the editor and the printed version it was not made clear that not only was the distortion traced to the* KDB1 *and not an error, but the form of distortion was shown on an oscilloscope. Quoting the performance of a different instrument costing far more than the* KDB1, *designed for professional use, and incorporating special circuitry to eliminate this particular distortion seems to me to be an unnecessary red herring and doesn't alter the facts.*
8. *I cannot comment on 'many demonstrations and experiments' Mr Larholt mentioned as I was not present. I can only report my own findings honestly and this I have done. The statement made by Mr Larholt that 'noise level in most recordings is almost all due to the tape and not the recorder' is complete nonsense and bears little relation to fact, particularly when domestic recorders are considered—the ones for which the* KDB1 *is supposed to be designed.*

8a. *I have often done exactly what Mr Larholt suggests—recorded a piano and played back in the same room at a level that made it impossible for people standing just outside the open door to tell whether the piano or the recording was being played. Even without a Dolby the noise level at this 'realistic' level is insignificant provided high quality equipment, properly set up, is used.*

9. *Sorry about this, another chunk of my writing got missed out somewhere and the whole sense of this paragraph was altered. The test originally described showed that a* 6*th generation Dolbyed copy had about the same hiss level as a 2nd generation non Dolbyed copy. The remark at the end referred to* 8*th generation copies.*
10. *See my comments on* (4).
11. *What does 'insignificant' mean to Mr Larholt? It seems that if he has to agree with what I say he must disagree with the words I use. Why?*
12. *The remarks on the vu meters were made because the instructions supplied with the* KDB1 *fail to give any guidance as to whether after lining up one should use the* KDB1 *or the recorder's meter for setting levels—in fact one should use the* KDB1 *controls and the recorder's meters—a pretty silly but I suppose necessary arrangement.*
13. *If Mr Larholt can't hear the difference 'a few dBs mainly between* 4 *and* 14 *kHz' made to a signal he should employ some younger ears to help. Considerable experience has shown me that it is surprising how few dBs are needed at this end to make all the difference, but after all I only stated 'It is possible that a slight change etc' and did not 'attribute the preference to it' as Mr Larholt states.*

I regret being involved in yet another exchange with a manufacturer over a review, but I suppose that unless my reviews are to be innocuous and meaningless I must expect this occasionally. I only hope that others read my reviews with more care and in a more generous spirit than Mr Larholt.

However, all this does not alter the fact that if you haven't a noise problem you don't need a KDB1 *but if you have and particularly if it is HF noise then the* KDB1 *is for you and is good value for money, but it is not a magic cure-all for other recording faults, and I hope I made this clear in my review.* **John Shuttleworth**

Patents Review

BY ADRIAN HOPE

DYNA Magnetic Devices have a new patent BP 1,237,566 for Inertial Reaction Transducers. Although at first sight these may not seem too relevant to our field, a closer look suggests otherwise.

In communications systems it is often inconvenient, for one reason or another, to have headphones and a mike boom or throat mike. Equally often, something along these lines is essential if the operator is to have both hands free for other purposes. Policemen, for instance, need their hands free but cannot really carry a mike boom on their helmets.

Dyna have devised a transducer which is suitable for fitting in a hat or helmet and their little gadget ('little' is the operative word, i.e. 0.67 gm weight and 11 x 6 x 5 mm size) is usable either as a microphone or receiver. It is formed from a suspended weight system linked by a rod to an armature of an electromagnetic motor system. When the gadget is being used as a contact mike (e.g. worn on top of the head), the tiny vibrations produced in the skull by speech cause most of the motor part of the transducer to vibrate while the weight and armature remains more or less stationary. The result is a signal voltage from the motor which can be amplified and fed out in the usual way.

When the transducer is being used as a receiver, audio signals are fed into the motor, which causes the armature arm and weight to vibrate in typical manner and, by inertial reaction, the whole gadget vibrates. As a result, Dyna claim audible sounds coming from the head top.

According to the inventors, their transducer shows a rising characteristic from 300 Hz to 2.4 kHz with a 9 dB rise per octave and a steady

(*continued on page 620*)

Sansui 4-Channel Stereo. The Doors Are Always Open.

Now, walk right in and step right up to a fabulous new experience in sound—Sansui 4-channel stereo. The door—both doors are always open.

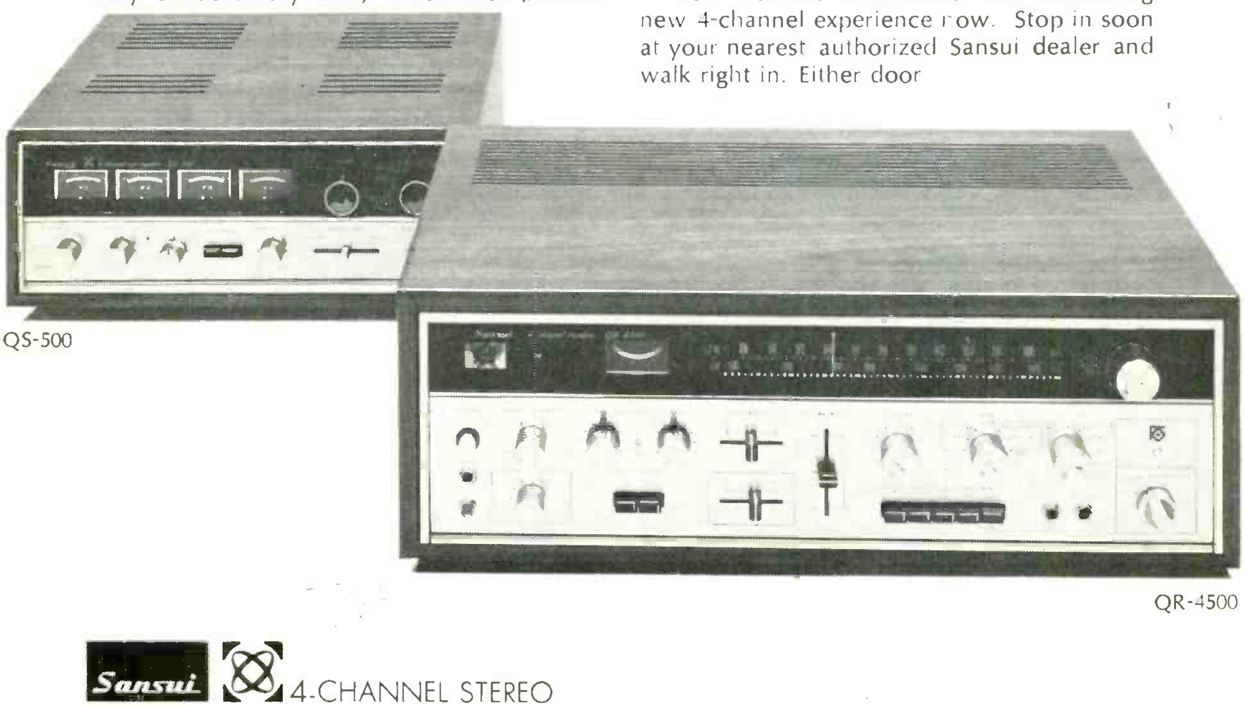
One door gives you access to new building-from-scratch 4-channel receivers, the other to supplementary components that will let you up-grade your two-channel system to 4-channel status in seconds.

Either way, you can instantly convert your valuable two-channel tapes and records (as well as FM broadcasts) into the new format.

For those interested in a complete new 4-channel system, the 240 watt Sansui QR-4500 4-Channel Receiver is the ideal nucleus. This truly extraordinary unit, which incorporates the exclusive 4-channel synthesizer decoder, also gives you a super-sensitive stereo tuner, plus a high performance control amplifier for all the power you'll probably ever need. But if that's still not enough, check out Sansui's 280 watt QR-6500. Something more modest? Sansui's 100 watt QR-1500 or 60 watt QR-500 might prove to be more in line with your needs.

Building on a two-channel system? Then choose the versatile new 120 watt QS-500 4-Channel Rear Amplifier. Added to your present system, along with a second pair of speaker systems, it elevates you to 4-channel status instantly. And the 50 watt QS-100 can do the same.

You're on the threshold of this enthralling new 4-channel experience now. Stop in soon at your nearest authorized Sansui dealer and walk right in. Either door



QS-500

QR-4500

Sansui 4-CHANNEL STEREO

England: VERNITRON (UK) LTD. Thornhill Southampton S09 5QF Tel: Southampton 44811 / Ireland: INTERNATIONAL TRADING GROUP LTD. 5 Cope Street. Dame Street, Dublin 2 / West Germany: COMPO HI-FI G.M.B.H. 6 Frankfurt am Main, Reuterweg 65 / France: HENRI COTTE & CIE 77, Rue J.-R. Thorelle, 77, 92-Bourg-la-Reine / Luxembourg: LUX Hi-Fi 3, rue Glesener, Luxembourg / Austria: THE VIENNA HIGH FIDELITY & STEREO CO. A 1070 Wien 7, Burggasse 114 / Belgium: MATELECTRIC S.P.R.L. Boulevard Léopold II, 199, 1080 Brussels / Netherlands: TEMPOFOON N.V. Tilburg, Kapitein Hatterasstraat 8, Postbus 540 / Greece: ELINA LTD. 59 & 59A Tritis Septemvriou Street, Athens 103 / Italy: GILBERTO GAUDI s.a.s. 20121 Milano, Corso Di Porta Nuova, 48 / South Africa: GLENS (PTY) LTD. P.O. Box 6406 Johannesburg / Cyprus: ELECTROACOUSTIC SUPPLY CO., LTD., P.O. Box 625, Limassol / Portugal: CENTELEC LDA. Avenida Fontes Pereira de Melo, 47, 4.o dto., Lisboa-1 / Malta: R. BRIZZI 293, Kingsway, Valletta / Canary Islands: R. HASSARAM Calle la Naval, 87, Las Palmas / SANSUI AUDIO EUROPE S.A. Diacem Bldg., Vestingstraat 53-55, 2000 Antwerp, Belgium / SANSUI AUDIO EUROPE S.A. FRANKFURT OFFICE 6 Frankfurt am Main, Reuterweg 93, West Germany / SANSUI ELECTRIC CO., LTD. 14-1, 2-chome, Izumi, Suginami-ku, Tokyo 168, Japan roll-off from the peak to 3.8 kHz. This, they suggest, produces good speech intelligibility, good speech pick-up and low ambient noise.

The kind of not-too-obvious application that springs immediately to mind is the possible use of this type of transducer in studio communications systems—it could for instance put an end to those occasions when a dramatic moment of TV drama is deflated by a live mike picking up an 'Over to your right, Camera One' instruction escaping from the headphones of a nearby crew.

Ampex Corporation's BP 1,239,363 describes some improvements they are making in the magnetic head assemblies for cassette recorders. The specification also provides a further insight into the problems involved in cassette head production and some of the ways that are used to tackle them. If cross talk and other bugs are to be ironed out of cassette recorders at reasonable cost, highly automated accurate construction techniques are essential.

Ampex use a head assembly which tapers from rear to front, i.e. gets wider away from the tape area, so as to provide for easier connection of the coils. The head assembly is formed from a pair of structurally complementary Bakelite carriers. Each of these carriers has a series of notches in its rear end and the notches are tailored to receive the various pole and core segments. As I mentioned above, there is convergence of the head entrails laterally towards the head-to-tape interface and the type of angles involved are in the order of 10°.

Ampex maintain that, by using their notched carrier system, they can set up the head assemblies quickly and accurately with a minimum of jigs. Apparently the only jigs necessary are those required to keep the proper spacing between the tips of the transducers at the head-to-tape interface and to hold the notched carriers in place. Otherwise the Ampex assembly is self-supporting and maintains everything in its proper spaced relationship until the whole thing is internally encapsulated with insulative epoxy.

Incidentally, Ampex remark that their erase heads are fixed to simultaneously erase Channels One and Two (and, of course, Channels Three and Four) without leaving an unerased intermediate spacing. This is achieved by having the erase transducers extend across the full width of the two associated stereo pair tracks and will provide more complete erasure than in the case where individual erase transducers are associated with each record / playback transducer.

According to Ampex this type of head assembly will provide a playback output signal of 265 μV at 1 kHz and cross talk 48-50 dB below operating level between stereo pairs.

For anyone wondering where it is all heading, Westinghouse Brake and Signal Co. Ltd, may have the answer in BP 1,236,483. In more or less their own words this patent is for a signal recording and playback apparatus of the type where the transducing head is co-operable with one of a number of longitudinal tracks on a recording medium, the head being mounted on a carriage which is displaceable in discrete steps by a uni-selector so as to allow a desired one of the tracks on the record medium. All of which is a bit of a mouthful. What it means is that a tape loop carries a number of parallel recording tracks and a head can be moved across the tape by uniselector. Westinghouse suggest that their invention is going to be particularly useful where it is wanted to record a number of messages on a loop of magnetic tape and then apply control signals to select an appropriate message in dependence on some condition or another—like the weather or the state of one's overdraft, or the system can be used in telephone answering systems or where each of the tracks carries a train of pulses representing a telephone number. This way, on receipt of a command signal, equipment will automatically dial a preset telephone number.

But Westinghouse have another suggestion. According to them the equipment can be fitted at a centre for supervising some unspecified thing or another and during periods when it is unattended by personnel, i.e. when the staff have gone home, can call up outstations and retain messages received from the out-stations, indicative of the states of gadgetry out at the outstations. And what happens if the outstations are also unattended? Presumably the Westinghouse gadgets will then be wasting the firm's time and money by calling each other up for a chat when they get bored.

THE FOLLOWING list of Complete Specifications Accepted is quoted from the September issues of the *Official Journal (Patents)*. Copies of specifications may be purchased at 25p each from The Patent Office, Orpington, Kent BR5 3RD.

September 2

1,249,203
International Rectifier Co (GB) Ltd
Electric battery charging circuits incorporating solid state rectifiers

1,249,221
Dawney, J. C. G. and Faulkner, E. A.
Electronic amplifier circuit arrangements

1,249,222
RCA Corporation
Gain controlled amplifier

1,249,236
Wilson & Longbottom Ltd
Means for winding materials at constant and variable tension and linear velocity

1,249,251
Westinghouse Electric Corporation
High reliability semiconduct ve devices and integrated circuits

1,249,266
Fernseh GmbH
Television camera

1,249,274
Ford Motor Co Ltd
Magnetically determining mechanical properties of moving ferro-magnetic materials

1,249,310
Columbia Broadcasting System Inc
Film recording method and apparatus

1,249,360
Sony Corporation
Lead assembly and method of making the same

1,249,395
Bofors A.B
Low frequency signal amplifier

1,249,464
Plessey Co Ltd
Piezoelectric transducers

1,249,483
Vyzkumny Ustav Matematickych Strouju
Arrangement for displaying and recording hysteresis loops of ferromagnetic materials

1,249,497
Sony Corporation
Apparatus for automatically eliminating an influence of the earth's magnetic field on colour television receivers

1,249,547
Telefon Aktiebolaget LM Ericcsson
Arrangement for indicating if a periodical signal exceeds a certain frequency

1,249,557
Telettra Laboratori di Telefonia elettronica e radio S.p.A.
Device for reducing noise in the ouput wires of a memory

1,249,593
International Standard Electric Corporation
Automatic gain control system for camera tube

1,249,598
General Radio Co
Signal generator apparatus

1,249,686
Wurlitzer Co
Numerical storage phonograph selector

1,249,696
Mattel Inc
Sound reproducing apparatus

1,249,704
Mohawk Data Sciences Corporation
Hub for tape reels and the like

1,249,716
RCA Corporation
Transducer arrangement

1,249,755
Amp Inc
Apparatus for crimping electrical connectors to wires

1,249,761
Telecommunications Radioelectriques et telephoniques
Transmission device for the transmission of analog signals by means of pulse code modulation

1,249,762
Philips Electronic & Associated Industries Ltd
Priority circuits

1,249,775
Eisen W. Trossinger Metallstimmenfabrik Hans Eisen
Sound Reproducing apparatus

September 9

1,250,226
International Standard Electric Corporation
Pseudo-random dot interlace television system

1,250,380
Phil'ps Electronic & Associated Industries Ltd
Speech controlled bidirectional amplifier

1,250,392
International Patente Etab
Sound playback apparatus

1,250,393
Philco-Ford Corporation
Formant frequency extractor

1,250,397
Stempel A.G. D
Sound damping material and the manufacture thereof

1,250,416
Peripheral Systems Corporation
Magnetic recording apparatus

1,250,430
Klostermark B.
Transportable coaxial cable

1,250,517
Braun K.
Gramophone pickups

1,250,640
Nippon Gakki Seizo K.K.
Loudspeaker

1,250,645
Matsushita Electric Industrial Co Ltd
Electron beam converging device

1,250,740
Philips Electronic & Associated Industries Ltd
Television camera tube

1,250,761
Electroube Ltd
Cleaning elements for electrical contacts

1,250,766
SOC Industrielle De Liaisons Electroniques
Device for detecting faults in a two-wire line

1,250,777
Western Electric Co
Phase controlled oscillators
1,250,780
Philips Electronic & Associated Industries Ltd
Device for unwinding tape
1,250,818
RCA Corporation
Circuit adaptable as a wide band amplifier
1,250,821
International Computers Ltd
Magnetic printing apparatus and magnetic transfer media
1,250,828
Fernseh G.m.b.H.
Colour television arrangement

September 15

1,250,919 and 1,250,920
Western Electric Co
Transistor oscillator circuits
1,250,930
Standard Telephone Cables Ltd
Electromagnetic relays
1,250,937
Siemens A.G.
Commutator-less DC motor with Hall generator control
1,250,967
Agfa-Gevaert AG
Method of producing asymmetrising tape in the recording tape technique
1,251,008
Columbia Broadcasting Systems Inc
Film recording method and apparatus
1,251,014
CKD Praha Oborovy Podnik
Inverter circuit utilising commutating transformers
1,251,055
Minnesota Mining & Mfg Co
Piezoelectric semiconductor acoustic wave signal device
1,251,074
National Research Development Corporation
Frequency multiplying electrical circuits
1,251,097
Alford A.
Coaxial connectors
1,251,114
Collins Radio Co
Variable impedance switching regulator
1,251,127
Institut Francais Du Petrole Des Carburants et Lubrifiants
Device for emitting acoustic waves in water
1,251,267
Standard Telephones & Cables Ltd
Wire wrapping tools
1,251,285
Philips Electronic & Associated Industries Ltd
Method of manufacturing printed circuits
1,251,308
Burroughs Corporation
Magnetic recording head
1,251,348
Sony Corporation
Semiconductor integrated circuit and methods of manufacturing the same
1,251,372
Racal-Thermionic Ltd
Tape recorder heads
1,251,379
RCA Corporation
Operational amplifier suitable for apparatus for measuring low voltages and currents
1,251,382
Plessey Co Ltd
Optoelectronic semiconductor devices
1,251,415
RCA Corporation
Tape receptacle
1,251,417
ITT Industries Inc
Oscillator circuit
1,251,439
Grundig EMV Elektro-Mechanische versuchsanstalt, Inh Max Grundig
Apparatus for transmitting pictures over communication channels of restricted band width
1,251,448
Western Electric Co
Methods of and apparatus for recording and reconstituting images of three dimensional objects and records produced by the recording methods
1,251,453
Matsushita Electric Industrial Co Ltd
Degaussing device
1,251,454
RCA Corporation
Integrated circuit
1,251,455
Burroughs Corporation
Record media processing apparatus
1,251,477
Xerox Corporation
Magnetic developing apparatus for latent electrostatic images
1,251,497
International Business Machines Corporation
Method and apparatus for recording colour images
1,251,515
Jungner Instrument
Method and a circuit for converting a dc voltage to an ac voltage
1,251,559
Sony Corporation
Cobalt ferrite system magnetic powder
1,251,563
Graphic Transmission Systems Inc.
Bandwidth reduction system
1,251,576
Siemens AG
Electric pulse generators or switches having permanent magnet circuit
1,251,587
Associated Electrical Industries Ltd
Control methods and arrangements for electric motors
1,251,596
Philips Electronic & Associated Industries Ltd
Dc permanent magnet motor
1,251,653
Selectro-Micro Co Ltd
Image reproducing apparatus
1,251,693
Westinghouse Electric Corporation
Semiconductor integrated circuit having mis and bipolar transistor elements
1,251,706
RCA Corporation
Mixer Circuit

September 22

1,251,837
Bosch G.m.b.H
Semiconductor components
1,251,851
Gauss Electrophysics
Video signal transducer
1,251,861
General Electric Co
Electrolytic capacitor and electrolyte material thereof
1,251,866
RCA Corporation
Automatic degaussing circuits
1,251,888
Caterpillar Mitsubishi Ltd
Method of dip-soldering
1,251,923
Polska Akademia Nauk Instytut Automatyki
Waveform generator
1,251,927
Siemens AG
Arrangement for generating a unidirectional voltage related to a speed of rotation
1,251,967
British Broadcasting Corporation
Inter-conversion between digital and analogue quantities

September 29

1,252,572
National Research Development Corporation
Alternating current rectifier and dc inverter circuit arrangements
1,252,574
Jayark Instruments Corporation
Projector for continuous loop motion picture
1,252,575
Jayark Instruments Corporation
Film cartridge for continuous loop motion picture film
1,252,741
Plessey Co Ltd
Speech encoding systems
1,252,814
International Business Machines Corporation
Electrical apparatus exhibiting negative resistance
1,252,841
Furuno Electric Co Ltd
System for recording electrical signal
1,252,845
Siemens AG
Magnetic disc data stores
1,252,874
Tektronix Inc
Attenuator apparatus
1,252,942
Communications Patents Ltd
Wire broadcasting systems
1,252,987
RCA Corporation
Integrated power output circuit
1,253,031
Dolby R.M.
Signal compressors and expanders
1,253,045
Bose Corporation
Loudspeaker system
1,253,256
Du Pont De Nemours & Co
Electrical circuit for suppressing undesirable electrical signals
1,253,356
Tong. D.A.
Super-regenerative oscillator circuits
1,253,390
AGA Ab
Arrangement for controlling and indicating the phase of an oscillation
1,253,431
Columbia Broadcasting System
Method and apparatus for optically recording colour picture information on a photographic medium

Studio Diary

BY KEITH WICKS

APPLE'S new studio in Savile Row is equipped with a 30/16 Helios mixer, 16 and eight track recorders by 3M, four and two track Studers, loudspeakers by Telefunken, Cadac and EMI, amplifiers by HH Electronics, Cadac and Audix, and microphones by Neumann, AKG, STC, and others. Reverberation is provided by EMT plates, and a chamber reputed to have cost £5,000 to build. The whole project cost around £500,000 and I hope to give more details next month.

At **Marquee** Studios, Colin Caldwell engineered a Black Widow album, produced by Malcolm Koss for Excellency Records. Johnny Johnson and the Bandwagon recorded a single, produced by Tony Macauley, and Chris Barber's Irish bass player, Jackie Flavelle, has just started on a single with producer Deke Arlon. Studio manager Phil Dunne recorded a Medicine Head single and has just started laying down album tracks for the same group.

Phil's most interesting session this month was a mobile recording at the Hampstead Theatre Club for Principal Edward's Magic Theatre. The Pye mobile unit was hired for this job, coped admirably, and was highly praised by Phil who directed the session. 'The van is marvellous,' he said. 'Quite the best thing I've seen in this country. It comes complete with staff, who are absolutely excellent. The van drives up, all the doors open, and all these people leap out and get on with the job. The session was quite difficult as all the 12 musicians doubled on instruments but the staff coped well and were so easy to work with.

'The most difficult thing was getting permission to park the van in front of the library, which was the most convenient position. There was talk about it being black asphalt incapable of supporting a heavy load. It took as long to get permission to park the vehicle as it did to record the session. I didn't get to talk to Sir Basil Spence, who designed the building, but I did speak to 300 Departments of Works. No lies, it took from 2 p.m. to 5.30 p.m. to get to the right department and then they were only worried about where we were going to empty out our ashtrays. The session itself went very well and some of the material will be issued on John Peel's Dandylion label.'

Hookey recently did an album of their own material, the producer for this being Roger Watson. The Houseshakers, a revival rock 'n roll band, complete with drapes and sideboards, made a single for RCA with producer Barry Bethal. Gerry Hamilton, arriving at the studio direct from a horror film session, recorded a single while covered in artificial blood. No comment. The Marquee Club, so convenient for recording live shows, was used for a Caravan session filmed by German television.

Phil Dunne's latest problem is how and where to record 200 voices, 80 kazoos, ten trombones, ten french horns, ten trumpets and an organ. 'I'll probably take a mobile van along to somewhere like the Kingsway Hall when I've worked out exactly what I'm going to do. David Bedford, a music teacher, was commissioned to write a few numbers for Dandylion and, when he told me what he wanted to do, I thought he was joking. But I rang the record company, and they confirmed the story. I was amazed.'

Facilities are to be improved still further at Marquee. The studio is to be extended to accommodate another ten musicians, more 6.25 mm tape machines are to be installed, and a new phasing unit is already in operation. Made by Helios, this unit costs about £160 and works very well according to Phil Dunne, although he was unable to tell me how it worked as certain parts of the circuitry have been encapsulated.

Wembley's **Intersound** studio has been continuing with pop cover material for Pickwick. The Anna Dell Trio recorded six original numbers, Simmsoframi of Paris laid down more tracks, and Dave Roberts produced the Sad for Phoenix Records.

At **Mayfair,** Paul Lynton of Acremere produced *I Live In A Dream*, a single which could do well judging by the interest shown by a number of record companies. Eddie Seago, a regular visitor to the studio, has been in with Mike Leander to record a number of demos, and John Drummond produced some four track demos for Martin-Coulter Enterprises. At least, they started off as demos with half a dozen session musicians on one track and voices on the other tracks but the results were so good that the demo became a master.

Mayfair hope to enlarge their studio and control room in the not too distant future and will probably install air conditioning, Dolbys, new speakers, amplifiers and limiters, as well as their new control desk.

Engineers Dave Maynerd and John Hudson are in the process of building some equalisers based on a new concept. These apparently do

(continued overleaf)

Dave Hadfield at Maximum's new 16 track Scully.

continued

what you would expect them to do, but better. John added an air of mystery to the project when he told me that the units would not be marked in the usual way with bass, treble, boost, and cut. 'They are going to be marked with words nobody has ever used before.' The mind boggles. Assuming all goes well when these equalisers are tried out, they may well be put on the market.

You may recall that Dave and John recently built a desk for Dublin's Trend Studios. Since then, they have been considering writing an article for this magazine entitled 'How *Not* to Build a Mixer'. I hasten to add that they were very happy with the Trend desk but discovered many problems which had to be overcome and which are never mentioned in the usual build-a-mixer articles.

Adrian Ibbetson is obviously very busy at **Wessex** studios. When I spoke to him, he had no time for details, only for the names of a few of the people who have been in this month. Lovelace Watkins, Brotherhood of Breath, Phil Pickett, Don Hunter, Vic Flick, Ronnie Oppenheimer, Putney Bridge, Ricky Beaumont, Mike Batt of Belfrey Productions, Sylvia McNeil, Tony Macauley, Roger Greenaway, Jimmy Wilson, Milkwood, Les Reed, Gerry Monroe, the Andy Ross Orchestra, and New Frontier.

Mike Hugg, Manfred Mann's ex-drummer, has been recording a complete album of his own material at **Maximum Sound Studios.** Kaleb Quale, Roger Pope and Elton Dean are among the musicians featured with Mike. Manfred has been in with his new four-piece band which includes Australian lead singer and guitarist, Mick Rogers. Studio manager Dave Hadfield described the band as 'funky and heavy' and said that they were trying to get a live-type sound in the studio. Freddie Mack and Sounds, in the process of recording an album, have also been attempting to obtain the feeling of a live performance. Dave explained that a lot of groups now feel that they should get away from the 'clinical' studio sound as it is totally different from what they sound like on stage. And who could argue with Freddie Mack, number nine in the top ten world heavyweight charts a few years ago, and currently an ABA instructor? Other work at the studio this month has included film music for Mid Atlantic, a Brian Short single for Transatlantic, tracks by Hokus Pokus produced by Kenny Lynch, and a peppermint matchsticks ad.

Maximum recently went 16 track with an £8,000-plus Scully. The recording rate is £24 per hour, 24 hours a day, seven days a week, which is very reasonable for 16 track facilities. Dolby *361* have been installed, and a variable speed unit is now switchable to any machine. Soon another two track Scully complete with Dolbys is to be purchased.

Next door to the studio, at 490 Old Kent Road, Dave Hadfield has just opened a rehearsal room called the 490 Rehearsal Suite. Groups will be able to practise here at any time of day or night for only £1.25 per hour. The price includes the use of a mono recorder with a single microphone, the room is pleasantly decorated, and clients have access to vending machines.

Dave Hadfield is also the studio manager of **Majestic Studios** in Clapham. Hal Carter has been in to record a powerful single by Billy Fury, and Gerry Shury has been arranging film music for Backfire, a film starring Edward Woodward. A Colonel Bagshot album has been completed and sent to the States for release in the near future, and Proclaim records have been recording large orchestral versions of songs recently performed in the first Portuguese Song Festival. The artists here were Soul Ray and Rick Jones, with arrangement and production by John Hawkins. Mike Morton and his Congregation have been continuing their successful *Non Stop Top Twenty* albums, and are now releasing these at the rate of one per month. Belsize Productions are now starting an album for the group Jigsaw.

At **Pan Studios,** Hampstead, Ruby Murray has been making a single, guitarist Ike Isaac has been in with Gordon Lottinger, and Nazareth have laid down a few tracks. Budget album material was arranged by Bill Hutchings and directed by Graham Facher for the Deacon label. Songwriters Simon Plug and Grimes have been in with bass guitar, drums, electric and acoustic guitars, piano, strings, trumpets, and tubas, to record for President Records.

Uncle Brian Matthew recorded a number of fairy tales, said by an enchanted studio manager, Vic Hawley, to be well worth listening to, and much too good for children. Hans Christian Andersen and the Brothers Grimm wrote the stories which include such classics as *The Swineherd and the Princess* and *The Tinder Box*.

Something completely different for **Trident** engineer Ken Scott was the mixing of an album for the Monty Python crowd. David Hentschel recorded a John Kongos single which was produced by Gus Dudgeon, and Roy Baker recorded Jumbo. The engineers have also been recording Genesis, the Tremoloes, Van der Graaf Generator, Chris Money, Raymond Froggatt, Hugh Lloyd and Bill Pertwee. Gasoline and Aubrey Small were mixed.

Malcolm Jackson still finds time to work at the **Jackson Studios** in Rickmansworth. A football team have recorded a song for Denver records, but no further information is available at the moment. If the record is anything like the efforts of other football teams, I hope we have heard the last of it. Mitey MO (Miniscule Orchestra) have been laying down backing tracks using metal NAB spools and trombone mutes (for banging) in order to get completely unorthodox sounds. The man behind this is John Dunsterville, who is now making a rock-folk group out of Tamlain and is recording old English folk songs with fuzz guitar. Doug Flett and Guy Fletcher have been in to record demos and masters for their own company, Big Secret Music, and Tony Back accompanied by the Hurdlers made a single to be released shortly on the Adrhythm label. John Bales of Studio Republic does all mobile sessions for Jackson and was recently employed to record a wind orchestra in Kent for Boosey and Hawkes.

Malcolm has just obtained a qualified engineer for a studio in Tel Aviv, and now has several engineers left on his books, so anyone looking for another pair of hands knows who to contact. Incidentally, many people have been writing to me to see if I can get them a job in a studio. I can't. If I know of any vacancies I am happy to pass on the information, but there are so many people looking for studio work at the moment that posts are filled almost as soon as they become vacant. One studio manager told me that he receives at least six letters every day from would-be engineers, and he has no vacancies. He estimates that the major studios must receive twice as many applications as he does so for newcomers the prospects do not look very bright at the moment.

Microphone Survey

CAPACITOR MICROPHONES

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
C12A	Stand	Variable	20 (max)	50, 200	0·4	£165
C24	Stand	Variable	20 (max)	50, 200	0·4	£319
C451	Stand	Variable	20	200	0·95	£50·50

AKG Equipment Ltd, 182/184 Campden Hill Road, Kensington, London W8.

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Audio Ltd., 26-28 Wendell Road, London W12.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
600	—	Omni	—	—	—	£29·70
652	—	Cardioid	—	—	—	£34·95
654	Vocal	Bass roll-off Cardioid	—	—	—	£34·95
1001	Hand vocal	Omni	—	—	0·3	£52·75
1050	—	Cardioid	20	30, 200	0·3	£52·75
1051	Vocal	Bass roll-off Cardioid	20	30, 200	0·3	£52·75
CB1000	Detachable Capsule bass	—	—	—	—	£31·45
CC1000	Capsule	Omni	—	—	—	£32·15
CC1050	Capsule	Cardioid	—	—	—	£32·15
CC1051	Capsule	Bass roll-off cardioid	—	—	—	£32·15

(CE500 500 mm extension tube: £17·15)
(CE700 700 mm extension tube: £18·60)
Calrec (Calder Recordings Ltd, Regent Street, Hebden Bridge, Yorkshire.)

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
C092	Electret	Omni	—	600	—	£14·00
C096	Electret	Cardioid	20	600	—	£14·00

Eagle International, Heather Park Drive, Wembley HA0 1SU.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
4136	Stand	Cardioid	32	30, 300	—	£110

ITT Components Group Europe, Standard Telephones & Cables Ltd, Electro-Mechanical Product Division, West Road, Harlow, Essex.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
KM88	H/S	Various	20 (max)	50 or 200	0·7	£97
SRM84	Stand	Cardioid	24	50 or 200	0·8	£133
KM73	Studio	Omni	—	200	3	£69
KM74/75	Studio	Cardioid	25	200	3	£76
KM76	Studio	Omni, Cardioid Figure of eight	—	200	2·8	£110
U77	Studio	Omni, cardioid Figure of eight	—	200	5	£112
KM83	Studio	Omni	—	50, 200	5	£65
KM84/85	Studio	Cardioid	25	50, 200	5	£70
KM86	Studio	Omni, cardioid Figure of eight	—	50, 200	0·7	£99
U87	Studio	Omni, cardioid Figure of eight	—	50, 200	8	£98
U67	Studio	Omni	—	50, 200	1·1	£106
		Cardioid	25	—	20	£138
		Figure of eight	Equal	—	14	£138
KMA	Neck	Cardioid	—	50, 200	0·5	£60
KM63	Studio	Omni	—	50, 200	9	£127
SM69 FET	Studio stereo	Omni, cardioid Figure of eight	22	50, 200	2	£215

Neumann (F.W.O. Bauch Ltd, Holbrook House, Cockfosters, Barnet, Hertfordshire.)

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
DC20/21	—	Omni	—	200	1·5	£37
DC63	—	44-patterns	—	200	1	£125
DC73	—	Cardioid	—	200	1	£48·50
DC83	—	Omni	—	200	1	—
DC96	—	Cardioid	—	200	0·9	£58
TC4V	—	Remote vari-pattern	—	50, 200	1·5	£84·50
FP92	Pre polarised	Omni or cardioid to order	—	200	0·5	£42
ST8	Stereo	Remote vari-pattern	—	200	0·9	£194

Power units from £22·50
Pearl (Jagor Interelectric Ltd, Mercury House, Hanger Green, Ealing, London W5.)

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
LBB9080	H/S	Uni	21	200	0·95	—
LBB9078	H/S	Omni	—	200	0·95	—
LBB9073	H/S	Uni	19	200	0·95	—
LBB9060	Stand	variable	—	200 & 50	0·4 & 0·2	—

Philips (Pye TVT Ltd, Coldhams Lane, Cambridge).

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
MKH105	—	Omni	—	200	2	£91
MKH405	Boom	Cardioid	18	200	2	£102
MKH815	—	Uni	25	200	2	£141

Sennheiser (Hayden Laboratories Ltd, 12/13 Poland Street, London W1V 3DE.)

MOVING COIL MICROPHONES

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
D11	H/S	Cardioid	18	500, 50 K	0·23, 2·0	£11
D11S	Stand	Cardioid	18	200	0·15	£10·50
DS11	Desk	Cardioid	17	200	0·14	£20
D12	Stand	Cardioid	18	200	0·22	£36
D14S	Stand	Cardioid	19	200, 40 K	0·22, 2·8	£14
D58	Stand	Noise-cancelling	—	200	0·08	£14·90
D160	Stand	Omni	—	240	0·13	£24
D190	Stand	Cardioid	18	280	0·23	£20·50
D200	H/S	Cardioid	18	250	0·14	£33
D202	H/S	Cardioid	20	300 (1 kHz)	0·16	£39
D224	H/S	Cardioid	20	250	0·13	£59·50

(continued on page 627)

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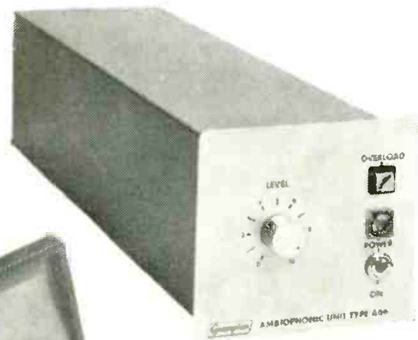

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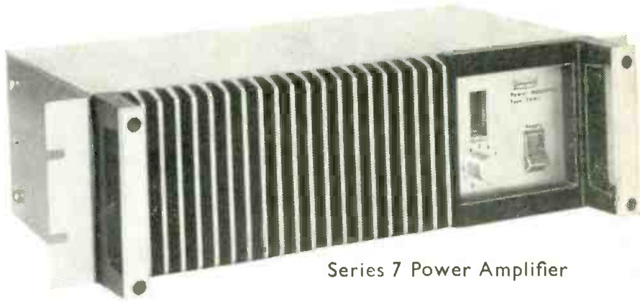

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MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
D501	H/S	Cardioid	18	200	0·22	£17
D505	H/S	Anti-Noise	—	200	0·2	£18
D707	H/S	Cardioid	15	200	0·16	£15·50
D900	H/S	Rifle	28	200	0·3	£50·50
D1000	H/S	Cardioid	20	200	0·23	£37

AKG Equipment Ltd, 182/184 Campden Hill Road, Kensington, London W.8.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
BEOMIC 1000	Hand	Omni	—	200	0·1	£10
BEOMIC 2000	Hand	Cardioid	—18	200	0·1	£13

Bang & Olufsen UK Ltd, Eastbrook Road, Gloucester GL4 7DE

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
M88N	Stand	Uni	22 (120°)	200	0·25	£63·95
M67N	Stand	Cardioid	18	500 or 200	0·25	£32·65
M69	Stand	Cardioid	16	200	0·24	£26·35
M101N	Stand	Omni	—	200	0·13	£31·65
X1	Stand	Cardioid	20	200	0·2	£22·80
M411N	Stand	Cardioid	20	200	0·14	£23·26
M410	Stand	Cardioid	20	200	0·25	£21·22
M111N	Neck	Omni	—	200	0·08	£41

Beyer Dynamic, (GB) Ltd, 1 Clair Road, Haywards Heath, Sussex.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
709	H/S	Cardioid	20	20	0·7	£12·50
710	H/S	Uni	20	200	0·7	£25·50

Bouyer (Douglas A Lyons and Associates Ltd, 8 Ryecotes Mead, London SE21).

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
C450	H/S	Cardioid	15	600 or 30/50	0·24	£27

Calrec (Calder Recordings Ltd, Regent Street, Hebden Bridge, Yorkshire.)

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
DM16HL	Stand	Omni	—	500, 50 K	0·9	£7
DM18HL	H/S	Omni	—	600, 50 K	—	—
DM18HL	H/S	Omni	—	600, 50 K	0·14	£8
DM31C	H/S	Cardioid	15	50 K	2·5	£8
DM34C	H/S	Cardioid	18	50 K	1·8	£7
DM58HL	Stand	Cardioid	18	200, 50 K	0·4	£11
UD50HL	H/S	Cardioid	20	600, 50 K	0·8	£8

Eagle International, Precision Centre, Heather Park Drive, Wembley HA0 1SU.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
643	Stand/gun	Uni	25	50, 150, 250	—	£760
642	Gun	Uni	23	50, 150, 250	—	£190
644	Gun	Uni	20	150, high	—	£32
668	Boom	Cardioid	20	50, 150, 250	—	£195
RE15	Boom, hand	Uni	24	150	—	£118
676	Hand stand	Cardioid	18	150, high	—	£29
627	Hand, stand	Cardioid	18	150, high	—	On app.
655C	Hand	Omni	—	50, 150, 250	—	£78
654A	Hand, stand	Omni	—	150	—	£30
635A	Hand, stand	Omni	—	150	—	£39
623	Stand	Omni	—	150, high	—	£17
636	Stand	Omni	—	150, high	—	£21
649B	Lavalier	Omni	—	150	—	£51

Electrovoice (Gulton Europe Ltd, The Hyde, Bevendean, Brighton.)

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
DP4/L	Hand	Omni	—	25	—	£10·25
DP4/X	Hand	Omni	—	200	—	£12·15
DP4/M	Hand	Omni	—	600	—	£12·15
DP4/H	Hand	Omni	—	50 K	—	£12·15
DP6/L	Neck	Omni	—	25	—	£10·22
DP6/X	Neck	Omni	—	200	—	£12·15
DP6/M	Neck	Omni	—	600	—	£12·15
DP6/H	Neck	Omni	—	50 K	—	£12·15

Grampian Reproducers Ltd, Hanworth Trading Estate, Feltham, Middlesex.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
4037A/C	Hand	Omni	—	30	—	£35
4105	Stand	Cardioid	15	30	—	£35

ITT Components Group Europe, Standard Telephones & Cables Ltd, Electro-Mechanical Product Division, West Road, Harlow, Essex.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
5-03	H/S	Omni	—	25, 200, 600, 50 K	0·2	—
5-30	H/S	Uni	?	as above	0·2	—
5-43	H/S	Omni	—	as above	0·14	—
4-20	H/S	Omni	—	as above	0·1	£16
4-30	H/S	Cardioid	?	as above	0·1	£20
FMT404/H	Radio/ hand	Uni	?	—	—	?

Lustraphone Ltd, St George's Works, Regent's Park Road, London NW1.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
76A	Speech	Uni	—	10 or 200	—	£13·50
77A	Stand	Omni	—	200	—	£32·85
78A	Music	Uni	—	10 or 200	—	£16·30
79A	Neck	Omni	—	10, 200 or 80k	—	£16·30
88	Stand	Omni	—	10 or 200	—	£30·05
C121	Stand	Uni	—	10 or 200	—	£12·85
C133	H/S	Uni	—	10 200, 1·5k or 80k	—	£17·25

Melodium (Keith Monks Audio Ltd, 26-30 Reading Road South, Fleet, Hampshire.)

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m²)	PRICE
MB150TR	Stick/Std	Omni	—	200	1·2	£5
MB160F	—	Omni	—	—	—	£5
MB160	—	Omni	—	—	—	£4
MB170S	Stick/Std	Omni	—	700	2·4	£5
MB170	Stick/Std	Omni	—	700	2·4	£4·50
MB170TR	Stick/Std	Omni	—	700, 50 K	2·4	£5·50

(continued on page 629)

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MB270S	Stick/Std	Cardioid	15	200	1·5	£17·80
MB270	Stick/Std	Cardioid	15	200	1·5	£15·75
MB270TR	Stick/Std	Cardioid	15	200, 50 K	1·5	£17·75
MB220	Twin stereo	Cardioid	15	200	1·5	£12·60
MB220TR	Twin stereo	Cardioid	15	200, 50 K	1·5	£13·65
MB215	Studio	Cardioid	15-18	200	1·5	£21

Mikrofonbau (Denham & Morley Ltd, 173/5 Cleveland Street, London W1.)

D44	H/S	Cardioid	—	200	0·28	£10·02
LD18	H/S	Omni	—	200	0·19	£12·75
LD19]	H/S	Omni	—	200 & Hi	0·19	£15·75
RD16	Capsule	Cardioid	—	200	0·3	£13·60
RD34/36	H/S	Cardioid	—	200 or 200 & Hi	0·2	£14-19
HM47	Neck	Omni	—	200	0·15	£20
HM49	H/S	Omni	—	200	0·2	£36·00
FS67LS	H/S	Cardioid	—	200	0·2	£16·60
FS67BS	H/S	Cardioid	—	Hi	0·2	£21·00
F69	H/S	Cardioid	—	200	0·3	£34·06

Pearl (Jagor Interelectric Ltd, Mercury House, Hanger Green, Ealing, London W5.)

EL6015/11	H/S	Cardioid	17	500	0·28	£15·50
EL6016/11	H/S	Omni	—	500	0·28	£13
EL6025	H/S	Cardioid	17	500, 25 K	0·28 & 2·0	£20
EL6026	Panel/ Stand	Cardioid	17	500	0·28	£16·50
EL6033/10	H/S	Cardioid/Omni	17	500	0·3	£26
EL6035/10	H/S	Cardioid	18	500	0·28	£26
EL6036/10	H/S	Omni	—	500	0·28	£20
EL6037	H/S	Cardioid	18	500, 25 K	0·28 & 2·0	£28
EL6042/05	H/S	Omni	—	200	0·11	£32
EL6061/02	Noise Canc.	Cardioid	—	500	0·12	£12
LBB9050/05	H/S	Cardioid	—	200	0·14	£36
LBB9500	H/S	Cardioid	—	500	0·28	£18

Philips (Pye Business Communications Ltd, Orchard Road, Royston, Herts.)

MPD ser.	various	Omni	—	30/50	0·04	£8-16
MMD2	Neck					
CPD ser.	H/S	semicard	14	30/50, 250/600, 50 K	0·04 at 30/50	£20
UD1	H/S	Uni	14	L, M, or H, as above	0·04 at 30/50	£22
SL1	H/S	Omni	—	L or M	0·06	£25
SL2	H/S	Noise canc.	16	L or M	0·06	£25

Reslosound Ltd, Spring Gardens, London Road, Romford, Essex.

MD21N	H/S	Omni	—	200 & 30 K	2·2	£26·50
MD211	H/S	Omni	—	200	1·3	£44
MD214	Neck	Omni	—	200	0·1	£44
MD420N	H/S	Noise-canc.	20	200	0·18	£21

Sennheiser (Hayden Laboratories Ltd, East House, Chiltern Avenue, Amersham, Bucks.)

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m^2)	PRICE
700	H/S	Cardioid	20	150 & 40 K	1·8	—
2203	H/S	Cardioid	20	150	0·1	—
SR785 ser.	Stand	Omni	—	150 or H	0·1, 1·6	—

Turner (Millbank Electronics Group, Bellbrook Estate, Uckfield, Sussex)

RIBBON MICROPHONES

BM5	Stereo H/S	Fig 8	—	180 per ch.		£30

Bang & Olufsen UK Ltd, Eastbrook Road, Gloucester GL4 7DE

M160	Stand	Uni	20 (120°)	200	0·1	£70
M260	Stand	Uni	20 (120°)	200	0·09	£28
M130	Hand	Fig 8	—	200	0·9	£62
M320	Stand	Uni	20	200	1·4	£34
M360	Stand	Uni	25	200	0·14	£92
M500N	Stand	Uni	20 (120°)	500 or 200	0·13 (500 Ω)	£37·75

Beyer Dynamic (GB) Ltd, 1 Clair Road, Haywards Heath, Sussex.

M8	Stand	Fig 8	—	up to 57 K	0·06	£11
M8A	Stand	Fig 8	—	up to 57 K	0·06	£11
M8S	Stand	Fig 8	—	up to 57 K	0·06	£12

Film Industries Ltd, Station Avenue, Kew Gardens, Surrey.

GR1	Stand	Semicardioid	10	25, 200, 600 or 50 K	0·0316, 0·086, 0·15 or 1·37	—
GR2	Stand	Fig 8	—	as above	as above	—

Grampian Reproducers Ltd, Hanworth Trading Estate, Feltham, Middx.

RM6	Stand	Fig 8	—	50 or 200	—	£43·75

Melodium (Keith Monks Audio Ltd, 26-30 Reading Road South, Fleet, Hampshire.)

CR2 ser.	Stand	semi-cardioid	10	30/50, 250/600, 30/50 & 50 K	1·3	£22
SR1 ser.	Stand	Fig 8	—	30/50, 250/300	0·2	£40

Reslosound Ltd, Spring Gardens, London Road, Romford, Essex.

SM33	Stand	Cardioid	16	30/50, 150/250	0·04, 0·089	£80
300	Stand	Fig 8	—	30/50 150/250 or High	0·04 (50)	£56
315S	Hand	Fig 8	—	as above	0·01 (50)	£34
330	Hand	Uni	16	50, 150/250	0·05 (50)	£45

Shure Electronics Ltd, 84 Blackfriars Road, London SE1.

4038	Stand	Fig 8	—	30 or 300	0·06	£60
4104	Lip	Noise-canc.	—	30 or 300	0·08	£75
4115	Lip	Noise-canc.	—	30 or 300	0·3	£30

ITT Components Group Europe, Standard Telephones and Cables Ltd, Electro-mechanical Products Division, West Road, Harlow, Essex.

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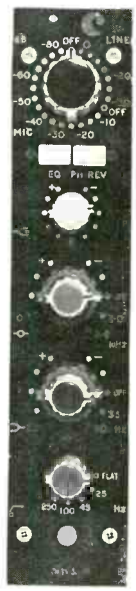

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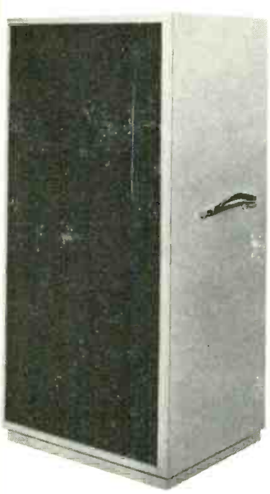

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Around the Studios

BY KEITH WICKS

TOOTING MUSIC CENTRE

THIS studio has limited facilities compared with most of the ones I have visited. Nevertheless, high quality recordings are being made here at the very reasonable rate of £5.25 per hour for four track work. The owner, Bernard Proctor, is ploughing back profits in order to purchase more equipment so improvements are being made all the time. I talked with Bernard Proctor and his engineer, Steve Vaughan, asking first how the studio came into being.

BP *The studio was the original Tooting Music Centre, selling instruments and music. A bigger shop became available up the road so we moved in there with the idea of using these premises as rehearsal rooms. Then I thought I might try my hand at running a recording studio so I mentioned the idea to Steve who used to come into the shop and who I knew was interested in recording.*

KW So is it true to say that your recording experience has been obtained mainly through using equipment in a music shop?

BP *It's not just a case of being in a music shop. I was in showbusiness for 25 years so stage-wise, sound-wise and music-wise, I learned a lot. I played the harmonica and did film work, backing tracks, and also performed on the stage as a variety artist.*

KW Do you ever wind up doing harmonica backing on studio sessions?

BP *I have done this, but not very much. I'll probably start doing more of that sort of thing but at the moment I have a lot to do with the shop and not much to do with the studio.*

KW When did you build the studio?

BP *We set everything up last November, and were a bit short of equipment when we started. The first thing we did down there was Hot Chocolate's* You Could Have Been A Lady. *We did a demo of that one although we didn't have any limiters then. We just had a two track Allen and Heath mixer, and Revox two track recorders with selsync. After we had been going six months we bought our four track TRD recorder, which has electronics by Richardson. The mixer was already built for four track and it was simply a case of plugging in extra modules. Actually, I hadn't intended going four track for about a year but we got such good reproductions and good reports straight away—and people were saying that it wasn't like the usual demo sound—that I was more or less forced into spending a lot more money in order to expand it into a four track studio.*

An important advantage of our studio is the fact that we have a music shop full of equipment for anyone to use.

KW How many musicians do you think you can accommodate?

BP *With all the gear in there I should say about 14 musicians. The point is that when most people quote how many their studio holds they talk in terms of just violins or just trumpets. So we have to think in those terms and if we took out all the gear it could hold about 25 or even 30. I say that because I remember the way we used to fit in the pit bands when I used to be on stage. You'd all be seated there in rows.*

KW Who was responsible for the acoustic design of the studio?

BP *That was done between Steve and myself. We didn't have any outside consultants in and we were surprised how well it turned out. Nothing special was done. I was told that the actual size and shape of the place would give a very good recording sound because there is not one wall exactly opposite another. The roof is quite low, but we couldn't do anything about that. However, we do get good separation and a good sound. The acoustic screens we made ourselves. They have fibreglass and hessian one side and acoustic tiles the other side. The walls are sound proofed with fibreglass, chicken wire being laid over it to hold it up. This is covered over with coloured hessian.*

KW Control room equipment. Let's start with the Allen and Heath desk. Is this a standard model?

BP *It's got 10 channels, four outputs and two built in limiters.*

SV *It's a standard Allen and Heath desk with one or two extra items added to my specification. For example, there is a small speaker for monitoring what goes on to the foldback system.*

KW I notice that you have got PPMs on the four track machine, although the meters on the desk are VUs.

Steve Vaughan at the Allen and Heath desk

SV *In fact, I prefer working with PPMs, but when the mixer was made Allen and Heath didn't do PPM metering. I think that we'll keep the present combination as it gives me a choice of using VUs or PPMs.*

KW What microphones do you use here?

SV *Mostly AKG. We've got one Neumann, a* KM56, *which can be switched to cardioid, figure of eight, or all round. We've also got two Beyers* M160s *and an American mike, a Metrosound that somebody brought into the shop. I tried it out in the studio and it worked quite well so I kept it down there. All the rest are AKGs. A* 202, 224E, *four* 3451s, *which are very good all round mikes, and a* D30. *I don't know how common these are. I got one because I used to use one at Olympic for bass drum. That's what I use it for here. It's like an elongated version of the* D20.

KW You've got a pair of Lockwood units for monitoring. Tannoys inside presumably?

SV *Tannoy Golds.*

BP *By the way, we'll shortly be getting echo plates. They are cheaper than EMTs and I've forgotten who makes them but they are very good. We're going to have an echo return module built for us by Allen and Heath. The plates measure about 2 m by 1 m. They don't have so much adjustment on them as EMTs but they are good. We are also going to get some more limiters, more versatile than the ones built into the desk. It costs a lot to buy new equipment but the studio warrants it. If we were just flinging stuff out that nobody bothered about, we wouldn't be willing to spend so much.*

KW What are you turning out these days?

BP *We're putting out a Dragonmilk record on the Beacon Label. This will be released very soon now. We are also doing a number of masters and pressings for various people and they are having them issued on the shop label which is called Pam.*

KW What is the Map label I saw in the shop?

BP *That is a label of mine which we use to save people having to have blocks made up.*

KW What has been issued on Map?

BP *One LP, a single, and we are now in the process of having another LP and two singles pressed. The LP we've had issued is a religious one that is being sold throughout the churches. Its called* Youth For Christ *and features Patrick Booth with instrumental backing. We recorded the Western Echoes at the Nashville Rooms in Kensington. They have already had a single out and are now having a single with their LP.*

KW On the subject of discs you have a cutting room above the music shop.

BP *Yes. We've got an MSS three speed cutter with a Grampian head. We had a heated stylus put in by Grampian to lower the cutting resistance, and make the cut less noisy.*

KW Any future plans for a reduction room, or other expansion?

BP *Not at the moment but we might use the room above the studio for video work—that sort of thing. Also, if we start issuing a lot of records we could even do the photography for the sleeves.*

SYNTHETIC STERE
REVERBERATION

THE recent introduction of high-quality electronic audio delay lines using integrated circuitry is an exciting new development in the generation of synthetic reverberation. However, delay lines are essentially monophonic devices, whereas much of the modern demand for synthetic reverberation requires a two channel, or even a four channel, spread of reverberation. One of the most promising uses of synthetic reverberation is not merely to add a richness to sounds, but also to simulate the changes in reverberation quality that occur naturally as the position of a live sound is altered. The challenge that faces new generation reverberation devices is thus two-fold: to provide a spread of reverberation rather than a few discrete sources; and to provide changes in the quality of reverberation to simulate the effect of sound sources occupying quite distinct positions.

For the foreseeable future the cost of electronic delay lines is likely to remain quite high, and so we are faced with the problem of generating convincing reverberation using as few of them as possible. The following account suggests possible new configurations of delay units to achieve the above aims economically; a sketch is given of the principles of the suggested mode of use, which is called the 'orthogonal matrix feedback' technique.

Basically, 'reverberation' is merely the effect obtained by adding to a sound a succession of delayed versions of that sound. Reverberation is distinguished from 'echo' or 'flutter-echo' by the large number of, and the short duration between, the successive delayed sounds. To qualify as reverberation the time intervals between successive delayed sounds should be less than 30 ms, and these intervals should grow shorter and more random as the reverberation dies away.

For stereophonic use it is additionally important that the various delayed sounds are directionally homogeneous, i.e. come from more or less random directions; this is more important for later delays than the earlier ones since in real life early reflections often arrive from walls close to the original sound.

Up to now there have been three methods of providing stereophonic reverberation, all with disadvantages. The first is to use a stereo pair of microphones in a reverberation chamber in which the sound is reproduced over one or more loudspeakers. While capable of excellent quality, this method offers little control over the reverb quality and is rather impractical in its demands on space and its susceptibility to acoustic interference. A second method has been to pan-pot several monophonic reverb signals into the stereo image. This does not give a convincing stereo spread. The third, most widely accepted method, is to use a so-called stereo reverb plate, which in fact is a reverb plate with a monophonic input and with two spaced pick-ups on the plate to provide an output with stereo spread. One disadvantage here is that precisely the same pattern of reverberation is imposed on all sound inputs, rather than a pattern continuously varying with the reproduced position of the sound. Another difficulty with stereo reverb plates is that the stereo spread of the reverb is non-ideal if spaced pick-ups are used. Coincident directional pick-ups on the two-dimensional plate can, however, give a more uniform stereo spread of reverberation.

Clearly we cannot produce a convincing stereo spread from a single monophonic reverberation device, whatever its operating principle. At first sight it would seem that two such devices would be hardly more adequate for producing a continuous spread—but then how often have first appearances proved deceptive? Let us suppose that two mono reverb devices are available, and that these have differing delay times. For the purposes of the following discussion it is convenient to regard them as simple delay lines, although in principle more complex devices such as reverberation springs could also be used in the manner suggested.

The simplest way of turning a delay line into a reverberation device is to apply feedback. If the output of the line is fed back and mixed with the input, then the signal will go through the line time and time again (**fig 1**). If the delay in the line is T milliseconds then signals will emerge at times T, 2T, 3T, etc. Such a reverberation sounds exceedingly monotonous. Another consideration is that if the signal acquires a gain of x dB after one passage through the delay line and feedback path, then it will acquire a gain of Nx dB after N passages

FIG. 1 BASIC FEEDBACK REVERB UNIT

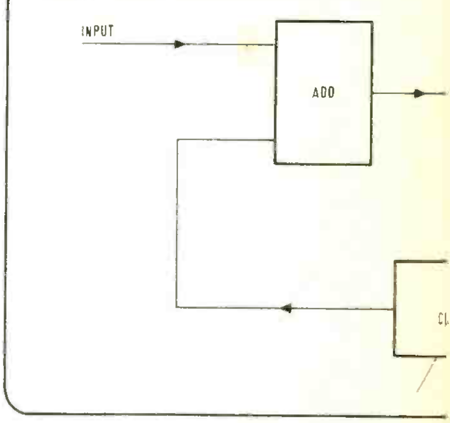
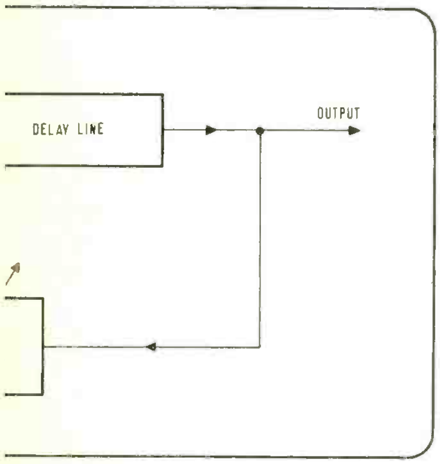
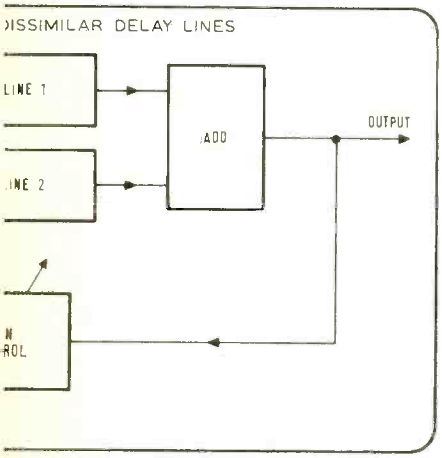


FIG. 2 FEEDBACK REVERB UNIT USING T

PART ONE BY MICHAEL GERZON





through the feedback loop. The gain of the feedback loop thus has to be less than one to avoid build-up and howl-round and this has to hold at all frequencies. In order that the delay T be short enough (30 ms) to be acceptable for reverberation and that the reverberation time be of the order of two seconds it is necessary for the sound to attenuate about 60 dB after 60 passes through the feedback loop. Thus to prevent an excessive variation of reverberation time, the gain of the whole feedback loop must lie within the range $-\frac{1}{2}$ dB to $-1\frac{1}{2}$ dB at all frequencies. If at any frequency the gain of the delay line is a mere 1 dB too high howl-round will result.

Thus delay lines used in a feedback mode to provide reverberation have to meet stringent frequency response requirements which a tape delay meets only after careful trimming of the frequency response, and even then the problem of consistency arises. Most so-called reverberation units based on tape involve time delays much longer than the required 30 ms and produce flutter-echo. Magnetic drum or disc delays are potentially better, as consistency is ensured by the lack of physical contact of the magnetic heads with the drum or disc. However, purely electronic delays should prove superior to either, although their technological glamour should not disguise the usefulness of magnetic drums or discs.

However, the unpleasant reverberation quality obtained by simple feedback is not really of much interest here and has been discussed mainly to make the principles of more complex feedback systems clear. For monophonic use the monotony of the reverberation can be greatly reduced by using two delay units of delay T_1 ms and T_2 ms respectively corrected in parallel as in **fig 2**. By placing a feedback loop round the paralleled lines sounds may pass successively through either of the lines in any order, giving rise to delays of the form T_1, T_2, $2T_1$, T_1+T_2, $2T_2$, $3T_1$, $2T_1+T_2$, T_2+2T_1, etc. Furthermore, as there are two ways a sound can have a delay T_1+T_2, either passing first through the T_1 delay line or first through the T_2 delay line, it will be seen that the amplitude of the signal with delay T_1+T_2 will be twice as high as that of the $2T_1$ or $2T_2$ delayed signals. Similarly, the $2T_1+T_2$ delayed signal can pass through the system in 3 ($= {}^3C_2$) ways, and so has an amplitude gain of three times that of signals that have passed through just one line three times. Similarly, the (say) $4T_1+3T_2$ signal can have passed through the system in 35 ($= {}^7C_3$) different ways, and has an amplitude gain 35 times that of signals that have passed through just one line seven times.

Thus it will be seen that the feedback system of **fig 2** rapidly emphasises the 'cross-delayed' signals that have passed through both lines, as compared to the 'repeat-delayed' signals that have just kept going round and round one of the lines. However, the cross-delays will only have the desirable property of being reasonably random if the two basic delays T_1 and T_2 are incommensurable, i.e. if the ratio T_1/T_2 cannot be expressed as a simple fraction. If T_1/T_2 were a fraction of the form n/m, then the cross-delay mT_1+nT_2 would be the same as the repeat-delays $2mT_1$ and $2nT_2$, which would cause much of the undesirable repeat-delays to be reinforced by the cross-delays. Ideally, the ratio T_1/T_2 should be as far from all fractions with a small numerator or denominator as possible, and should be between $\frac{1}{2}$ and 1 but not too close to either. In these respects, the *Grampian* monophonic spring delay is near ideal, with its two spring delays of 29 and 37 ms having ratio 0.784, although the Grampian's mechanical feedback system is not quite the one described here.

It is important to note that the signals that have passed through the system of **fig 2** in many different ways to form a delay $mT_1+(n\text{-}m)T_2$ will only add up in amplitude if they are in phase with one another, and they can only be in phase if the delay of the two lines does not vary over periods of a few seconds. This means that the feedback reverb system of **fig 2** will only work as it should with tape delays if the wow and flutter is low. Because of the statistical nature of speed fluctuations, signals that have made 60 traversals of the feedback loop in two seconds with an rms wow and flutter of 0.1 per cent will have a two-thirds probability of emerging within 0.25 ms of their nominal delay. This indicates that wow and

(*continued over*)

continued

flutter (unweighted!) has to be kept down to the highest studio standards for frequencies above 1 kHz to emerge unattenuated from a **fig 2**-type reverb unit using tape delays. In general, one gets the impression that tape is being pushed to the limits of its performance when used to provide reverb, and reliability is better achieved by working well within the tolerances of an electronic delay.

In order to prevent howl-round, the gain of the feedback loop in **fig 2** has to be kept well below unity because of the amplitude build-up of the cross-delay signals. Were the outputs of the two delay lines more or less independent the output energy would be twice the input energy, as the energy in each of the two lines would be added. If this were the case, then a gain of just less than −3 dB would prevent howl-round. However, an analysis of the coefficients ^nC_m of the $mT_1+(n-m)T_2$ delayed signals show that a gain of less than half (−6 dB) is necessary to prevent howl-round; the energy in such a feedback system with gain just over half can only build up if the signals in the two lines are virtually identical, and a detailed analysis indeed shows that the sounds in the two lines become virtually identical after many passes.

This shows that one cannot get reverb with a good stereo spread by taking the two outputs of the lines in **fig 2**, as, surprisingly, the reverb from the two lines coalesces into the middle as it decays. Another curious feature of the system of **fig 2** is that the reverb dies away faster than exponentially by a small extra factor proportional to the inverse of the square root of time elapsed.

The ground has now been prepared for describing a stereophonic reverberation unit using just two delay lines. The basic circuit of a two line stereophonic reverberation unit is shown in **fig 3**. In such a unit, a two channel stereo signal, which is to be reverberated, is fed into the two delay lines, one channel into each. The signals L and R emerging from the two delay lines are then fed into a matrix circuit

FIG. 3 BASIC STEREOPHONIC REVERBERATION UNIT USING TWO DISSIMILAR DELAY LINES

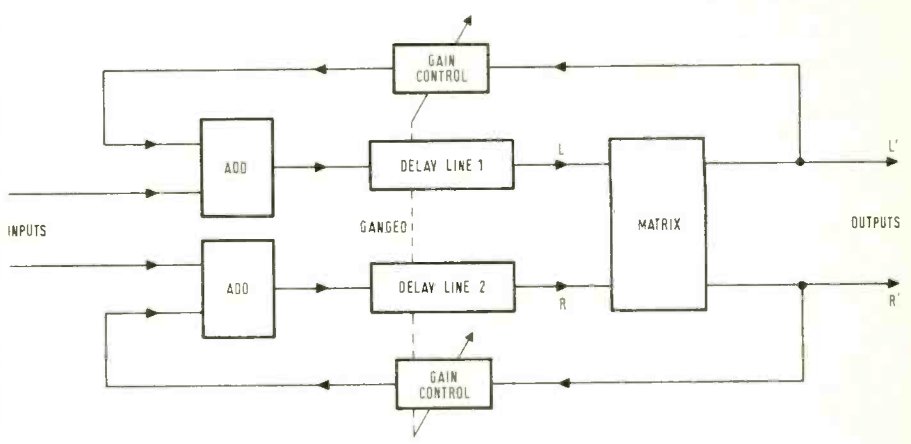


FIG. 4 N-CHANNEL ORTHOGONAL MATRIX FEEDBACK REVERBERATION UNIT

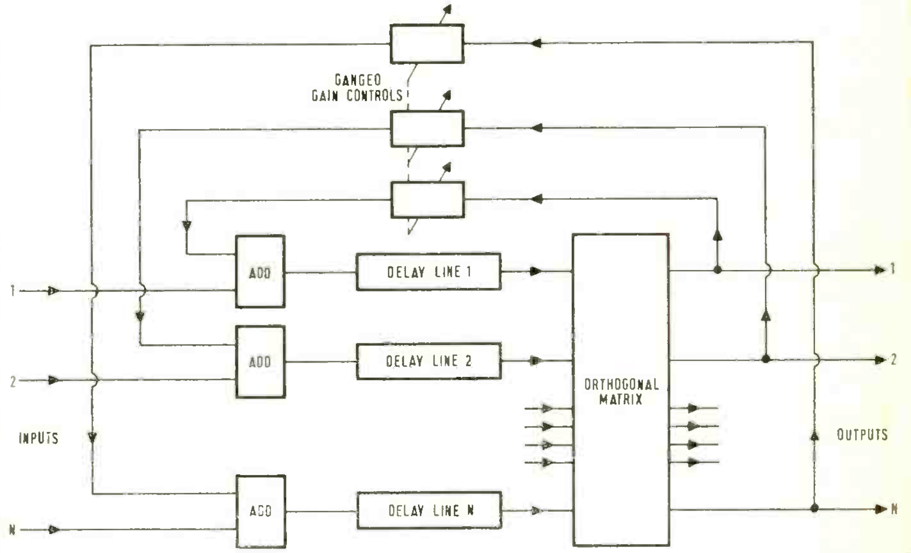
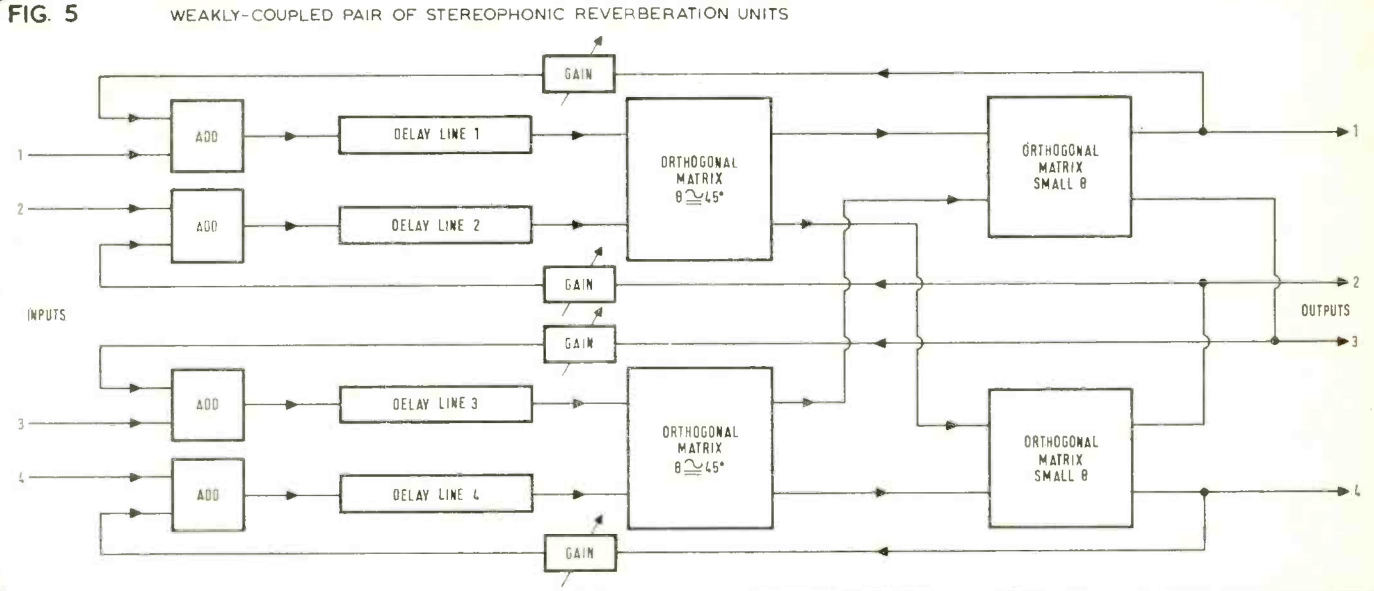


FIG. 5 WEAKLY-COUPLED PAIR OF STEREOPHONIC REVERBERATION UNITS



producing two outputs of the form:

$$\left.\begin{array}{l} L^1=a_{11}L+a_{12}R \\ \text{and}\ \ R^1=a_{21}L+a_{22}R \end{array}\right\} \quad (1)$$

These matrixed signals L^1 and R^1 provide a stereophonic output, and are also fed back and mixed in with the respective channels of the input to the two delay lines, as in **fig 3.** Basically this feedback system provides a preponderance of cross-delays in a similar manner to the monophonic feedback unit of **fig 2.** The difference is that a large degree of independence is retained between the two channels, as long as the four coefficients of the matrix (formula (1)) are chosen suitably.

The monophonic unit of **fig 2** may be considered as a special case of the above stereo unit in which the four coefficients in formula (1) are all unity. This indicates that to obtain a genuine stereophonic reverb the matrix coefficients have to be chosen carefully. The simplest way of ensuring that the reverberation energy dies away according to the proper exponential law without any anomalous behaviour is to require that the total energy of the two outputs from the matrix be precisely the same as the total combined energy of the two input signals. By this means, as long as the total energy gain of the two channel feedback loop is set at less than unity the reverberation will die away in a uniform manner, as on the $n+1$ 'th pass through the lines the stereo energy will be less than on the n 'th pass by a factor equal to the loop gain. This can only be the case for all possible input signals if passage through the matrix leaves the total energy unaltered.

A matrix circuit with N inputs and N outputs is said to be *orthogonal* if, whatever the input signals happen to be, the combined energy of the N output signals always equals the combined energy of the N input signals. This is equivalent to saying that the coefficients of the matrixing form an orthogonal matrix in the usual mathematical sense. In the circuit of **fig 3,** we have required that the matrix used to derive the feedback signal be orthogonal, and this means that formula (1) describing the matrixing becomes:

$$\left.\begin{array}{l} L_1=L\cos\theta-R\sin\theta \\ \text{and}\ \ R_1=L\sin\theta+R\cos\theta \end{array}\right\} \quad (1)$$

for some value of the parameter θ. If the value of θ is 0°, then the signal fed back to the input of each line is the output of just that line, and one merely has two crude monophonic reverb units as in **fig 1;** these will not give a good stereo spread. If the value of θ is small, say $\pm1°$ or $\pm2°$, then there is in addition a small amount of energy bleeding from one line to the other. This situation is described by saying that the two lines are *weakly cross-coupled*, and this situation is analogous to two reverberant rooms connected by a doorway; each room has its own reverberant quality, which is modified by the leakage of reverberation through the doorway from the other room.

The situation of most practical interest is when there is strong cross-coupling between the two lines, corresponding to θ taking values between, say, $\pm10°$ and $\pm80°$. In this case, the signal with a cross-delay $mT_1+(n-m)T_2$ can have passed through the two delay lines in a large number of different possible ways, and will have acquired a different gain on each journey through having passed through the matrix of formula (2) n times. The component of this cross-delayed signal emerging from one delay line will in general have a quite different amplitude gain to that component emerging from the other line, due to the differing experiences of the signal with delay $mT_1+(n-m)T_2$ depending on which of the two lines it passed through on its i'th passage round the feedback loop. The reproduced stereo position of the signal with cross-delay $mT_1+(n-m)T_2$ depends on the relative amplitudes of the components emerging from the two delay lines. While this process is not easy to visualise, the result is that different cross-delayed signals are reproduced from a wide variety of different stereo positions, giving a stereo spread of reverberation.

Unfortunately, the mathematical analysis of such reverb units is much tougher than the simple system of **fig 2,** and has not been satisfactorily resolved. However, certain properties of the abstract formalism (the absence of frequency independent eigenvectors of the complex matrix describing the feedback loop) suggest that, after enough passes through the system, the reverberation energy ought to become evenly spread across the whole stereo image, with an equal amount of reverb energy being concentrated in every direction in the stereo groove if the reverb is imagined to be recorded on a stereo record. This means that there is as much reverb in phase as out of phase, and the reverb should be ideal for matrix-system surround sound reproduction via the Sansui or Hafler systems. Such a reverb distribution is the same as given by 90°-angled coincident crossed figure-of-eight microphones.

However, if the degree of cross-coupling (i.e. θ) is substantially less than, say, 20° the reverberation energy will at first cluster near the two channels, and take an appreciable fraction of a second to spread across the whole stereo image. This behaviour nicely simulates the live situation where early delayed sounds come from near the direct sound. On the other hand, values of θ around 45° will more quickly suppress repeat-delays, and give a uniform reverb spread far more quickly. Much experiment is clearly needed to find the optimum orthogonal feedback matrices for various effects.

The orthogonal matrix feedback reverb unit can be modified in a number of minor ways: the reverb can be taken direct from the two delay line outputs before the matrix and one/both feedback paths can include phase inversion of the fed back signals. As before, it is important to ensure that the gains of the feedback paths and delay lines are precisely right at all operating frequencies. For the same reasons, the coefficients of the feedback matrix should be adjusted accurately, using components of at least one per cent accuracy. Whereas the effect of wow and flutter in a monophonic reverb unit is to attenuate the treble of delayed echos, in the case of an orthogonal feedback unit its effect is to smear the position of the treble of echos, without any attenuation.

One problem is that good electronic delays do not yet seem to be available in incommensurable pairs of values. For instance, the *Gotham* lines are only available in precise multiples of 5 mS. It is very important for the delays to be incommensurable for the stereo spread to be obtained. Hopefully, manufacturers will soon remedy this deficiency, as will be discussed further in part two of this article.

If more than two delay lines are available, then there is great scope for experiment with special effects. If N delay lines of delay $T_1,\ldots T_N$ are available which are mutually incommensurable (i.e. no ratio T_i/T_j has small numerator or denominator), then an N-line orthogonal matrix feedback reverb unit will be as in **fig 4.** There is a great richness in the variety of possible orthogonal matrixing that can be used, the number of parameters capable of being varied being $\frac{1}{2}N(N-1)$. If none of the coefficients of the matrix is small, then there is a strong cross-coupling between all the delay lines, and I would expect the reverberation energy rapidly to become uniformly distributed among the N channels. (The precise definition of 'uniformly distributed' would take us into the higher maths of elliptic geometry, but the intuitive meaning is clear enough.) Thus three or four mutually incommensurable delay lines should be enough to provide a high-grade four channel reverberation although a detailed analysis shows that, ideally, quadraphonic reverberation should *not* be distributed completely uniformly.

It seems likely that orthogonal matrix feedback techniques will come into their own once units combining strong coupling between some lines and weak coupling between others are used. As a simple example of the possibilities, consider the reverb unit of **fig 5,** using four mutually incommensurable delay lines. To a first approximation lines one and two are coupled strongly as a two channel reverb unit, and lines three and four are similarly coupled together. In addition there is a weak cross-coupling between the two channel unit containing lines one and two, and the two channel unit containing lines three and four. By our earlier analogy we have two acoustics with a certain degree of leakage from one to the other. If the degree of cross-coupling is not *too* weak then the two acoustics will become completely intermixed after a fraction of a second, but not initially. It thus seems likely that we can simulate the effect of different sounds lying in different parts of a building by feeding them into inputs one and two only for one part of the imagined building, into inputs three and four for another part of the imagined building, and into both sets of inputs for intermediate positions. A two channel output can represent microphones in the first part of the building by using outputs one and two, can represent microphones in the second part of the building by using outputs three and four, and other positions by matrixing these outputs together in different ways.

More complex modes of cross-coupling can be envisaged for more accurate simulation of real acoustics and much experiment will be needed to test the subjective effect of all these theoretical proposals. Meanwhile, it is possible that orthogonal matrix feedback will prove to be an economical means of using electronic audio delay lines to provide synthetic stereo reverberation.

Next month, methods will be described for ensuring that the reverberation has an uncoloured quality, and suggestions will be given for the design of an economical electronic stereo reverb unit.

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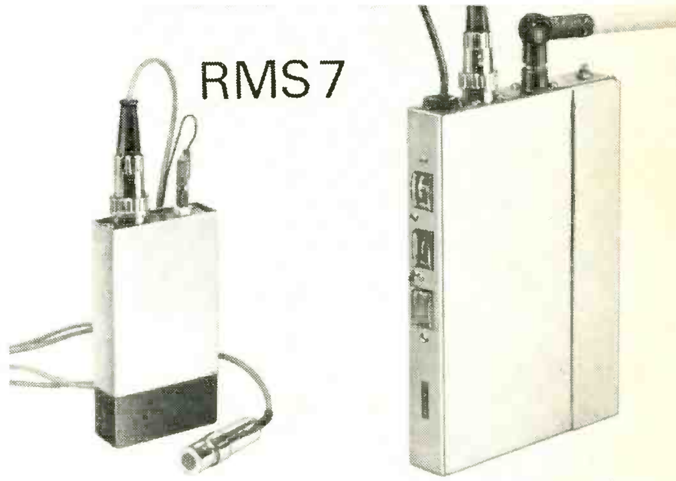

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Microphones

By John Fisher

THE general requirement for most microphones used in recording or broadcasting is fidelity in translation of acoustic energy to electrical energy. This implies a constant output over the required frequency range, a polar response that is independent of frequency, the absence of distortion at the highest acoustic levels encountered, good response to transients, an output level high in relation to induced, self-generated and thermal noise, insensitivity to external electrostatic or magnetic fields and to wind (draughts); in addition the microphone should be sufficiently robust to withstand handling and mishandling in use. In practice no microphone is perfect in all these respects, or indeed in any, but some do come much closer to perfection than others.

Certain microphones depart from these requirements deliberately: for instance, microphones to be used on lavalier cords about a speaker's neck may have an output rising with equency in order to offer some compensation r being screened from the speaker by clothes, tc, and for being off the speaker's 'axis'. Similarly, noise-cancelling microphones may be designed so that their falling bass response is compensated by being used close-to.

Directional properties

In addition to the general requirements above, microphones in professional use may be required to be omnidirectional (equal in sensitivity to sounds from all directions), or directional in order to discriminate against indirect sound or sound coming from unwanted sources, or—as in coincident mike stereophony —the directional properties may be used to produce directional information in the subsequent signal.

The two basic types of microphone may be regarded as the *pressure operated* (constant amplitude or omnidirectional) microphone and the *pressure gradient* (constant velocity or figure-of-eight) microphone. Other directional patterns (cardioid, cottage loaf, hypercardioid) may be regarded as being derived from addition or subtraction of these two basic patterns (phase-shift operation).

Pressure operation

A microphone which is designed to isolate the prevailing atmospheric pressure and use the variations in pressure representing sound waves to actuate the transducer is called a pressure operated or *pressure* microphone. Essentially, it consists of a thin membrane (diaphragm) stretched in front of a case containing air at the prevailing atmospheric pressure (**fig. 1**). The instantaneous differences in pressure between the air in front of and behind the diaphragm cause the diaphragm to move, and this movement is translated into electrical energy. The force obtained is proportional to the acoustic pressure and independent of frequency or the direction from which the sound arrives (provided the microphone is small enough not to act as an obstacle to sound waves: in practice some obstruction is inevitable and this makes the microphone insensitive to sounds from behind at high frequencies). Since the microphone is sensitive to sounds from all directions it is termed 'omnidirectional' and the polar response pattern is nominally a sphere.

Pressure gradient operation

In pressure gradient operation, both surfaces of the diaphragm (or ribbon) are open to the atmosphere and subject to acoustic pressures. Since sound reaching the rear face has to cover a slightly greater distance than that reaching the front (this difference in path length may be extended not only by the thickness and size of the diaphragm [or ribbon] but by the pole pieces and casing) the pressures at the front and back differ in phase relationship by an amount depending on this difference in path length. The *pressure gradient* between the two surfaces causes the diaphragm to move towards the low pressure side (**fig. 2**). The gradient (and therefore output) is proportional to the extra path length and also frequency, since the small extra distance forms an increasing proportion of the wave-length with increasing frequency. When the difference reaches a half-wave-length the pressure reaches a maximum and thereafter decreases until it reaches a null where the difference in path length equals a wave-length, and so on. The magnitude of this extra path length determines the sensitivity and upper usable frequency limit of the microphone.

When sound arrives from off the main axis of the microphone, the pressure gradient may be seen to be reduced as the difference in path length is reduced, until with sounds arriving at 90° to the axis there is no difference in path length to the two sides of the microphone at any frequency, and there is a null in output. Plotting the output for sound sources at various angles to the microphone gives a polar diagram that is a figure-of-eight rotated about the main axis, with the rear lobe in antiphase to the front lobe, i.e. a higher pressure arriving at the back of the microphone is equivalent to a rarefaction arriving at the front.

If a microphone operates close to a small sound source, the wavefront is spherical and the pressure gradient is greatly increased at low frequencies, resulting in output being boosted at low frequencies. This is responsible for the familiar rise in bass from a directional microphone used close to a singer or speaker, reaching its ultimate (?) in the crooner's microphone.

Pressure and pressure-gradient operation

So far we have considered the principles of omnidirectional and bidirectional (figure-of-eight) microphones. A cardioid may be considered as the summation of an omni and figure-of-eight of equal on-axis sensitivity. The result is addition of the outputs in the front, the omni contribution only at 90° and cancellation at the rear, giving a polar diagram which is a cardioid rotated about the main axis (**fig. 3**).

Alternatively, these microphones may be regarded as phase-shift microphones in which the sounds reaching the rear of the diaphragm are delayed by an acoustic path (**fig. 4**): this is arranged so that the length of the acoustic path from the back of the microphone to the diaphragm through the microphone is equal to the shortest path round the microphone to the front, so that there is no pressure difference on the two sides for sounds coming from the rear; but there is a reinforcement of the difference in pressure between that due to the sound arriving at the front of the diaphragm and atmospheric, due to the shift in phase of sound passing from the front round the microphone to the back of the diaphragm. The effective path length through the microphone is modified by the size of the cavity behind the diaphragm and the size of the apertures allowing sound to enter from the rear.

If the proportion of pressure-gradient to

(*continued over*)

FIG. 1

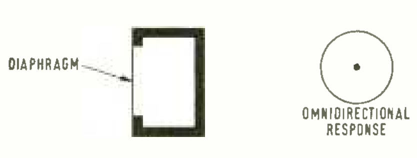


FIG. 2

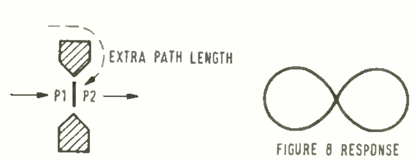
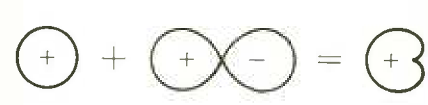


FIG. 3



pressure operation is increased, a lobe appears at the rear with a reduction in output at the sides and with nulls between 90° and 180° to the front face, to give a family of intermediate patterns.

Further study

Obviously it is beyond the scope of an article such as this to go into the detailed theory and mathematics of microphones. Anyone wishing to pursue the matter is strongly recommended the BBC Engineering Training Manual 'Microphones' by A. E. Robertson, published by Iliffe Books Ltd. There are also interesting BBC Engineering Monographs on the design of a broadcast quality ribbon microphone, and on preferred stereo balances.

Susceptibility to mechanical shock

Cardioid and bidirectional microphones are susceptible to mechanical shock or rumble, as the diaphragm, being light and controlled by the air, tends to stay still while the case moves. In twin diaphragm microphones there is susceptibility to shock because unless the diaphragms are connected in parallel so that the induced rumble voltages which will be in antiphase, cancel out, there is a residual rumble component in any directional mode.

A single diaphragm omni mike tends to have the diaphragm controlled by the stiffness of the air trapped between it and the backplate: the result is that the diaphragm and housing move together, and because there is no relative movement, rumble and handling noise are at a much lower level.

It is therefore generally the case that omnidirectional microphones will be less prone to rumble, mechanical shock and handling noise than directional ones.

Highly directional microphones

There are purposes for which none of the polar patterns considered so far give sufficient discrimination against unwanted sounds off the main axis of the microphone. Where the normal first - order pressure gradient or pressure/pressure-gradient pattern is insufficiently discriminating, a second or higher-order pressure-gradient component would give narrower lobes and better discrimination. Unfortunately there are practical difficulties in producing even a second order microphone that has a response flat throughout the audio bandwidth. Microphones have, however, been produced giving acceptable quality over a narrow range of frequencies for speech or sound effects.

This can be done in a number of ways, for instance by using staggered pressure gradient transducers or a single transducer with staggered apertures for the sound to enter, or a bundle of tubes or a single slotted tube on the front of the microphone (fig 5)—the idea being that sound arriving from any direction but straight ahead arrives in random phased components through the different apertures or, in the case of the multi-transducer assembly, generates out of phase signals that cancel.

FIG. 4

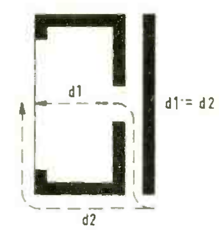
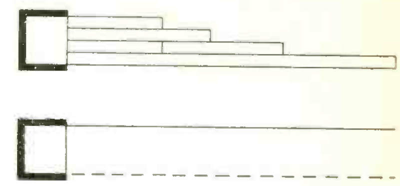


FIG. 5 TWO ULTRA DIRECTIONAL MICROPHONES



Another highly directional system uses a parabolic reflector, focusing sound on to the face of a pressure microphone. These microphone systems find application in film and television work and in outside broadcasts of sports events, where a restricted bandwidth is acceptable, rather than in music reproduction.

The transducers

Rather than go straight into the various ways of making a microphone with a particular polar pattern, it is worth looking for a moment at the various ways of producing a signal from sound. There is not room to consider them in depth, and again reference may be made to the BBC manual 'Microphones' and to the literature that occasionally appears from manufacturers.

Ribbon

The ribbon microphone is basically one of the simplest transducers, although it needs many refinements to produce something of the quality of the BBC/STC *4038*, which is still one of the finest microphones in professional use although it has been around for a number of years. The essentials are a ribbon suspended between two polepieces, between which a strong magnetic field exists. Because the ribbon is open to the atmosphere on both sides there is pressure-gradient operation and a figure-of-eight polar diagram. In order to preserve the figure-of-eight in the horizontal plane, the magnet system must, as in the case of the *4038*, be at one end of the polepieces (fig 6); this will modify the polar diagram in the vertical plane, but this is generally less serious. Where size and efficiency are more important, such as where the mike has to appear on screen, the magnet or magnets may be cupped behind the ribbon and polepieces (fig 7), as in the Reslo *RB* and *VR* designs; this makes the rear lobe of the 'eight' both frequency conscious and modified in size, as a small pressure component is introduced. There may be a resonance caused by the cavity behind the ribbon; this can be arranged to maintain the front-face response where it would otherwise be falling off. Such modifications to the polar diagram and the polar response may adversely affect the stereo image obtainable with a pair of such microphones.

In some cases part of the rear of the ribbon is deliberately enclosed to introduce an equal pressure component, in order to generate a pressure/pressure-gradient response (cardioid). This is not always successful over a wide frequency range.

The ribbon is normally corrugated. The purpose of this is to increase the rigidity of the very fragile ribbon across its width, to increase the compliance and to enable some control over the tensioning in order to place the low frequency resonance low enough not to be troublesome, i.e. where it is damped by the primary inductance of the matching transformer. A matching transformer is necessary because the output of the ribbon is very small; a specially wound transformer is therefore built into the case of the microphone in order to step up this voltage and match the ribbon impedance (which may be a fraction of an ohm) to the amplifier input impedance, which may be tens, hundreds or even thousands of ohms.

The case of the ribbon microphone tends to be larger than many others because of the size of the magnet system, and special care has to be taken in the design not to affect the frequency and polar response adversely; in some microphones (again the STC *4038* is an example) the shape of the case may be tailored to improve the response of the microphone at high frequencies.

The capacitor microphones

The capacitor microphone has for many years enjoyed great popularity in professional fields, partly because of the good signal-to-noise ratios obtained from a microphone of modest dimensions and partly because, as alternatives to the ribbon's figure-of-eight, the best omni and cardioid microphones were capacitors.

Essentially the capacitor microphone consists of a back-plate full of damping holes, and a thin metal or metallised diaphragm stretched in front of and spaced slightly from it (fig 8). A high voltage is applied between the diaphragm and backplate through a high value resistor that maintains a constant charge on the diaphragm. Small movements of the diaphragm cause small changes in the capacitance between diaphragm and backplate, which are thus reflected as small changes in voltage on the diaphragm. These small voltages are amplified in a 'head amplifier' (fig 9), normally a valve in days gone by but now more usually a combination of field-effect and bipolar transistors, which provides a high input impedance (necessary because of the small value of the transducer's source capacitance) and a low output impedance (to prevent high-frequency attenuation in the microphone cable).

The diaphragm is normally thin metal or metal-flashed plastic, and is under tension to raise the diaphragm resonance (it behaves like

FIG. 6

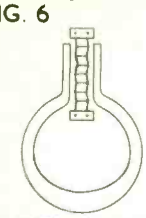


FIG. 7

FIG. 8

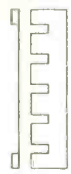


FIG. 9

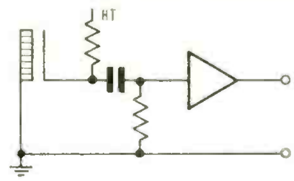


FIG. 10

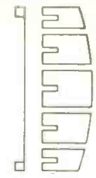
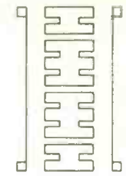


FIG. 11



a miniature drum) above the audio band (ideally, in practice towards the top of it). Plastic diaphragms have certain advantages in construction and lightness but may be affected by television lights, for example. AKG are now using an embossed metal diaphragm which would appear to have many of the advantages of both kinds while having a claimed resistance to ageing and temperature effects.

Having said an essential of the capacitor microphone is a polarising voltage, let me retract that: a minority use the transducer capacitance in an RF bridge or similar system, which avoids the problems of high-voltage leakage and its associated noise and arcing, and can theoretically offer a much better signal-to-noise ratio. Some of these RF types have been shown to be very successful, but I understand that others are troubled by drift, especially in the presence of high studio temperatures and powerful lights, causing a deterioration in the noise performance.

In the form described, the microphone is pressure-operated since the diaphragm is open to the atmosphere only at the front face. If the backplate is drilled so that in addition to the damping holes there are holes through the plate, and these have free access to the atmosphere and to sound arriving from behind the capsule, a pressure-gradient component is introduced and there is pressure/pressure gradient operation (**fig 10**), the result being a cardioid or hypercardioid depending on the number of holes. Alternatively, the backplate may be made of a porous material which also allows sound to pass to the back face of the diaphragm.

A further variation, perhaps best known in the AKG *C12* and *C24* variable polar diagram microphones, is the twin-diaphragm capsule. In this, two diaphragms are spaced a small distance from each other by the central plate which contains damping holes and a number of holes connecting the cavities behind the two diaphragms (**fig 11**). The diaphragms are separately polarised relative to the central plate (**fig 12**), and the outputs are combined via isolating capacitors. Each half of the microphone will have a cardioid response. If both diaphragms are polarised (say) positive with respect to the central plate, the outputs will add and the result will be the sum of the two cardioids, which may be shown to be a sphere or an omnidirectional response. If only one diaphragm is polarised, the microphone has a cardioid pick-up; if one diaphragm is polarised positive and the other negative with respect to the plate, the outputs cancel partially, the result being the difference between two cardioids which may be shown to be a figure-of-eight. By applying intermediate voltages to one of the diaphragms and holding the other constant, it is possible to produce a full range of patterns between omni, cardioid, cottage loaf and figure-of-eight. This can be particularly useful in a stereo microphone such as the *C24* which contains two such capsules, as it enables the polar diagram required to be selected remotely once the microphone is in position. It is more difficult to produce a variable pattern RF bridge microphone.

Electret microphones

These are the new babies. Essentially they are very similar to the conventional capacitor microphone (single diaphragm types) but require no polarising voltage as they have a 'permanent' charge on the diaphragm. An electret is the electrical equivalent of the permanent magnet, but practical electrets have not been around quite as long, and less is known about them. Rumour has it that the 'life' of the electret may be as short as three years for some types; other suggestions are that they will last as long as a permanent magnet. This remains to be seen. They certainly offer some attractive simplifications in design, but I suspect that much remains to be done before they displace conventional capacitor microphones. Of the two I have actually handled, I would not consider one suitable for anything but domestic efforts at recording pop groups in full bay at close range, and the other, claiming and pricing itself for the professional market, seems to lack some of the qualities of its lower-priced conventional counterparts. But the electret is here to stay, in one sense at least, and no doubt there will be improvements in the next few years that will increase the output and reduce the noise. Possibly one of the problems is producing and maintaining sufficient charge on the diaphragm?

Moving-coil

In terms of sheer numbers in use, the moving-coil microphone is and for a long time has been the most popular. It consists of a light coil in a permanent magnetic field, the coil being attached to a light diaphragm—rather like a miniature loudspeaker (**fig 13**). The unit may be sealed at the rear, so that sound only has access to the front (pressure operation), or apertures may be provided at the rear to provide phase-shift operation (cardioid). Unfortunately it is more difficult to produce a good cardioid with a moving-coil than with a capacitor microphone, and elaborate phase shifting tubes, chambers and apertures are utilised at the rear of the capsule to provide a reasonable cardioid over the frequency range; this is partly due to the mechanics of the moving-coil system, partly to the higher mass and mechanical elements of the moving-coil system. The best moving-coil cardioids are produced with twin element systems but passable single-element cardioids are also produced. Normally, however, the transient response suffers as well as the polar and frequency response, and the sound quality of most single element moving-coil microphones does not rival the capacitors and ribbons.

Variable polar diagram moving-coil microphones have also been produced, combining the outputs of two back-to-back moving-coil elements to add or subtract to give omni and figure-of-eight as well as two cardioids.

The advantages of moving-coil microphones are their robustness and relative resistance to condensation (a point on which capacitors fall down), their relatively high output without the need for a massive (and expensive) magnet system or a head amplifier, and the fact that they can if necessary be made quite small in size (as can capacitor mikes).

Twin-element dynamic microphones

Twin-element microphones are an attempt to overcome the inherent defects in certain

(*continued on page 641*)

FIG. 12

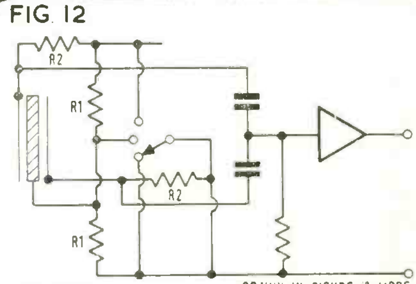


FIG. 12A DRAWN IN FIGURE 8 MODE

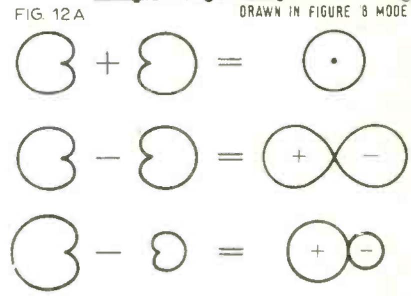
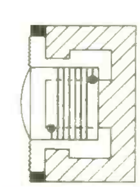
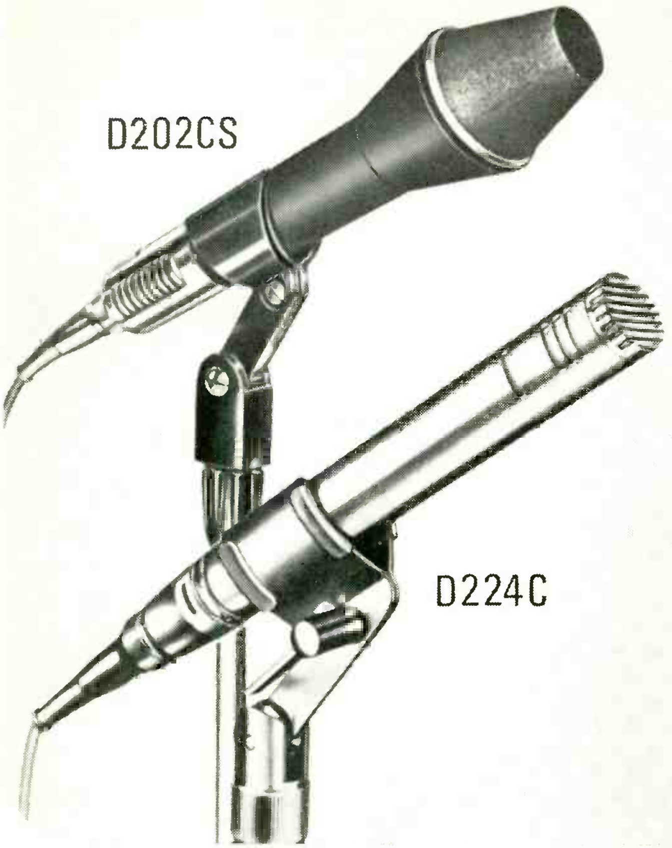


FIG. 13





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single-element moving-coil systems. Recently revived in the AKG *D202* and its offshoots, with great success, the principle is not entirely new. In the early 1930s a twin-element microphone was designed by STC for use on booms in broadcast and film studios. It incorporated a moving-coil unit and a ribbon, plus a phase correcting and combining network (**fig. 14**). The moving-coil unit provided the pressure (omni) component at low and mid frequencies, but became progressively more directional at high frequencies, due to the obstruction of the casing. The ribbon unit provided the pressure-gradient component at low and mid frequencies, and its output was rolled off progressively to match the increasing directionality of the moving-coil unit at high frequencies. This provided a reasonable cardioid over the audio range in the horizontal plane; in the vertical plane the polar pattern and response were relatively poor, but this was of less consequence, as the sound normally arrived from within a few degrees of the axis.

In the more recent AKG *D202* design referred to earlier, the principle is similar to that of a phase-shift single capsule microphone, but with the audio frequencies split between the two capsules. The front (smaller) capsule is designed to handle the higher frequencies and provide a cardioid pick-up with a relatively small acoustic phase correction network, and the rear capsule handles the lower frequencies with a larger arrangement of phase and frequency correcting elements in the tubular casing behind. The apertures for the sound entering the rear of the second capsule are set further back in the handle than is normal, as the wavelengths handled are longer; this has the effect of improving the output at low frequencies from the rear capsule, and incidentally of reducing the bass rise when the microphone is used close to a sound source. For a closer look at this microphone, the reader is referred to the recent reviews in STUDIO SOUND. Despite the fact that the capsules are not absolutely coincident, the microphones produce a remarkably good sound comparable with that from capacitor microphones. The polar pattern is well maintained over a wide range of frequencies and (again despite the fact that four non-coincident capsules will be involved) the microphones produce very pleasant stereo when crossed. It has, however, been suggested that crossed microphones of this kind would not be suitable for coincident quadraphony; in practice I suspect that the sheer bulk of four of these microphones would be more of a practical problem than theoretical limitations on the grounds of the distribution of capsules and apertures.

Crystal microphones

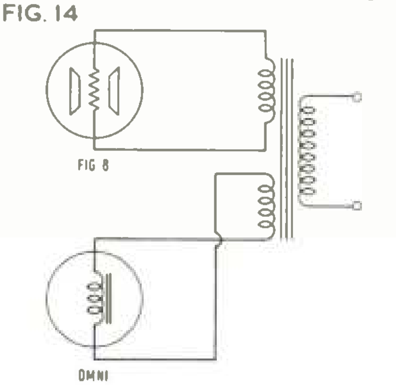
Although crystal microphones have been used for some professional purposes in the past, including measurement and probe microphones where a very small size was necessary, they are rarely used now except in domestic equipment. Basically, they operate due to the fact that when certain crystals are bent or compressed they exhibit the Piezo effect of developing voltages between crystal faces. Like the capacitor microphone, the source impedance of a crystal microphone is largely capacitive, and requires a following amplifier impedance of several megohms to maintain a useful response in the bass. The crystals are inevitably very stiff; the most efficient microphones have one corner or end of the crystal fastened to the case, while the opposite corner or end is attached to a diaphragm (**fig. 15**); the capsule can then behave as a pressure or phase-shift device in much the same way as a moving-coil microphone capsule does. Most crystal microphones are made as pressure units, however. One stereo crystal microphone did appear, using crossed pairs of staggered pressure elements and the phase shift between capsules in the pairs to produce directivity through cancellation off the 'axis' of the pair. Inevitably there were limitations, however. A less efficient method of generating the voltage, that resulted in a smaller capsule and hence better response, used a pair of crystal plates cemented to a spacer at the edges (**fig. 16**); the pair behaved as a pressure-operated device with the crystals bending inwards and outwards with sound pressure; the voltages were small, however, and a stack of series-parallel connected elements was necessary to produce a workable design, with the amplifier used very close to the microphone.

A number of crystal microphones have in the past been used in portable outside-broadcast equipment using miniature valves, for speech purposes only. They were robust, but were not improved by rain which to a greater or lesser extent affects all crystal mikes (moisture can dissolve many of the crystals and temporarily spoil some of the ceramic alternatives).

Carbon microphones

These are reserved for situations where intelligibility is undesirable and provide useful service in GPO telephones where they ensure that the conversation is protracted by frequent requests to 'say that again', thus contributing to the telephone department's remarkable profitability.

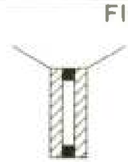
FIG. 14



(PHASE AND RESPONSE CORRECTING COMPONENTS OMITTED)

FIG. 15

FIG. 16



'SOUND-CELL' CRYSTAL MIC

Use and misuse of microphones

The Editor closed his brief by instructing me to say something about how and how not to use microphones. As if this were not enough, he suggested I refer to the use of ribbon microphones for BBC news-readers which, he alleges, makes them sound as though they have taken an overdose of hormone tablets.

In fact the bidirectional *4038* is a very good microphone for speech in small studios as it can be arranged to cut out unwanted sounds and reflections, particularly from the table below it, while not sounding too dead. One factor which might be mistaken for hormones, in a talks programme rather than in news, is the occasional unfortunate use of screens. If they happen to be arranged with too many absorbing faces around the speaker, the result is a lack of reflected highs but still a certain amount of intruding tubbiness from the small room (some studios are worse than others, inevitably); the result can be very dead and the speaker may be tempted to produce a 'bigger' sound. Another factor with speech on ribbons is that the microphone may be too close to the speaker; inevitably there is a rise in bass and this can be compensated for with tone controls. What cannot easily be compensated for is the situation where the earnest speaker leans over to his microphone; inevitably both level and the amount of bass change. The answer is to arrange things so far as possible that the speaker cannot move much (without being uncomfortable) or at least that such movements as he is likely to make form only a small part of the distance between himself and the microphone. Another variable is the script. Obviously one discourages a reader from placing the script between himself and the microphone; not so obviously, the script must be held or placed on a rest in such a way that the speaker is not speaking into the table by the time he gets to the bottom of the script.

Another 'hormone factor' is that very quiet speech amplified to a normal speech level sounds more bassy than loud speech turned down to the same level.

The script table also needs some attention: if it is too hard, there may be high frequency splash-back on to the mike; if it is covered with a woolly absorbent surface (if only to cut down clunks and script noises) the effect may be that the top sounds down. For many purposes, including talks and discussions, a perforated table surface may be preferable, in order to minimise reflections, particularly at low frequencies. Where two readers or only two people in a discussion are involved, the bidirectional ribbon between them gives a fairly natural balance: again, the late arrival who places himself too far or too near is a problem. Where several people are involved in a discussion or small conference, an upward facing cardioid in the middle of the group gives equal pick-up all round while preventing pick-up of reflections and noises from the floor (boots hitting shins). With larger groups,

(continued on page 653)

Comparison: Studio Microphones

By Angus McKenzie

FOR many years there have been great differences of opinion between engineers as to the merits or otherwise of particular microphones in common use professionally in the UK. It was felt therefore that a general assessment of some well known models tested under ideal conditions would be of considerable use to readers, some of whom may be biased unfairly towards a particular type or make where another type might well be preferable in some respects.

It cannot be doubted that criteria have changed greatly over the last 10 or 15 years; with the design of very low noise microphone pre-amplifiers, microphones producing a high output for any given sound level in order to overcome noise present in the front end of some mixers may not be the most suitable today, particularly in pop studios where engineers have to cope with very high sound pressure levels which may easily overload microphone pre-amplifiers.

It was decided to check the sensitivity, the noise level, the frequency response, the ability to stand high sound pressure levels and the front to back ratio in the cardioid position of the microphones under test. As a result some very surprising measurements have been obtained which may well influence readers in their choice.

For the sensitivity measurements the output of each microphone was connected via a load impedance of 1000 ohms to a B & K spectrometer type *2112*. The load impedance was a step up transformer of fairly low ratio whose response after damping both the primary and secondary was matched within very tight limits from 15 Hz to 20 kHz, and the impedance over this range did not vary by more than ± 10 per cent. An accurate and constant sound pressure level was obtained from a B & K oscillator type *1022* with the frequency set at 1 kHz with 100 Hz deviation wobbulated 16 times per second. A B & K 25 mm free field standard omni-directional microphone was suspended beside the microphone under test one metre above the *BC 1A* loudspeaker used for the tests, in such a way that the microphones were situated to either side of and equidistant from the line running through the centre of the three units in the loudspeaker. The output from the B & K mike was taken via a B&K microphone amplifier/sound pressure level meter to the compression input of the *1022* oscillator and the tests were carried out at a monitored sound pressure level. The figure obtained in millivolts on the Spectrometer was then related to 74 dB sound pressure level which also incidentally represents one dyne per square cm, or more commonly, one microbar. It will be seen in the table that the STC *4136* cardioid capacitor microphone has an extremely high output, whereas, as would be expected, ribbons and moving coils have the lowest outputs.

For the signal to noise ratio of the capacitor mikes it was necessary to impedance match, transform and amplify very heavily since some of the noise levels were found to be so exceptionally low. The readings were again taken on the B & K Spectrometer using the dBA weighting curve as it was felt that this curve, as well as being the best known in the UK, corresponds fairly accurately with the subjective difference of noise level also checked with various microphones. It was found that these figures tended to expand slightly the differences between the noise levels of the microphones so that, for example, an *SM69* Neumann microphone does not necessarily sound 9 dB better than an AKG *C24*. Since the figures were dBA weighted the values quoted are an approximation to the equivalent noise produced in the microphone in phons, the relative scale being the same as for dBs of sound pressure level. For these measurements the microphones were placed in turn in a B & K anechoic box normally used for testing hearing aids, having sand-filled walls and a highly absorbent anechoic chamber internally. The box incidentally was situated in my studio which itself is triple glazed to eliminate outside noise. Despite these precautions octave analysis of the noise showed that occasionally it was possible to pick up the rumble from very distant traffic and tube trains, sometimes as far as a mile away, and I must emphasise that this part of the testing was extremely difficult. Very old twin screened mike cable was used to connect the microphones to the floating balanced input amplifier as this old cable had superior screening. Considerable precautions also had to be taken with earthing of the equipment to allow the measurement of such low levels as 17 phons. All the microphones were also assessed initially for approximate frequency response using the same technique as for sensitivity but with less wobbulation, the B & K frequency response tracer being used running at a slow speed. The microphones were later each checked very carefully in an anechoic room under excellent conditions.

In order to test whether any microphone was subject to blasting or distortion at high sound pressure levels each was checked with a sound pressure level of approximately 130 dB peak obtained by my blowing hard on a trumpet only 150 mm away from each microphone in turn, the sound pressure level of each test being checked with the B & K microphone.

All the microphones were tested subjectively by listening to speech, and I have also been able to check the performance of almost all the microphones on recording sessions made over the last few years. Where applicable the back to front ratio in the cardioid position was also checked in an anechoic room.

It was also decided to determine the basic noise level in phons of all the magnetic type microphones by regarding a very low noise Richardson Electronics microphone preamplifier as an integral part of the microphone circuit so that the resulting equivalent noise could be compared under the most favourable conditions with the noise produced by the capacitor type microphones. The transistorised microphone pre-amplifier was fed from three *PP9* batteries in series, giving just over 27 volts.

Capacitor Microphones

AKG C24

This microphone, introduced approximately ten years ago, is a stereo co-incident type having the properties of two mono *C12*s in one microphone head. A 20 metre cable having a stand mount on one end connects to a mains power unit, the output of which contains both the audio output wires and the remote control polar diagram connections to the control box. This box allows each microphone capsule to be set independently in any one of nine patterns varying from omni-directional to figure eight, super cardioid, cardioid and hypercardioid, for example, being included. A *6072* low noise double triode is used in this microphone as the amplifier for both sections, and although in its day this microphone was regarded as one of the finest made, by today's standards it has a rather high noise figure of 26 phons. As with many other earlier designs of AKG capacitor microphones it has a rising response at treble frequencies, this being provided at the request of the BBC and some European broadcasting companies. The end capsule rotates through 270 degrees with respect to the other static one allowing any relative position to be obtained between the capsules. Some rapid frequency interference has often been encountered with this microphone, but careful experimentation with the various earthing combinations again minimises this. AKG explained that the power supply should always be connected if possible via the mains to a mains socket taking its earth from the same point as the socket feeding the mixer's power supply, this assisting in the reduction of rf interference.

The bass response is very flat with the exception of the figure eight position where the loss is approximately $2\frac{1}{2}$ dB at 50 Hz. At 10 kHz the response rises to a peak of 6.5 dB falling fairly steeply so that at 15 kHz it becomes flat again. The off axis response follows the same characteristic as the *C12A*. The back to front ratio in cardioid is approximately 20 dB at middle frequencies, deteriorating at low and high frequencies.

AKG C12A

The earlier *C12* was entirely redesigned in a very much smaller housing but with the same

(*continued over*)

type of capsule. The original valve design was replaced with a nuvistor which proved to have an improved signal to noise ratio. The very noticeable boost at high frequencies of the earlier model was noticeably reduced to meet professional requirements, and apart from the significantly lower output level is very similar to that of the *C12*. The noise level is approximately $2\frac{1}{2}$ dB better than for the *C12*. Early samples of nuvistor tended to produce a very low level, middle frequency singing which has not been present in recent models. The power supply has the polar diagram switching integrally mounted and a bass cut switch is also provided with three operational positions. The frequency response is very similar to that of the *SM69* but without the latter's bass roll off, the response extending down to 30 Hz when in the cardioid position. A slight bass roll off was however noticed for the figure eight position. At 30° off axis the high frequency shelf is not so pronounced, but in cardioid as one approaches 90° a peak of 5 dB becomes noticeable at 10 kHz due to internal reflections inside the housing. The back to front ratio measured 20 dB, deteriorating at the low and high frequencies.

AKG 412

The nuvistor preamplifier in the *C12A* has been replaced by an FET/NPN configuration preamplifier with very much lower noise of 21 phons, a considerable improvement. The model tested was an early one and a further improvement is likely. The response is almost identical to that of the *C12A*, but the high frequency shelf is only 2 dB up. At its price its performance is considered excellent although as with the Neumann *U87* I feel that a hypercardioid position would be very useful.

AKG 451/452

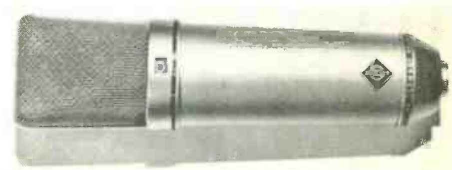
The need was apparent for the production of a modular microphone system in which different types of capsule could be screwed on via various adaptors to either of two types of amplifier. The *451* runs off 10 volts obtained from a mains power supply with phantom powering or a battery power supply ideally having a battery voltage not exceeding 9.4V obtained from a single *PP3*. The *452* amplifier runs off a conventional phantom powered circuit often provided in custom built equipment. A separate mains power supply is also available for obtaining the necessary voltage. Of the available capsules the *CK1* type is cardioid having an almost flat response. The *CK2* is omni-directional and the *CK5* has a permanent windshield and internal anti-vibration mount, and is designed particularly for public address use, having also a bass roll-off. The *CK6* will shortly be available and includes switching on the capsule allowing either omni, cardioid or figure eight response to be obtained. The *CK9* is a rifle type, highly directional capsule and assembly, having a long tube extending from the capsule to achieve the directional properties. A high output *CK1* capsule will shortly be available, a prototype of which was tested and found to have approximately 4 dB higher output than the normal *CK1*, and thus very much better signal to noise ratio. In the tests it was found that the spread of sensitivity and hence noise performance was rather variable for the *CK5* capsules, the variations falling within 4 dB in output. With *CK1*s and *CK2*s however this variation was reduced to a spread of $1\frac{1}{2}$ dB. The *451* and *452* head amplifiers had identical gains but the *452* has slightly lower noise than the average *451*, the noise spread of the latter also being within 1 dB. The *451* amplifier contains a dc converter using a one MHz oscillator to achieve an adequate polarising voltage, and has a zener diode incorporating stabilisation from 9.7 volts. Unfortunately in Austria *PP3* batteries, made by Philips, have a somewhat lower voltage under load than similar batteries made in this country. Short circuit current of the Austrian batteries is approximately 150 mA whereas the British batteries give out 600 mA. AKG did not realise this and it is therefore unfortunate that British batteries give a voltage very close to the zener diode regulated one, and some battery power supplies tend to create therefore a small degree of noise in the feed to the amplifier and capsule. To obviate this I suggest that a series resistor be incorporated into the battery compartment to lower the 'on load' voltage to approximately 9.2V. A metal windshield type *W17* is available for the *CK1* and *CK2* capsules. Various extra tubes can also be provided as well as a swivel joint allowing the capsule to be angled at plus or minus 90 degrees from normal, this allowing for four microphones to be mounted in very close proximity for quadraphonic recording. The excellent response of the *CK1* capsule makes this microphone ideal when the engineer prefers to alter the response curve on the control desk, and the modular construction makes the microphone very adaptable. The off axis response is very similar to that of the *KM84*, both cardioid capsules being of the pressure-gradient type with slots behind the capsule and in the body of the microphone giving a cardioid pattern. A very steep cut bass filter is available and battery and single or double mains power supplies are available, and also one having six outlets.

Neumann SM 69/FET

As with AKG, Neumann have now adapted their entire microphone range to incorporate FETs in the head amplifiers. This microphone had the lowest noise of any tested (17 phons) and also by today's standards a high output level. The microphone has similar facilities to the *C24* with an identical choice of directivity patterns, a 20 metre head cable being provided. The pattern switch is incorporated in the power supply. Neumann large capsule microphones have their capsules suspended both from the periphery and from the centre, whereas AKG ones are held only from the periphery. The response on axis was $3\frac{1}{2}$ dB down at 50 Hz gradually rising to a shelf of $3\frac{1}{2}$ dB at 5 kHz, the shelf falling back to +2 dB at 15 kHz. This shelf up at high frequencies is intentional to make up for high frequency air losses when the microphone is used some distance away from the sound source. The excellent response was not only held to very tight tolerances between the two capsules and from back to front in the figure of eight pattern, but also no noticeable change in the response shape occurred at 30° or 60° off axis, making this microphone quite the most remarkable one ever encountered by the writer.

Neumann U87

This FET equivalent of the earlier *U67* has switching for omni, cardioid or figure eight patterns, and as with the *SM69* uses 2.5 cm diameter diaphragms. The sample tested had almost the same low noise level as the *SM69*, and also includes a 10 dB cut switch incorporated into the circuit before the gate of the FET. It was felt that good as this microphone is there should be a hypercardioid position which might be in addition to, or in place of, the omni-directional one, allowing the microphone to be of far more use when used in other than close miking techniques, thus giving better control of the reverberation pick up. The microphone is internally powered, and incorporates a battery state indicator, but may also be phantom powered externally. A windshield, type *WS67*, is also available. In cardioid the response is held within 2 dB from 200 Hz to 14 kHz, above which it falls very steeply. At 50 Hz, however, quite a noticeable bass loss of 5 dB is apparent. The frequency response curve remains almost identical up to 60° off axis, but at 90° the response falls very sharply above 10 kHz, but has a 4.5 dB resonant peak at 9 kHz. The back to front ratio of this micro-



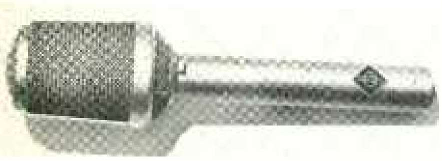
phone was only 13 dB, deteriorating quite markedly at low and high frequencies. It was felt that possibly the polarising voltage of the second diaphragm had not been set accurately enough by the manufacturer, since this type of microphone should have a back to front ratio better than 16 dB.

Neumann KM84

This microphone is the most modern development of the well tried cardioid *KM64*, and has the low noise level of 18 phons. The microphone is phantom powered, and a battery supply type *BS45* or mains power supply type *N451* is available. A twin mains power supply type *N452* is also available to power two microphones. Apart from a 50 Hz 3 dB droop the response was held to within 2 dB up to 16 kHz, and was only 5 dB down at 20 kHz from average level. Off axis the bass loss became very slightly more noticeable and at 90° the response fell sharply above 10 kHz.

Neumann KM 86

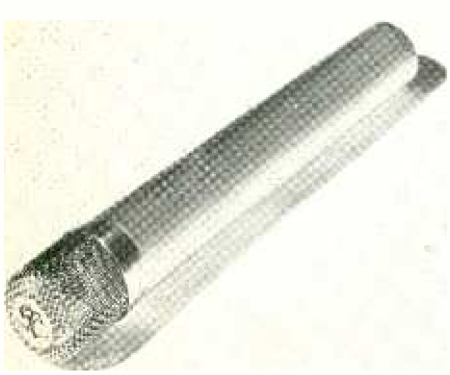
When a microphone of smaller dimensions than the *U87* is desired, but with the same directivity pattern facilities, this microphone can be used. As with the *KM84*, a swivel mount is available and the same phantom powering supply is needed. Neumann can also supply various cables incorporating head mount adaptors of different lengths to meet all requirements. In cardioid position the response is very similar to that of the *KM84* but a slight high frequency shelf of approximately 2 dB was noticeable between 8 and 15 kHz, with a peak of $3\frac{1}{2}$ dB at 8 kHz itself. The polar response was also similar to that of the *KM84*. The back to front ratio was 20 dB from low frequencies up to



approximately 5 kHz reducing to 10 dB at 10 kHz. This excellent ratio at low frequencies would make the microphone particularly suitable for use in TV studios where rumble behind the microphone would thus be considerably less noticeable.

STC 4136

This pressure gradient microphone obtains its cardioid response acoustically, and is phantom powered. The twin power supply is provided with impedance switches allowing either 30 or 200 ohms to be selected. All the tests were carried out in the 200 ohm position. A very high output is obtained; in my opinion far too much gain being made available. Although the response was flat and the noise level relatively low, this model is not suitable for reproducing very high sound pressure levels as considerable blasting and distortion become progressively noticeable above a sound pressure level of approximately 115 dB. It is envisaged that a group of brass instruments playing close to the microphone might well produce audible distortion, as in the test my trumpet at 150 mm sounded intolerable. Even on normal input signals it is suggested that the 30 ohm output be used, thus decreasing the possibility of the subsequent stages being overloaded. The microphone's forerunner, the *4126*, had only a single FET amplifier and therefore had a very low output of the same order as a moving coil microphone, and it is suggested that the manufacturers should decrease the gain by the application of approximately 10 dB more feedback, which should also improve the overload characteristics. A little more trouble in the design of the parameters of the amplifier could have made this one of the most recommendable microphones to be tested. This microphone's response is very flat, with excellent hf response off axis. At 90° a slight resonance occurs at



10 kHz of 5 dB, similar to the *C12A*. The back to front ratio is extremely good, being the best measured for any capacitor microphone.

Calrec 1050

Available also in modular construction, this cardioid capacitor proved to have a good frequency response and also a very low dBA weighted noise figure. However, on all the samples tested the rumble level produced by the FET used became particularly noticeable because the hiss level was very low. This caused the unweighted noise to measure rather poorly, although listening tests showed the microphone to be subjectively very good. A marginal coarseness was audible under some conditions, giving a sound not quite as good as the AKG *451E*, but the noise level was noticeably superior. Some samples tested had a rather worse rumble level, but I understand that this variation has now been corrected by the manufacturer.

Dynamic Microphones

AKG D 202E1

This model is unusual in that two separate cardioid capsules reproduce the high and low frequencies. The outputs are matched and are passed through a bass cut switch on the body of the microphone. A stand mounting clamp is provided. The microphone can easily be hand held and is fairly insensitive to external shocks or vibration. Apart from its obvious use as a general purpose cardioid microphone, it has a particularly pleasing quality on speech and is in common use in the continuity studios at the BBC, since it is also very free from speech popping. The crossover between the capsules is quite complex, and occasionally a wire can become dislodged if the microphone is carelessly handled, but since this can be easily resoldered it is not too serious a criticism. Although the response on the main axis is held to within 4 dB between 50 Hz and 10 kHz, falling rapidly above 14 kHz, off axis the high frequency fall off becomes very marked. At 30° off axis 10 kHz is 4 dB down, at 60° 9 dB down, and at 90° 12 dB down. The front to back ratio at middle frequencies is exceptionally good, being 25 dB, this figure only deteriorating to 20 dB at 10 kHz. However at lower frequencies the ratio is 10 dB. Because of the off-axis fall off of high frequency response this microphone is quite unsuitable for use as a stereo pair, and for this reason if used in a back to back cardioid configuration gives a very serious loss of high frequencies on the centre image, a fact well known to professional engineers who have tried this technique. Its highly directional properties at high frequencies, however, makes it eminently suitable for spotting one solo instrument in a group when a multi mike technique is used, since such a solo instrument will sound more forward than instruments on either side. The sample tested had dips of 2 and 3 dB respectively at 1 and 7 kHz.

AKG D224

This is a slimmer stick version of the *D202* with very similar characteristics, although having a slightly flatter frequency response. The appearance is rather more pleasing than the *D202* and it is therefore more suitable for use in TV or in cases where the appearance is important. The sound produced by speech is of similar quality to that produced by the *451E*, and with a first class microphone preamplifier the noise level is slightly quieter, although having a different spectral analysis. The polar response at high frequencies is slightly superior to that of the *D202*, but I consider nowhere near good enough to allow two of the microphones to be used as a stereo pair. A bass roll off of 4 dB was also noticed at 50 Hz.

AKG D12

This model has been available for some years and is of a box type construction with the usual AKG silver and black sides. The sensitivity is some 3 dB higher than for the *D202*, allowing the very low noise level to be obtained of 21.5 phons, noticeably superior to a number of capacitor microphones tested. In order to achieve a good front to back ratio at low frequencies the cardioid response is partly achieved by acoustical means in the body of the microphone. This however increases the impedance at low frequencies so that a bass roll off of approximately 4 dB is noticed at 70 Hz even into a 600 ohms input, the bridging impedance normally recommended for 200 ohm moving coil microphones. Incidentally, all capacitor and professional moving coil microphones in the AKG range have a source impedance of nearer 150 ohms. This microphone is particularly insensitive to shocks and is probably the most reliable over a long period of the microphones tested. Studios have frequently dropped them with no deterioration. Although the response extends to 12 kHz it is rather more peaky than the more expensive moving coils.

STC 4038

Some years after the war the BBC designed what has been regarded as one of the finest ribbon microphones ever made, namely the *PGS*, after many years of experimentation. This design was taken over by STC who developed the *4038* as a result, its characteristics being very similar to those of the *PGS*. Even today its quality can still be regarded as good, and its velocity directional properties proved to be very useful in studios. Many engineers like to use this microphone on different types of instrument, and the characteristic, common to all velocity sensitive microphones, of boosting bass from a sound source in close proximity becomes very useful on occasions. The response is extremely good for a ribbon microphone, tailing off above approximately 10 kHz. Since the microphone includes an extremely powerful magnet it should be kept well away from recording tapes. Although this may be obvious to many readers, I have heard of many tragedies in which masters have been damaged. The unusually high output from this ribbon microphone makes it very suitable for simple stereo recording provided very good microphone amplifiers are available, but a lack of rising top can tend to make the microphone sound rather dull. Even at 60° off axis the frequency response remains almost identical, giving very precise positioning when two microphones are used for stereo. The response is, of course, identical on both sides of the microphone.

A general analysis of all the subjective and

(continued over)

Microphone	Type	Polar Diagram	Sensitivity†	Equivalent dBA weighted noise level	Treble response trend	Bass response trend	Front-to-back ratio (50 Hz)	(1 kHz)	(10 kHz)	Price
CAPACITOR										
AKG C24*	Stereo valve	9 position remote	—61	26	rising to 6·5 dB hump at 10 kHz	flat fig 8 —2·5 dB 50 Hz	good	good	average	£319
AKG C12A*	mono nuvistor	9 position remote	—71·5	23·5	+3·5 dB shelf	flat fig 8 —2·5 dB 50 Hz	average			£165
AKG 412*	mono fet pp	on mike o.c. 8	—68·5	21	+2 dB shelf	flat fig 8 —2·5 dB 50 Hz	average	average	good	£83·20
AKG 451/452*	fet pp or batt									£50·50
CKI/HO	modular mono	cardioid	—60·5	20·5	flat	50 Hz —1·5 dB	good	good	fairly good	to be announced
CKI Standard	modular mono	cardioid	—64·5	24·5	flat	slightly falling	average	good	average	£14·80
CK5	modular mono	cardioid	—61·5	21·5	3 dB peak 10 kHz	—3 dB at 50 Hz	average	good	average	£22
CK2	modular mono	omni	—63	24	flat	flat				£14·80
Neumann SM 69 fet*	stereo fet	9 position remote	—57	17	+3·5 dB shelf	fig 8·50 Hz —3·5 dB	good	good 13 dB	good	£215
Neumann U87*	mono fet pp or batt	on mike o.c.8	—62·5	17·5	flat to 14 kHz	roll off	fair	fair	fair	£98
Neumann KM 84*	mono fet pp or batt	cardioid	—59	18	flat to 16 kHz	50 Hz —3 dB	good	good	good	£133
Neumann KM 86*	mono fet pp or batt	o.c. 8 on mike	—64	22	3 dB shelf above 5 kHz	—4 dB 50 Hz	very good —20 dB	good —20 dB	average —10 dB	£99
STC 4136*	mono fet pp or batt	cardioid	—51	21	10 kHz flat 18 kHz —3 dB	50 Hz —2 dB 80 Hz +1	—22 dB (50 Hz —25 dB)	—12 dB	—10 dB 6/16 Hz—16 dB	£110
Calrec CM 1050*	mono fet pp or batt	cardioid	—70	18 (mainly rumble)	+2 dB shelf 17 kHz —3 dB	flat	average	good	good	£32·15
MOVING COIL										
AKG D224*		cardioid	—79·5	23·5	fairly flat	bass roll off	average	good	average	£59·50
AKG D202EI*		cardioid	—80·5	24·5	fairly flat	fairly flat	—10 dB average	—25 dB very good	—20 dB very good	£39
AKG D12*		cardioid	—77·5	21·5	peaky steep cut above 12 kHz	—4 dB 70 Hz	average	average		£36
AKG D19C		cardioid	—77·5	21·5	peaky	bass roll off		not measured		£15·96
STC 4021 (30Ω)		omni	—84·5	21·5	fairly flat	slight roll off				obsolete
RIBBON										
STC 4038 (30Ω)*		fig 8	—83·5	20·5	10 kHz —2 dB 15 kHz —6 dB	flat				£60

* See text.
† Output into 1 kΩ for 74 dB spl: cardioid where applicable.
pp power pack.

objective tests has shown clearly that there are considerable differences in noise level between different types of capacitor microphone. Furthermore, the frequency response at the very low end and at the treble end are noticeably quite different from one model to another. It should not be assumed that a microphone should always be as flat as possible as a bass roll off can be particularly useful for reducing rumble and studio boom, whereas a high frequency boost is almost always desirable for most purposes, particularly when microphones are not in close proximity to the instruments being recorded. Air tends to absorb high frequencies more than lower ones over a distance, and this is the main reason why treble boost was designed into many models of capacitor microphone, although by today's standards some of the earlier models took this to excess. In many cases this boost was obtained in the capsule itself, giving rise to a slightly worse signal to noise ratio since the effective electrical damping at these frequencies on the input stage of the built-in microphone preamplifier becomes worsened. Insertion of a correction network in the microphone lead can not only flatten the microphone's response but decrease its noise level. Many engineers therefore prefer to work with a flatter microphone and introduce a controllable boost in the mixer which I personally think is slightly preferable. If no boost is available in the mixer, however, on average a more acceptable sound for the majority of listeners is obtained by having a capsule with built-in boost. The earlier Neumann *SM2* had much more high frequency boost than the *SM69*, and for this reason many semi-professional users not having tone control facilities have found it preferable, although the signal to noise ratio is inferior.

Rather the same situation occurs with the comparison of the AKG *C24* with the Neumann *SM69*. Care must be taken not to take too much notice of the differences in microphone noise levels below 21 phons or so since even for speech recording a noise level below this will be below the normal ambient noise of almost all frequencies found even in recording studio conditions. For the recording of music, especially on close miking, any microphone having a noise level better than 24 phons will not be likely to produce any audible noise. The lowest noise microphones are particularly useful when either speech or very quiet sounds are being recorded in an unusually quiet studio having a fairly low reverberation time, or alternatively in situations where the microphone is being used in a very large concert hall, such as the Royal Albert Hall, in which the music to be picked up has an unusually wide dynamic range necessitating the balance engineer to pot up the quietest passages. Under these conditions the *SM69*, the *U87*, the *KM84* and the *412* and *451E* with the high output capsule, should all give excellent results. The Calrec *1050*'s rumble level might unfortunately become just noticeable.

For general studio purposes the price difference between the AKG *451* range and the far more expensive Neumann *KM84* must weigh heavily, as must also the modular adaptability of the *451*.

The *U87* is a very fine microphone indeed, and perhaps if potential and present users were to demand it, it could be supplied with my proposed hyper-cardioid position. AKG's equivalent *412* is subjectively only a little inferior, having more middle frequency noise, this being particularly emphasised with the dBA weighting curve. It is possible that the *412* will be available with remote control pattern selection, thus making it more adaptable than the existing Neumann. The Neumann, however, has the advantage of having its built-in battery supply, making it ideal for location work.

The STC *4136* microphone can only be recommended on occasions where normal sound pressure levels are experienced. I have myself experienced clipping on brass on a recent session with this microphone, which was immediately replaced in the emergency with the *D224*. On speech the *4136* sounded excellent, but it is worth pointing out that this microphone is strictly recommended for use into loads greater than 1000 ohms. To a lesser degree this recommendation applies to Neumann microphones, their specification being 1000 ohms exactly, whereas AKG microphones are quite happy working into 600 ohms, very often found in practice. The output level from the microphones also should be considered in addition to the noise. A mixing desk having poor input amplifiers will not only give an unsatisfactory noise performance with dynamic microphones, but even with low output capacitor ones. On the other hand, some mixing desks tend to overload easily or have a distortion level increasingly noticeable from 10 dB below the input clipping level. In such cases microphones having an output level in excess of –60 dBV for one microbar should be used with caution since sound pressure levels of 114 dB found quite often in practice will give a level in excess of 100 mV.

The nature of the noise itself is important and, with many types of double diaphragm capacitor microphone, the diaphragm being held at the same potential as the centre becomes a load impedance on the other diaphragm. This will slightly reduce the output from the microphone but will double the capacitance applied to the input of the amplifier and therefore alter the noise level to one octave lower turnover. Microphones having this second diaphragm actually switched off may sometimes sound subjectively lower noise, and such was the case with the well known Neumann *U47*.

A good front to back ratio is important when microphones are used either to spotlight a sound in front, discriminating against sounds behind, or when a rejection of general studio ambience is desired. In selecting microphones for reverberation pick up where the cardioids are facing away from the sound being recorded a good back to front rejection is again desirable, allowing a high proportion of reverberation to direct sound to be picked up. For this application backward-facing cardioids must also have an inherently low noise level allowing the reverberation to be brought up considerably in level without hiss being audible.

For high quality public address work or on occasions where a public address feed is required from the recording or transmission, balance, a good back to front ratio will considerably increase the amount of amplification that can be given to the public address speaker system without howl round.

Should two separate microphones be required in fairly close proximity for recording in stereo care should be taken to choose models with a good high frequency response off axis, and for this reason the *D202* and *D224* should definitely be avoided. Almost all capacitor microphones also show a reduction of extreme top response considerably off axis, but it was interesting to note that the *C12A* had a slight boost under these circumstances. The BBC's choice of these microphones as a stereo pair for the Royal Albert Hall Proms this year was therefore quite wise since it improved the proportion of high frequencies noticeable in the centre of the sound stage, and also the accuracy of positioning of instruments half left and half right. Although the STC *4038* ribbon has the finest off axis response relative to that on axis of any microphone tested, hiss would most certainly be noticeable at very high frequencies if it were used at a considerable distance from the sound source. Remember too that moving coil and even ribbon microphones tend to show a comb filter effect (mechanical resonances) if the response is measured with a very slow sweep with a pen chart recorder running at high speed. This effect found to a greater degree in loudspeakers is responsible for what is commonly termed coloration.

When considering the choice of a pair of microphones for stereo, or a group of four microphones for quadraphonics, the method of mounting should be seriously considered. Any obstacle near the capsule of a cardioid microphone, particularly in front of it, such as the body of another microphone, can seriously distort the sound field by causing reflections at high frequencies. Right-angle bend adaptors allowing the four amplifiers to be mounted vertically grouped together with their capsules therefore only 6 cm or so apart back to back, would give a very much less distorted sound field than one in which the microphones are all mounted horizontally in criss-cross fashion with the back of the body of one microphone being in front of the capsule of the opposite one.

Looking to the future, AKG will be bringing out their stereo equivalent of the *412* to replace the *C24*, in about a year. They are also working on a quadraphonic microphone with four cardioids in one microphone head as a further modification of the FET version of the *C24*. Neumann will shortly be introducing, as a result of many requests, an FET version of their old but popular *U47*.

As a final test to prove that a very low noise level could be achieved from a moving coil microphone, my children bought some Mexican jumping beans which make very quiet clicking noises as the insects inside eat the interior of the bean. I placed six of these in an anechoic box together with a *D12* microphone and applied some 80 dBs amplification. The resulting sound was quite astonishing, and the signal to noise ratio quite reasonable under these special circumstances.

I would like to acknowledge with thanks the assistance given by the BBC in helping with some test facilities. They wish to make clear that they do not accept responsibility for any measurements, or conclusions, drawn in the article. I would also like to thank the manufacturers for their considerable co-operation.

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Kenny Everett-Disc Jockey Extraordinary

By Adrian Hope

ONE of the nicest things about being in Sussex last summer was having the chance of picking up BBC Radio Brighton on the FM band and hearing Kenny Everett's Saturday lunchtime show. On the Saturday that I heard it he was in fine form, offering bribes to the gentlemen in blue over the air—'the local police have promised not to book me for speeding if I play them a record—so I'm playing them a whole LP,' and then giving out a snow warning for Bank Holiday Monday.

Everett lives and works surrounded by family, chickens, a horse-sized dog and cauldrons of bubbling nettle wine in near idyllic surroundings. With a well equipped little studio christened 'wireless workshop' built into a small room of the farmhouse, and original beams poking through the acoustic tiles, he really has no need to move further afield than the nearest railway station and despatch the tapes of his programme to whatever local radio station has commissioned them. That is exactly how he now works. But to start at the beginning . . .

Once upon a time there was a young lad who played around with a couple of primitive Philips four track domestics to produce 'layered' tapes which he sent round the country for the amusement of anyone interested.

'I was so fascinated by tape,' says Everett, 'I couldn't understand why everyone wasn't using it. I still don't know why anyone ever buys a disc.'

Sure enough, discs are surprisingly thin on the ground in his studio. Just a few all-time favourites (like the early Nilsson recordings) and a pile of current choices. A clue perhaps to the creative content and the success of his programmes is his comparative lack of involvement in the current music scene. 'I get records, but I usually give them away.'

Back in the early 1960's someone on *Tape Recorder*, as STUDIO SOUND used to be, suggested that he send a tape to the BBC. He did, and the tape ended up in the hands of Wilfred D'Eath, who recently came into the public eye by luring Daphne du Maurier in front of a TV film crew for the first time. D'Eath broadcast the tape before leaving BBC radio and in some way or another the pirate station Radio London acquired a copy. As a more or less direct result, Kenny Everett started a two and a half year stint with that ship and maintains that he loved every moment of it, not only through the mists of nostalgia. Possibly this was because he left six months before the legal guillotine fell. He quit for a variety of reasons. For instance, he felt that the pirates, still relying on virtually 100 per cent needle time and with obviously no hope of ever moving on to land, had by then played themselves out. There was no sign of the great British listening public downing their apathy about land-based alternatives to the BBC. He further believed that before very long dozens of ex-pirate disc jockeys would be knocking on the doors of Broadcasting House looking for legal jobs.

But despite this shrewdness, things didn't quite work out the way they might have done. Everett only started regular broadcasting with the BBC some six months ARO (After Radio One), probably because of his fairly open criticisms of the way the BBC had until then handled its disc jockey programmes. Whereas in America and Australia—and at the pirates—it was traditional to have one man playing the records, doing the chat and working the controls, the BBC had always used a whole team. Along with everyone else who had served an apprenticeship on the pirates, Everett knew that the only way you can run a fast programme is to adopt a one man driver technique.

Eventually the BBC eased him into broadcasting, and the rest is more or less history. His Saturday show won him critical acclaim, fame and possibly a little fortune. It is also history that he was sacked a year or so ago in a blaze of publicity, supposedly for commenting over the air on a news bulletin. In his view, the real reason for the sacking was that for a long period of time he had answered Fleet Street reporters honestly when they asked him what was wrong with Radio One.

After the BBC came a mass of publicity which, had local legal commercial radio been ready to go, would have earned him a fortune. As it was, he went briefly into Luxembourg and the short-lived Radio Monte Carlo British transmissions.

He is still banned in the most forceful way from Broadcasting House but, by a curious ambiguity, the local stations are able to employ him. Which is how I happened to hear him on Radio Brighton. *(continued over)*

Kenny Everett in his 'Wireless Workshop'. The mixer is detailed overleaf.

The programme I heard was put together (like everything he does) in his 'wireless workshop'. The basic equipment is a Gates Cartridge Machine with record amplifier and Astronic Equaliser, two Pye compressors, a 10 channel mixer with echo and tape remote controls, two EMI *BTR4*, a Revox and a Gates turntable with Grey arm. Rather surprisingly, he uses only one turntable and so, after each disc played, stops to edit.

Playback monitoring is on a Quad *303* through a couple of EMI speaker units built into tailor-made cabinets. These—and everything else—were put together by Mike Howell, who used to be a pirate technician. Not surprisingly, the whole set-up is rather like a landborne pirate ship.

It was on the pirate ships, with hours to spare between programmes and not much else to do, that Everett perfected his present techniques of jingle production. Some BBC local stations commission him to do jingles alone. The way he does them is interesting.

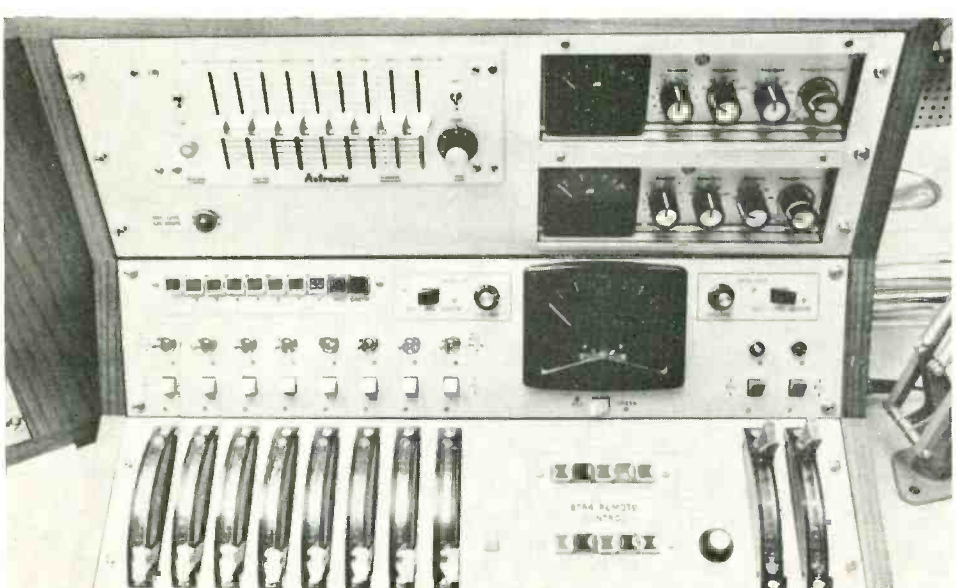
The starting point is any one of his pile of copyright-free discs. Having picked a track, Kenny spends hours fitting suitable words to the music. Like references to the station involved, the wavelength and 'what a fun station it is, although usually they aren't'. He then uses the two *BTR4* in a to-and-fro manner to add on several voice harmonies (usually four) and possibly an over-the-top spoken voice. The final result then goes on to a continuous loop cartridge of the type used by the BBC, with compression to keep the transmission staff happy. The cartridges used are the normal type, compatible with the BBC Rola-Plessey machines which use a loop running at 19 cm/s with audio on one track and cue pulses on the other. Everett uses the Gates instant stop-start machine because he prefers it to the Rola-Plessey. Having heard a bit of Radio One recently, the number of times the disc jockeys have trouble with their jingles does make me wonder about either the jockeys or their machines.

The finished product, either jingles alone in cartridges or whole 38 cm/s programme tapes, are sent off with PRS lists to the stations involved. They go three days early so that the station managers can ensure nothing naughty is being said.

What makes Everett's radio programmes a cut above the rest? Part of the answer is obviously his reputation of being not exactly a man to play safe (one might sum him up as being a bit of a boundary nudger). But there is a whole lot more to it than that. Working on the assumption that disc jockeys are a necessity (because, Everett claims, simply playing whole LP's over the air has been tried in the States and just doesn't work), there seem to be two types of DJ that are worth listening to. On the one hand there are those like Alan Dell, who play music either with very little chat or with only hard-core informative chat. And then there are the 'creative' disc jockeys who put out a programme which almost *incidentally* uses discs. Come to think of it, I can't think of any DJ other than Everett who really succeeds at this end of the line. In between there's the ego-tripping rest who are best forgotten.

All of which takes us back to Everett's comparative lack of involvement in music for music's sake and an almost obsessive involvement in using tape creatively. So it doesn't come as any surprise to find that, of all the media, he prefers radio, and regards it as grossly neglected and unexplored. He has done plenty of TV work but on the whole he hates it.

'There is no spontaneity on TV. You work all day on the studio floor getting ready for a take. After hours of fiddling around with the lights and your make-up, they try a take and you do something good. But it turns out that the tape is broken or something has blown up and they ask you to do it again. How can the result ever be spontaneous?'



Everett has a fascinating collection of tapes from abroad, mostly America, instancing what he sees as best in the mass of good, bad and terrible radio broadcasting being put out all over the world. I was interested to hear one of his tapes, a very relaxed FM stereo programme put out in Los Angeles. I say interested because, by his own admission, Everett's are 'nerve-endy type programmes'—the very opposite of relaxed broadcasting. He has been criticised for overlooking the value of silence. This dates back to the indoctrination of two and a half years on Radio London. The pirate Bible had an extra commandment to the effect that on no account shalt any broadcaster ever leave a pause.

Like plenty of people in his position and with his particular type of talent, Everett is not an easy man to interview. That is not to say that he is unfriendly or aloof—he is just the opposite—but anyone with his exuberance is almost by definition surrounded by defensive shells and disguises which only occasionally fall away in the presence of an outsider. But still a lot came through. I asked him about the future; where he sees himself broadcasting and in what style. He has more faith than I in the ability of the local commercial stations (legal) to improve the general picture. With local broadcast advertising rates far less than on Luxembourg there will no longer be any need to cram the basic essential advertising information into such a short space of time—'the 15-second jam commercial'. Instead, and for the same money, the advertiser will get a 30-second or even one-minute commercial break in which greater creativity can play a part. After all, in 15 seconds there is room for little more than the name of the jam.

But with relatively few programmes to do at the moment, Kenny Everett admits to his still having a sense of urgency. 'I want to cram as many goodies as possible into the only programme time available,' he says, 'and I want to show what I can do'. Whether more programmes and more broadcasting time will mean less urgency and a more relaxed attitude, and whether the final result will be improved or degraded by a slower approach, remains to be seen. For hopefully he must sooner or later get more programme time to work with.

Whatever happens, I somehow can't see Everett putting out a boring programme. Like all creative people, he makes mistakes and does things that don't come off, but he is never boring. Unfortunately with that Broadcasting House ban all too obviously in operation at the time of writing, and with local commercial radio still rather pie-like in the sky, the only chance of hearing one of the true originals in British radio is to watch your local BBC radio station schedules like a hawk, and pounce accordingly. When I left him he was in the throes of sending a letter off to each local station manager offering them some tape-recorded action. 'Do not delay too long,' he warned one of them, 'these tapes are set to auto-destruct after a few days'.

As I drove home I put on the car radio to hear, between a couple of disc jockeys shamelessly plugging their own terrible records and playing the same old jingles, a gentleman with a soft Irish accent and a daily two-hour programme admit that he hadn't the vaguest idea what 'phasing' was.

Equipment Reviews

KEITH MONKS MICROPHONE STANDS

WHAT are the qualities one looks for in a good microphone stand? The following points are suggested and it is by these standards that this review is written. It should be stable, robust, easily and smoothly adjustable. It should be able to accommodate all types of microphone. It should provide good sound insulation from noises via the floor. It should be elegant and, if needed in conjunction with cameras, should have an anti-flash finish.

It should be easily transportable and reasonably priced. The stands submitted for review by Keith Monks range from the baby *MS/S* to the *MS/L*.

The stability of the stands was checked in the following manner. Each stand was adjusted to its maximum height and its boom adjusted to maximum horizontal span directly over one of the legs of the stand. This is the correct way to direct the boom for maximum stability. A gradually increasing force vertically downwards was then applied to the end of each boom.

With some stands used in this way, the boom turns about its pivot before the stand tends to topple. With others, the stand tends to topple first. All the booms that turned before toppling did so quite slowly, giving reasonable warning to the engineer setting up. It could, however, be a traumatic experience to sit in the control room watching a pair of back-to-back cardioids descending slowly over the conductor's head.

Each boom was then turned to bisect an angle between its legs. The downwards force necessary to cause instability was again measured at the end of the boom. Stands would not normally be used at their extremes but mistakes can be made and it is better if they are not too costly. Several of the boom arms supplied with the Keith Monks stands are interchangeable. For the purposes of this review, each stand was fitted with the arm recommended by the manufacturer.

Better comparisons of the stability of the stands themselves are given by the product of the length of the boom arm and the force required. Where equilibrium was broken by toppling, this product is given in the column headed 'moment'.

Below: BS/1 Right: MSP/A

BS/1

This is a treble stand with a cast base which can be used in two positions: upright or at an angle. The review model was in aluminium and would be suitable for use with cameras. As can be seen from the photograph, it would be ideal for a newsreader as there is adequate room for notes between the stand and the reader. The stand is well made, robust and stable enough to hold even the heaviest microphone safely. At £5.50 it is considered excellent value for money.

BS/2

This is the big brother of *BS/1* and would be an ideal table stand for a speaker standing up; just right for public speaking. It is similar in style and quality to *BS/1* and at £6.75 is still considered excellent value.

MS/S

This is the baby of the floor stands but is very sturdy and easily set up in an emergency. At £6.75 plus £5 for the boom, studios might well consider having a couple handy for use when an extra microphone is needed quickly in a crowded situation. The stand and boom are in chrome and well finished. The clasp for the arm is efficient and easy to use.

MS/M

This stand looked better than the *MS/S* and is more robust but the screw threads on this particular model were rough. Screwing and unscrewing the legs was unpleasant and sometimes tricky. When the height adjustment was attempted, the extension tube fell out through the bottom of the stand.

The boom arm supplied for use with this stand was the least stable of those tried and is not recommended as it required two hands to adjust. This stand with *BA/S* would make a slightly cheaper and more satisfactory combination.

MSP/A

This is an unusual and useful stand. Its toggle action makes it possible to place microphones in positions that might be very difficult with ordinary stands. It is easily and smoothly adjustable though care must be taken, as with the *MS/M*, not to let the extension tube fall down inside the stand if adjustments are made without a microphone attached.

The model supplied had an anti-flash finish and was robust. The legs did not screw in and out very smoothly and it was found difficult to persuade the thread on one of them to engage properly.

The stand was tested for stability with all the upper part of its length horizontal. The results show it to be remarkably good. Because of its unique action, it is a very useful stand and is highly recommended.

MS/L with BA/L

This is the most impressive combination in the range. With a stand 183 cm high and boom 162 cm long, it is a useful intermediate between the usual portable stand and boom and the larger ones found in most studios.

The stand has four screw-in legs and, closed down to its minimum length of 106 cm, is easily transportable. The boom is in one piece and would not therefore fit into the boot of even large cars but could be carried happily in a van.

The boom adjustment was found to be a little jerky, but otherwise this stand and arm fulfil

(*continued on page 653*)

FRANCIS OF STREATHAM

DECKS WITH PRE-AMPS
(Microphone extra)
Akai 8 Tr. Cartridge CR.800
Akai 4000D Stereo
Brenell Mk. 6 Stereo
Ferrograph 702/4
Philips N.4500 3 sp. 4 Tr. Stereo
Revox 1102/4 2 sp. Stereo
Sharp RD 712D 3 sp. 4 Tr. Stereo
Sony 366D 3 sp. 4 Tr. Stereo
Sony 630D 3 sp. 4 Tr. Stereo
Sony 266D 3 sp. 4 Tr. Stereo
Sony 255 Stereo
Tandberg 1800 4 Tr. Stereo
Tandberg 3000X 3 sp. 2/4 Tr. Stereo
Tandberg 6000X 3 sp. 2/4 Tr. Stereo
Telefunken 205 3 sp. 4 Tr. Stereo
Telefunken 203 Studio

MAINS SPOOL RECORDERS
*Akai 1710L 2 sp. 4 Tr. Stereo
*Akai 4000 3 sp. 4 Tr. Stereo
*Brenell Mk. 6
*Ferrograph 713
*Ferrograph 722/4
Grundig 141 4 Tr. Mono
Grundig TK.121 2 Tr. Mono
Grundig 146 4 Tr. Mono Auto.
*Grundig TK248 2 sp. 4 Tr. Stereo
Philips 4303 2 Tr. Mono
Philips 4307 4 Tr. Single Speed Mono
Philips 4308 2 sp. 4 Tr. Mono
Philips Stereo 4404 2 sp. 4 Tr.
Philips Stereo Cassette 2401 Auto.
Philips Stereo Cassette 2400
Philips 4407 3 sp. 4 Tr. Stereo
*Revox 1222/4 Stereo
Sharp 708 3 sp. 4 Tr. Stereo
Sharp 711 3 sp. 4 Tr. Stereo
Sony 630 3 sp. 2/4 Tr.
Sony 540 3 sp. 4 Tr. Stereo
Sony 252 3 sp. 4 Tr. Stereo
*Tandberg 15 2 or 4 Tr./3 sp./Mono
*Tandberg 4000 3 sp. 2/4 Tr. Stereo
*Telefunken M207 2 sp. 4 Tr. Stereo
Telefunken 203 Stereo/Mono 2 sp. 4 Tr.
Telefunken 201 Mono 4 Tr.
*Uher 714 4 Tr. Mono
*Uher Royal de Luxe 4 Tr. 4 sp. St.
*Uher Varicord 263 Stereo
*Uher 724 4 Tr. 2 sp. Stereo

MAINS CASSETTE MODELS
*Philips RH882 Stereo Tuner/Amp/Cass.
*Sony HST399 Stereo Tuner/Amp Cass.
Sony TC 330 Stereo Cass./Spool

* Kellar Dolby Stereo
*Rank Wharfedale Dolby Stereo
Philips 2400 Stereo
Philips 2401 Autochange w. ski-slope

*Sony TC 127 Deck and Pre-amp
*Sony TC 122 Deck and Pre-amp
*Philips 2503 Deck and Pre-amp

BATTERY MAINS CASSETTE
Philips 2204 — Sony TC. 80
Philips 2205 — Sony TC. 100
Sony TC. 60
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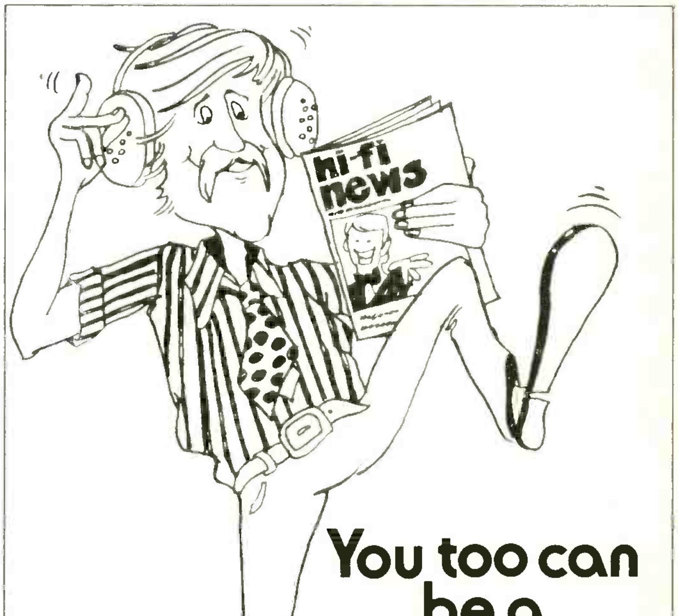

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KEITH MONKS REVIEW

continued

most of the requirements laid down.

Having four legs, the stand could wobble on floors that were not level, although this did not occur on test. Presumably most places where a stand like this would be used would have a level floor anyway.

The stand and boom are very sturdy and inspire confidence in use. They are elegant and fairly easy to adjust.

There are few easily transportable stands available high enough to be of use when recording organs. In this price range, it is quite remarkable to find one that will do this. This stand and boom represent quite remarkable value for money and are highly recommended.

A range of thread adaptors is available for all the stands, to accommodate a large variety of microphones and fittings.

An interesting attachment is the clasp which, when fitted on the tube of one of the stands, enables an extra microphone to be mounted there. Used with *MS/L* and *BA/L*, two microphones could be quite widely spaced using the one stand and boom. None of the stands supplied had anti-rumble feet, though these are easily improvised with plastic foam.

MS/C

This stand allows singers close to the microphone without their kicking the base. It performs this function well, has an anti-flash finish, and is reasonably stable. Difficulty was experienced in screwing and unscrewing the adaptor on the extension tube. The thread on this tube appeared soft on the review sample.

MS/CT/2

This stand is robust, well made and elegant. It is well suited for use on stage and is considered good value for money.

SB/1

This stereo bar is well made and thickly chromed but is rather heavy and should therefore only be used with stable booms or with the boom upright.

SC/1

This side clasp, as mentioned elsewhere, is an extremely useful attachment. It is well made and does its job easily and is highly recommended.

Just as I completed this review, another boom arm was sent for examination. This has the excellent idea that the counterweight screws off one end and on to the other, thus exposing different threads for the microphone fitting. Unfortunately the clasp on this stand was not very positive and equilibrium was broken by pulling at 0.5 kg. It is a pity that such an excellent idea should be spoilt in this way.

Keith Monks Ltd were contacted about the criticism in this review and state that they have now included stops in the stands to prevent the extension tubes falling out when being adjusted without microphones fitted.

John Shuttleworth

Stand and boom	Stability in best position		Moment		Ease of Adjustment	Value for Money
	Boom turned (Kg)	Stand toppled (Kg)	Best (Kg)	Worst (Kg)		
MS/S & BA/S	—	2	1·98	0·49	Good	Excellent
MS/M & BA/M	0·75	—	—	—	Poor	Not recommended
MS/M & BA/S	3·5	—	—	1	Average	Good
MSP/A	—	0·75	3	2	Average	Excellent
MS/L & BA/L	3	—	—	3·24	Average	Excellent
BS/1	—	—	—	—	Good	Excellent
BS/2	—	—	—	—	Good	Excellent
Brand X	4	—	—	3	Excellent	Good
Brand Y	—	2	1·98	—	Excellent	Poor

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BS/1 30 to 55 cm high stand, aluminium finish, 2 kg weight, £5.50
BS/2 46 to 82 cm high stand, aluminium finish, 3.1 kg weight, £6.75
MS/S 91 to 153 cm high stand, chrome finish, 3.1 kg weight, £6.75. (Accepting BA/S.)
MS/M 91 to 175 cm high stand, chrome finish, 4.65 kg weight. £9.25. (Accepting BA/S or BA/M.)
MSP/A 130 to 210 cm high stand, aluminium finish, 3.54 kg weight, £10.25.
MS/L 106 to 183 cm high stand, chrome finish, 6.2 kg weight. £13. (Accepting BA/L.)
BA/L 162 cm boom, chrome finish, 2.2 kg weight, £8. (To fit MS/L stand.)
MS/C 96 to 155 cm high stand, 4 kg weight, £6.75. (Accepting BA/C.)
SC/1 Side clamp. £1.80.

Distributor: Keith Monks (Audio) Ltd, 26-30 Reading Road South, Fleet, Hampshire.

MICROPHONES

continued

where speakers talk at different levels or where the microphone is to appear in shot, several small microphones may be preferable to one central one.

To complete our catalogue of microphones and uses it might, however, be worth putting down one or two points that get overlooked, and which don't have to affect the way you balance a music session.

Instruments and singers tend to sound both more realistic and more pleasant if the microphone is in front of rather than over them. It is frequently necessary for practical reasons and to avoid audience noise to raise the microphone somewhat, but this should not be taken to extremes, especially with a close microphone. Violins and tenors sound horrible from above (except where the tenor is singing to his loved one in the Gods) and some singers are not improved by having the microphone placed so far below that it is in a direct line with the nose; clarinets, oboes and to a lesser extent brass also do not take kindly to a microphone looking up the bell. One normally hears the instrument from in front so it is not a bad idea to record it that way. In the same way pianos and harpsichords sound better without the sensation of being poised where the lid may descend to end one's troubles.

Hand microphones, whether for pop music singers or interviewers, are best chosen to be omnidirectional. There is less of a bass rise problem to contend with, you don't have to keep on axis so carefully, and handling noise is much lower than with directional microphones, as explained earlier. Some moving-coil and capacitor cardioids are better than others as regards handling noise, particularly if they have a bass cut switch to remove both bass and rumble before they can cause intermodulation in the mike amp. In general the omni is more suitable and the ribbon the worst for handling noise. Capacitor mikes with power coming up the cable must have good connections and attention to the earthing if DC is drawn through the screening braid—potentially a cause of fearful noises if it is carrying dc.

Since I have to end this somewhere, may I leave readers with the point I have made before in these pages, and which I think DK was making in the September editorial: what most of us started in this lark for was the music. If it all sounds wrong, put away your mikes and buy a ticket for a live performance. Better still, do some performing. A perfect and uplifting performance is rare, but when it comes no audio system on earth will do it justice or ever capture completely the sheer exhilaration of making, or hearing, a great performance live. A really good recording or broadcast can be an extension of one's memory and the range of one's hearing: that is their justification. Anyone who believes that recorded sound will ever completely displace the live performance, even in popular music, is either a fool or no lover of music.

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