DECEMBER 1969 2s 6d

tape recorder

REVIEWS: AKAI X360 AND FOSTER FSA-1

AUDIO FAIR REPORT

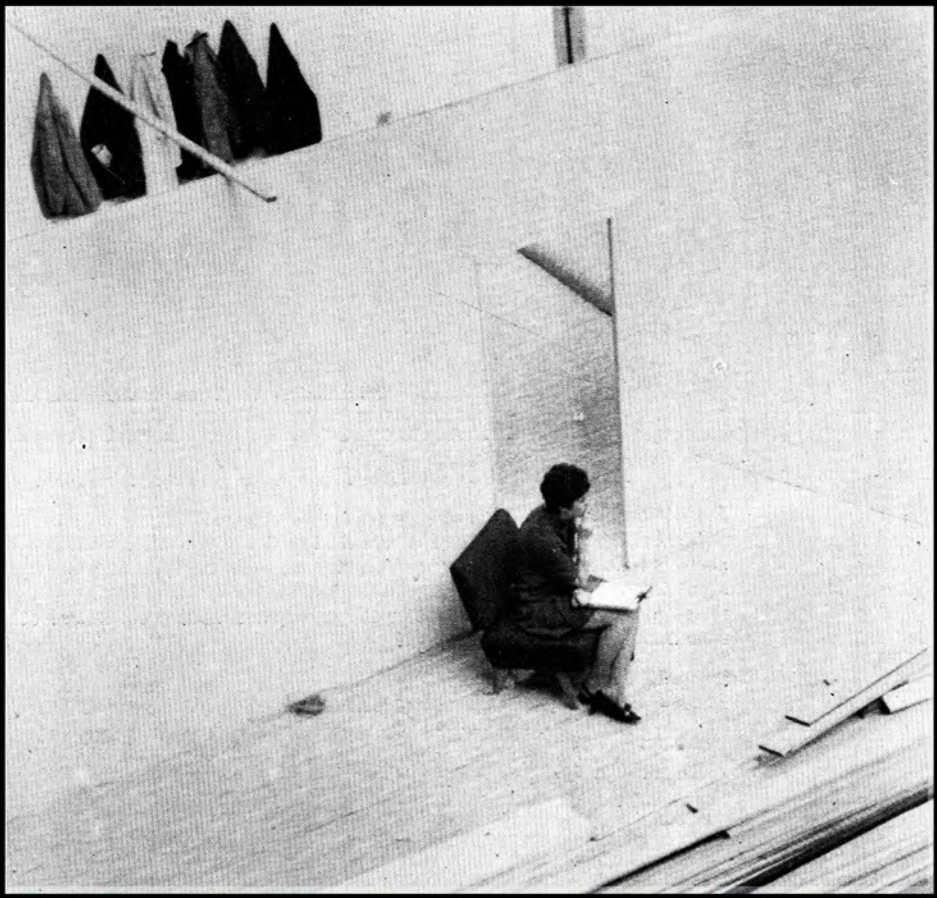
TALKBACK: NEW COLUMN BY PETER BASTIN

A DUBBING BOX

VTR CIRCUITRY: PULSE WIDTH MODULATION

AZIMUTHING WITH WHITE NOISE

INTERVIEW: TOM REPS



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Technical specifications

Frequency range	MW: 525-1605 KHz (571-187m)	Power source	AC: 50-60Hz. 110/200/220/240V
	FM: 88-108 MHz	Dimensions	Centre unit:
Transistors	16		$14\frac{7}{8}$"(W) x $6\frac{11}{16}$"(H) x $11\frac{13}{16}$"(D)
Diodes	11		379 x 170 x 300mm
Sensitivity	MW: 10uV/50mW FM: 10uV/50mW		Cabinet speakers:
Power output	5W-5W (P.M.P.O.)		$7\frac{15}{16}$"(W) x $11\frac{7}{32}$"(H) x $5\frac{23}{32}$"(D)
Speakers	Two $6\frac{1}{2}$" (16cm) PM dynamic speakers		202 x 285 x 145 mm
Phonomotor	2 speeds (33 & 45 rpm)	Weight	Centre unit 12 lb (5.5 kg)
Pickup	Ceramic		Cabinet speakers: 7 lb (3.3 kg)

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1200′ on 5¾″ reel Long Play P.V.C.	36/1	22/6	65/-	125/-
1800′ on 7″ reel Long Play P.V.C.	51/4	29/6	86/-	165/-
1200′ on 5″ reel Double Play (Polyester) ...	43/1	27/9	81/-	157/6
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SANYO DC. 904 complete stereo system (Tuner-Amp, Turntable, Speakers)	82 10 0	69 10 0
GARRARD WB.2 base for LAB.80	4 13 8	3 19 6
GARRARD SPC.2 cover for above	4 8 10	3 16 0

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DESCRIPTION	LIST PRICE	OUR PRICE ONE	THREE	SIX
900′ L/P on 5″ reel ...	29/-	23/6	69/9	137/9
1200′ L/P on 5¾″ reel ...	36/-	29/-	86/-	170/-
1800′ L/P on 7″ reel ...	51/-	41/6	123/-	243 -
1200′ D/P on 5″ reel ...	43/-	34/6	102/3	202/-
1800′ D/P on 5¾″ reel ...	56/6	45/6	135/-	266/9
2400′ D/P on 7″ reel ...	79/-	63/6	188/3	372/-
1800′ L/P Dynarange ...	58/-	46/6	137/9	272/3

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Complete Hi-fi Stereo Systems at fantastic package deal prices. Fabulous reductions on superbly matched systems which are despatched to you, all ready to plug together.
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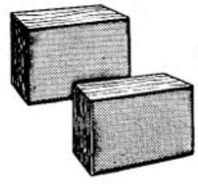

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4 tracks. Frequency response: 40-18,000; 40-14,000; 40-8,000 cycles ± 2dB at $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s. respectively. Signal-to-noise ratio better than −55dB −53dB and −52dB at $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s. respectively. Wow and flutter less than 1 R.M.S., ·15 R.M.S. and, 35 R.M.S. at $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s. respectively. Cross talk better than − 60dB. ·9v output per channel. Teak cabinet. £89.10.0

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tape recorder

DECEMBER 1969 VOLUME 11 NUMBER 12

INCORPORATING
SOUND AND CINE

Editorial and Advertising Offices:
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CROYDON, CR9 2TA
Telephone: 01-686 2599

COVER PICTURE

Trade Day at the Audio Fair. The exhibition stands were finally completed early on the second day of the Olympia exhibition, their construction having been delayed by union disputes. Our photographer, Mike Cousins, was abused by stand constructors while covering the event.

SUBSCRIPTION RATES

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

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

THE FIRST ISSUE of this magazine appeared in February 1959, since when we have endeavoured to serve a changing and sometimes elusive hobby, together with its supporting industry. Tyros and technicians, amateurs and professionals, sound men, mechanicians, electronics men—all have joined our readership.

For a time it seemed that tape recording might become a widespread popular hobby in the manner of photography, and accordingly we published tape plays and kindred material for creative beginners. Two other magazines ploughed a similar furrow, Editors got together to help with the organization of tape recording competitions, the BBC has promoted similar events; but still the hobby of tape recording has failed to expand as hoped—and as might reasonably have been expected from sales of recorders running into millions.

Of the three magazines (now reduced to two), *Tape Recorder* has always been the most technical, and we have wondered from time to time whether the bulk of our readers appreciate or need material aimed at the absolute beginner. Certainly articles such as the 'Sound Studio' series, Gerald Chevin's Limiter-Compressor and David Robinson's 'Studio Quality Mixer' have produced a very much larger and more interested response than anything aimed at the technically uninitiated. Such evidence, and the data from our readership survey conducted early in 1967, point to a rather more sophisticated and enthusiastic 'average reader' than was typical ten years ago. Accordingly, for just over a year now the magazine's editorial content has been shifting in a more serious direction, to meet the needs both of the devoted amateur and the professional recording engineer.

The result has been a rise in readership and improved support from advertisers, encouraging us to take a further step in the same general direction. In February our title will become *Studio Sound and Tape Recorder*, and later simply *Studio Sound*, thus reflecting on our cover a change of emphasis already apparent in the contents. The best of our present contributors will stay with us in the new journal, to be joined by: Stanley Kelly, well-known expert on many aspects of audio; Bob Auger (Granada Records), who will write about microphone techniques, studio acoustics, etc.; and Angus McKenzie (formerly of Olympic Studios), who will make a continuous tour of the professional studios. Gerald Chevin (Advision), Terence Long and Keith Wicks will appear more frequently, and of course the indispensable H. W. (Mac) Hellyer and Alec Tutchings will continue to pour forth, respectively, their servicing wisdom and tape recorder test measurements.

If we can reach the standard at which we are aiming, the result will be a magazine written largely by studio engineers and the musicians they serve, but at a technical level suitable for any serious-minded audio man. In our experience the keen audio amateur is insatiably curious about 'how the professionals do it', so there will be an endless supply of intriguing information and comment to hold the attention of existing readers, while the increased professional bias should attract extra people from within the recording industry. Tape recording and tape recorders will continue as our mainstay, and we shall certainly not disdain the efforts of amateurs if and when we feel that others could learn from them. Also, we have a modest backlog of articles about relatively elementary recording projects, and these will appear from time to time.

The new name will overcome a long-standing (and sometimes embarrassing) confusion with another magazine carrying a similar title; from now on *Studio Sound* will be the journal for sound recording, matched by its sister paper *Hi-Fi News* in the field of sound reproduction.

FEATURE ARTICLES

REGULAR ITEMS

EQUIPMENT REVIEWS

WORLD OF TAPE

MULTI-PURPOSE TAPE TRANSPORT

LOW-COST TAPE transport to meet audio, industrial and data requirements has been developed by a recently formed company Tape Systems of Egham, Surrey. Conceived by Dr. Peter Shardlow, the managing director, the decks may be mounted in stack assemblies in any plane and remote controlled. The design accepts *Packette* cassettes or endless loop cartridges and is claimed to give acceptable audio quality at speeds of 4.75 cm/s down to 1.3 cm/s. Ten thousand units have been ordered by E. J. Arnold for inclusion in teaching equipment and will be marketed as a player at £27. Quarter-track record/play models will cost £35 and £41. A slow-scan television recorder is currently being developed and is expected to result in a still-picture CCTV system at under £150.

SABC BUY KEF MONITORS

A QUANTITY OF KEF *LS5/1A* studio monitor loudspeakers have been purchased by the South African Broadcasting Corporation. The choice was made after extensive electronic and audio comparisons with a variety of speakers from countries including Japan, America and Europe. The contract was arranged by Mr. J. Mason-Gordon of KEF's South African distributors, Fidelity Acoustics (Pty) Ltd., Johannesburg.

LOW-COST VIDEO TAPE PLAYER USES LASER

THE FIRST CONSUMER product to employ a laser is expected by RCA to be their newly developed *Selectavision Player*. Shown for the first time at RCA Laboratories in Princeton, New Jersey, towards the beginning of October, the unit is essentially a colour television reproducer using inexpensive photoresist-coated transparent tape about one tenth the cost of an equivalent area of cine film. Holographic coding techniques are employed. Production of players is planned to commence in 1972 and they will be marketed in the USA at under £170. A choice of 100 30-minute original programmes will be offered at around £4 each. Where EVR (Electronic Video Recording) fits into the RCA scheme is not clear.

PENTY CAPACITOR MICROPHONE

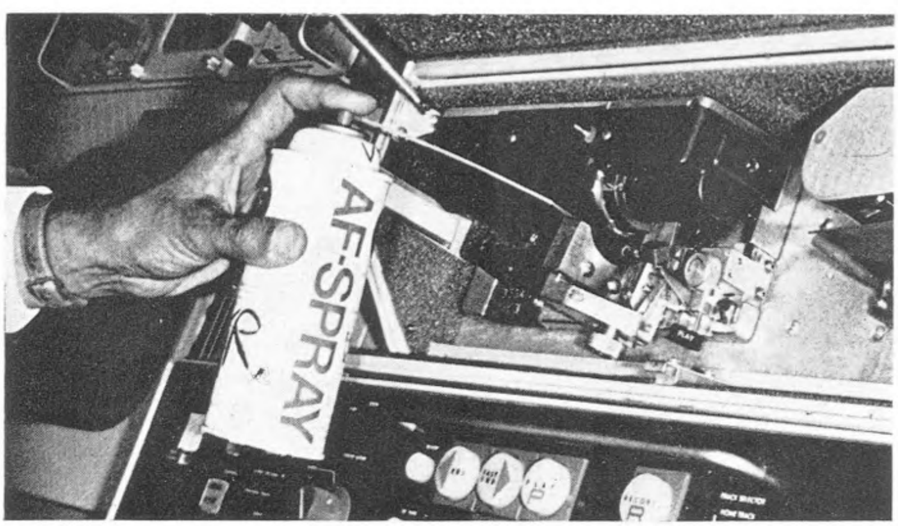
SINCE JOHN PENTY'S November article 'Constructing a Capacitor Microphone' was prepared, a modification to the output of the amplifier has been incorporated, giving an easier method of adjusting frequency response. A 200 ohm skeleton potentiometer connected as a variable resistance is inserted between the negative output of the 50 μF electrolytic capacitor and the top of the 0.25 μF (nominal value) capacitor. The output is taken from this junction, as in the original circuit. Variable resistance and 0.25 μF capacitor are housed in the battery compartment. A value of 160 ohms has been found to provide the flattest frequency response on the microphone tested. Constructors working from the wiring diagram at the top of **fig. 1** should note that the connections to **e** and **c** of the *2N 3702* transistor are transposed in the layout diagram. The $\frac{3}{8}$ inch backplate drilling hole depth (first column, page 453) should read $\frac{3}{16}$ inch as indicated (0.1875 inch) in **fig. 1.**

CCTV FOR CHESTER CATHEDRAL

CLOSED CIRCUIT TELEVISION and sound amplification equipment are being installed by Pye TVT in Chester Cathedral. The CCTV system will enable the organist to see the choir.

AEROSOL MAINTAINS VTR QUALITY

AN AEROSOL SPRAY manufactured by Automation Facilities Ltd., Oxford Avenue, Slough, Buckinghamshire (Tel: Slough 25571) is being used at the Thames Television studios in Teddington to maintain the quality of Ampex video tape recorders. The recorders, two *VR 1200* and three *VR 2000* models, are cleaned before fresh tape is threaded. Until recently, cleaning solvent was applied by rags to the tension arms, idler, erase head, video heads, vacuum guides, control track head, audio and cue heads, capstan, pinch roller, counter idler and take-up tension arm. The control track head and vacuum guide shoe slots were particularly inaccessible to rags but the operation is simplified by 126 mm extension tubes attached to the aerosol.



TAPE RECORDER TO ORBIT MARS

A DATA RECORDER produced by Lockheed Electronics will be incorporated in the unmanned Mariner spacecraft due to orbit Mars for a 90-day period in 1971. The unit measures 152 x 152 x 229 mm and weighs about 4.5 kg.

MILLBANK ELECTRONICS MOVE

THE SALES AND administration offices of Millbank Electronics moved early in October from Hartfield, Sussex, to new premises at The Square, Forest Row, Sussex (Tel: 0342-82-2288). The move is part of an expansion programme which includes improvements in Special Projects and Design Facilities. The Millbank manufacturing plant remains at Chesham, Buckinghamshire.

LESLIE GOULD TO LEAVE PHILIPS

MR LESLIE GOULD is to relinquish his position as Managing Director of Philips Records Ltd. on December 31. He does so at his own request in order to interest himself in other aspects of the entertainment industry.

CATALOGUE OF TAPE RECORDS

THE FIRST EDITION of a catalogue covering open-reel, cassette, $\frac{1}{4}$-track and $\frac{1}{8}$-track cartridge tape records has been published by Ronlex Productions Ltd., Bristol & West House, High Street, Salisbury, Wiltshire. *Tape Music Parade* is to be issued quarterly and costs 4s. 6d. Some 90 pages are devoted to listings, each entry comprising title, contents, speed, format, manufacturer's number and recommended price. The second edition, due to appear on December 15, will include eight pages of tape reviews.

NEXT MONTH

THE CONSTRUCTION of a directional capacitor microphone using an STC capsule will be described in the first of two articles by Trevor Attwell. David Kirk interviews Terence Long and Angus McKenzie contributes the first of a series on studio recording techniques. Alec Tutchings will review the Telefunken *250* stereo unit and Philips *4307*.

A DUBBING BOX

BY JOHN FISHER

TO judge by recent letters in our postbag, there seems to be interest among individual readers and also tape clubs in a self-contained response shaping unit for use in copying tapes. The purpose of this article is to present some circuits and ideas, and draw attention to others, which may meet the requirements of readers.

Passive units will be considered first. When I first became seriously interested in tape recording (after some abortive attempts earlier to build a disc recorder!) I had a 'black box' consisting of passive tone controls, an adjustable attenuator and a form of switched filter of uncertain characteristics, lifted wholesale from an old AM radiogram. The 'black box' with a multitude of different sockets and leads was used occasionally when copying between an early Cossor ½-track machine, a Ferrograph and an old Grundig. It was used to compensate to some degree for the deficiencies in some of the recordings, for the differing replay characteristics, and to smother the worst effects of occasional overmodulation by turning down the treble and filtering hard at the crucial points. Success was definitely mixed. However the principle is quite usable and **fig. 1** shows a circuit for a passive control unit for use between a fairly high output-impedance playback machine and a high input-impedance recorder. As there is insertion loss, and a variable attenuator is provided, it is generally more convenient to feed the high impedance low-level (mic) input of the second machine. If the input impedance of the second machine is lower than shown, the values of the resistors may be scaled down to suit and the capacitors increased by the same factor: alternatively a series output resistor may be added to reduce the loading on the tone control circuits when feeding a lower impedance. If the unit is to feed relatively low impedance inputs (a few K) of, say, a transistor recorder, or if long leads are required between the black box and the recording machine, the controls should be followed by a compound emitter-follower stage (**fig. 2**) or source-follower. If gain is required after the attenuator, to cater for high level inputs (**fig. 3**), may be found suitable to provide the gain and low output impedance.

A balanced input (**fig. 4**) may be provided for recorders with 600-ohm balanced outputs by the addition of a switchable loaded-line matching transformer. A suitable type is Gardners *MU7524* price £4 8s. 9d. from *Gardners Transformers Ltd, Christchurch, Hants BH23 3PN*. An isolated balanced output (ideal for minimising earth loop problems) may be provided with a similar transformer after the gain stage of **fig. 3.** If programme at nominal zero level (PPM 4=0 dBm=775 mV) is to be fed out, the supply should be increased to about 24 V to avoid clipping peaks, with some component changes.

Having dealt with passive tone control circuits, this seems to be a suitable place to deal with active tone controls. These work by frequency-selective negative feedback in an amplifier of one or more stages. A typical circuit, using a single transistor stage and designed by Mullard, is reproduced in **fig. 5.** Voltage gain is unity (or strictly 0.91) and distortion remains below 0.1% for outputs up to 250 mV, rising to 0.85% at 12.5 kHz, 2 V rms. The input impedance is relatively low and varying, 40 K with the controls flat, and a buffer stage is necessary in front of the tone control stage, if it is to be versatile as regards input. The circuits in **fig. 2a** or **fig. 3** would be suitable. Alternatively the buffer amplifier of

FIG. 1 (a) PASSIVE TONE CONTROL (MULLARD 5-10 AMPLIFIER)

(b) PASSIVE TONE CONTROL (MULLARD 2-VALVE PREAMPLIFIER)

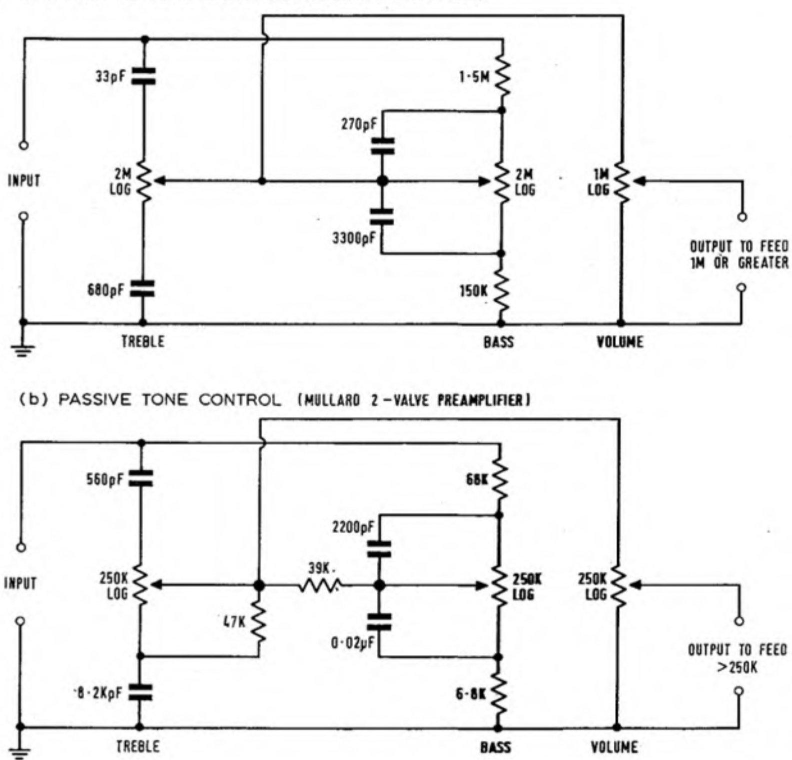


FIG. 5 ACTIVE TONE CONTROL

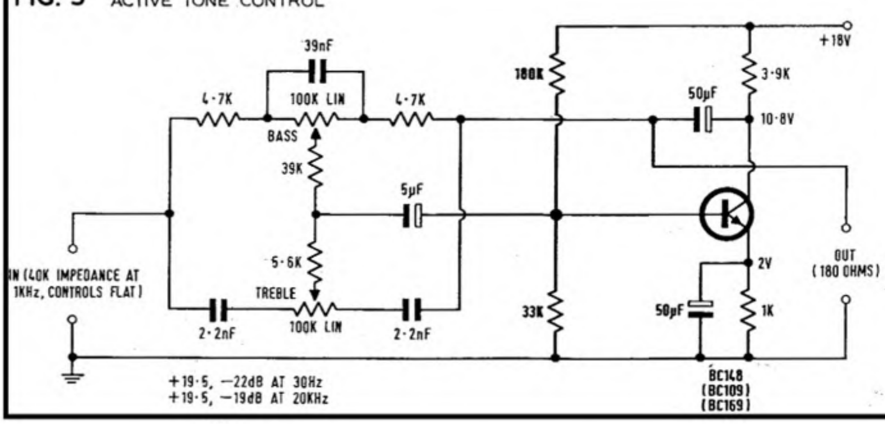


FIG. 2

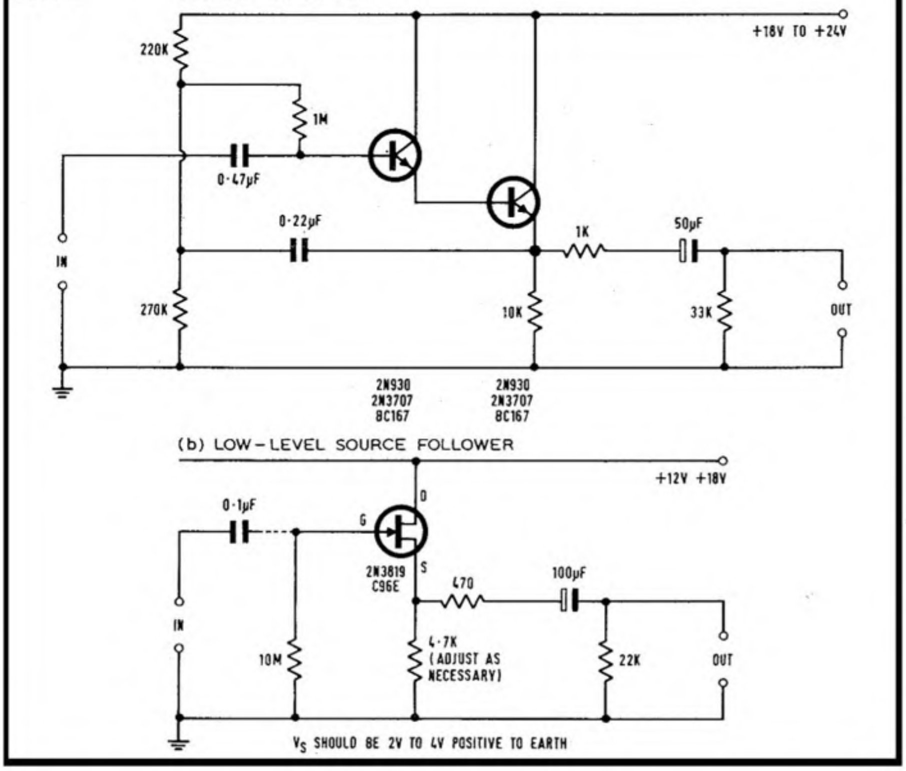


FIG. 3 OUTPUT STAGE

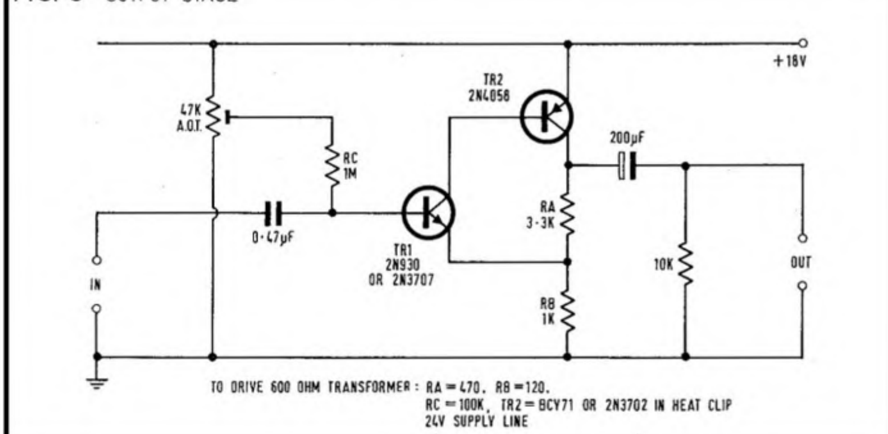


FIG. 7

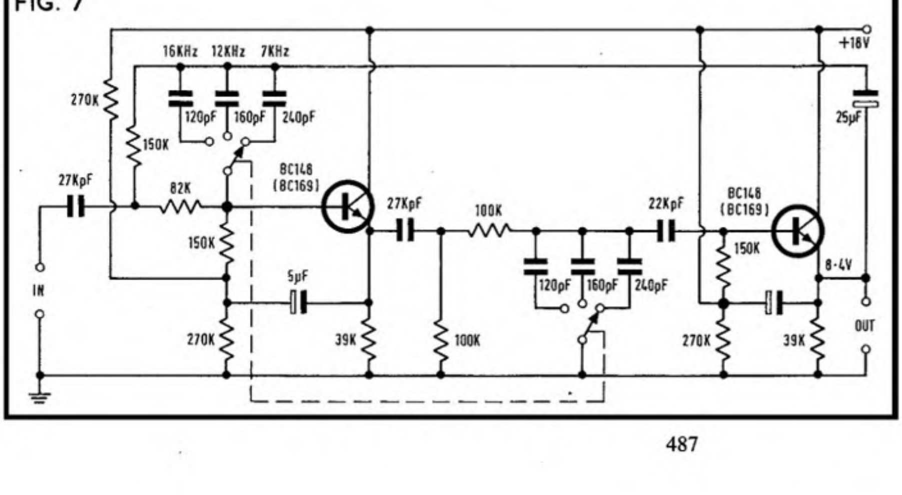


FIG. 4

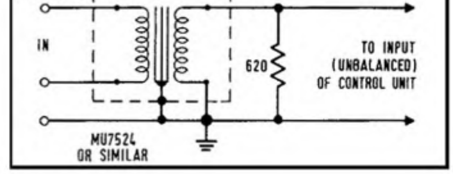


FIG. 6

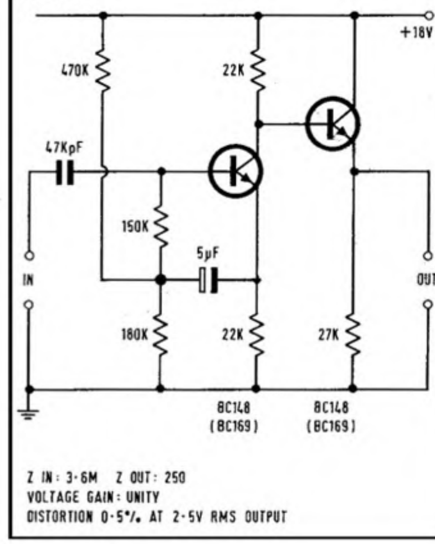


FIG. 8

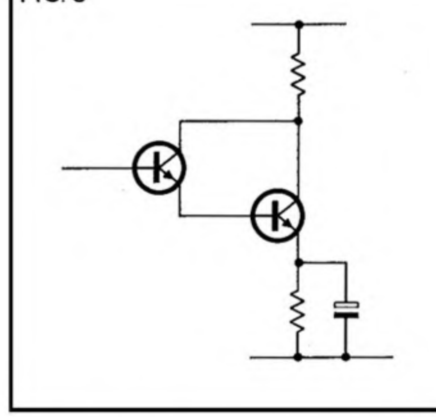


fig. 6, also by Mullard, may be used. To avoid overloading the tone control stages it would be as well to precede the control stage or buffer with an adjustable attenuator; if required, the tone controls may be followed by another variable attenuator and gain from a circuit such as **fig. 3.**

At this point it would be a good idea to direct readers' attention to a very neat tone control circuit described by R. Williamson in the March 1969 *Hi-Fi News*, which I imagine will find wide use. The feedback tends in this circuit to increase the input impedance rather than lower it, which can be an advantage. I would also refer constructors back to the tone control circuit used in my 'Pint Pot' amplifier described in the December 1967 *Tape Recorder*, which also incorporated switched filtering. There I pointed out that, where an appreciable current is being drawn in the transistor of the

(*continued on page 515*)

Model MR-120

-a highly versatile portable tape recorder

Operates on six flashlight batteries or regular household current. Develops tremendous output power of 2.5 watt when played on AC. Solid state circuitry. 2-speed, 2-track operation. Spindles accommodate 5-inch reels. 3-position mood switch provides instant tone adjustment for popular and classical music and speech. Twin recording level controls—for speech recordings the automatic level control guarantees a constant recording level, for music, the accurate level meter is used. Two different sources (mike +radio, mike+record player etc.), can be used simultaneously for recording. Light, sturdy plastic cabinet is convenient to carry with slide-out handle that disappears when set is in use.

SPECIFICATIONS

Recording System:
AC bias, 2 tracks
Erasing System:
DC erase
Tape Speeds & Recording Time:
(with 5″ reel, 2 track 50μ tape)
$3\frac{3}{4}$ ips. (9.5 cm/sec) 64 min.
$1\frac{7}{8}$ ips. (4.75 cm/sec) 128 min.
Frequency Response:
70-8,000 c/s at $3\frac{3}{4}$ ips.
70-4,000 c/s at $1\frac{7}{8}$ ips.
Output Power:
Maximum 2.5W (at AC operation)
1.8W (at DC operation)
Power Requirement:
AC: 115V/230V 50-60 c/s
DC: Size-D (UM-1) x 6
Output Impedance:
Ext. sp: 8 ohm
Input Impedance:
Mic: 3k ohm
Radio: 100k ohm
Loudspeaker:
$6\frac{3}{8}$″ x $3\frac{1}{8}$″ permanent dynamic speaker
Voice coil impedance 8 ohm
Power Consumption: 15W
Dimensions:
12″ width x $8\frac{1}{4}$″ depth x $4\frac{1}{8}$″ height
(305 mm x 209 mm x 105 mm)
Weight:
9.7 lbs (4.4 kg) approx.
Accessories:
Microphone; 5″ full tape;
Empty reel; Patch cord;
Splicing tape

The MR-120 is available from the Sanyo **dealer in your area,** specially selected for first-class before-and-after-sales service. Or **you can write** for illustrated leaflet to:

Sanyo Marubeni (U.K.) Ltd.,
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Telephone: 92 25355

SANYO

People the world over agree there's something about a Sanyo

Readers encountering trouble with their tape equipment are invited to write to the editorial office for advice, marking their envelopes "Readers' Problems —Tape". Replies will be sent by post and items of general interest may also be published in this column at a later date. This service does not, however, include requests for information about manufacturers' products when this is obviously obtainable from the makers themselves. Queries must be reasonably short and to the point, limited to one subject whenever possible. In no circumstances should such letters be confused with references to matters requiring attention from other departments at this address. We cannot undertake to answer readers' queries by telephone.

SPLICING TAPE LOOPS

Dear Sir, I am engaged in building a tape echo unit for inclusion in a home-built electronic organ, using the last mortal remains of a Grundig *TK30* recorder. The problem is the tape loop join (the loop is between 35 and 38 cm long). Both the splicing-tape butt and the chemical lap joint methods produce joins which wow badly at the pinch wheel and, to a lesser extent, at the guides. You will appreciate that the steady tones of an electronic organ are as critical for wow as a constant sinewave.

How do commercial tape echo units get round this problem? The only alternative I have thought of is to use an endless tape cartridge.

Yours faithfully, **B.M.T., London W.3.**

Trouble with short tape loops is often due to unsuitable guiding. Please check these points against your equipment:

- *(a) The tape should not wrap more than 60° round any fixed guide, and preferably less if possible.*
- *(b) Outside the normal head path, the tape should be taken round guide rollers. These should consist of small accurate rollers—small ball races are ideal—between fixed flanges.*
- *(c) All guides must be at exactly the same height and have vertical axes.*
- *(d) One of the guide rollers should be on a pivoted arm, sprung so as to tension the tape to 40-80 gm, according to the tape thickness.*

Obviously the capstan drive must be sufficient to overcome by a good margin the frictional drag of the tape at this tension against the heads and fixed guides.

If your equipment already satifies these requirements, then evidently your joints are either too stiff, too thick, too wide, discontinuous or sticky.

In our experience, the best kind of joint is a 45° butt backed with the best splicing tape you can find—Scotch No. 41 is fairly good, but Scotch No. 620 is near perfect for the job, although not available retail as far as we know.

Commercial tape echo units almost always use drums now instead of tape loops.

The endless loop cartridge probably would be the best solution, both for the infrequent appearance of the joint and for tape wear. Most of them, especially the American types used on car players, can easily stand working with 40 cm of tape outside the cartridge, there being necessarily a large amount of slack in the coil. If it isn't there already, just pull it out gently with a greater tension on the tape coming off the outside of the coil than on that from the inside, until there is enough to go through your head path, or even just through the drive. Then set the drive going and pull the cartridge away from it until you have enough free tape outside the cartridge. Make sure that the tape is pulled off the outside of the coil and fed back to the inside.

LIVE RECORDING WITH A 736

Dear Sir, I use a Revox *736* tape recorder and Hammond capacitor microphones, making a lot of recordings of church organs and services. The main problem is that four out of five sessions turn out to be useless: the top is missing and the bass end is boosted. For playback (Quad valve and speakers) the tone controls have to be set at −3 bass and +4 treble to be even tolerable. I use two microphones, one feeding direct to each track, and the trouble affects both channels equally. Dynarange tape has on occasions produced better results but at others made no improvement. Hammonds say that there is nothing in the mikes or their black box that could cause this kind of trouble on both channels simultaneously, or for that matter in the recorder. They insist that it *must* be the heads and that I must clean them more thoroughly. I have always cleaned and degaussed them before a session but am now taking even more care and admit that the results are certainly better.

Do you agree with Hammonds' verdict and their comment that headphone monitoring is essential to do justice to the recorder and mikes? If so, what types of headphones are most suitable for use in high ambient noise situations.

I was originally recommended to buy an AKG *D19C* for the Revox but organ recordings made with this were shrill and unlike any organ I have heard (over the Quads). Am *I* bats, or was the person who suggested that this mike was suitable?

Yours faithfully, **M. H. W., London N.6.**

From the symptoms you describe and the tone control settings you are forced to use, it certainly seems that something is very wrong somewhere. The first thing you must do is borrow, buy or build a variable tone source of constant output and an AF valve or transistor voltmeter of some kind. Then you can go through the recorder, the Quad preamp and main amp, and any accessories, checking to see where the fault lies. A standard test tape would be an asset. Otherwise you must determine by experiment with other people's equipment which piece of your own is giving the trouble, returning the offending object to its makers. Possible causes of the trouble would be exceptional overbiasing of the tape, a failure in the record pre-emphasis circuit or switching, a damaged or misaligned replay or record head, plugging the Revox into an equalised input on replay, or something like that.

The better results on the Dynarange are probably due to its excellent HF response and need for higher bias than whichever other tape you have been using.

Headphone or (preferably, depending on the location) loudspeaker monitoring is really essential for live work, particularly as the 736 has only VU meters. The Sharpe HA10 headphones are among the best for monitoring in areas of high background noise. They cost about £23 and are now handled by Carston Electronics, 71 Oakley Road, Chinnor, Oxfordshire. They were formerly imported by S. G. Brown. You will need some form of headphone amplifier, or possibly just a transformer, to match the Revox cathode-follower outputs.

The D19C is quite a good general purpose cardioid microphone but you need something better, as you have found, for organs. If you want to try dynamics again, you might consider the AKG D202 which in crossed pairs can give very pleasing stereo. The early Hammonds were only omni types and could therefore not be used in the preferable crossed pair fashion.

RECORDING THROUGH COILED CABLE

Dear Sir, When recording live with 30-ohm and 200-ohm balanced dynamic microphones I use 45 m reels of twin screened cable. Often the reels are only partly paid out and as much as 35 m is sometimes still on the reel, the usual cardboard drum of about 7 cm core diameter. Will the coiled cable act as a choke and reduce the higher frequencies? My ears cannot detect much difference but I would be glad of your view on this.

Yours faithfully, **R. L., Melksham.**

You need not worry too much about stray inductance in your coiled microphone cables. With the arrangement you are using, the coiled cable is approximating to a non-inductive winding, with the direction of current flow in the two leads of the cable in opposition to each other. This is rather like the non-inductive winding of resistances in a resistance box, with the resistance wire wound back on itself from a loop (in this case the microphone) in the middle. There will of course be some stray inductance around, this being an imperfect world, but as you have noticed it should have no audible result in your setup. Perversely, you may one day find a coil of cable that doesn't know about cancellation and the virtues of balanced operation and the coil could turn out to be the cause of hum or radio pickup. However, you can forget about that remote trouble until it arises; loose cables are a far more immediate menace to a recording session.

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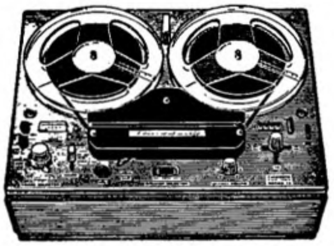

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Synchronising **Tape** with **Film**

Part Two
By Richard Golding

IN the early days of sound film, all location recording was synchronised by photographing the sound directly on to perforated filmstock. The system needed a large truck loaded with such equipment as a photographic sound camera fitted with a galvanometer, a huge rotary AC generator, heavy batteries, and a mixing console. For technical reasons, the sound was recorded on an optical edge track 26 frames ahead of its corresponding picture frame and this standard is still in use today for cinema release prints. Since sound and picture were recorded on the same medium, they were always in synchronisation. Then a battery-powered DC motor with relatively stable speed eventually removed the need for a bulky mains generator.

There were disadvantages with this optical recording system. The technical quality of location recording was really only acceptable for news films and documentaries. Some other system had to be found. Improvements in magnetic recording during and after the 1939 to '45 war saved the day and portable recorders employing standard 6.25 mm tape served both to simplify the equipment in the sound truck and to obtain very much higher sound quality. The arrival of transistorised recorders, of course, eliminated the sound truck altogether. But it was a slow evolution, taking about 30 years to effect. During this time the magnetic Single and Double Systems were developed.

The Single System consists of recording the sound and picture simultaneously on the same film and in the same camera, and is a direct development of the old film camera with its galvanometer; the optical track being replaced by a magnetic stripe pre-coated on the edge of the raw filmstock. One of these early models was the Auricon Sound-on-Film 16 mm camera, a very successful modification of the Auricon optical camera. It was a good camera; in fact, only the other day I came across one of these in use at Film Craft Ltd., a film actors' training studio in the centre of London, and was told that it had been in frequent use for eight years and was as efficient as ever. The advantages of Single System are generally that synchronisation is assured even if the camera motor does not run at constant speed. How important this is depends on what it is being used for. With Film Craft Ltd., immediacy is more important than quality, for the student needs to see results as quickly as possible and there is the possibility of reproducing the synchronised sound and picture immediately after processing. The disadvantages are: (1) There is difficulty in editing the film due to the sound being 26 frames away from the corresponding picture frame (you lose one second of sound every time you make a cut); (2) Wow and flutter are high owing to the relatively small flywheel that must be used to keep the size of the camera to a minimum. If a large flywheel is used, there are problems when using certain camera movements. Signal-to-noise ratio is rather low also, due to the relatively narrow 25 μm sound track width.

The Double System is much more versatile and has the following advantages: (1) High quality magnetic tape recorders can be used; (2) The sound system is removed from the camera, thereby reducing the camera size and making it more mobile; (3) The editing possibilities of sprocketed tape are identical to those of recordings made in the studio with magnetic *film* recorders. The disadvantages include: (1) The necessity to transfer the original recording to magnetic sprocketed film; (2) The need for an electrical connection between the camera and the recorder to record the synchronisation signal.

Tandberg Pulse Synchroniser

Although the Double System seems to be completely superior to Single System, at least one 16 mm camera (the Bolex *16 Pro*) has provision for both systems to meet television news requirements, where rapid editing is sometimes essential. The customary 16 mm arrangement employs one of the various pulse sync systems, Nagra, Perfectone, Leevers-Rich, Uher or Tandberg recorders, working in conjunction with the pulse sync generator attached to the camera. The sound is later transferred from the tape by a specialist recording studio on to 16 mm magnetic film. The tape frame pulses keep the magnetic film in synchronisation during this transfer, resulting in a frame-for-frame sync with the picture film. For static studio work, the camera may be driven by a synchronous or interlocking motor, with a similar motor on a 16 mm magnetic film recorder.

In the studio, the link between recording apparatus and camera will present no problems, but for location work and news filming the possibility of eliminating this cable link is very attractive indeed and a new motor has been developed which does just this. The system involves two crystal controlled oscillator units. One supplies a constant frequency to drive the camera motor, and the second oscillator works at an identical frequency to provide the sync pulses on the tape, or alternatively to drive a 16 mm magnetic film recorder. Another refinement is a radio controlled slating mark device which fogs a frame of the film and places a bleep on the track, thus obviating the need for a clapper board at the start of each shot.

The camera, for example an Eclair 16 mm, is driven by a DC motor with a toothed-wheel tone generator. This tone is intended mainly to control the motor when driving the camera, by frequency comparison with a quartz crystal oscillator. The recorder contains an identical crystal oscillator, the output of which is recorded on tape and used as a reference for subsequent transfer. Two input sockets are provided to allow the motor to be referenced or controlled from an external source of 50 Hz or 100 Hz frequency, division being automatically provided for by the crystal oscillator divider circuits. For synchronous playback, the external reference signal would be the sync signal on the tape. This could be taken from the sync head of the recorder, via a sync signal preamplifier, and would accurately control the motor even if the frequency varied by $\pm 10\%$ from nominal.

The electronic unit is also fitted with a socket supplying a 50 Hz output signal. It allows the crystal-controlled motor to be used with a portable tape recorder not equipped with its own crystal oscillator. (*continued on page 503*)

VTR CIRCUITRY PART 4

BY HENRY MAXWELL

WHAT, in the way of video tape recording, will the 'Seventies' have in store? Ampex are well ahead with a *Random Access Programmer*, which selects 'addresses' on tapes being run on different machines, runs up the mechanisms until they are in step and locks them synchronously from there on. The advantage will be evident to anyone who has done any videotape editing. One obvious method is to play two 'cued' machines into a video mixer, the output of the mixer supplying an edited signal to another VTR in the record mode. Exponents of multitrack techniques will see at once where this is leading.

To be honest, the idea is far from new. In the early days of VTR we experimented in our own hamfisted way with several machines linked with a common servo pulse. But there are a number of snags, not least the differences in motor and transport tolerances. The Ampex method requires that cue signals be recorded on the tape through a fixed head, using digital coding. This may be done before, during or after video recording. Computer techniques are applied, automatic searches being made during fast winding. The tape is halted at the required address and run back ten seconds to a previous cue point, where it waits for the 'go' signal from the programmer. Whichever recorder reaches the cue point first waits for the other, then off they go at the same nominal speed while the programmer scans the addresses, works out any discrepancies and corrects by an override circuit of the tape capstan control via the logging machine. This ensures that the two machines are in perfect sync at the desired frame and the tape control then reverts to normal intersync (internal sync).

Many of these computer control systems are being developed, RCA, General Electric, Sarkes-Tarzian and Visual Electronics as well as Ampex having tied the method to their own automation system. The pity is that so many alternative systems exist. Absolute compatibility is not only far away, it seems to be getting more remote.

The beauty of such systems is that quite short programme segments can be switched and cued without break, and without the help of manual control. Added to which, different types of display device (film projectors and other VTR's) can be used, with immediate and synchronised switching— something that has always required not only manual control but also numerous gimmicks to cover the electronic 'splice.'

Typical control methods may employ IBM punched cards, with information as to source, type of transition, duration of programme segment (in, for example, a short commercial) and a title or code reference. When the cards are stacked and fed into a 'reader', the sequential information is fed to a control unit, synchronised to the station clock. Programme segments 'coming up', as many as ten ahead, will be indicated, usually on some form of visual monitor, so that changes can be made if required. All the pre-roll cues for projectors, VTRs and recorders are given automatically by the control mechanism. The card information masterminds switching while the controller keeps an exact watch on timing and synchronism.

Ideas of digital TV handling are not new. Efforts to improve picture quality without increasing bandwidth have occupied research and development engineers for years. Consider the radical difference between telephone and telegraph systems. Telephony involves an analogue signal, one that varies continuously between set limits in proportion to the driving course. The ordinary telephone signal is an electrical analogue of the variations in sound pressure acting on the microphone diaphragm. In the same way, although rather more complicated in structure, the television signal is an analogue of light variations collected by the lens of the camera tube.

Telegraphy is quite different. It is a voltage or current wave which may have two or more discrete values. Like the flip-flop we were talking about a few sleepless nights ago, it is either on or off. Provided the interference pulses or other damaging factors do not exceed the receptor limits of the equipment, the output will still be an on or off waveform, zero and one or perhaps plus one and minus one. Linearity is not a fundamental requirement of the system.

First point is that very fast digital techniques will be needed to get the same resolved signal at the output of the chain as existing analogue methods provide. With modern computer systems, this is not beyond our means. In fact, we can store one thousand million 'bits' per square metre on conventional videotape with present techniques. If tape is used at one-tenth of a square metre per second, corresponding to 50 mm tape at 200 cm/s, read-out of digital information can compare

FIG. 1

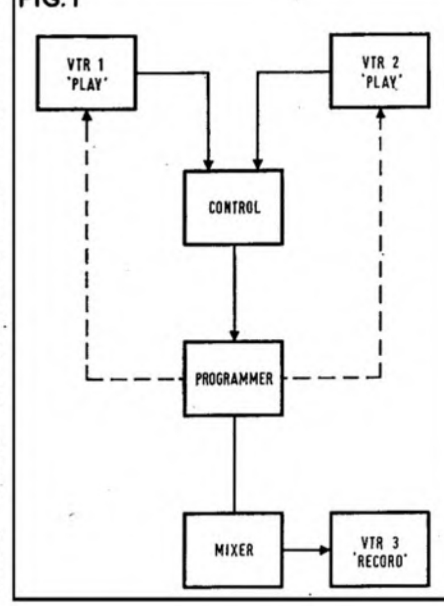
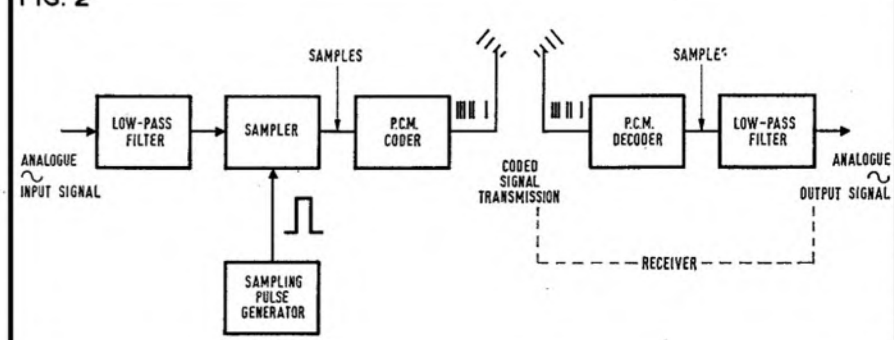


FIG. 2



with analogue methods, which, at this packing density, are impaired by noise at the high end of the video spectrum.

So let's take a closer look at digital conversion of analogue signals, to see what limits may be imposed or what the advantages may be. To start with an easily demonstrated examples, consider PCM.

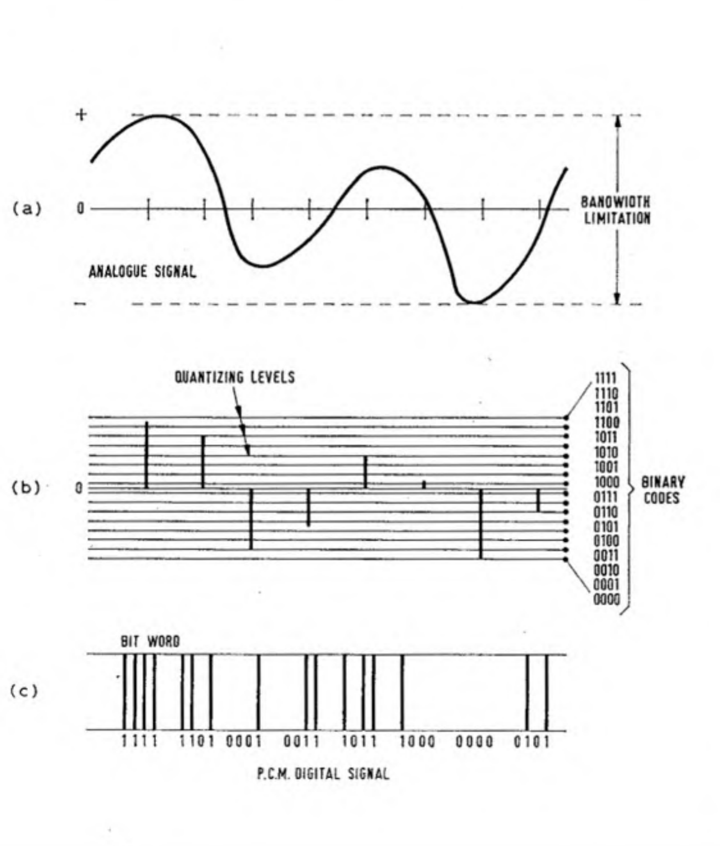
Pulse code modulation was proposed by A. H. Reeves in 1939 and is now widely used for telephony systems. **Fig. 2** shows the basic chain of the transmission system. The idea is that samples of the continuously varying signal are taken at regular intervals giving a code which is transmitted, decoded and reconstituted. The important factors, quite obviously, are the bandwidth of the analogue signal and the rapidity of the sampling pulse. They can be expressed as a relationship. If the bandwidth is B and sampling is by narrow pulses (i.e. short time duration) whose repetition frequency is at least $2B$, the resulting pulses, received and passed through a low-pass filter whose cut-off frequency is B, will give a distortion-free replica output.

Again obviously, if we follow Einstein and make each sample small and frequent enough, we get back to the original analogue. To be scientifically accurate, we approach as near as can be to it without ever quite getting there! The snag will be in the receptor apparatus which will have to receive all these pulses of different magnitudes and will become, in the final form, simply another analogue receiver and detector. So the pulses are quantized to make handling easier. **Fig. 3** may make the principle easier to understand.

Quantization consists of confining the magnitude of the pulses to a set of fixed values, each value then being represented by a group digit or 'word' which can be transmitted and not affected by distortion. Filtering at the receiver gives the resultant analogue signal. In **fig. 3** the digits are in binary form, so our transmitter-receiver apparatus has only to worry about the two states, zero and one, and is not going to be greatly affected by fading, interference or random noise.

In our example, the analogue signal is bandwidth limited, and the sampling is at sixteen well-defined levels. If we take the datum as the most negative value and call this 0000 (and we could as easily have made any other level, including signal zero, the datum), the quantized magnitude of each sample is voltage defining that datum level, and the binary 'word' representing this voltage output is transmitted. In our example we have eight sampling pulses, and the resultant signal from the analogue, as represented by a digital 'train', is shown in the quantization sample of **fig. 3c**. (Remember that an absence of a pulse train, 0000, is as significant as the presence of one to four pulses in the appropriate formation.)

FIG. 3



Serial or parallel transmission may be used, the bit words being broken up and transmitted in different ways, but this does not interest us except insomuch as it may effect quantizing noise. When using PCM techniques to transmit a television signal, the difference between the original and the reconstituted signal (which is a direct result of cutting down the number of samples) is measured and expressed as quantizing noise. Not such a silly idea when you see the screen and note that the fewer the samples per unit time, the more grainy and less well-defined the picture appears.

With telephony, signals at 8 kHz may be sampled with 128 quantum levels, at seven bits per word, but high quality sound needs a 30 kHz bandwidth and as much as 4096 levels (12 bits per word). For television we would need at least 11 million samples per second, 256 quantum levels, or 8 bits per word, putting the 'bit-rate' up to 100 million bits (100 megabits) per second.

Video tape recording is only one method of storage. Film offers a rival medium which can also be adapted to digital techniques and offers a high packing-density. The EVR system which has received enormous (perhaps excessive) publicity, is hovering on the brink of commercialisation. It involves electron beam recording on a moving film, with sound occupying magnetic stripe. We shall go into greater detail later, and take a look also at the methods proposed for colour television recording, such as the pilot-tone systems.

Another technique being developed uses a modulated laser focused to burn holes in the opaque coating of transparent tape. Packing density is good enough for digital TV recording.

The argument against digital recording methods is that an immediate recognisable image is not available. This was, of course, the argument against conventional videotape recording when we began playing around with the medium. It has proved in practice to be no drawback. So long as monitoring is possible with slow-scan and other slow-motion or picture-stop techniques, then the actual signal recorded on the tape can be a succession of noughts and crosses for all it matters.

To be continued

the synthesis of musical instrument tone Part Three

By Robert M. Youngson

ALL instruments have a characteristic dynamic range of which the most important feature is the typical maximum. Some are capable of such delicate control of low output levels that sound can be sustained right down to inaudibility, but many have a definite minimum. It is important, in synthesis, to avoid exceeding the characteristic range. To do so is to risk confusion with other instruments of similar wave-form pattern but different characteristic dynamic level.

Loudness changes are always associated with changes in timbre (i.e., with an alteration in the number and relative intensity of the harmonic and other components) and it is important that this factor should receive sufficient attention in the design. This means that a simple volume control at the input of the power amplifier will not do and that, whatever complexities of tonal synthesis may have been achieved in the tone-forming circuits, the gain control system must always effect further tonal changes coincidentally with changes in dynamics. In this we are assisted by the fortunate circumstance that almost all instruments show harmonic simplification with reduction in output level and increasing complexity with increase in loudness. This permits relatively simple tone-compensated gain control systems of the type shown in **fig. 26 (a)** to **(c)**. There is no inherent difficulty in arranging for quite complex tonal changes with changes in loudness but this is not generally necessary.

Table 3, which is a list of typical output power levels, will give some guidance on the kind of amplifiers necessary. The surprisingly low power levels needed refer to electrical power needed rather than to acoustic power and assume a moderate loudspeaker efficiency of 10%. (Compact, totally enclosed, low-resonance loudspeakers have very low efficiencies but in any case are unnecessary as we are not concerned with extreme bass frequencies.)

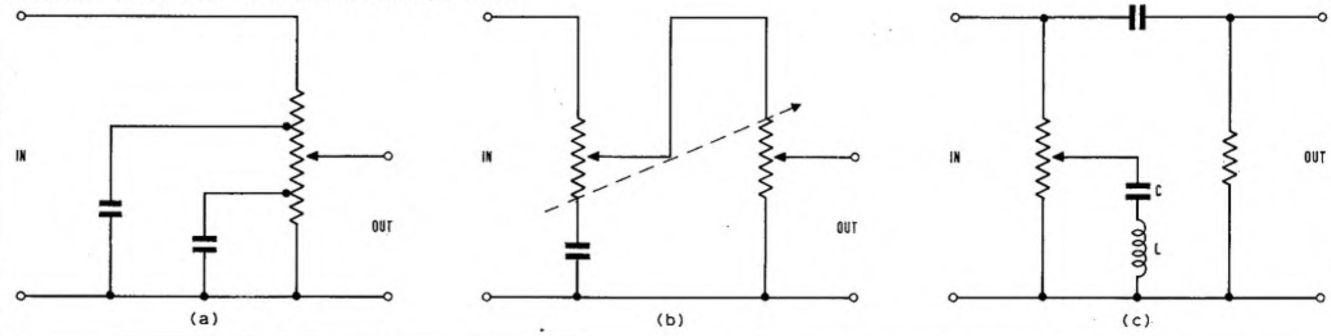
Amplifiers must, of course, have extremely low noise levels and low harmonic distortion. Intermodulation distortion is irrelevant in monophonic instruments and amplitude distortion of moderate degree does not matter very much as natural musical instruments have markedly non-linear frequency output characteristics. You can rely on inevitable variations in oscillator output to take care of this characteristic. At the power output levels required you are not likely to be troubled by heat problems if a Class B amplifier is used. A transformerless output stage is almost mandatory nowadays and this is not conveniently arranged unless fairly large output transistors are used. Such a stage, in Class B, will be capable of providing many times the power required but may involve risk of crossover distortion. An amplifier, such as that shown in **fig. 27 (a)** or **(b)** employing complementary symmetry output transistors will fulfil all requirements.

The loudness control, however arranged, must be quick acting but not over-sensitive entirely noiseless (since it will often be used in a silent period prior to the sounding of a note) and rugged. Moulded-track potentiometers can provide a surprisingly long life and are available with tappings for compensated control. Stud-contact controls are better still and facilitate tone compensation connections. The use of light-dependent resistors is an attractive approach to low noise and long life, and compensation can be arranged similarly.

Hand-operated loudness control offers advantages in delicacy of playing and convenience of portability. But unless the other 'left-hand' controls such as attack, transients and timbre can be arranged so as to be manageable simultaneously, some flexibility in playing is lost. Moreover, in playing a monophonic instrument, it is a great technical advantage to be able to use both hands, from time to time, on the fingerboard, so on the whole it is best to settle for a foot-operated gain control.

It is also a considerable playing convenience if some sort of calibrated indication of the dynamic level can be incorporated. The appropriate starting volume level must be set before playing begins and lack of some indication can cause embarrassment. Whatever form of gain control is used, a simple circuit such as that in **fig. 28** can be included. The potentiometer RV is operated in tandem with the gain control and the meter, which may be calibrated '*ppp, pp, p, mf, f, ff, fff*', can be mounted in any convenient position.

FIG. 26 SIMPLE TONE-COMPENSATED GAIN CONTROLS



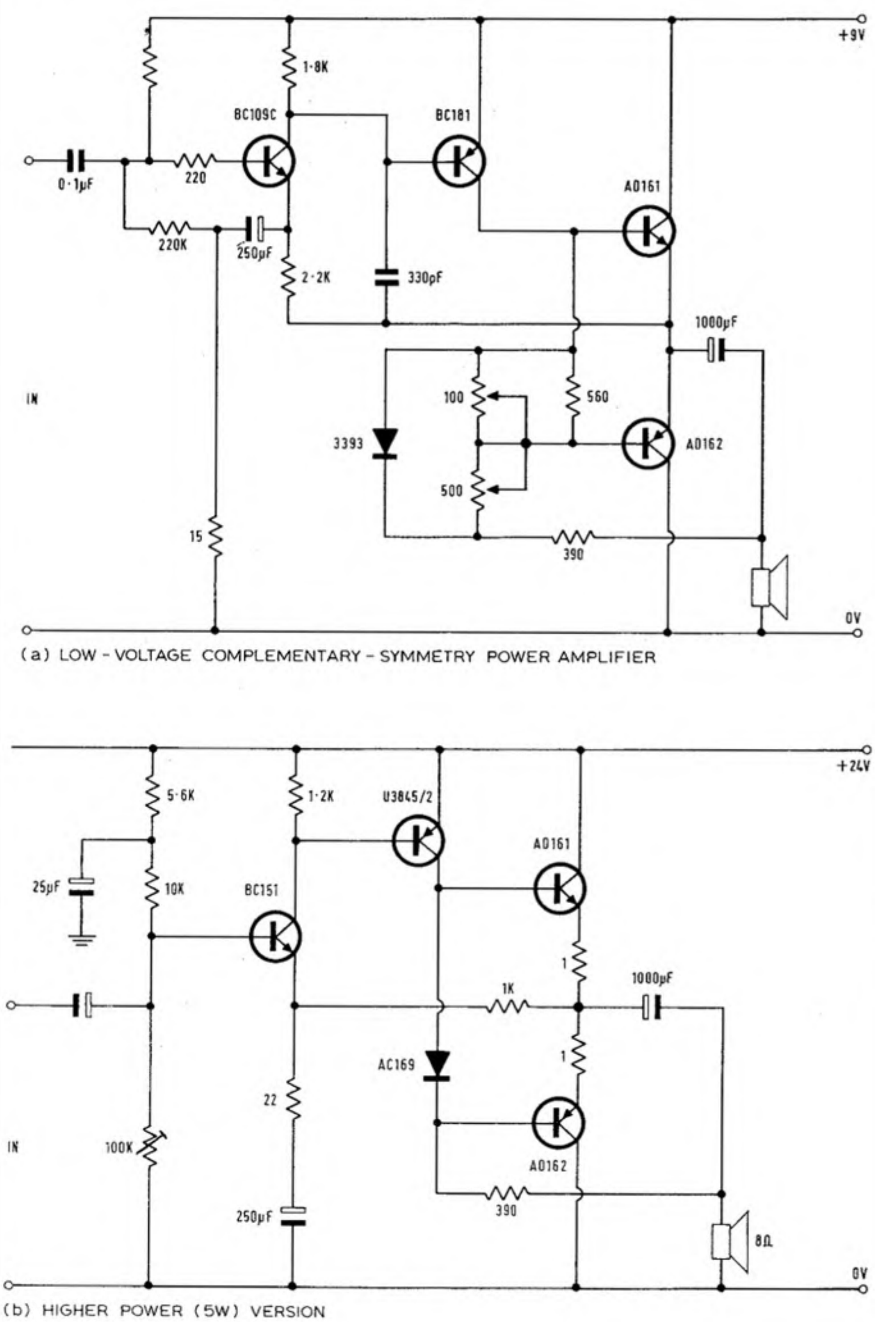
If you decide to fit a hand-operated control, avoid the simple rotating knob, which is quite unsuitable, but remember that the control must be such that it can be changed, with equal ease, in either direction. A short joystick, moving at right angles to the long axis of the instrument, with a bulbous end capable of fitting into the palm of the hand and leaving the fingers free for other duties, is one possibility. The conversion of rotary to linear motion can be achieved with two levers, as in **fig. 29** and the appropriate range of resistance obtained by selection of potentiometer values. If you can find, or construct, suitable parts, you can make use of the full length of the potentiometer track by using gearing as in **fig. 30.** Linear potentiometers should be employed for foot-operated controls, but normal 'logarithmic' law tracks are better if a hand control is used.

Photoelectric control of gain is possible by a similar mechanism, a suitably shaped vane being used to vary the amount of light falling on the light dependent resistor. Because of the small size of the cell, you will need a reduction leverage such as that in **fig. 31 (a)** in which the control lever is shown in the position of near maximum gain for the potential divider circuit shown in **fig. 31 (b)**. You may find it more convenient to have the cell fully covered in the fortissimo position in which case the light dependent resistor should be put in the shunt arm and the fixed resistor in the series arm as in **fig. 31 (c)**. The supply to the lamp should be rectified and smoothed with a silicon diode and a capacitor of about 1000 μF and the LDR shielded from other sources of light. If you use a 6 V 200 mA bulb and run it at about 5 V it will last for a very long time. Adjust the distance of the lamp to get the appropriate rate of control.

Tone compensation can be arranged in various ways and two suggestions are given in

(continued overleaf)

FIG. 27



(a) LOW - VOLTAGE COMPLEMENTARY - SYMMETRY POWER AMPLIFIER

(b) HIGHER POWER (5W) VERSION

FIG. 28 METHOD OF INDICATING DYNAMIC LEVEL SETTINGS. THE METER, CALIBRATED IN MUSICAL DYNAMIC MARKINGS IS FED CURRENT VARYING WITH THE GAIN CONTROL SETTING

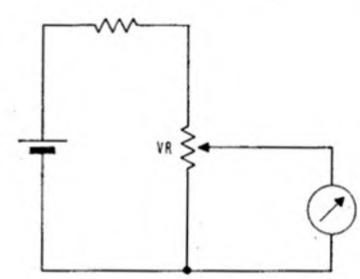


FIG. 29 LEVER-OPERATED POTENTIOMETER

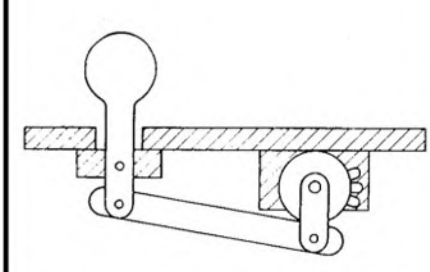


FIG. 30 IMPROVED METHOD OF OBTAINING POTENTIOMETER LEVER ACTION

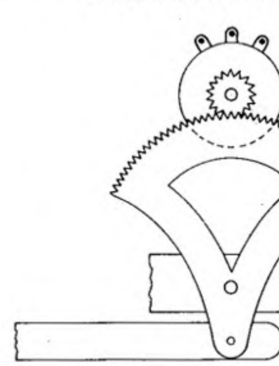


fig. 32 (a) and (b). In the case of the latter a considerable range of control is possible as the light shuttering can be arranged progressively to give (a) poor illumination to both LDR's (b) poor illumination of LDR2 and good to the other and (c) good illumination to both. Thus C and C1 can be placed effectively in parallel (LDR^1 low resistance, LDR^2 high resistance) or shunted out (both LDRs low resistance).

The partial structure of a tone, while important in its identification is by no means the only characteristic by which the source can be recognised. If the complex opening section of the note (up to about 50 mS from the onset) is not heard, and if the pitch is kept constant, confusion between similar instruments readily occurs. It follows that some licence is permissible in arranging the steady-tone characteristics.

All partials are not necessarily harmonics, the latter being defined as components of the tone having frequencies equal to whole-number multiples of the fundamental frequency. Enharmonic partials are important in piano tone, but fortunately, may be neglected in the synthesis of most solo instruments.

The harmonic structure of the tone of any given musical instrument is not a fixed characteristic, but varies notably with large changes in pitch and to a lesser extent with changes in loudness. Again, the harmonic structure can be modified by changes in the mode of playing the instrument or by making legitimate alterations in the mechanics of the instrument (such as by the use of mutes). Changes in the harmonic structure with change in pitch, or more obviously, with change in register are most conveniently described by the concept of 'formants'. The majority of solo musical instruments, by virtue of their physical structure, possess a natural range of resonant frequencies within which pitches will be accentuated by forced resonances. This range is the formant, and when the constituent frequencies are plotted in terms of magnitude, it will be found that the curves drawn have a shape and location in the frequency axis specific to the instrument concerned.

The formant, being a consequence of the physical structure, is, of course, fixed, and any pitches produced, of frequency higher than the upper end of the formant, will not share in the characteristic accentuation and will be anonymous. When the fundamental lies below the formant, those harmonics falling within it will resonate so to produce the typical tone quality. This is why musical instruments have different tone qualities in the different registers and is part of the reason why sustained notes at the top of the compass of many instruments are difficult to distinguish from each other. Of course, high-pitched notes necessarily have fewer audible partials and the possible differences are fewer. The fact that the formant is fixed in its position on the frequency spectrum is of considerable convenience in the design of tone-forming circuits as will be seen.

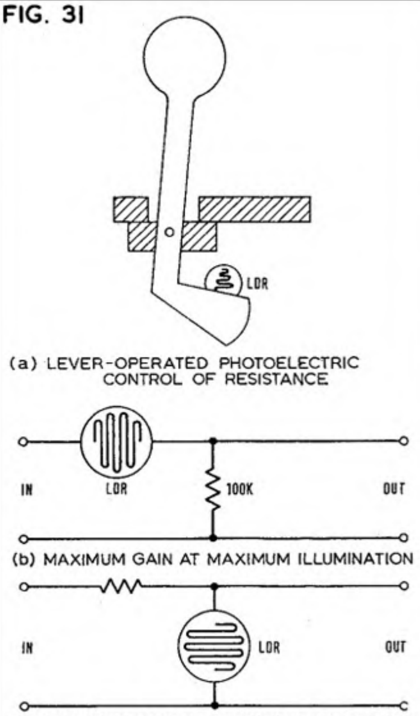
One of the main reasons for failure to achieve good tonal synthesis is inadequacy in the supply of the raw materials—the harmonic series. Unless all the necessary partials are present in the signal from the oscillator, no amount of passive tone filtering can produce the desired result. We must therefore first direct our attention to basic waveform production.

LC oscillators designed for good frequency stability (i.e. designed to load the tank circuit to the least degree compatible with the maintenance of oscillation) produce a near perfect sine output waveform. Such a waveform, of course, consists of a fundamental and virtually no harmonics and is, in itself, of no value for our purpose. The effect of filters on a sine-wave, acoustically, is merely one of attenuation.

Analysis of the sawtooth waveform illustrated in **fig. 33** shows that this is composed of a fundamental sine wave and a (theoretically) infinite series of harmonics, the amplitude of each of which is proportional to the reciprocal of its ordinal number (i.e. the second harmonic has half the amplitude of the fundamental, the third, one third, and so on). This harmonic series is a most convenient starting point for tonal synthesis. Unfortunately, most free-running sawtooth oscillators are inherently of poor frequency stability. In practice, the output from a sinewave oscillator must either be used as a synchronising signal for a separate sawtooth oscillator, or must be passed through some sort of non-linear device, active or passive, which will produce the desired output.

Let us first consider synchronised oscillators. Obviously, it is desirable that the circuit used should be aperiodic (so that in the absence of synchronising signal no spurious tone is produced). But if we reject any form of free-running oscillator, this narrows the field considerably. In electronic organ practice, by far the commonest synchronised oscillator is the bistable multivibrator shown in **fig. 34.** This one is inoperative unless supplied with a synchronising signal, but unfortunately, produces a square-wave output which is usually devoid of even-numbered harmonics and is, in addition, of half the frequency of

FIG. 31

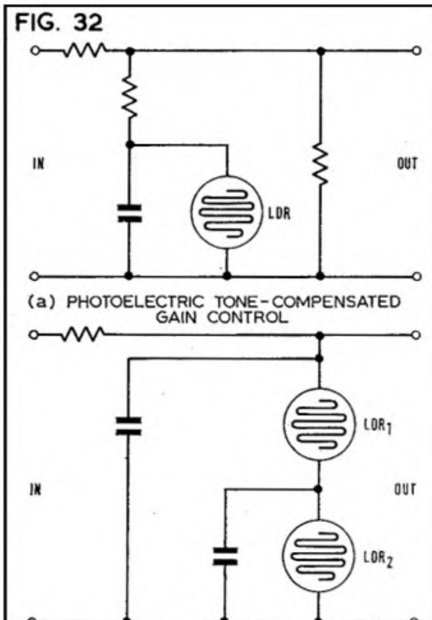


(a) LEVER-OPERATED PHOTOELECTRIC CONTROL OF RESISTANCE

(b) MAXIMUM GAIN AT MAXIMUM ILLUMINATION

(c) MAXIMUM GAIN AT MINIMUM ILLUMINATION

FIG. 32



(a) PHOTOELECTRIC TONE-COMPENSATED GAIN CONTROL

(b) ARRANGEMENT GIVING FULLER DEGREE OF CONTROL

FIG. 33 DIAGRAM SHOWING HOW THE SUM OF SUCCESSIVE HARMONICS OF REGULARLY DIMINISHING AMPLITUDE APPROXIMATES TO A SAWTOOTH WAVEFORM

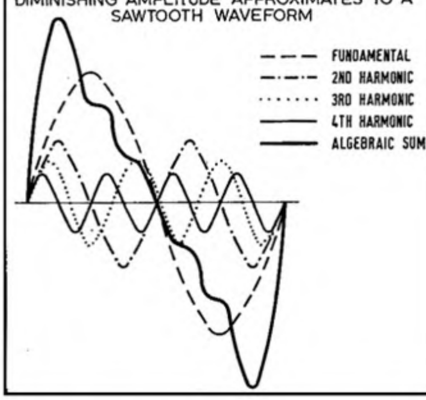
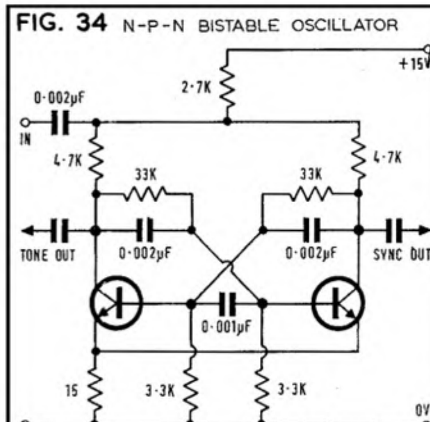


FIG. 34 N-P-N BISTABLE OSCILLATOR



the synchronising signal. Even-order harmonics are wholly absent if the mark-space ratio is 50:50. A much fuller, and variable, harmonic spectrum is obtained by varying this ratio. Such a waveform, by itself, is not sufficient but can be useful, if supplemented by a lower amplitude sawtooth, as a basis for clarinet tone. A square-wave can also be converted to a sawtooth by an integrator circuit (**fig. 45** next month).

If we can arrange for the sawtooth oscillator to be inoperative until the synchronising signal is applied, a useful range of possible circuits becomes available. Some of these are given in **figs. 35** to **39**. The simplest and most convenient of those shown is the unijunction sawtooth oscillator of **fig. 37** although the four-layer diode oscillator of **fig. 38** runs it a close second. You can, if you wish, substitute for the unijunction a *p-n-p/n-p-n* combination as in **fig. 39**. Although the mode of action is different, this combination may be treated in much the same way as if it were a unijunction. All of those shown will free-run at a frequency determined by their intrinsic time-constants and to ensure that they remain in sync with the master oscillator it is necessary to fix the natural frequency a little lower than that of the master. Allowance should be made for frequency instability (the triggering voltage of a unijunction drops with rise in temperature) and, since these circuits are inherently voltage-sensitive, the power supplies must be well stabilised.

To be continued

Table 3

Instrument	Maximum electrical power required assuming conversion efficiency (Electrical to Acoustic Power) of 10%
Violin	0.5 watts
Viola	0.5 watts
Cello	1 watt
Bass	2 watts
Flute	0.6 watts
Oboe	0.6 watts
Clarinet	0.5 watts
Bassoon	0.5 watts
Horn	0.5 watts
Trumpet	30 watts
Trombone	60 watts
Tuba	2 watts
Piano	4 watts
Pipe Organ	150 watts
Cymbals	100 watts
Full Orchestra	700 watts

FIG. 35 BLOCKING OSCILLATORS SUITABLE FOR SYNCHRONISATION

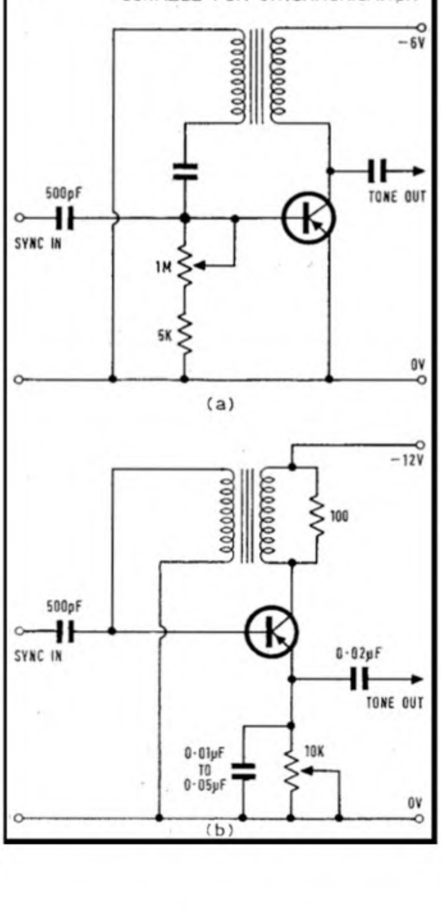


FIG. 36 LINEAR SAWTOOTH GENERATOR (GB CLAYTON) THIS IS A DEVELOPMENT OF THE EMITTER-COUPLED MULTIVIBRATOR

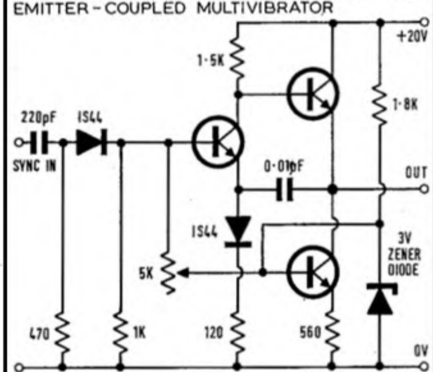


FIG. 37 UNIJUNCTION RELAXATION OSCILLATOR

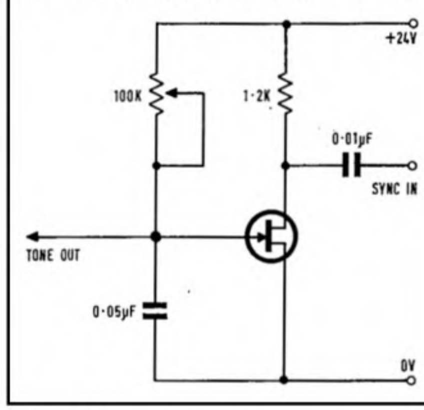


FIG. 38 PNPN 4-LAYER SYNCHRONISABLE OSCILLATOR

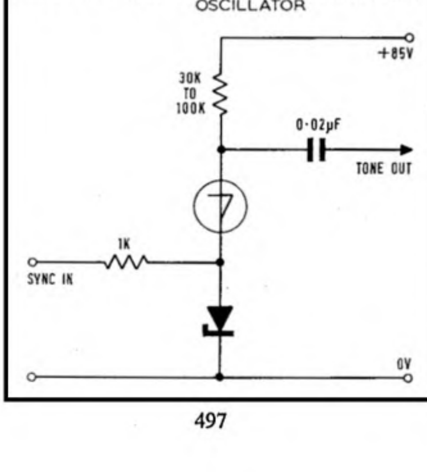
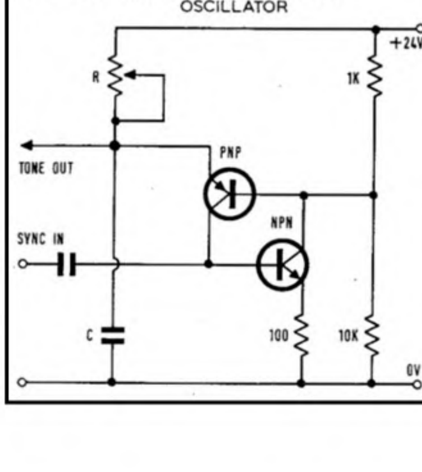


FIG. 39 PNP–NPN RELAXATION OSCILLATOR



PHILIPS
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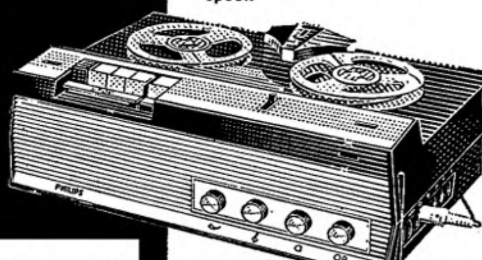
OUR PRICE 36! GNS

List Price £46.13.11

N 4305
Everything the family could want in a taperecorder. Record your children's first words, music lessons, etc. A lifetime's enjoyment. Superb quality won't let you down. Four tracks, two speeds. Excellent reproduction and many features of much more expensive recorders. Supplied complete with microphone, recording/playback lead, 5" reel of long play tape, 5" empty spool.



ALSO COMPLETE PHILIPS RANGE INCLUDING—
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Your choice of music anywhere. Trim, streamlined musicassette player. 76 hour batteries. All transistor amplifier. Our Price 9½ gns. List price 13 gns. Only a few left.

GL 559 Smart, attractive loudspeaker enclosure. 6 watt. Size 10½" x 7½" x 7½". List Price £11. Our Price 8½ gns.

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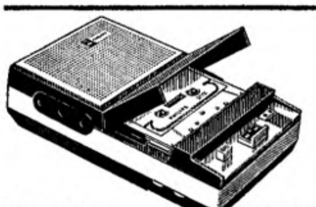

PHILIPS EL 3302
CASSETTE PORTABLE RECORDER

OUR PRICE **22 GNS.**

LIST PRICE £28 . 7 . 0

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FERROGRAPH MODEL 713
A mono system of tremendous potential. Vertical or horizontal operation. Silicon solid state electronics. 3 motors (no belts). Half track. Tape speeds 1⅞, 3¾, 7½. Output: 10 watts RMS.
OUR PRICE £153 . 6 . 3
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MODEL 702/4 A superb stereo system. Specification similar to 713 with no output stage. Damped tension arms for slur-free starting. Will mix four inputs into one channel. Half or quarter track. **OUR PRICE £173 . 8 . 5**
List Price £194.15.8.

MODEL 722/4 A masterpiece in stereo equipment. Specification similar to 702/4 with an output of 2 x 10 watts. A speaker for each channel. Unit construction, etc., etc. Must be heard and compared. **OUR PRICE £194 . 3 . 1**
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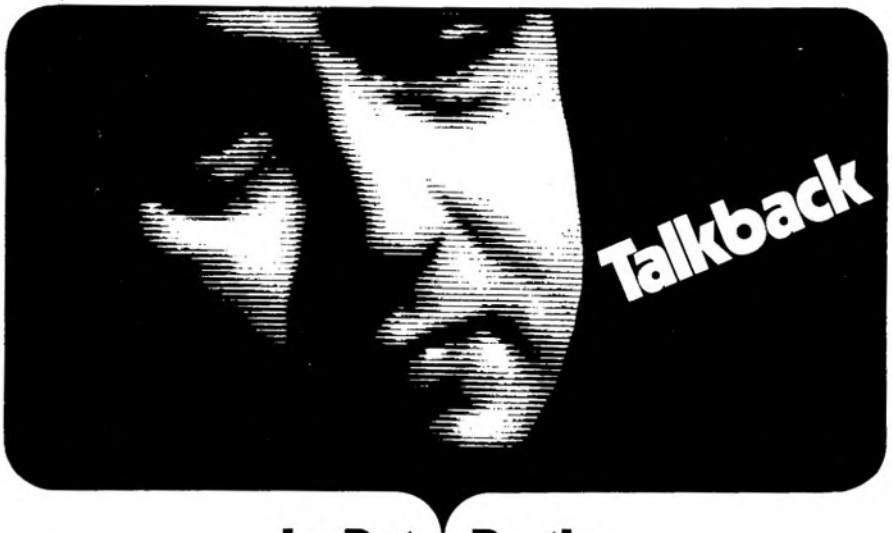

by Peter Bastin

THE Editor who is 8 feet three inches tall (an inch or two bigger than me) said 'You wrote me a rude letter.' Because he's an Editor, I agreed with him. 'About metric' he said, very heavily. 'I meant to send you a very nasty letter back, but my aunt was sick' he went on, utterly regardless. And that was how it all started. He forced me—forced me—to write this column. Otherwise, he said, he'd put a spell on my Tandbergs which would cobble them up for all time.

So I'll write his rotten column and I'll jolly well start with this metric business. It's true that I wrote a letter about 19 cm/s tape speeds and all that sort of Common Market stuff and it's equally true that I detest not only centimetres and centilitres but anything else which is Continentally confusing. Just consider the ramifications. Consider the chippy's mate who is sent for a metre and a third of 76.2 mm by 50.8 mm pine, the dedicated boozer who has to guzzle 800 centilitres of brown ale per night and the poor house-missus who has to buy 0.4536 kg of sugar to make a good old English cake. For the life of me, I'll never know whether my machine is running 0.395 cm/s or 0.452 cm/s slow or not. I suppose the answer is to have a French mathematician in your broom cupboard. 'You get more than a machine when you buy a tape recorder.'

LOOKING THROUGH the October edition of *Tape Recorder* I was, as usual, thoroughly irritated by the advertisements which tell you everything except the price. B & O, National, Film Industries, Telefunken, Sanyo, AKG and Akai appeared to regard the price of their wares as national secrets. Ferrograph, Sony and Tandberg were vague ('prices from . . .') and only Ferguson stated flatly the price of their advertised machine. Why bother with all the splendid splurge about frequency-response, cross-field wow and so on if you don't know what you're expected to pay for all these unique refinements?

The advertisements are, of course, in the best of taste but they would, I feel, be more acceptable to the buying public if the prices were included.

In the same edition, a curious advertisement by a Mr Kirkman of The Broadway, Crawley, appears. Kirkman quotes tape discounts 'from 5% for £1 to 25% for £14'. He also says 'Top brands and others at half the price.' Half the price? The list price? Or the ambiguous discount price? I tried working out how much it would cost me to buy, say, ten 50s. tapes. I retreated in confusion very soon. Try again, Kirkman of Crawley.

THERE HAS been some mild claptrap about how interested local radio is in the amateur. Like a fool, I nearly believed this. I submitted work to one station in the north and, even after travelling some 250 miles to talk to them, I ended up with four guineas for a 25-minute programme and a lot of hollow promises. The most recent case was with a Midlands station which, an authoritative journal said, was 'certainly eager to receive work from amateurs'. I sent some. Nothing whatsoever happened. Several months later I wrote a hefty letter and the tape came back. Sorry, we are only interested in very short, very topical material. Well, now. Local Radio, for my money, is an amplified parish pump, churning out slightly sickening news about $7\frac{1}{2}\%$ pay demands in local meringue factories. Occasionally, they have something interesting, which is probably accidental. Ah, but, they will say, the service is to serve an *immediate* public. Perhaps they do. Let us hope that the massive rash of electrified gossips which we are promised will give amateurs a chance to prove that they are more than collectors of insipid interviews.

IN THE AUGUST 17 edition of the German magazine *Stern* there was a full page advertisement for a Philips VTR. The VTR comes complete with a TV receiver/monitor. The prices of the two models advertised were 1980 DM for model *LDL 1002* (about £198) and 1880 DM (£188) for model *LDL 1002*. An interesting feature was the inclusive sum of 30 DM which was a fee for the right to record broadcast television transmissions. This strikes me as an excellent way of overcoming all this tiresome business of copyright fees. Anyone wishing further information on these VTRs should write to Deutscher Philips GmbH, 2 Hamburg 1, Postfach 1093, Germany.

THE BRITISH Amateur Tape Recording Contest, in common with other similar competitions, presents magnificent (and sometimes dented) silver cups to the winners. At the end of the year, the holders have to pack these tin brutes up and send them back to whence they came. This is a nuisance, to put it mildly. Furthermore, I do feel that the winner of any trophy in any competition is entitled to keep the thing for all time as a token of his ability. It is not always that a replica trophy is provided and the poor winner is left with but a memory and not a shred of evidence that he ever was a winner. I realise, of course, that it is a fad of every organising body to engrave the names of successive winners on the cup, but I think that winners would forgo this privilege in favour of a decent little cup with just *their* name on it.

LOOKING THROUGH an Italian musical magazine, *Strumenti & Musica*, I was very impressed by the wide range of electronic instruments apparently available in Italy: in fact, I had no idea that there were so many electronic organs in the world. Most of them have highly anglicised names like *Student*, *Cobra*, *Tiger Two*, *Parade* and *Prestige*. A number of Continental magazines have an odd habit of printing advertisements completely or partly in English, and *Strumenti & Musica* has several full-page advertisements wholly in the Anglo-Saxon tongue. One supposes that all Italian popsters achieved A-levels in English.

PHILIPS ELECTRICAL have an astonishing way of answering letters and queries. I asked them to supply me with a function-control knob for my cassette recorder. This was on September 16. On October 4, I got my letter back with a green label stuck on it giving a code number (!) and a price. This green label said 'No discourtesy is intended by replying on your original letter'. Perhaps it is not intended, but I feel it is very successful in doing just that. I am old-fashioned enough to believe in a sort of personal contact. And an immediate reply.

WHAT SORT of tape to use is a perennial question and I long ago fought shy of answering this sort of query. All I can say is, don't buy stuff that isn't in a reputable manufacturer's box. I once knew an electronics engineer, who, in a moment of high glee, made a machine for cutting computer tape down from $1''$ to $\frac{1}{4}''$. Extremely high performance rating but the blasted stuff fouled up a very expensive battery-portable tape transport. Reason: his tape-cutter was very slightly out. Maybe it was a thousandth of an inch—or was it 0.00736 mm?

(continued on page 503)

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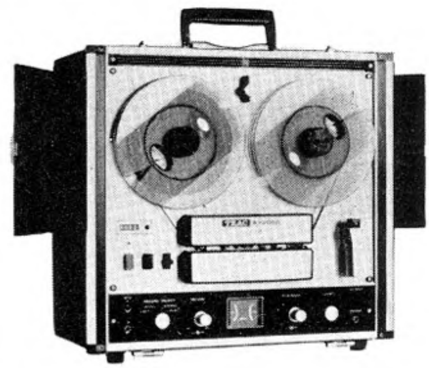

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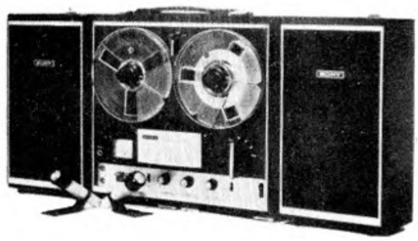

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7


1 Sony *TC.800A* three-speed
2 Sony *TC.20* stereo cassette player
3 Teac *A-2060* stereo
4 Sony *TC.252* stereo
5 Reslo *OM.1* moving-coil
6 Reslo *SR.520* mixer/amplifier
7 Sony *TC.124CS* stereo cassette
8 Akai *4000-D* stereo unit

8


OlympicFare

Things seen, heard and recorded at the 1969 International Audio and Photo-Cine Fairs

LAST year's report on the London Audio Fair was accompanied by a number of photographs taken during the exhibition. This year, publishing schedules being what they are, our photographic facilities were limited to the first day of the Fair, Trade Day. The organisers were well aware of the labour disputes which have beset Olympia and Earls Court in recent years, and, as it turned out, their worst fears were realised. Retailers and overseas visitors invited to the trade preview on Thursday October 16 found themselves politely turned away. The enterprising few who did gain entry found themselves touring empty shells of stands and piles of wood planks and debris. The nearest things to hi-fi were the Tannoyed invitations to trade union meetings.

By Friday the stands were complete, the exhibits in place, and the electric power laid on. The International Audio and Photo-Cine Fairs opened to the public and, in compensation for Thursday's non-event, were extended a further day to October 23rd.

Agfa-Gevaert backed out of the Fair at the first whisper of labour difficulty. They had already been bitten this year at the Business Efficiency Exhibition where their stand was finally completed four days after the opening.

Akai ran a continuous demonstration of tape/slide sychronisation and displayed a battalion of *4000-D* stereo tape units. An improved version of the *3000-D*, the *4000-D* has been reduced in price to £87. Not so prominently shown was the Akai *X-330*, a solenoid-controlled three-speed motor stereo tape unit. This accepts 27 cm spools and costs £293 including tax. There are no plans to introduce Akai's 6.25 mm helical-scan mains VTR into the UK, we were informed, though a battery portable VTR was expected here in the fairly near future.

One of the busiest parts of the upper gallery was the BASF stand, where visitors made and took away ½-track stereo copies of a music selection *For a City*. There as elsewhere one could see and hear the excitement of listeners hearing headphone stereo for the first time.

Brenell displayed but did not demonstrate the recently introduced transistor stereo *ST200/400*. A surprise exhibit on this stand was the *Type 19* solenoid-controlled tape transport. This is designed for remote operation and fits the standard GPO 406 mm rack. Three outer-rotor Papst motors are employed, including a two-speed *KM20* for the 19 and 9.5 cm/s capstan. Claimed 19 cm/s integrated wow and flutter is 0.08% RMS. The transport is aimed at the industrial market and accommodates 27 cm NAB spools. The remote control facility and ease of deck removal attracted considerable commercial interest.

BSR didn't show any tape decks.

EMI concentrated their demonstration on the virtues of Afonic low-noise tape, being evidently fascinated by its performance in 4.75 cm/s Compact Cassettes. Two new loudspeaker systems were demonstrated in conjunction with the tape, the *315* comprising a 35 W 380 mm diameter bass unit (20 Hz resonance), two 127 mm diameter mid-range units, two tweeters, crossovers and a switch plate. No EMI recorders were shown, the company's last mains model, *BTR4*, being defunct.

The main FBTRC (Federation of British Tape Recordists and Clubs) activity was the presentation of prizes to winners of the 1968/9 British Amateur Tape Recording Contest. This took place in a screened-off section of the Exhibitors' Club Restaurant, Cyril Rex-Hassan, Douglas Brown and the Johns Borwick and Bradley battling vainly against an incessant rumble of background chatter. The eleven recordings suffered badly under these conditions, the worst in the Contest's twelve year history. Lack of treble in the reproducing chain, due possibly to dirty heads, unsuitable loudspeakers, the low speed of the tapes (five at 9.5 cm/s, the rest at 19), or most probably simply the room acoustics and background, contributed a slightly farcical atmosphere to the whole proceedings. Amongst other things, it was impossible to judge either stereo quality or any of the quieter subtleties. All contributions were played on a ½-track stereo Ferrograph, including a ¼-track copy of Peter Bastin's *Have A Drink*. An earlier recording was audible beneath the latter—understandable in itself, *but why did nobody check before?* Two of the prize-winning entries, *Greensleeves* and *Samson*, were allowed to break the contest's rule: *No tapes submitted may contain anything taken from radio or TV transmissions or commercial recordings*. Robert Prizeman's *Addington Palace* contained several very well recorded (mono) choral sequences, spoilt by a rather ham-fisted attempt to tell a story: 'The choirmaster certainly seemed keener on his job than I certainly imagined.' *Tape of the Year!*

For the second year running, **Ferrograph** have forgone a formal demonstration ('the sound of Ferrograph is well-known to everybody' states their Catalogue entry), giving visitors instead a chance to see and handle the *Series Seven*—or listen via headphones.

A commercial tie with Calder Recordings Ltd. has made **Keith Monks (Audio) Ltd.** (appearing under the *Audio & Design* name) the Southern England distributor for *Calrec* capacitor microphones. These were marketed by Fi-Cord until the company's recent demise and include models for the studio and amateur markets. Most of the French **Melodium** microphones displayed on the Keith Monks stand are designed for PA applications, though a studio ribbon is available at £45. A wide range of stands is available to suit these and most other microphones.

The **Koss** headphone range could be heard at the company's stand in the gallery. This noisy environment provided an ideal setting in which to compare the insulating properties of different models.

Microphone manufacturers all face the same dilemma where exhibitions are concerned: short of organising repeated live performances at great cost and to the inevitable tedium of the instrumentalists, they can do little more than place their equipment on static display. Deprived even of a window for their *Radiomic* demonstration of recent memory **Lustraphone** employed a projector to show their equipment and its applications. The company produces several models for studio application, including the *4-50* bi-direction ribbon at £18 18s. and twin-ribbon noise-cancelling *4-70* at £27 15s. A very reasonably priced coaxial stereo pair, the *4-65* ribbon, is available at £26 5s.

MB Mikrofonbau displayed a series of microphones ranging in price from under £3 to over £100, including capacitor units. The company is still represented by Denham & Morley (now Denham & Morley (Overseas) Ltd.) who have moved to 453 Caledonian Road, London N.1.

Talking point at the **Multicore** stand was the new *Bib 24* 3 mm splicing block aimed at users of Compact Cassettes. The block is said to be suitable even for the sextuple-play tape found in *C.120* cassettes and comes complete with clamps, razor blade, marker, splicing tape, withdrawal device and instructions. Retail price is 29s.

The **Philips** emphasis was very strongly on promoting the Compact Cassette system in general and pre-recorded Musicassettes in particular. Price continues to be the main stumbling block (where are the 'cheap labels'?) but the recent drop from 55s. 11d. to 47s. 6d. is a major step forward. Chrome-dioxide Musicassettes are currently being produced in Germany by Deutsche Grammophon and also, according to one report, in the UK. This will improve the system's chances against discs. Four-channel Musicassettes, if introduced, should carry it still further. A stereo auto-changer taking six cassettes and designed to feed external reproduction equipment was displayed, the *N2502* at £49 1s.

Reslo occupied rooms in the 'Hand & Flower' Hotel opposite the Olympia, displaying the *OM.1* dynamic microphone, a new design aimed at stage and PA markets and costing £15. It is available in three forms: the 30/50 ohm *OM.1/L*; dual impedance (200/300 and 500/600 ohm) OM.1/M and high-impedance OM.1/H (50 K). All are supplied with a two metre cable. Another new Reslo product was the *SR.520* transistor mixer/amplifier: three low-impedance microphone inputs plus one high-level input. Microphone bass cut and high-level treble cut facilities are incorporated.

Revox departed from formal demonstrations this year, inviting visitors to produce and replay their own recordings. The staff of this stand at least were not particularly distressed by the loss of trade day. Like other importers, their main concern was for the home market and the absence of Thursday's overseas visitors did not unduly affect them. One overseas visitor who did take the trouble to attend was Colin Hammond, now living in the USA and representing Revox on both sides of the Atlantic.

A 16-track *Mincom* studio recorder was displayed by **3M** in the vicinity of six hard-working Akai *X-360* domestics participating in a 'Guess the Sound' competition. The *Mincom* employs an *Isoloop* transport and was seen earlier this year at the APRS Exhibition.

A major topic of conversation at the **Sony** stand was the news that a *TC50* miniature Compact Cassette recorder was used during the manned lunar landing expedition. Samples of the 144 x 91 x 36 mm battery portable are currently being tested by the BBC. Equally exciting, for the Sony Sales Staff, was the public's enthusiasm for the versatile *TC630D* stereo tape unit illustrated in last month's Audio Fair Preview.

Has Olympia proved superior or inferior to

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TAPE/FILM SYNCHRONISATION CONTINUED

The associated recording equipment to Eclair is Perfectone, though you are not limited to using the one make with the other. The film industry is known for its remarkable marriages of equipment. There is a great deal to choose from and more on the way. The Perfectone *EP6A II* portable recorder seems to be a popular choice of the moment, especially in the French studios. It was at the 1968 Winter Olympic Games in Grenoble where the Eclair/Perfectone crystal control system first made its impact. One is always coming across interesting combinations. The *Crystamatic* handled by Audio Engineering Ltd., 33 Endell Street, London, W.C.2, is to be seen in harness with the Jensen Synchroniser, Nagra Recorder, and Arriflex 35 mm and 16 mm cameras. The Synchroniser has been specially designed by Georg Jensen Electronics of Denmark for use with the Nagra and has the following applications:

Shooting picture with sound in AC line mode.
Post-sync shooting against a pre-recorded sync tape in AC line mode.
Post-sync shooting against a pre-recorded sync tape in battery mode.
Post-sync shooting against a pre-recorded sync tape in battery mode, using luminous edge marking in an Arriflex *M* camera (35mm designed for 25 F/S).
Sync sound transfer from tape to film.
Sync sound transfer from tape to film with bloop marking.
Sync sound transfer from tape to film using marker pencil.
Camera speed check.

16 mm film producers now have a choice of some fine professional cameras to go with all this sound equipment, properly silenced for shooting synchronised sound. Nearly all the new professional 16 mm cameras have their own blimps. The Bolex *H16 RX-5* can now be fitted with a seven-layer plastic and felt blimp weighing only 1 kg but cutting down camera noise considerably. It is made in two parts; the protective cover goes over the camera and a separate shield encloses the 135 m magazine. An outer covering in clear plastic provides good heat insulation. Paillard-Bolex have also changed the clapper system used with the MST drive motor. Until recently, the fogging lamp in the turret provided a visible mark on the film which stopped when the camera ran up to speed, and at the same time the pilot tone was only emitted when the operating speed was reached. With special transfer arrangements, the start of the pilot tone track could be used to trigger off a 1 kHz oscillator to mark the edge track on the 16mm film. As not all transfer systems use this method the MST has been changed to provide pilot tone right from the start.

When the film marking lamp is on, 12 V DC is sent down the control line which powers a small 1 kHz oscillator and puts a sync mark on the tape track of specially adapted recorders such as Perfectone or Nagra. Where a recorder has not been specially adapted, a contact is also closed which can be used to trigger an external oscillator for slating.

TALKBACK CONTINUED

I BOUGHT a small Wharfedale speaker a few weeks ago. It cost me sixteen guineas and is good value. In fact, it was so satisfactory that I decided to get another. My good friend, the dealer, when confronted with this extraordinary state of affairs, assumed his undertaker's expression and told me very gently that the speakers were now eighteen guineas each. Tell me, Wharfedale, how does an item *suddenly* increase in cost by 12.5%? I think that everyone is sick to the teeth with this upward sliding-scale of costs and it's no excuse to bleat about S.E.T. If I were a communist, I'd say that it is a question of inflated profits.

THE AMATEUR recordist normally has only the sketchiest idea of his status when it comes to receiving or earning fees for work in connection with recording. In fact, when is an amateur not an amateur? At what point does he cease to be officially an amateur and thus become ineligible for amateur contests and the like? I took this point up with John Bradley of the Federation of British Tape Recordists and Clubs and he expressed the opinion that an amateur ceases to be such when his earnings from his amateur activities exceed those of his normal (full-time) employment. Or, of course, when his full-time employment is recording. This means that an amateur recordist is free to undertake recording commissions, write articles and reviews, give talks, and otherwise work for fees without losing his 'amateur status'—subject, of course, to his spare-time earnings not being in excess of his full-time salary! That's how I see it, anyway.

In the same context, the amateur should be very much aware of his rights in the copyright field. He should, for his own protection, charge a fee for any *original* work which he allows anyone else to copy for public-performance purposes. This is very applicable to multi-track music composer/recordists. Too many repertory theatres, amateur theatrical groups, lecturers and cine clubs use amateur recordings without either payment or, very often, acknowledgement. In most cases, this is due to the recordists over-helpful attitude to the whole thing. Where the work is creative, I think it is realistic and very necessary to charge for the talent and labour involved.

LOOKING THROUGH *Hi-Fi News*, I am once again struck by the obsession most manufacturers have for code numbers. Practically every piece of equipment manufactured has some wierd combination of numbers and letters attached to it—rather like an Abyssinian car registration plate. This mysterious practice is also common in other fields; look through a motoring magazine or a camera catalogue. It seems that only in the field of the ignorant housewife do manufacturers scornfully call their products by recognisable and logical names. Many writers of letters to technical magazines thrive on quoting these ridiculous codes; it is part of being frightfully important and knowledgable. The fact that their machine is a *G5 76T* does not hide or, indeed, excuse the fact that the thing is a Japanese transistor radio costing £5 11s. 3d. For those of you who are wise to this sort of thing, work this one out: Two *1541*s, *DP4H*, *DP4M*, *M69*, *D14S*, *EL3300*, *SP25*, *SE1*, *636*, *W20D*. No prizes.

PRACTICAL WIRELESS in their November issue state 'Readers will not need reminding that tape-recorders are proliferating in a bewildering manner'. Reference to my dictionary revealed that this means they are multiplying. Sounds rather like a handbook on rabbits, so treat that battery-portable with care: it may be pregnant and you may even be presented with twins.

OLYMPIC FARE CONTINUED

the Hotel Russell as an Audio Fair setting? Opinion varies so much that it is unfair to condense it into an overall *pro* or *anti*. We have our own views, of course, but these are biased by the ease with which journalists may get around the new Show. The experiment appears, on the whole, to have succeeded. The listening rooms were as effective as many of the Hotel Russell bedrooms, except in the extreme bass where a constant murmur of passing feet remained unfiltered by the partitions, and succeeded in making any reproduced LF noise. Some rooms leaked sound to the main hall, but this was immediately lost in the existing hubbub. Others were at times warmer than one would wish. In general rooms were quiet enough for gramophone record crackle to be audible, though not quiet enough to reveal hiss or the subtleties of pianissimo musical passages. But demonstrators chose their material accordingly—and the public seemed to like it.

Akai X330

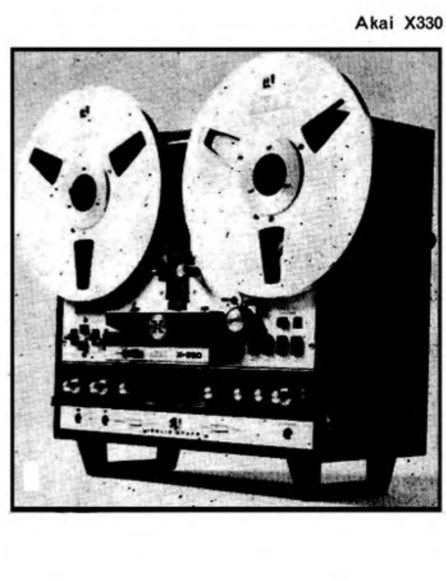
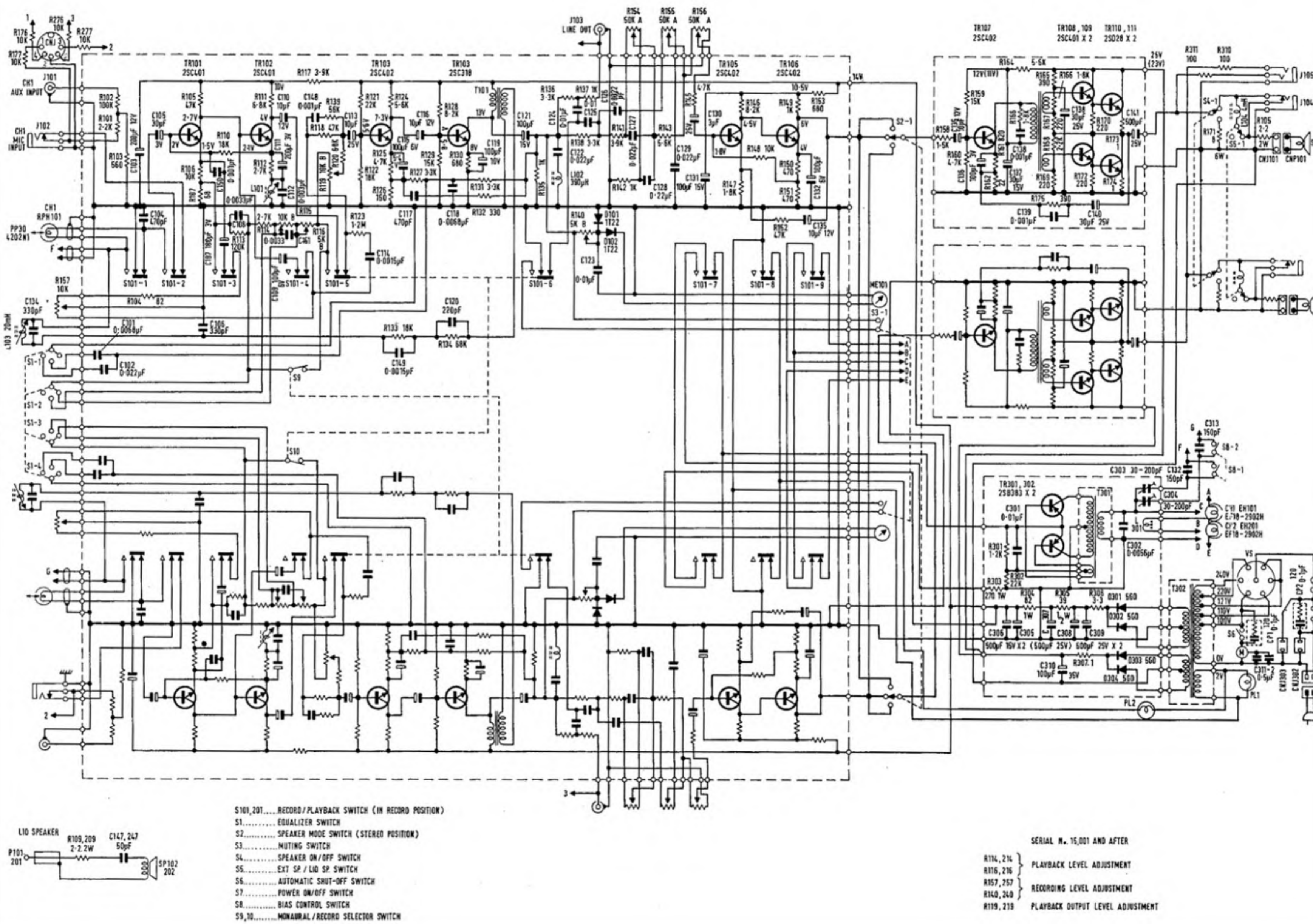
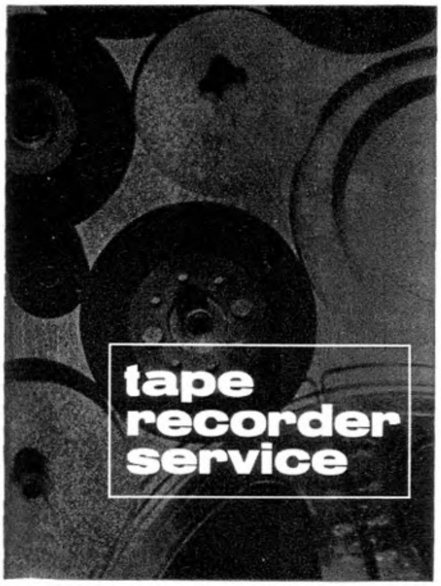


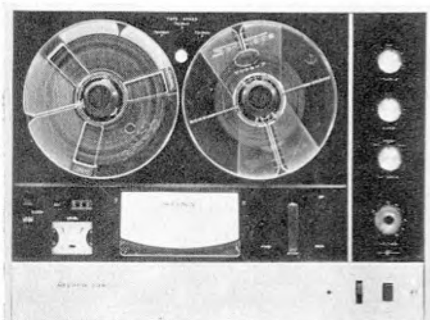
FIG. 1 SONY TC530 CIRCUIT DIAGRAM





SONY TC530

BY H. W. HELLYER



IN the final paragraph of the October contribution I promised a run-down of the *TC260* meter preset adjustment. This is especially important as it is combined with the amplifier level preset so the equalising circuits should be checked immediately after, and the whole procedure gone over again to make sure these interdependent settings do not throw everything out of balance. They certainly can, should there be trouble with the record/play switching, or a faulty component within the feedback loop. Faulty transistors I have not found so common in this range, but it has sometimes been necessary to change a *2SC401* or *2SC402* where there are broad differences in gain between the two channels, and several times we have traced noise problems to the *2SB381* immediately following the volume control.

If tests do show this transistor to be faulty (often with symptoms that sound like a classic case of control-track wear), replace the 10 μF electrolytic, using as good a component here as you can afford.

For the level measurements we use a VVM plugged in to the line out socket and load its terminals with a 100 K resistor. Switch to the scale that gives a 1 V reading about two-thirds FSD. We require to read off 0.775 V which is the 0 dB level. Then we replay the test tape, which in this case is the Sony *N-19-F1* tape with frequency bands at stipulated levels. We use the second section, which is 700 Hz at -12 dB. Replay of a 1 kHz test tape at 100% modulation will give us the same effect, or a recording signal of 1 kHz at -10 dB to the auxiliary input socket, in the absence of a test tape.

With the machine uncased and standing vertically, looking at the rear, we find the printed board of the main section on our right, and as it were, upside-down. Components appertaining to the left channel are on the right of the board as viewed, and vice versa.

There are three preset potentiometers on each half of the board. Reading from top to bottom they are (left channel) R130, meter level; R114, playback level; and R110, equaliser. Right channel equivalents are R230, R214 and R210.

Adjust R114 for an output reading of 0 dB (0.775 mV)—ignoring the service manual if you have one, which has a naughty misprint that will eventually send you whizzing round in circles. I found it the hard way by wasting ten minutes adjusting and readjusting the same potentiometer for an 8 dB difference in indicated signal level.

We now have the amplifier giving us the right gain *at the test frequency*, so we go back over the same section of tape and replay it again, this time adjusting the meter preset R130 for an 0 dB indication, 100% modulation level.

Now, note the italics in the above paragraph. One of the common complaints with this whole range of machines we have been discussing is an apparent discrepancy of stereo meter indications when a paralleled mono input is applied. Meters kick up by different amounts and yet, when we apply a sinewave generator to the same input at a mid-range frequency for test, the same input level gives us the same meter indication. Conclusion: meter faulty somewhere—bad damping, slack pivot, or a needle catching on the case.

Such an eventuality is not unknown but, before wasting your piggy-bank on a new meter, always check both head azimuth and the equalising adjustment. Replay test tape signals (third and fourth sections of the test tape mentioned above) at -22 dB, and at 700 Hz and 10 kHz. These *must* give the same output with tone controls flat, and first test must be at the line out socket, adjusting R110 for the same reading on the VVM. Watch the indicator meters while you do this, and check both channels for similar swing of the needle. Then go back over the playback level and meter adjustment again to check that all is well.

Adjustment of the *TC530* electronics is, if anything, simpler than the previous routine. This time, however, we take into account the correcting effect of the postline out section of the circuit when checking equalising, or we are likely to find ourselves in difficulty. The VVM is connected across the speaker output with an 8-ohm resistor as load. In practice, because the *530* opens up so easily and there is a pair of speakers *in situ*, I always clip the test leads on the speaker terminals for output measurements. We now need the F2 test tape with a -22 dB level at 700 Hz and -12 dB at 10 kHz, and R116 is adjusted to bring the latter signal into step, to give the same output from each band.

After this we need another band, either using the F1 tape or the second section of the F2 tape, with 700 Hz at -12 dB. We can measure at the line out socket or at the output. My own method is to ensure that there is an 0 dB output, that is a reading of 0.775 V at the line out socket across a 100 K load, then to transfer immediately to the speaker output and see that you are getting the specified 5 W.

No prizes offered if you have problems with this measurement. The *TC530* used what Sony are pleased to call a *Quadradial* system. This means sideways facing internal speakers and lid speakers (that appear to be less sensitive) plugged in to parallel-wired sockets so that the stereo image can be broadened. In my humble opinion the lid speakers are too shallow and the way to get the best from them with a fairly large room is to remove the backs, mount the speakers on high shelves with at least a 23 cm clearance from the wall, and keep both bass and treble controls down beneath the 'flat' position. Advancing the bass brings out a nasty tizz at about 500 Hz and advancing the treble gives distortion in the mid frequency range as the output is pushed near full output.

To deflect the inevitable comeback, I must say that this distortion is evident only when the *TC530* is pushed to the limit; but as we have installed several of these excellent machines in public places, and anticipate that a machine of this nature will be used for large gatherings, pubs, clubs, and the local church hall, the warning may save a few worries. Use the lid speakers for moderate level domestic listening; in larger venues, feed the output to low-resonance loudspeakers. The defence rests!

Setting the recording level and its indication can be rather a tricky business on the *TC530*. If you have transistor trouble at the front end, you will get all sorts of weird and wonderful results. Best check is transistor voltages (**fig. 1**), and give a very good clue to correct operation. Because of the rather crowded nature of the printed circuit board, and the smallness of these transistors, I find it best to check suspect ones with an *in situ* 'Diotester', which saves an awful lot of unsoldering. Then, a useful trick is simply to parallel a suspect transistor with a known good one, switch on again and note the difference, (you can't do *that* with valves!). Soldering is done from the print side, and many a replaced transistor has been left on the easy-to-reach print rather than face the chore of getting the board off and those miniscule leads in the right place.

Returning to our muttons: Mute the speakers, connect the measuring VVM to the line out socket with its 100 K load, then feed a 1 kHz signal across a 600 ohm load into the microphone socket with the *TC530* set up for recording in the stereo mode. An input of -60 dB, which the astute reader will already have realised is our magic figure 775 mV should bring the recording level meter up to the division between the red and the black portions on the scale. But before adjusting

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Interview

David Kirk talks to Tom Reps, Managing Director, Magnetic Tapes Ltd

Tom Reps

D.K. *What first made you go into the tape recorder business?*

T.R. If I remember correctly, it was purely curiosity; I wanted to hear my own voice. This was way back in the old days, around 1950, when Truvox made a tape transport with a black crackle head cover and a cork pinch wheel. All one did then was buy the deck, and design the electronics and the cabinet. It was very crude.

D.K. *Equalisation?*

T.R. Nothing at all. You just chanced your luck. It was only a two-speed.

D.K. *What were you doing in those days?*

T.R. I used to design radios and make them with ex-government valves. Then I made televisions. You could sell radios easily just after the war but it became hard to compete. Then tape recorders came along and the market just grew. The Truvox deck proved to be, well not the bee's knees. British decks never had the sophistication of the Continental ones like the Grundigs in those days. They didn't have the features. They just worked. Time went by and then Collaro brought out the two-way deck and we went over to that.

D.K. *That was the Transcriptor.*

T.R. Yes. It was quite a good seller. The important thing in those days was that if you couldn't make it good, make it loud. People weren't educated to buying separate speakers to the extent they are now. Eventually Collaro dropped the deck and we were left with a pile of chassis parts and components. That set me thinking about making my own deck. We lost a certain amount of money in the changeover but went on to the Studio deck.

D.K. *Did Collaro give you any advance warning?*

T.R. They did, that's fair enough. They asked our requirements and kept a number of decks back for a period. But a small company could not afford to take a large quantity of decks into stock to keep them going.

D.K. *I gather you had trouble with idlers in the Studio deck.*

T.R. Well, if you are going to make an idler wheel that takes a lot of wear you have got to make it of a material that doesn't shed. Rubber is not good enough. This is one of the reasons we use Polyurethane. What you try and rely upon with all idlers is servo action, so the greater the load, the more the idler pulls in. If the flywheel and motor are too close together you don't get servo action. If they are too far apart you get wedging. It's a compromise because the drive motor has different diameters to suit each speed. At 4.75 cm/s it tends to wedge in and at 19 it probably isn't servoing in. The basic question, however, is will the drive material stand up to wear? If you place a razor blade edge on rubber idlers, the rubber scrapes off. To get better traction Collaro gnurled the pulley, which in my opinion was a mistake. It took the surface off the rubber. Polyurethane has the advantage of being a high compression moulded material; it isn't cast and cured like rubber. The compression gets rid of all the air bubbles. Air bubbles near the surface make an idler useless. Any superfluous oil on the drive members inevitably gets onto the rubber and makes it sticky. Oil used to rise up the Studio deck capstan and get on to the pinch wheel, the rubber swelled and you had had it. Polyurethane is completely unaffected by oil, petrol and solvents. It doesn't form permanent flats unless pressed beyond 8%. It has a constant density, which rubber hasn't. If you've got a non-uniform pinch wheel, half soft and half hard, it will vary the loading. Polyurethane is also resistant to long-term cracking and wear. I keep on harping on this but it is a very important point. These idlers are 100% reliable, there have been some in public houses for up to ten years which have had a real good bashing; you can just forget about them.

D.K. *Why did you leave Reps (Tape Recorders) Ltd.?*

T.R. I was already thinking about designing and making a deck and, due to policy disagreements in the company they didn't feel there was any point in making a recorder because they had neither the capital nor the production facilities. I took a gamble, sold my interest and started from scratch with my colleague, Frank Collings. The electronics are no problem at all because you know from experience what is required. You want electronics in a unit form so that if anything goes wrong the unit can be taken out and returned by the customer for replacement. This is most important. You must ensure that it is transistorised so that virtually no heat is generated inside and the circuitry has got to be 100% reliable. If you use transistors, you have got to ensure that the power amplifiers cannot be damaged by shorting the loudspeakers. So you do the same thing as other reputable manufacturers and have a stabilised power supply with an automatic cutout. A stabilised supply ensures that the oscillator bias does remain constant with different mains voltages. If I can be perfectly honest here, there is not one customer who has sent a machine back with a faulty transistor. The silicon planar transistors we use are extremely reliable.

D.K. *Do you have the same trouble with transistors that you had with decks, the component manufacturer stopping the line you are using?*

T.R. You have to accommodate this by designing the circuits such that variations in transistor performance and types do not significantly alter circuit performance. The amplifiers are all DC coupled so the whole thing is independent of temperature and transistor performance.

D.K. *And resistors?*

T.R. These must be within 5% because the

DC voltage levels on your transistors have to be correct.

D.K. *How does one go about designing a recording amplifier? Do you start from scratch or do you work, say, from a Mullard circuit?*

T.R. The Mullard circuits were useful as a guide.

You decide first of all that you're going to have three speeds, 10 W output, you're going to work at 2% distortion at peak record level, you're going to have PPMs. Are you going to split up your printed circuit boards into units, what inputs are you going to have? Having finalised these points, you then get down to the detail. First you decide which heads you are going to use, their inductance, whether you're going to have pressure pads, and so on. You must have adequate previous experience of tape recorders because there are many ways of going about the same problem. I had to allow, for example, for the future introduction of chrome dioxide tape which will probably be less sensitive than present-day tapes. The recording amplifier must be capable of supplying much greater signals than are required at the moment which means working at a relatively high voltage. This is tied up with the impedance of the power output. If you are going to work at 4 ohms you have the advantage that you don't need a high supply voltage, you can work at 24 V possibly to get, say, 10 W continuous sine wave. A lot of people already use 15 or 8 ohm speakers. If you are going to work at 15 ohms, you require about 56 V which puts the cost up. At 8 ohms you work at about 36 V and on that basis you can have a high supply voltage to your record amplifier, allowing a large AC swing on the output to the head, and correspondingly low distortion. This allows high series resistance, I have a 22 K head feed from an emitter follower. There is consequently no need for bias rejectors, one less set of coils to adjust and one less source of hum pick-up. There are no inductors at all in the recording amplifier.

One has to decide whether one is going to adopt the CCIR record/replay standards, which are virtually the same as the IEC. The CCIR 2 is a 70 μS time constant. The IEC is identical but has a bass boost in the bottom end. Now the big advantage of applying a certain amount of bass boost on record is the fact that you need less bass boost on playback and therefore get rid of any noise resulting from variation between head and tape contact. It definitely gives a cleaner bottom end. Hum is reduced as well but I am talking about 20 and 30 Hz where the heads can give quite a good output now.

One of the biggest problems with transistors is that they require a DC supply at the inputs. Do you have an isolating transformer between the replay head and preamp, do you feed straight to the preamplifier and allow a small current to flow through the replay head coil, or do you apply an isolating electrolytic? A transformer is out because of the cost. If you use an electrolytic, as a lot of people do, it has to charge and discharge through the replay head. If you apply the top end of the replay head straight to the base of the first transistor and the bottom end to the supply, which is the same potential as the base, and you decouple the bottom end adequately, the current flowing through the replay head can be kept down to very much less than 1 μA. In fact it is in nano Amps which is perfectly satisfactory.

D.K. *Is residual magnetisation in the record head entirely looked after by bias fading away?*

T.R. Yes. This is a function of the oscillator time constant. Noise from the record head can be caused by slight DC leakage from the recording amplifier into the head. Leakage in an electrolytic is a function of its capacity. The higher your feed resistor, the smaller that capacity need be. I use a 0.47 μF electrolytic and there seems no advantage in going over to the tantalum type. Record noise is mainly caused by the bias waveform and one spends a lot of time trying to get the noise (not hiss, I might add, which is basically a function of the tape oxide) down. An assymetrical waveform creates a sort of rumble. The erase head is the major load on the oscillator and if the head contains two windings their electrical characteristics must be equal. In a transistor oscillator, the transistors must be matched or at least capable of being balanced. We have a striped tape loop, sections of oxide scratched away. This is run through on record/replay and you adjust the oscillator preset for minimum noise. There's a lot in the design of erase heads, far more than people realize.

D.K. *You offer a low-impedance microphone input stage if customers ask for this. How do you manage without a transformer?*

T.R. When you have a low impedance microphone, although the power output from the microphone is the same as if you have a matching transformer, basically a low-impedance microphone gives current. A transistor amplifier amplifies the voltage output from the microphone and not the current, in this particular instance. Therefore you are not utilising the full output power from the microphone. This is why you need far more gain and consequently your hiss goes up. The transformer converts current to voltage which can be amplified with optimum signal-to-noise ratio.

D.K. *So all you're saying really is that you have got to, underline got to, use a transformer?*

T.R. Well, there are ways round it but they are very expensive I should imagine.

D.K. *Such as?*

T.R. Low noise resistors and specially selected transistors give a marginal improvement. But yes, transformers are the only proper way of doing it. On the other hand there is a big advantage in having a simple transistor low impedance input because some of these pop boys, where the signal going in is so loud that they are not concerned with hiss, find it perfectly satisfactory. That is why I make provision on the microphone board for a couple more components to accept low-Z. My thinking is that if somebody wants to use low-impedance microphones, they often want several and therefore we make a low impedance mixer with balanced transformers taking three stereo pairs. If you build it into a recorder, a lot of people are obliged to pay for a facility they don't want.

D.K. *What does the mixer cost?*

T.R. About £40.

D.K. *What ratio of ½-track to ¼-track machines do you sell?*

T.R. About 75% ¼-track. Very often people buy ½-tracks (a) for ease of editing, (b) because they already have a lot of ½-track tapes and (c) they are industrial users and require the highest possible signal-to-noise ratio.

D.K. *Tom.*

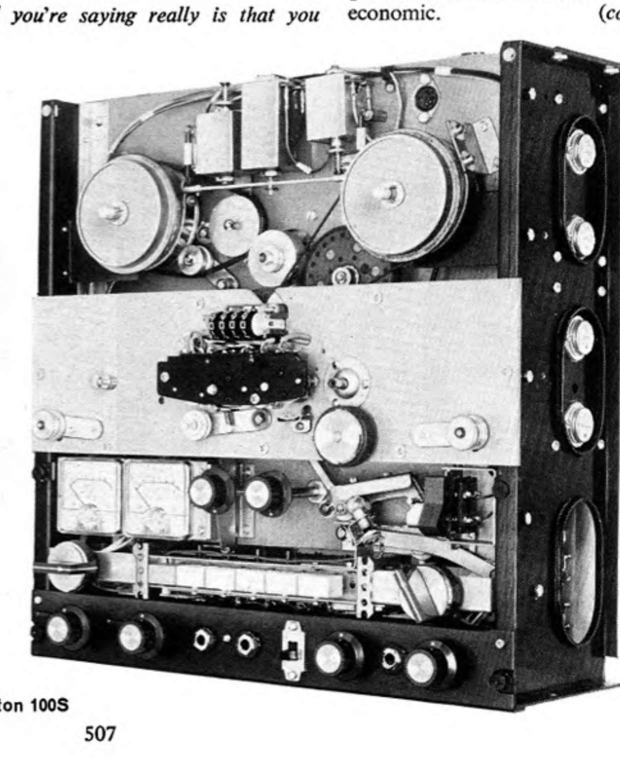
T.R. Sir.

D.K. *Like a number of other recording equipment manufacturers, you dropped out of the Audio Fair this year. Any reason?*

T.R. Yes. Six hundred pounds is a lot of money to spend when you consider that you are exhibiting for about a week with staff tied up for that period. The cost is rather high for a small company. When it was about £200 for a long weekend, this was all right.

D.K. *And the extra orders you would get?*

T.R. They wouldn't cover the cost. You have got to sell a hell of a lot of machines. It's not economic. *(continued overleaf)*



Chilton 100S

TOM REPS INTERVIEW CONTINUED

D.K. *I notice that no magazine ever had the opportunity of reviewing an R.10. To me this means that you are producing fairly small numbers and that a review would be embarrassing, or that you are perhaps a little dubious about reviewing as a procedure or, I don't know, frightened of the effects of a review.*

T.R. To what extent does a review affect the sale of a product?

D.K. *It increases them. Even critical reviews have been known to increase sales, for a while.*

T.R. With the *R.10*, we were selling virtually all we made. Towards the end there was no advantage in having it reviewed because we knew it was going to finish. With a new product, on the other hand, one doesn't like to have it reviewed initially because one likes to get it out in the field to find the dealer/customer reaction. If anything has been overlooked it normally becomes evident during the first six to nine months of production.

Let me give you an idea of a recent mod that was put on. Long pole-face replay heads tend to pick up more hum than the short pole-face type, while being virtually free of head contour effects. When your Mu-metal shield is away from the head, the hum goes up. I didn't have a short on the stop bar for the preamplifier because I thought that on rewind people would want to edit. A lot of customers found the hum objectionable, however, and also disliked hearing Chinese on rewind. We had to overcome these problems without making the recorder useless for editing, so we put a shorting switching on the pinch wheel so that when the pinch retracted it shorted the preamp, cutting the hum and rewind noise. If you want to search on rewind, you push the pinch wheel slightly forward. This de-mutes and pushes the tape slightly nearer the heads so you can hear quite clearly what is on it. So you get the best of both worlds. We had to ensure that this modification was thoroughly tested before we introduced it. It required extensive tooling even for a minor alteration like that.

With the best of intentions, I fitted a stereo headphone jack socket to take a non-shorting plug so that the two power amplifiers wouldn't be shorted when the plug was inserted. The reason I fit the headphones to the power amplifiers is because a lot of headphones are 8-ohm and this works very well with the Koss electrostatics. When the machines go out, and despite a note in the instruction manual, people insert jack plugs with a large tip, forcing open the socket contact which then doesn't work. So I have bowed down to requirements, not commonsense, and put on a socket which accepts both the large-tip and the GPO standard non-shorting one. Another example is the fact that I have increased the wrap-round on the heads now because certain tapes shed oxide and this caused a variation in output by building up close to the head gap. Increasing the wrap round ensures that any oxide build-up is well before and after the gap. Little things like that.

D.K. *How do you see the future?*

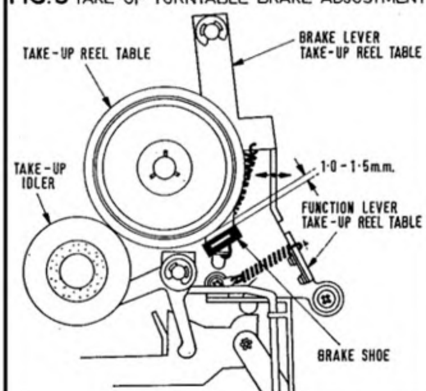
T.R. Looking back on our first year of production, I am completely confident that our terms of reference were correct. All that remains is to maintain our standards.

TAPE RECORDER SERVICE CONTINUED

R140 to ensure that it does, check that the recording level (small knob under sliding panel) is set to give you a reading of + 1 dB, that is 800 mV, on the VVM.

The *TC530* has extremely good noise performance, with system noise at better than 46 dB below 0 dB as measured from a test tape. Distortion performance up to the Line Out socket is also good by domestic standards. Looking at the foregoing paragraph, we can see one reason why; and can also find one reason for the lack of 'hiss' that besets so many

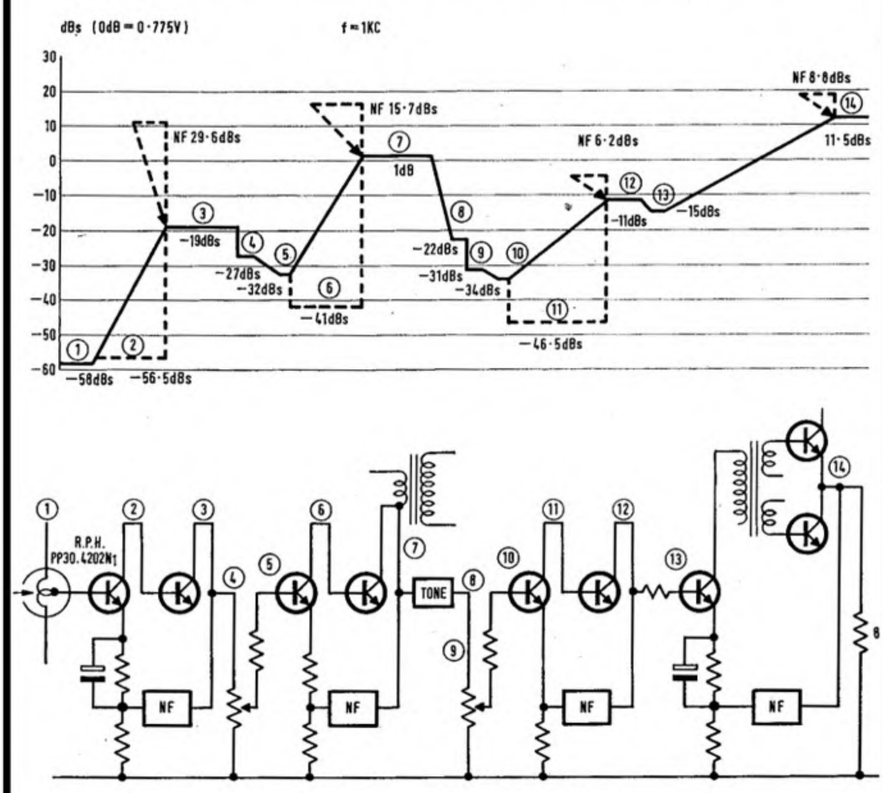
FIG. 3 TAKE-UP TURNTABLE BRAKE ADJUSTMENT



otherwise good machines. If you take record/play readings, you will note that at 19 cm/s the specifications are excellent, but, at 9.5 and 4.75 cm/s, the treble drops off as much as 5 dB in the 7 to 10 kHz region.

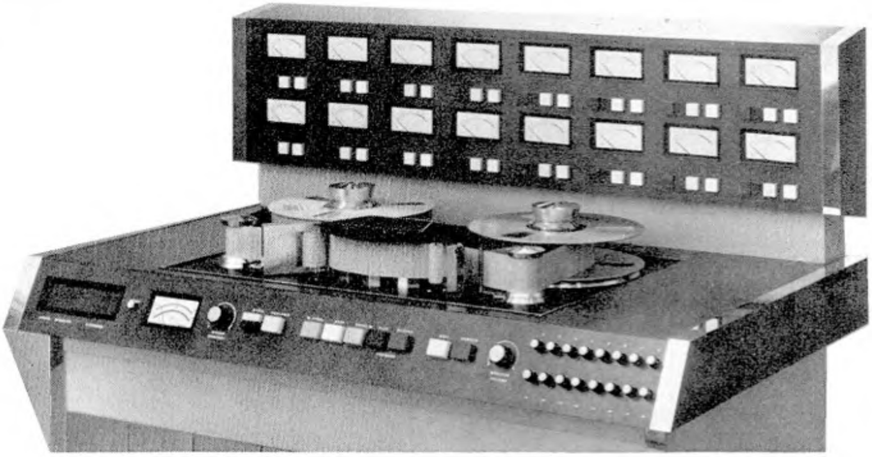
Mechanical differences on the *TC530* are quite considerable. There is a different clutch lifter and a fast forward knob by the function control that interlocks a lever and is released when the pivot returns to neutral. Record buttons are now separated, the meter is a combination type, the pause control is on the left of the deck and quite differently arranged,

FIG. 2 SONY TC530 CIRCUIT GAIN DIAGRAM. CIRCLED NUMBERS REFER TO SKELETON CIRCUIT GIVEN BELOW GRAPH



the drive system is a combination of belt and idler. and, of course, this is a three speed machine. But the most notable difference is the braking arrangement, and. as this may need attention occasionally, **fig. 3** shows the important take-up side. With the selector mechanism in the forward mode. there must be 1 to 1.5 mm. clearance from shoe to turntable.

Final notes: the erase head is fixed and the azimuth adjustment depends on tape level between right-hand guide and erase head gaps, before record/play azimuth is adjusted to suit. So *do not* move the right-hand guide—adjust the left one to bring the tape edge up to the erase head datum, then adjust the record/play head, using the screw without the spring.



UNITRACK MULTI-CHANNEL RECORDERS

A SERIES OF studio console recorders covering the 6.25 mm mono and stereo, 25 mm four-channel and eight-channel, and 50 mm eight-, sixteen- and 24-channel formats has been announced by the recently formed Unitrack Equipment Ltd. The basic mechanism operates at 38 and 19 cm/s, driven by a printed circuit servo motor, phase locked to a crystal oscillator. Models *Uni 8-2* (eight-channel 25 mm), *Uni 16* (16-channel 50 mm) and *Uni 24* (24-channel 50 mm) incorporate an additional oscillator, variable frequency, providing continuously variable speed between 76 and 9.5 cm/s. This is mounted in an oven to achieve a claimed 0.1% frequency stability. Wow and flutter at 38 cm/s are 0.06% RMS integrated, 0.04% RMS at 76 cm/s. Absolute speed stability (crystal clock) is 0.05%. Photo-electric sensors are employed on each side of the head assembly and activate a closed loop servo. A differential dual capstan system is coupled to the motor by a belt. Separate motors are provided for forward and reverse wind, with controlled back tension throughout the reel. Mishandling is overcome by a four-layer diode memory in the mode selection circuit.

Frequency response at 38 cm/s is 30 Hz to 18 kHz ±2 dB for 62 dB signal-to-noise ratio (+4 dBm output) and 0.5% THD at up to +18 dBm output. Crosstalk is 54 dB at 1 kHz, 52 dB at 10 kHz. Bias frequency is 180 kHz, the erase current being divided to 60 kHz. The line sending amplifier (Class A) supplies up to +24 dBm before clipping, all inputs and outputs being designed for 0 dBm 600 ohms balanced operation. Equalisation is NAB, IEC or CCIR to order, by plug-in card. Connectors are Switchcraft *Audio*, compatible with Cannon *XLR*. Dimensions of the *Uni 16* illustrated are 1270 mm (total height) x 1144 mm wide and 673 mm deep. Deck height is 915 mm from the floor. Weight is 254 kg.

Manufacturer: Unitrack Equipment Ltd., 590 Wandsworth Road, London S.W.8. (Tel: 01-720 1124).

ELCOM 4 W AMPLIFIER MODULE

THE GPA MODULE, newly announced by Elcom, is a low power general purpose amplifier constructed on a printed circuit board and suitable for ISEP rack mounting. Minimum input level for 4 W output is 20 dBm (100 K input impedance). Distortion at this output is 0.3% (*GPA 24*) or 0.1% (*GPA 50*). Noise level is −100 dB and frequency response is 30 Hz to 20 kHz ±1 dB. Output impedance (AC coupled) is 7.5 ohms (*GPA 24*) or 15 ohms (*GPA 50*). Balancing transformers to suit 3, 7.5 and 15 ohm loudspeakers are available. The GPA units require a stabilised DC supply of 300 mA at 50 V on full load, or 550 mV at 24 V. Quiescent consumption is 50 mA at 50 V, 40 mA at 24 V. The operating voltages are specified in the type number.

Manufacturer: Elcom (Northampton) Ltd., Weedon Road Industrial Estate, Northampton. (Tel: 0604 34251).

MULTI-CHANNEL RECORDER ALIGNMENT UNIT

A TENFOLD SAVING in the time required to set up multi-channel tape recorders is claimed for the *D.R. Alignment Unit* by James Scott Ltd. Although initially designed for use with Ampex *ES100* instrumentation equipment, it is described as suitable for other recorders. The unit may be employed in the adjustment of bias, signal-to-noise ratio, record level for 2nd and 3rd harmonic distortion, unity gain playback level, and frequency response. The 2nd harmonic test facility is included since, if greater than 1% distortion, it implies magnetised heads or guides. Tape speeds of 304 down to 2.325 cm/s may be accommodated. Dimensions are 364 x 237 x 213 mm.

Manufacturer: James Scott (Electronic Engineering) Ltd., Carntyne Industrial Estate, Glasgow, E.2.

EIGHT-TRACK STUDER

PRELIMINARY DETAILS of the Studer *A 80-8-1* have been announced by EMT. A development of the 4-track *J 37-4-1*, the new model provides eight tracks on 50 mm tape and will be ready for delivery during the second quarter of 1970. Facilities include 38 and 19 cm/s speeds, selsync monitoring, full remote control, remote tape time indication, continuously variable forward and reverse wind, low-wear *Alfenol* heads, and electronic supply and take-up tension operative during normal drive and fast wind. A memory circuit is incorporated in the mode switching. **Distributor: F. W. O. Bauch Ltd., Holbrook House, Cockfosters, Barnet, Herts. (Tel: 01-440 3277).**

FOUR-INPUT STEREO MIXER

A STEREO MIXER designed basically to accept one stereo pair and two pan microphones is now being produced by Soundex Ltd. Model *4S* accepts 70 μV at 25 to 60 ohms or 180 μV at 150 to 600 ohms (switchable) for an output of 125 mV (250 mV stereo) into 10 K. Maximum output is 4 V, input stage overload being more than 45 dB above the rated level. Distortion at up to 40 dB above rated input is 0.25% (1 kHz) and crosstalk is better than −55 dB. Frequency response is 20 Hz to 20 kHz ±2.5 dB. Three-pin jack sockets are employed at each input to take balanced or two-pin unbalanced plugs. Two-pin output jacks and a five-pin DIN socket supply the output signal. Front panel controls comprise an on/off power switch, mono/stereo switch, four microphone gain controls, one stereo pair control, two pan controls and a master gain. The unit operates from two Ever-Ready *PP9* batteries or equivalent, or from an 18 V 25 mA external supply. Price is £45 plus 12s. 6d. carriage and packing.

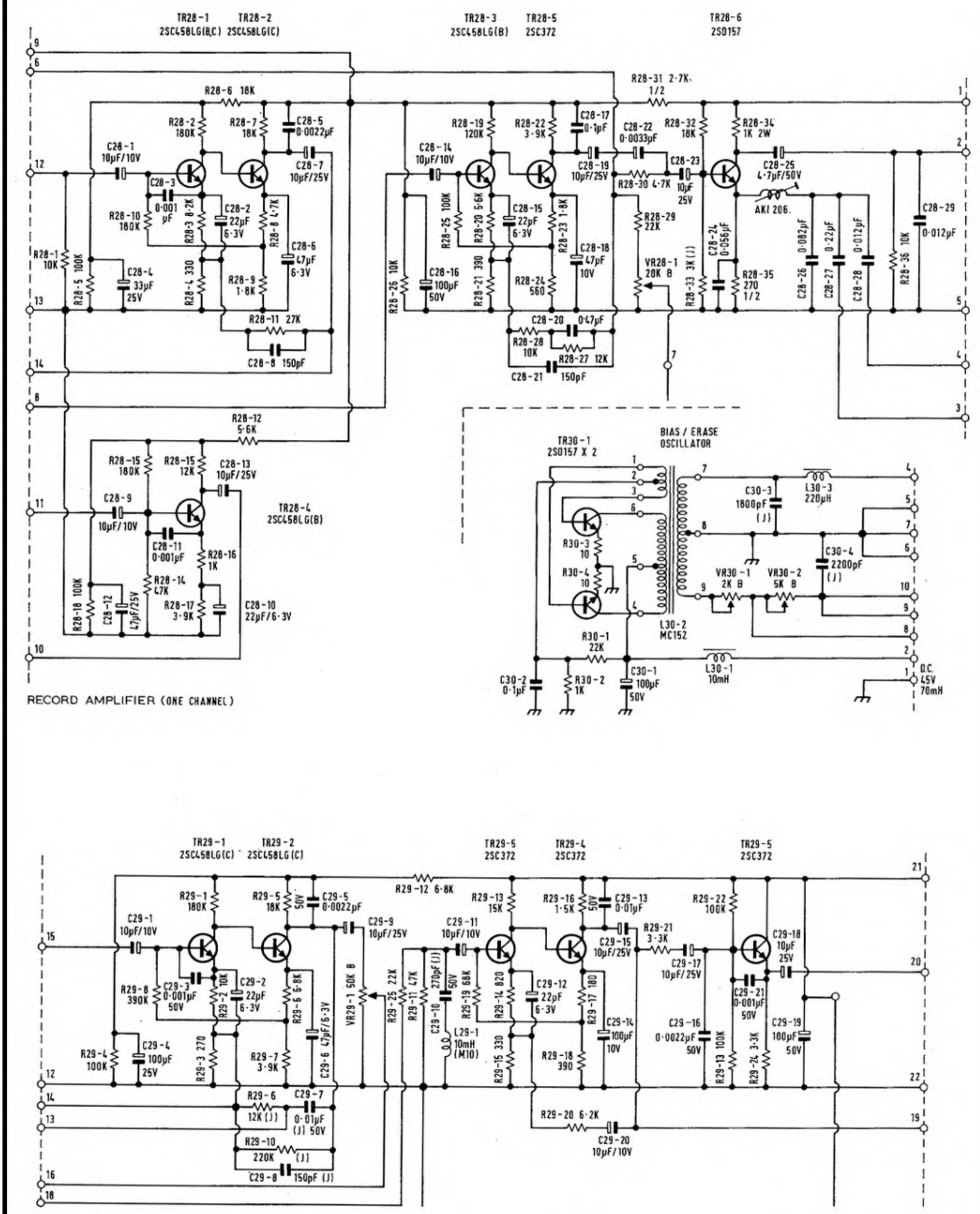
Manufacturer: Soundex Ltd., 18 Blenheim Road, London W.4. (01-995 1661).

AUDIO FADERS

COMPLIMENTING THEIR EXISTING range of studio faders, Penny & Giles have introduced a new low-cost series for mobile installations, semi-professional mixers and (Thyristor controlled) studio lighting. The slide track is 76 mm with a claimed 0.06% resolution. Maximum resistance values of available models are from 500 ohms to 40 K, 2 W.

Manufacturer: Penny & Giles Ltd., Mudeford, Christchurch, Hampshire BH23 4AT. (Tel: Highcliffe 2233).

FIG. 1 AKAI X360



RECORD AMPLIFIER (ONE CHANNEL)

PLAYBACK PREAMPLIFIER (ONE CHANNEL)

equipment reviews

AKAI X360 STEREO

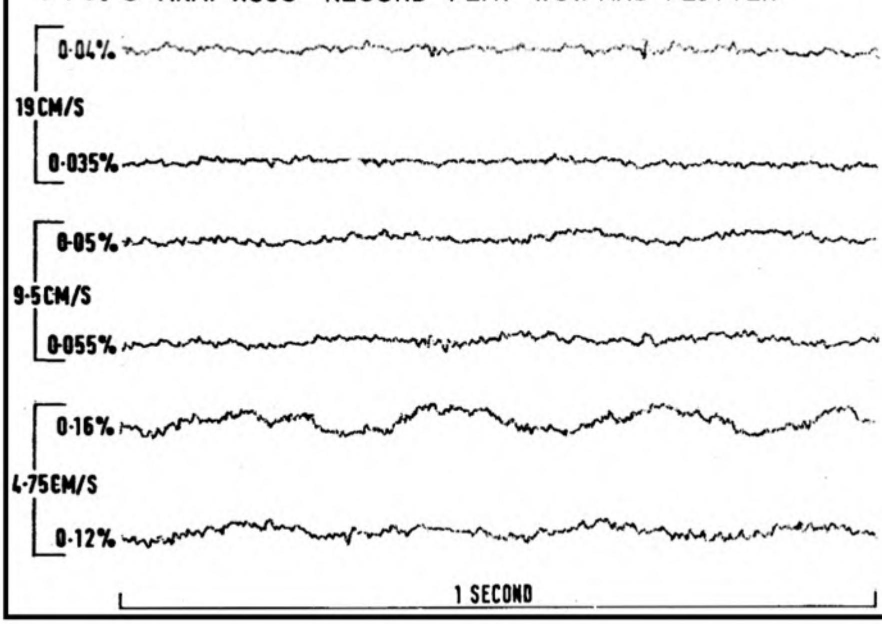
MANUFACTURER'S SPECIFICATION (Scotch 202 at 19 cm/s). Quarter-track stereo recorder with side-facing loudspeakers. **Tape transport:** Direct capstan drive from three-speed hysteresis synchronous capstan motor, separate induction motors for forward and reverse wind. **Wow and flutter:** 0.04% RMS. **Spool capacity:** 18 cm. **Frequency response:** 30 Hz to 20 kHz ±3 dB. **Signal-to-noise ratio:** 50 dB. **Distortion:** 1.5% at 1 kHz. **Equalisation:** NAB. **Tape speeds:** 38 (with sleeve, not equalised), 19, 9.5 and 4.75 cm/s. **Bias frequency:** 100 kHz. **Modulation indicators:** Twin meter. **Microphone input:** 0.5 mV at unspecified impedance. **Auxiliary input:** 50 mV at unspecified impedance. **Auxiliary outputs:** 0.4 or 1.23 V at unspecified impedance. **Headphone output:** not specified. **Sockets:** unbalanced jack (microphone), phono and DIN (auxiliary), three-contact jack (headphone). **Tape heads:** Erase, record, bias and play. **Dimensions:** 444 x 406 x 254 mm. **Weight:** 25 kg. **Price:** £359 (287 2s. 10d. plus p.t.). **Manufacturer:** Akai Electric Co. Ltd., 12, 2-chome, Higashi-Kojiya, Ohta-ku, Tokyo, Japan. **Distributor:** **Pullin Photographic Ltd., 11 Aintree Road, Perivale, Greenford, Middlesex.**

THIS technical review should be read in conjunction with David Kirk's Field Trial report of August this year. If ever there was a status symbol tape recorder then surely this is it. It is studded with gimmicks and gadgets which contribute little to the final recordings but can be used to impress even a technical visitor by the sheer profusion of automatic and semi-automatic facilities. There is an indicator light that comes on when the heads need cleaning (this costs nine transistors and three diodes), and a servo system (eight transistors, four diodes and an electric motor) which turns a ganged gain control up and down to avoid tape overload. The automatic reversal of tape direction, which can be preset on the top central dial, has been seen before on the *X355* and its predecessor the *345*.

The full circuit diagram, with switching and interconnecting wiring, covers about a square metre so we have selected the circuits of the main printed circuit boards for reproduction in

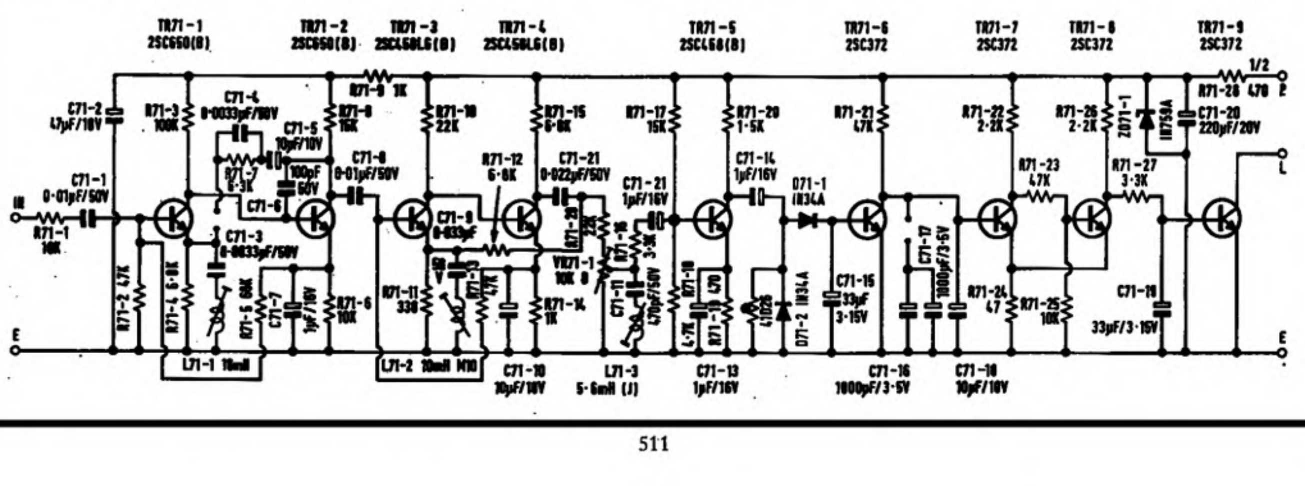
(continued overleaf)

FIG. 3 AKAI X360 RECORD-PLAY WOW AND FLUTTER



'DUST MINDER' CARD (AKAI X360)

FIG. 2



figs. 1 and **2**. The power amplifier, omitted for reasons of space, uses an interstage drive transformer to feed two emitter-followers which in turn drive the main output transistors. Feedback is applied over four stages to reduce harmonic and crossover distortion.

We shall be referring later to the record amplifier which has NAB bass-lift by feedback over stages three and five, with medium-high pre-emphasis by interstage components C22 and R30. Extreme treble pre-emphasis is by a series tuned circuit across the emitter resistor of the output transistor (inductance *P-10L* and capacitors 26, 27 and 28 which are brought into circuit by the speed switching).

In the playback preamplifier, the time-constant is set by frequency selective feedback over stages 1 and 2. The components shown give the 9.5 cm/s 90 μS equalisation, with external resistors switched in for the other speeds.

The wow and flutter performance of the *X360* shows considerable improvement over the *X355*, with total cumulative wobble not exceeding 0.04% RMS at 19 cm/s. At 9.5 cm/s the highest reading obtained was only 0.055% and, at the lowest speed of 4.75 cm/s, the worst reading was 0.16% where the 4 Hz capstan wows happened to coincide on record and play. The fluttergrams of **fig. 3** show negligible high frequency flutter and no perceptible wow at 19 cm/s; only the very slightest trace of wow at 9.5 cm/s; and which could be heard on a sustained tone at 4.75 cm/s but which was not at all likely to be obvious on programme material recorded at this speed.

The playback equalisation is very close to NAB standards at the three speeds shown in **fig. 4**. Only at 9.5 cm/s is there a slight droop at 10 kHz. Note that the equalisation remains at 50-3180 μS for the two highest speeds of 38 and 19 cm/s.

Unweighted system noise was −52 dB (upper track) and −60dB (lower track) when compared to the output of the 32 mM/mm reference level tape. This was due to very slight hum pick-up from the motor on the top track. When weighted to the IEC 'A' curve, to simulate the ear's response at low sound levels, the system noise was −62 dB on both tracks. Bulk-erased tape was −61 dB and tape erased and biased on the machine with record gain controls at zero was −58 dB.

Recording tests on BASF *LGS35* tape showed evidence of underbiasing, as the recorded signal level was still increasing when the bias was raised to the limit of the preset controls VR1 and VR2 on the oscillator panel. This was confirmed on other tapes including the specified Scotch *202*. It was then decided to reduce the spacing of the back-bias head to increase the bias flux through the tape. It was found that optimum spacing was within the specified 200 to 250 μm quoted in the service manual. It was now possible to over-bias the tape at any speed by means of the preset controls. The bias was therefore set for minimum 3rd harmonic distortion at 1 kHz 19 cm/s at 32 mM/mm, reference tape level and this proved to be at an all time low of 0.8% which was exactly the distortion level on the DIN *45513* reference tape itself.

Record/play tests at 19 cm/s showed that high note pre-emphasis was rather overdone, and adjustment of *P-10L* in the series resonant circuit mentioned earlier made very little difference. Even short circuiting the coil completely only reduced the high note rise to that shown by the dotted curve of **fig. 5**. Considerable over biasing dropped the 20 kHz response to 1 kHz level but only at the expense of a dip in the 3 to 8 kHz region and a general drop in level. It would therefore seem that the pre-emphasis has been designed to match Japanese tape which generally has a thicker oxide layer with relatively poor extreme high note response. It is not very often that we have to complain about *too much* extreme high note response and indeed, for 'round the corner' listening on the side-facing speakers fitted to this recorder, the extra treble is very useful, But with certain types of programme material played into wide range external speakers, there could be complaints of hiss or fizz from younger listeners with a hearing response extending to 20 kHz. Perhaps the cunning Oriental designers realised that potential customers for the *X360* would probably have to be above 50 years of age to be

FIG. 4 AKAI X360 PLAY-ONLY RESPONSE (NAB TEST TAPES TO LINE OUTPUT)

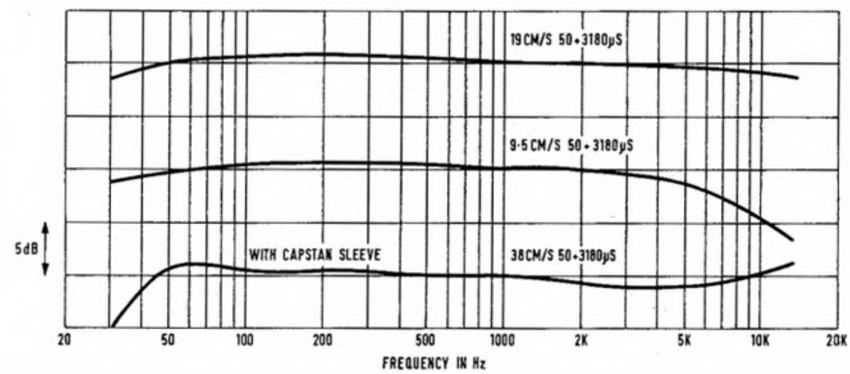


FIG. 5 AKAI X360 RECORD-PLAY RESPONSE (LINE IN, BASF LGS 35, LINE OUT)

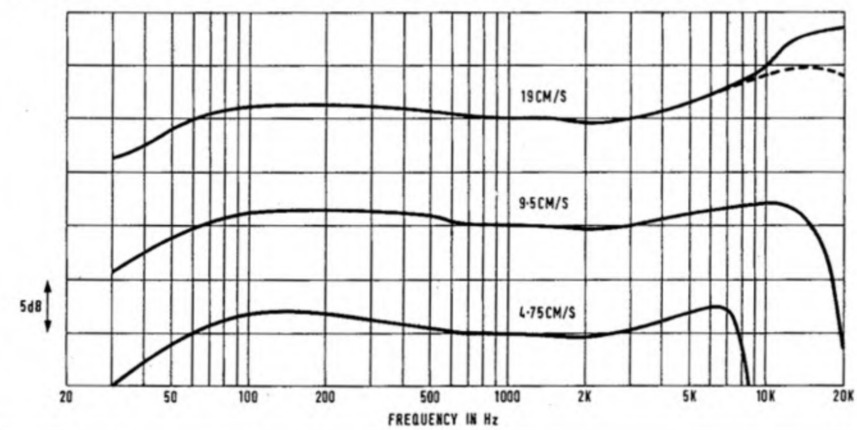
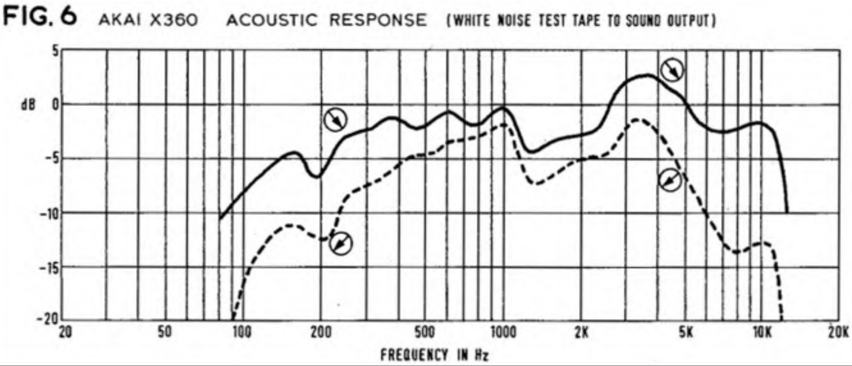


FIG. 6 AKAI X360 ACOUSTIC RESPONSE (WHITE NOISE TEST TAPE TO SOUND OUTPUT)



able to afford one anyway!

Fig. 6 shows the effect of the tone controls on the overall acoustic response which was measured by playing a white-noise test tape and measuring the axial sound output of one of the speakers in one-third octave bands at the extreme settings of the bass and treble controls. Full bass and treble gave the best results on the *X360* internal speakers.

COMMENT

I am impressed, as any engineer would be, by the sheer technical complexity of this machine and the fact that all the gadgets seem to work and continue working. Impressed, too, by the extremely good signal-to-noise ratio and short-term speed stability, and by the extremely low level of tape distortion when the bias is correctly adjusted.

I am not at all impressed by the price, which is far too high for a domestic recorder. It cannot by any stretch of the imagination be classed as a professional or even semi-professional instrument, except perhaps as an endlessly repeating playback machine or for use in the entertainment or catering industries.

The Akai *X360* certainly demonstrates very convincingly that it is possible to record a very wide frequency response with extremely low tape distortion using back biasing. *But* let it be remembered that, as submitted for review, the bias was *not* set to optimum level, and David Kirk's note about Gilbert Briggs' bias modification would seem to indicate that it is normal practice for Akai to issue them in an underbiased condition.

A. Tutchings

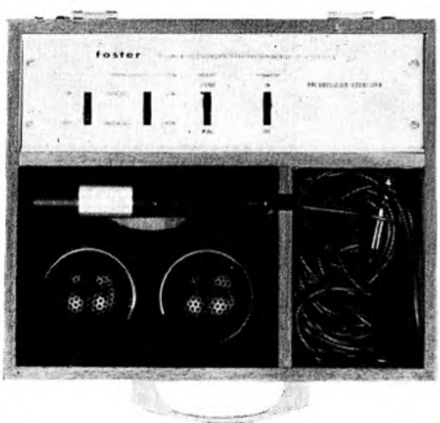
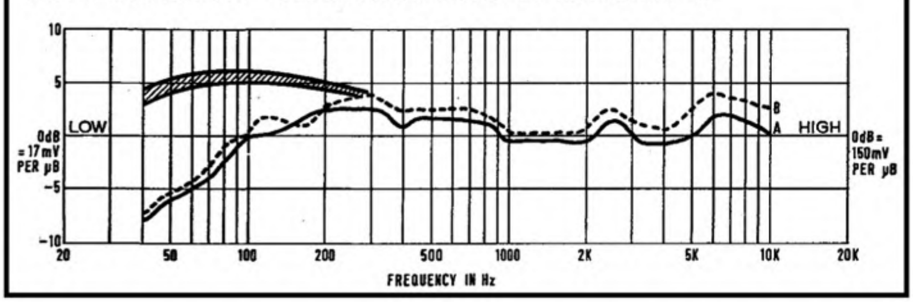


FIG. 1 FOSTER FSA-1 STEREO MICROPHONES AND PREAMPLIFIERS



FOSTER FSA-1 MICROPHONES

MANUFACTURER'S SPECIFICATION. Low-price stereo moving-coil microphone system with preamplifier/equaliser unit, windshields and table stands. **Sensitivity:** 0.2 V for 100 dB sound pressure level (low gain) or 80 dB SPL (high gain). **Preamplifier/equaliser gain:** 45 dB or 65 dB at 1 kHz, switchable. **Frequency response (low gain):** 25 Hz to 15 kHz ±2 dB. **Microphone Impedance:** 200 ohms. **Output impedance:** 250 ohms or 3 K (stereo); 10 K mono. **Distortion:** 1%. **Power supply:** 14 to 18 V DC. **Price:** £19 10s. **Distributor: B. H. Morris & Co. (Radio) Ltd., 84-88 Nelson Street, London E.1.**

THE microphones and associated transistor preamplifiers, together with two well designed spherical windshields, are contained in a dark wood box measuring approximately 280 x 250 x 100 mm fitted with a chromium plated handle and lid clips. The lid can be removed by unhooking at the hinges.

A panel along the back of the case contains four rocker switches which are labelled from left to right: Channel A Low/High Gain, Channel B Low/High Gain, Stereo/Mono and On/Off.

Each microphone is fitted with 6 m of lightweight screened cable terminated in an unbalanced jack plug. A rectangular compartment holds the coiled microphone leads and the two small 9 V batteries for powering the preamps. The rest of the case consists of padded seats for the stick microphones and the wind shields.

At high gain, the amplifiers have a level response from 40 Hz to 25 kHz within 1 dB. The microphones have a sensibly level response from 200 Hz to 10 kHz within ±2 dB. The preamp output is 150 mV for a sound pressure

at the microphone of 1 μB. The lower curve of **fig. 1** shows the high gain unequalised response of the microphones plus preamplifiers. The unweighted noise level under these conditions is 28 dB below 150 mV. Weighting the noise to the IEC 'A' curve, to simulate the ear's response at low listening levels, improves the reading to 34 dB below 1 μB (74 dB above sound threshold). In other words the amplifier noise is at 40 phons compared to 22-25 phons for a high quality capacitor microphone.

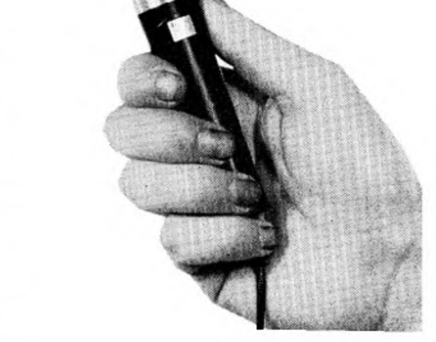
Amplifier distortion is below 1% up to 3 V output, rising to 3% at 5 V output. Thus the effective sound level for 3% distortion is 104 dB.

At low gain, the gain of the amplifiers is reduced by about 18 dB with a 12 dB bass rise from 300 Hz to 30 Hz to give the overall response shown in **fig. 1.** The overload point is thus increased by 18 dB to 122 dB above threshold, and IEC weighted noise is increased slightly to 42 phons due to the rise in bass response.

COMMENT

The microphones proved to be non-directional and can therefore only be used for spaced stereo recording. Their most obvious application is to boost the extreme left and right of a conventional stereo pair recording. They gave worthwhile results when tested in this manner but a slight dirtiness at the extremes betrayed their presence. Amplifier noise was audible at low sound levels.

A. Tutchings



AZIMUTHING WITH WHITE NOISE

BY ANGUS McKENZIE*

UP to recently, the replay heads of all tape recorders have had to be azimuthed using test tapes with a high frequency recorded over the entire width of the tape. The best way of using these tapes with a stereo recorder has been to examine the wave form from both tracks independently on a double beam oscilloscope, rocking the head so that not only are the two traces of maximum height, but also the top of each cycle is coincident.

The procedure followed when no oscilloscope is available has usually been to parallel the outputs and adjust the azimuth for peak output from the two channels. Unfortunately some inexperienced people have often adjusted azimuth on the wrong peak.

Some years ago I spent some time myself on finding a way to increase the accuracy of azimuthing, and proposed the use of white noise. I have used this technique for a considerable time now, and at last BASF have produced a professional test tape including a white noise azimuth section, which I find extremely simple to use.

Up to recently I have used the hiss from a tuner into the recorder to adjust the record head azimuth, and I have found the azimuth peak to be extremely narrow, a slight incorrectness resulting in a drop of extreme top, and further error resulting in very obvious cancellations at various sharp bands of frequencies.

An inexpensive white noise source has not to my knowledge been available in the past, and I would particularly like to recommend an inexpensive device marketed by a firm supplying mainly radio amateurs, namely Radio Shack Ltd., 182 Broadhurst Gardens, London, N.W.6. This device is in fact an antenna noise bridge designed to determine the resonant frequencies of radio aerials, together with their impedance. Since it contains an amplified white noise source, the main output can be simultaneously fed into the two stereo inputs of a tape recorder, and used as previously explained for very accurate azimuth. It will be found that the use of this device, which costs £13 10s will not only cause the user's tape recorder to be very accurately aligned from record to playback, but will also improve the variation of high frequencies that are sometimes wrongly thought to be drop-outs.

Perhaps some enterprising firm will make a simplified form of this device for the purpose. In the meantime I recommend the unorthodox use of the *Omega Noise Bridge*, as it is called. The use of an FM tuner will not be anywhere near as accurate because of course the de-emphasis in a tuner decreases the hiss as the frequency increases, which is opposite to the effect that one really needs.

*Roundabout Records

A DUBBING BOX CONTINUED

tone control stage, it may well be worthwhile making it a compound-connected pair (**fig. 8**) with a low-current low-noise transistor as the first of the pair in order to keep noise down and make the stage able both to produce a fair current output and maintain a good signal-to-noise ratio at low input levels. This principle may be applied elsewhere if noise problems are encountered.

Filters are another facility which may be required, both high pass to remove rumble and low pass to filter off hiss, distortion and HF peakiness. Basically there are two approaches—passive and active filters. Tuned LC circuits are perhaps the most popular means of producing passive low pass filters, but they have their snags; in particular the problem of accurately winding inductances if one does not own a suitable bridge, providing the correct terminating impedances and avoiding hum pick-up in the coils. Since one may well end up using a buffer stage, a switched active tone control is likely to be no more complicated. **Fig. 7** shows a Mullard circuit for active low pass filtering which has been combined with a high pass rumble filter by the use of small coupling capacitors in the circuit. If high pass filtering is not required, these components may be increased in value so that the cut-off comes below any frequencies in which one is interested. The low frequency cut-off as drawn is 45 Hz, and the high frequency cutoff frequencies are 16, 12 and 7 kHz. An additional position using 56 pF capacitors could be provided for anyone who seriously believes he will be losing much above 16 kHz. The response is about 3 dB down at the cut-off frequencies, with a slope of approximately 13 dB per octave above.

The tone control and filter circuits may be placed in tandem, and followed by an attenuator and buffer stage.

Most of the circuits suggested could conveniently be battery driven as this simplifies hum and portability problems. The exception would be the modified **fig. 3** to drive a balanced output at high levels, since considerable current must be available. However, if this is required, a simple mains power supply could easily be provided.

I am grateful to Mullard Ltd for permission to reproduce circuits from their booklet *Audio Circuits Using 'Lockfit' Transistors* (the alternative transistors are my own suggestions) and those associated with their earlier valve designs.

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AN OCCASIONAL COMMENTARY BY DROPOUT

BEING ever a man to take his own advice, I recently sallied forth and acquired a Ferrograph *634*. It is new, in the sense of being unused, and of course a very late one. Indeed, I like to think that it is the last of its kind to be made. I have christened her 'Evening Star', after the last of the steam locomotives; and there she sits beside an ageing *Series 4*, a machine which, despite years of thrashing, still gives a very good account of herself. Now, if I could get hold of a good *Series 6* deck, and renew the youth of the *4*, I should be set up for years, should I not?

Be that as it may, there is something comforting about the sight of those two machines: a tradition, an era, a relic of British craftsmanship. Above all, perhaps, a link with my own recording past: memories of all those sessions in draughty or stifling halls; of memories preserved in the rows of tape-boxes in the shelves—the voices and the music of some now dead, oddments of moments now forgotten until the tape recalls them: getting up in the dark to record the dawn chorus; the voices of nightingales ringing over the valley on still nights. Is this all nostalgic rubbish? I think not; and I also think that it is not the least of the services of the tape-recorder that it makes such memories live through the years.

A few months back I issued a challenge to recording clubs to disprove David Kirk's appellation of 'god-forsaken'. I expected a flood of angry achievement; but I have received only two letters—only two from a whole movement, if I may believe that what I write is read—a large assumption, perhaps. One of the letters described a lecturing technique adopted by one club when it accepts invitations to demonstrate its craft; the other, significantly, came from a man who is totally blind. It was written by his wife, who described how together they make complex tapes, he finding the spot for the cut, and she making the splice. Amongst other things, he is an accomplished musician on a number of instruments and won a special award in the National Contest for a tape submitted by a handicapped person.

If that were all, I should give David best, and banish God from the ranks of recording clubs. But I happen to know that that is *not* the whole story: in a connection quite different from this column, I received a letter from one club to which some of my own recordings had been played. It contained a request that some of the material might be used in a programme for the handicapped, which that club—or some of it—produces regularly. Naturally, I was delighted; and there must be many other ventures of the same kind going on all the time—indeed, I know of some myself.

One should not boast about such things, or about any other small services one may render to any cause, but it does seem to me a pity that all these good works are carried on in isolation, when we might all be helping each other. Work of this kind can quite easily get beyond the scope of small groups working alone and a degree of cooperative organisation could help to prevent breakdowns.

The fact is that it is not realised, when these projects are cheerfully started, how much of a sheer chore they can become as time goes on. The ready volunteers of the early days fall by the wayside and move on to other things, or nothing, and a very small band can be left carrying the can. Being one of such a band, I know!

I am therefore going to offer myself as a clearing-house, if anybody would like to take advantage of it. If I could know who is doing what, it might be possible for me to put in touch groups who could help each other; and if there is any club which does not undertake work of this kind, but which would be willing to help, for example, in dubbing circulation copies, I might be able to set them to work. Having, for more than eight years now, been privileged to witness the good that these things can do, I should greatly like to extend the range of them. In that way, God might return, and all that lovely gear might reach out to a fulfilling purpose.

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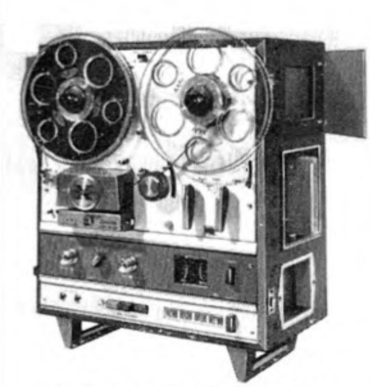

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