No. 10 - Autumn 1982

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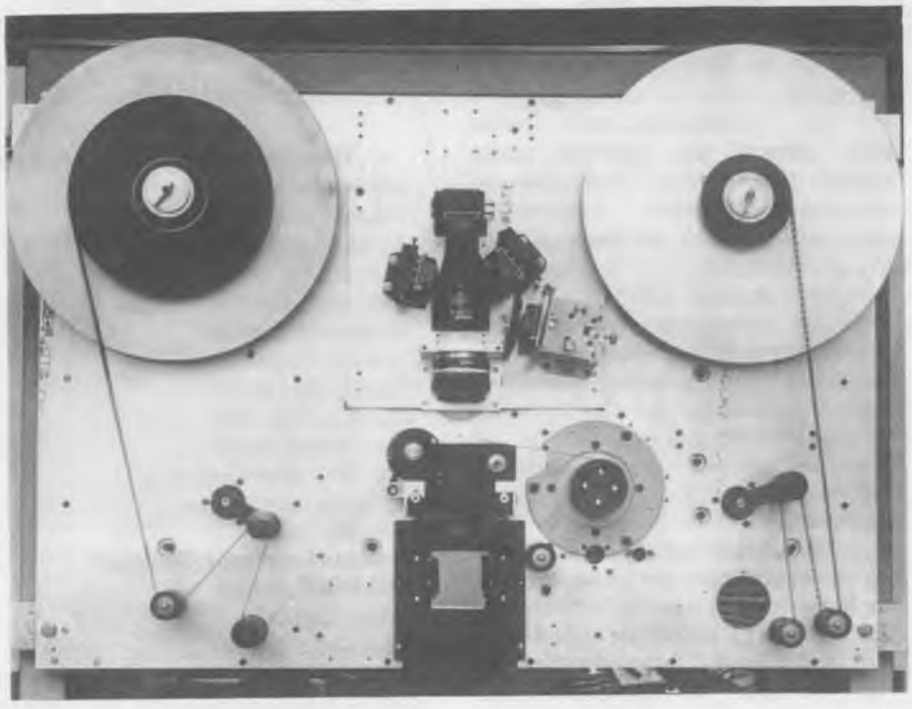
ENG INF

The Quarterly For BBC Engineering Staff

BBC helps Rank Cintel



View of the prototype line-array telecine.

On the eve of the International Broadcasting Convention in Brighton came the announcement of two important agreements between the BBC and Rank Cintel. The first was the result of a collaborative agreement for Research Department to conduct research into improvements into film transmission techniques as applied to telecine machines. This has resulted in some novel features that will be incorporated into Rank Cintel machines. The second agreement allows for the manufacture under licence of the studio stills store (described in Eng Inf No. 8) and now to be marketed under the name of "Slide File".

Line-Array Telecine

Engineers at Kingswood Warren have been conducting research into the use of solid-state image sensors in broadcasting since the end of 1972. Although solid-state sensors have still not found a place in broadcast-quality television cameras, domestic television cameras based on their use are now obtainable. However, it was recognised from the outset that they could find an earlier application in the televising of films. This is because the motion of the film as it runs through the telecine can be used to provide one of the two television scans; thus a simpler solid-state sensor, consisting only of a single line of around 1000 picture elements can be used, as compared with a two-dimensional array of nearer 0.5 million elements which would be required for television camera applications.

Although the flying-spot scanning method using a CRT and photo-multipliers is preferred for post-production work, the latest line-array sensors are capable of producing broadcast quality pictures and offer several advantages over camera-type and flying-spot systems:

'continued on Page 8'

In this edition of ENG INF

Editorial

The reputation and standing of the BBC engineers has, once again, been enhanced by their contributions at the recent International Broadcasting Convention. Hardly any delegate or visitor could fail to be impressed by the high standard of technical papers or quality of engineering exhibits. This hard won reputation should be guarded closely, and not allowed to slip. The introduction of cable television, and additional satellite channels in the not too distant future will undoubtedly provide a challenge to the BBC.

IBC always produces its lighter moments amongst the serious discussions. Someone suggested that the 1/20th scale model of L-Sat, being used to demonstrate our involvement in DBS, be made to rotate; the air-draught thus caused could be used to cool the exhibits (and staff) down. Congratulations must be extended to Don Kershaw for winning, of all things, a VHS recorder in a competition on the Ampex stand!

Stereo Sound

For some time both viewers and industry alike have been asking when the BBC would start stereo sound transmissions with television (see elsewhere in this edition). It must be emphasized that the *experiments* now taking place are just that. There is absolutely no guarantee that this system, or any other, will be adopted by the BBC. Everyone will just have to be patient and await the outcome of the Research Department experiments.

Engineering Ties

For those engineers who are interested, Designs Department have just produced a "BBC Engineering" tie. They are available in blue or maroon, and feature the BBC logo, engineering lion logo, and the word "engineering" woven onto the background. They cost £2.75, and can be obtained by writing to me at 701 Henry Wood House, stating colour preference. The next batch will take about six weeks to manufacture and deliver.

Alan Lafferty

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ENG INF 1983

The final dates for sending stories for inclusion in Eng Inf are as shown. Engineers with information should contact Alan Lafferty on LBH 5432 or Room 701 HWH.

Spring - March 4th
Summer - June 3rd
Autumn - September 2nd
Winter - November 25th

Merriman Report

Earlier this year in June, the Home Secretary, in a written Parliamentary reply, set up an independent review of the radio frequency spectrum from 30-960 MHz.

As part of the review he charged the Chairman, Dr. J.H.H. Merriman CB, OBE, F.Eng. and his committee, Air Vice Marshal, A. Foden CB, CBE and P.M. Vine, Esq., CBE, DL, to make a recommendation with some urgency by September 1982 on the future usage of tv Bands I and III.

The Committee recently reported back to the Home Secretary, and the substance of their recommendations were that;-

(i) Continuing, even accelerating, demand for spectrum space requires the maximum exploitation of emerging alternative technologies wherever practicable and major changes to current usage.

(ii) Bands I and III, with their particular propagation and coverage qualities, should increasingly provide the main radio frequency spectrum areas of exploitation for a combination of mobile services and services in operational support of broadcasting, with priority when necessary for mobile services.

(iii) Britain's television broadcasting services (whether for picture or text) are likely to be best served to the end of the Century by maximum exploitation of, and earlier concentration of resources upon, the emerging combinations of uhf, satellite and cable services.

In implementing this strategy, they recommended:-

(iv) 405 line tv services be closed by the end of 1984;

(v) a revised mobile radio frequency allocation plan be developed in consultation with manufacturers and users by the end of 1983;

(vi) a revised broadcast ancillary services radio frequency allocation plan be developed in consultation with Broadcasting Authorities by the end of 1983,

In responding to the report, the BBC regretted the recommendation that television broadcasting should be withdrawn from Band I and III for all time. Although there is no identifiable demand for broadcasting in these Bands, pressure could develop for local or area broadcasting that could only be accommodated in these Bands.

However, the BBC was pleased to note that the importance of broadcasting ancillary, services such as OB communication links, had been recognised. The lack of available ancillary service frequencies could seriously affect the cover given to important national events.

The recommendation for earlier than planned closure of Band I and III stations will mean a loss of service to viewers in remote areas who are still dependent upon vhf signals. Many of these viewers will eventually be able to receive uhf signals off air from newly constructed relay stations. However, there will be some time when they will be deprived of a service entirely.

Transmitters Opened

The following uhf relay stations have opened since July:
Polperro, Cornwall
Aislaby, North Yorkshire
Ogbourne St. George, Wiltshire
Hartland, Devon
Mevagissey, Cornwall
Bossiney, Cornwall
Swimbridge, Devon
Boscastle, Cornwall
Over Norton, Oxon
Holmfield, West Yorkshire
Hangleton, East Sussex
Rye, East Sussex
Wootton Courtenay, Somerset
Micklefield, Bucks
Orton, Cumbria
Afon Dyfi, Powys
Thurso, Highland
Banff, Grampian
Strathblane, Central
Ness of Lewis, West Isles (Highland)
Dumfries South, Dumfries & Galloway
Largs, Strathclyde

Vhf

Exeter, St. Thomas, Devon

* * *

The crowded BBC stand

BBC engineers played an important part in the 9th International Broadcasting Convention (IBC) held, once again, in Brighton from September 18th to 21st. Seventeen papers, covering technical subjects from solid-state sensors to satellite broadcasting, were read by engineers from specialist and operational departments. Reviewing the impact of new broadcasting technology on future broadcast services, Charlie Sandbank (HRD) spoke at some length on Direct Broadcasting by Satellite (DBS), digital television, the role of the microprocessor in broadcasting, and high definition television.

Some of the new technology mentioned in HRD's paper was on display in the accompanying exhibition. Twelve exhibits from Research, Designs and Engineering Training Departments provided a lively demonstration inside the crowded exhibition halls. Outside on the promenade three OB vehicles created much interest to both conference delegates and general public alike. Space inside the exhibition halls being at a premium, one vehicle from Radio OBs, also contained some interesting new technology from Research and Designs Departments.

Details of the exhibits are given elsewhere in Eng Inf, but are summarised here.

From Research Department came a demonstration of high-quality text used to demonstrate improvements in alpha-numeric fonts. The studio stills store, recently licenced for manufacture by Rank Cintel Ltd., and borrowed from Television Centre for the exhibition, was used to demonstrate how live pictures could be "grabbed" and stored; these included some startling pictures from the Type 5 CMCR on the seafront! Many visitors were attracted to the demonstration of Extended PAL which was freely available for discussion with the specialist engineers on the stand. A prototype Teletext adaptor for the BBC microcomputer allowed visitors the chance to see Telesoftware in action.

Using signals specially radiated from the Rowridge vhf transmitter, research engineers demonstrated the full potential of "Radio-data", the experimental system used for station identification and programme labelling. The studio part of the Radio OB vehicle on the seafront was used to demonstrate an automatic reverberation timer developed by Research Department.

Many of the equipments featured by Designs Department on the exhibition stand were available for licence by British manufacturers. The ME3/502 TV waveform analyser (see Eng Inf No. 8) was coupled to a digital fibre-optic link, and visitors were able to test both exhibits simultaneously. The 2kW Band II amplifier, recently licensed to Eddystone Radio Ltd., dominated one corner of the exhibition, and created much interest. Also of interest were the generation of electronic graphics used, for example, as the opening sequence for TV News, or the Open University rotating symbol. Elsewhere the potential of "Editrace", the two machine video tape editing equipment was demonstrated. A practical demonstration of headphone limiting equipment allowed visitors to hear for themselves how the equipment worked.

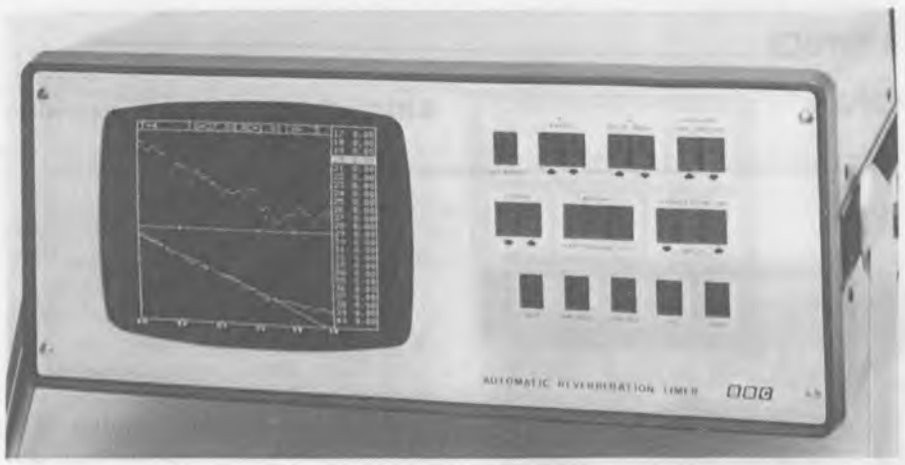
Engineering Training Department created considerable interest in their colour TV training package, with many enquiries from visitors from the UK and abroad.

On the promenade SCPD were demonstrating the last of the Type 5 CMCRs to be manufactured. Television OBs demonstrated the potential of their mobile satellite ground station; the design has just been licensed to Marconi and will now be made available to other broadcasters. Radio OBs demonstrated one of their two mobile studios. Inside the control room were a pair of the new LS 5/9 monitor loudspeakers for visitors to appraise.

An estimated 1200 visitors a day came to the BBC stand in the exhibition hall, (where the air-conditioning still left a lot to be desired). No single exhibit captured the show, but the hard work of many engineers made each exhibit valuable in its own right.

Credit must be given to all of the staff who worked hard over many months to make IBC worthwhile. Thanks must go to Research, Designs, Studio Capital Projects, Television VT, Engineering Training, Radio OBs, Television OBs, Equipment and Engineering Information Departments who each contributed to the overall success of the exhibition and conference.

Automatic Reverberation Timer



The BBC carries out acoustic measurements as part of the acceptance procedure on almost all new or refurbished areas in which sound quality is important. These areas include all types of studios, control rooms, listening rooms and recording areas. In addition to the acoustic background noise level and the sound insulation to adjacent areas, a measurement is also made of the average reverberation time as a function of frequency. Using conventional methods, this last measurement is extremely laborious and time consuming, requiring a manual analysis of about four hundred and eighty individual recordings of the decay of sound energy as a function of time. With the sixty to one hundred areas which need to be measured in the BBC each year, use of this manual method would require a large amount of effort.

An automated, microprocessor-controlled, measuring system for reverberation time has therefore been developed. It employs the same basic measurement procedure as the earlier manual method but uses a microcomputer to control the individual elements and to record the decay of the sound energy. A clear, annotated display is included, showing both the individual and the cumulative average decay of sound pressure level in decibels as functions of time using a standard 625/50 television format. A computational routine can be initiated, either manually, after a sufficiently representative average decay has been acquired, or automatically after a preset number of individual decays. This calculates the average gradient of the decay and hence, the reverberation time in seconds. The numerical result is displayed in a table showing reverberation times and frequency (as third-octave band numbers).

Measurements can be made in any of twenty-four, 1/3 octave-wide bands of frequency over the range of centre frequencies from 50 Hz to 10 kHz with full-scale time axes from 0.5 s to 15 s. The displayed dynamic ranges of both the individual and average decays are 60dB, the gain of the microphone amplifier being automatically adjusted over the range 40 to 100 dB to start the display of the decays near to the top of the displayed range. Reverberation times can be measured accurately over the range 0.1 s to 15 s, with less accurate estimates down to 0.06 s and up to 60 s. The instrument is capable of being operated remotely as part of a larger integrated acoustics measuring system via an integral interface bus, which is designed to the IEEE - 488 GPIB standard.

Although designed specifically for measuring times the instrument may be used for any other types of measurement which require a signal source with 1/3 octave wide bandpass filter and a receiving chain. The receiving chain consists of an optional variable gain microphone amplifier, rectifier and logarithmic analogue-to-digital converter. In addition the individual elements of the instrument were designed to be easily used for other purposes. For example, the display controller can be used as a high resolution (256 x 256 pixels) graphics display for any computer system with an RS232 serial interface.

Better Rostru

A new video rostrum camera and a digital picture storage system have been developed to overcome many of the difficulties encountered when using conventional film rostrum cameras in a television environment. A video tape recording, demonstrating the new system, was shown on the stand at IBC.

The video rostrum camera

The new video rostrum camera comprises a television camera with a 15:1 zoom lens mounted on a column over a horizontal table top. The camera and lens are counterbalanced and are free to travel up and down the column. Artwork is placed on the table top which can be rotated and moved along the north/south and east/west axes. Also set into the table top are four sliding tracks (called 'panning bars') designed to accurately locate and move separate pieces of artwork individually. All these table functions are computer controlled, as are the zoom, focus, iris and black level on the camera and lens.

The video rostrum camera is operated from a control desk which comprises two panels and a visual display unit. The operator can program a sequence of table positions and camera operations into the control system. These can then be automatically replayed whilst the result is viewed on a picture monitor. Movement may be slowed down or stopped at any time to check the effects being generated. Any necessary changes can easily be made to the control data before the final output is recorded.

The programmed route can be traversed in a continuous motion or can be stepped along frame by frame. This stepped movement is especially useful for cell animation where it may be necessary to change the artwork for every frame in this case the output is recorded into the animation stills store a picture at a time.

The animation stills store

The animation stills store provides a means of storing up to 815 television pictures (1630 fields) in digital component (YUV) form and replaying

ım Facilities

them either individually or as a sequence at normal television rates subject to certain restrictions. Facilities are also provided to allow pictures to be combined by mixing and colour separation overlay (CSO) whilst in digital form. The main storage medium is a computer type disc-pack adapted to record and replay at television rates. Three semiconductor picture (frame) stores are included to provide temporary storage of pictures during internal processing operations.

The control desk for the animation stills store comprises three panels and a VDU in a similar layout to that of the video rostrum camera. Various 'pages' of control information can be called up onto the display and these allow an operator to program the system to replay the desired sequence of pictures. The mixing and CSO facilities can also be used to combine sequences of pictures to form the final output sequence.

Pictures can be loaded into the stills store either individually or as a continuous sequence at normal television rates. This recording operation can be momentarily interrupted at any time in order to check the continuity of movement between subsequent pictures. Any mistakes can then be corrected by re-recording. After all the pictures have been recorded the entire replay sequence can be viewed. If any changes are then necessary, they can be incorporated into the control details of the output sequence and the results viewed immediately.

By retaining the original pictures of an output sequence within the stills store system, the animation produced can be radically altered wherever necessary. Sequences can be played in reverse and a picture may be held for many frames instead of appearing for only one frame in the output sequence. In this way, a wide range of different effects can be generated using the same stored pictures without re-recording from the original artwork.

Headphone Limiter

Single limiter (centre) with case (right) for holding two for stereo.

The self-powered headphone protector safeguards both the headphones and their wearers against excessive levels. It is self-powered and easy to install being simply added between the amplifier and the headphones. The device allows a maximum subjective output before shutdown and its delayed action gives no distortion of short-term peaks. By using an 'A' weighting action, the protector gives no distortion of safe low-frequency waveforms. Its foldback action gives a reduction in output once the safety threshold is exceeded.

Investigation has shown that listeners choose an appreciably higher listening level when using headphones than when using loudspeakers. Factors leading to this are:-

1. A headphone listener may choose a high listening level without disturbing anyone else.
2. At high levels a loudspeaker - amplifier system distorts and thus gives warning; a headphone - amplifier system does not.
3. The physical sensations to feet and chest provided by a loudspeaker are not present when listening on headphones.

In addition to this tendency, operational circumstances may give rise to high sound levels in the following circumstances:

In broadcasting studios high ambient sound levels lead to higher listening levels, both for effective quality monitoring or balancing operations and for intelligibility of communication in the presence of high background noise.

The sound feed to the headphone system may be subject to disturbance by a person not aware of the resultant headphone level. This can occur when a programme source is selected or level adjustment made. If 8 ohm headphones are inadvertently connected to a loudspeaker amplifier output, sound levels in excess of 140dB (A) are possible.

Clearly, headphones are potentially capable of causing damage to hearing. Two forms of hearing damage can occur. Intense sounds higher than 150dB cause instantaneous damage, and prolonged exposure to sounds in excess of 90dB cause progressive loss of hearing as the result of the intense or prolonged high sound levels.

The design of equipment for protecting headphone wearers presents a number of problems. The variable and extreme peak-to-mean ratio of speech and music restricts the use of simple peak clippers, as their action is audible on peaks of programme, even though the average programme level may be much lower than the clipper level.

The energy output of a conventional clipper circuit continues to increase with progressive overdrive due to waveform squaring and clipper circuit impedances. A condition of any protective device is that no distortion must occur until protective action is initiated.

Proposed regulations included in two Stationery Office publications, "Protection of hearing at work"; and "Code of practice for reducing the exposure of employed person to noise", used 'A' - weighted measurements (dB(A)) up to the very high sound levels of 150dB or higher.

On demonstration at IBC was a method of limiting the electrical signal fed to the headphones to provide safety protection for the wearer and overload protection for headphones. This required no additional source of power other than that present in the signal itself.

The insertion of an 'A' weighting network in the control chain allows higher level of signals at less damaging frequencies to pass in the main chain before limiting takes place.

A time delay or averaging circuit prevents short term peaks from triggering the protection. A foldback action ensures the output level is reduced to a lower level than the threshold level for all levels above threshold. Finally, to prevent instantaneous damage a fast acting circuit by-passes the above frequency-dependent and averaging circuits for very high level signals.

* * *

TV Signal by Fibre Optic

Optical fibre cable, laser and a ferrule connector.

In 1980 Communications Department were faced with the problem of replacing a couple of obsolete balanced-pair cables which were used as vision circuits between Television Centre and Lime Grove. In the normal course of events these would have been replaced by coaxial circuits. But the current interest in optical transmission methods coupled with a desire to gain first-hand experience of this technology led to the decision to replace the balanced pairs by optical fibres. British Telecom installed eight fibre cables early in 1982. The fibre length is short by telecommunication standards, only about 1km, but is typical of the transmission path lengths found within studio complexes.

At an early stage it was decided that if possible, the performance of the optical circuit should be no worse than the performance of a coaxial link. The results of a feasibility study suggested that the desired performance could be achieved by using pulse frequency modulation of the optical source.

However, the price of such a link would be high and the report recommended that a more appropriate use for this circuit would be as an experimental link for digital transmission of composite television signals using PCM. A single channel system would need approximately 140 Mbit/s, but a two-channel system, needing 280 Mbit/s, is of more interest as the bit rate is similar to that required for component coded digital video - the favoured system for use within studios. The link would then provide valuable experience of high bit-rate digital transmission as well as the experience gained of optical transmission methods.

The System

The Fibre and Optical Connectors

The cable installed has eight fibres arranged in four pairs. Each pair is contained within a loose tube, helically wound around a steel strength member. Each fibre has a 50μm graded index core. The cladding and a hard lacquer coating bring the overall fibre diameter 150μm. The numerical aperture is 0.13 and the loss in the region of 6dB/km. The length is just under 1km but the system total optical loss is about 20dB due to the inclusion of several demountable connectors.

The optical connectors used are butt-jointed ferrule connectors of the 'epoxy and polish' type. Typical power losses of 2-3dB can be obtained if the connectors are assembled with care.

The Transmitter

The analogue-to-digital converter is a standard BBC design based on a TRW integrated circuit (CO8/509). The composite coded input is sampled at 14MHz and coded into 8-bit words. The sampling frequency is not line or subcarrier locked and the input need not be a PAL coded signal.

At a bit-rate of 280 Mbit/s a semiconductor laser must be used as the optical source as the rise time of high radiance LEDs is too long. The laser chosen can launch a mean power of about 1mW into the fibre and the device contains an integral photodiode which is used to stabilise the mean optical power against the effects of temperature and ageing.

The Receiver

The expected optical power at the output of the fibre is about 10μW and a PIN photodiode used with a low-noise GaAs FET amplifier will provide adequate sensitivity. The digital-to-analogue converters used are a standard BBC design (CO9/506).

General

The interconnections of high-speed logic devices need careful design. In the critical parts of the transmitter and receiver three-layer pcbs are used. The central layer is an earth plane and this allows critical interconnections to be treated at microstrip transmission lines whilst retaining all flexibility of a double-sided layout.

* * *

LS 5/9 et Al

The LS 5/9 was on working display in the mobile radio studio at IBC. This medium size monitoring loudspeaker has been developed for use in locations where space is limited, or where portability is an important consideration. The design objective was to provide, in one quarter of the cabinet volume, as close an approximation as possible to the BBC's large high-quality monitor, the LS 5/8. In terms of subjective quality, the approximation is very close indeed; the only concessions to the larger loudspeaker are a reduction in maximum sound level and the loss of about half an octave of bass.

The LS 5/9 employs two drive units with a passive crossover and equaliser. The tweeter is a proprietary soft-dome type of 34 mm diameter; the low-frequency unit is a BBC design with a 200 mm polypropylene diaphragm and a high-temperature voice coil. The cabinet is vented, with a volume of 28 litres (1 cubic foot). Panel damping is achieved by an internal bituminous layer, and air damping is provided by a lining of mineral wool enclosed in thin polyethylene to prevent the escape of loose fibres.

The crossover frequency is about 2.4 kHz, with asymptotic rolloff rates about 18dB/octave. The filter circuit includes low-frequency equalisation to provide an approximately flat free-field axial response, and provision is made to compensate in initial setting-up for production tolerances in relative drive-unit sensitivities.

Provided that it is driven by an amplifier of nominal power not exceeding 50 watts, this loudspeaker will not be damaged either mechanically or thermally by electrical overload, whether momentary or prolonged. The tweeter is also protected against accidental impact by a perforated steel guard.

When driven at a nominal 50W (20V R.M.S.) the LS 5/9 will generate sound levels in excess of 100dB over the frequency range 50 Hz to 16 kHz measured at 1 metre in a typical listening room.

Designs Department have just completed design of a new loudspeaker assembly, the LS 3/4C for close monophonic listening. This is intended for use in television mobile control rooms and similar types of area. Although it replaces the LS 3/4B which is now obsolete, it is able to handle higher powers and has an improved high frequency response.

Two new licences have been negotiated with Spendor Audio Systems and Goodmans Loudspeakers for the miniature monitoring loudspeaker, the LS 3/5A. Rogers-Swisstone already holds a licence to manufacture and market another BBC designed miniature monitoring loudspeaker the LS 3/8A.

* * *

Type 5 CMCR

A Type 5 CMCR was exhibited on the promenade at the IBC at Brighton. Because of weight restrictions on the promenade, the sound control desk had to be removed and re-installed when the vehicle was in its final position. The vehicle is one of a series of replacements for the BBC main television outside broadcast fleet vehicles built around 1970. These earlier vehicles, known as Type 2, have covered the bulk of the BBC's major outside broadcast commitments throughout the '70s and into the early '80s. They were three compartment vehicles, production, engineering and sound, and were equipped with five cameras.

By the late 1970s outside broadcasts had developed and expanded to the point where five cameras were insufficient for many broadcasts and it was therefore necessary to deploy more than one vehicle for these programmes.

The Type 5 carrying up to eight cameras, was designed to cope with all but the most complex broadcasts without the use of additional production vehicles. It is a three compartment vehicle with the production area in the centre. The production desk and monitor stack are oriented along the length of the vehicle in order to provide adequate elbow-room for a staff of four seated along the desk. This cannot be achieved with the more conventional cross-ways layout in a vehicle which is restricted by traffic regulations to 2.5 metres width. A customised Grass Valley 16 channel vision mixer is installed with monitoring and line routing facilities to match the complex requirements for the production of sports and other live programmes which are demanding in terms of cameras, video tape, slo-mo and caption effects.

The sound area, at the rear, is equipped with a 24 channel Neve desk with 20 auxiliary channels. The area also houses the communications equipment. This is a BBC design which is aimed at total flexibility to cope with all kinds of outside broadcast. Its heart is a 100 x 50 active peg-board matrix. Colour coded pins set the gain of each cross-point thus enabling any combination of inputs to be mixed, at different levels if required, on to an output feed.

The engineering and camera control area is at the front and incorporates a five position desk. Four of the positions are camera control points equipped to control two cameras each, although for most programmes not all eight are used. The fifth position is a colour balance point where all the cameras are colour balanced from a single routable control panel. The standard cameras are Philips LDK5s operated on triax cable or through a radio link. LDK14L cameras are also available enabling a lightweight camera head to be deployed using the same cable and camera control equipment as the standard camera.

The vehicle as displayed was virtually complete but not completely tested. It is one of three to be operated from the BBC North base in Manchester and was exhibited in cooperation with Link Electronics Ltd who were the BBC's main contractor for the Type 5 fleet.

Stereo Sound

For some years the BBC has been interested in the possibility of broadcasting stereo sound with television, from the existing network of uhf transmitters. However, the technical difficulties are considerable.

One obvious method is to transmit a pilot-tone multiplex signal. When this possibility was examined it was shown that the multiplex signal is easy to transmit and causes no compatibility problems with existing receivers. However, because of the buzz-on-sound it is far from straightforward to design a stereo receiver that will give good sound quality. Furthermore, if a subcarrier of 38 kHz is used, it beats with line frequency and produces intolerable whistles. In order to avoid these whistles it is necessary to use a subcarrier, locked to twice line frequency, which may restrict the audio bandwidth that can be used.

The problem of buzz-on-sound can arise in a number of ways, and mostly affects the difference channel. One cause is unwanted phase modulation of the vision carrier (ICPM), which is transferred to the 6 MHz sound I.F. in the intercarrier process. Among the sources of ICPM is the asymmetrical filtering of the vision signal which is applied in all TV receiver I.F. stages. At present, since it is not clear whether a satisfactory domestic receiver can be produced, a two carrier sound system is being tried instead.

The two carrier system uses a second f.m. sound carrier, between 250 kHz and 350 kHz above the existing sound carrier, to carry the extra sound information. The level of the main sound carrier is reduced with the second carrier being at an even lower level. (In order to improve the compatibility of the system with existing receivers). A compromise is necessary because if the carrier levels are too low the service area for stereo sound will be smaller than that for the pictures and existing receiver sound stages may not work properly. Another matter for compromise is the frequency of the second carrier. Choosing higher frequency improves compatibility but may worsen adjacent channel interference and increase the difficulty and cost of modifying transmitters.

Patterning of the picture and crosstalk from the extra sound channel into the main one are compatibility problems which can occur due to the characteristics of existing receivers. Two series of test transmissions from Crystal Palace showed that compatibility problems may arise with a significant minority of receivers. However, the samples were too small to be certain about the number of viewers who would be affected. Nevertheless, these tests gave valuable results and Research Department are grateful to those who participated.

It is hoped to involve many more people in another series of test transmissions from Crystal Palace planned for late October/early November. A range of carrier levels and frequency separations will be tried in order to investigate the compatibility aspect further.

In view of the plans to introduce satellite television with digital sound we might also consider the possibility of using digital sound with terrestrial television. One possibility is to add a carrier about 500 kHz above the existing sound carrier and modulate it with a form of phase shift keying. This might accommodate two sound channels, but it is likely that a compromise would again be needed over the technical parameters of the system.

In conclusion, the search is on for a two channel system which will give both hi-fi sound and satisfactory compatibility with existing receivers. Attention is presently concentrated on the two carrier system, but if compatibility proves to be a serious problem then other approaches may be tried.

At this stage there is insufficient information to make firm proposals for a stereo sound service for our terrestrial transmissions. This is only the first phase of a long term project.

'continued from Page 1'

The foremost advantage is the reduced need for adjustment and maintenance, because solid-state sensors have a long lifetime and are completely free from problems of ageing and drift. Other advantages are that the telecine is smaller and less complex, high voltages are eliminated from the equipment, and flying-spot afterglow is absent as is geometric distortion and variation of focus over the field.

Development of commercial telecines has been hindered by two factors. The first is the scarcity of suitable line-array sensors. (It is only in recent years that the quality of these devices has become high enough for them to be suitable for use with the wide range of film that must be handled by broadcasters). The second factor is that the signals emerge from the sensor in a non-standard sequentially-scanned manner. In order to convert them to standard interlaced form, a standards converter incorporating a large amount of storage is required. Although this was unthinkable several years ago, the rapidly falling cost of storage, coupled with the wide use of microprocessors available for control purposes, fortunately means that it is not a significant drawback today.

This is especially true if the storage can be used to provide additional facilities. One facility that can be provided is full variable-speed running with broadcast quality over a wide speed range and sufficiently good quality for review purposes at film speeds up to 400 frames per second. Another is the use of a fourth optical channel in the machine which is sensitive to infra-red light. This fourth channel is able to detect particles of dirt on the film and suppress their visibility before transmission.

Studio Stills Store

The studio stills store, which was on display at IBC, was a prototype of a simple, inexpensive, electronic still-picture storage and display system. It enables still pictures to be selected for transmission, replacing more conventional slide-scanners. It provides storage for pictures derived from slides, or "grabbed" from electronic sources such as cameras, caption generators and graphic sources.

When used with electronic sources, the electronic stills store avoids the time delays and quality losses of the photographic process. A "clean-up" mode removes inter-field movement blur from the picture by using interpolation techniques. When used with slides, the store removes the need to change slides rapidly on-air and thus allows time for adjustments to be made to focus and colour balance for example. The prototype equipment stores 40 still frames on an 8-inch "Winchester" magnetic disc, and the contents of the store can be viewed as a composite "poly-photo" display on the VDU screen. Two independent Red, Green and Blue (RGB) outputs are fed from two digital luminance (Y), and colour difference (U and V) picture stores, which may be accessed from disc in 2.5 seconds. An unbroken sequence of stills may be obtained by loading each store while the other is on-air. Unlike current slide scanners, the stills may be taken in any order while maintaining this unbroken sequence.

The disc is loaded by grabbing an RGB input picture in either of two buffer stores before recording it on the disc.

The stills store is controlled by a keyboard which can be operated remotely from the equipment. The keyboard displays the identification numbers of the pictures being output. Pictures can be selected for transmission either randomly, using a number keypad, or in sequence using a single 'Cut' button.

Further developments of the store are now in hand. These include an increase in the number of pictures stored, a reduction in the access time and a method of conveying pictures between stores and providing long term storage using a removable medium.

During field trials at TV Centre, the prototype stills store has been used 'live' for several programmes. It has also been used in conjunction with the 'Flair' electronic graphics equipment (see Eng Inf No. 7) to produce a series of programmes to be broadcast later this year.

View of stills store controller.

Test Card F

The BBC has radiated Test Card F during trade test transmissions for a number of years but its future use became uncertain partly due to the difficulty of obtaining quantities of high quality slides.

Consultations with the receiver trade via the British Radio and Electronic Equipment Manufacturers' Association (BREMA) revealed that many service engineers prefer Test Card F to other purely electronic patterns. This is thought to be because the central picture of a young girl gives a subjective assessment of picture quality and aids the setting of colour saturation. For future use, Designs Department are producing an equipment which stores the test card in digital form in order to overcome the problems of slide duplication and the need for a slide scanner.

Data will be held in YUV form using eight bits and 13.5/6.75 MHz sampling frequencies. All of the geometric patterns will be derived from computed picture samples calculated by programs which take account of the requirements for different risetimes in the corner diagonals, the circle and the frequency gratings. This data, which describes an essentially perfect test card, will be combined with the central picture samples obtained by a YUV 'frame grab'; techniques for noise reduction on this central image will be explored.

Captions for network identification will be added to the complete test card from separate integral digital generators so that the one equipment will deliver several differently annotated outputs, all of which are coded PAL. The first equipment is expected to be in service by mid 1983.

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