International Broadcast Engineer

No 11
August 1965
3/6

RCA NEW LOOK

Compact TV Tape Recorder

This budget-priced, quadruplex Recorder accepts high band, color, and electronic splicing accessories

This total performance compact does just about everything the deluxe model does. Complete in a 33 by 22 by 66 inch cabinet, the transistorized TR-4 is the answer for installations where low initial cost and broadcast quality pictures are indicated. A complete recording and playback package, it has suitable monitoring facilities, built-in picture and waveform monitors, and other provisions to meter key circuits for proper setup.

Like other RCA transistorized TV tape equipment, new circuit techniques, needed for high band, are accommodated by the TR-4. With such circuits, (available as optional extras) high band can be selected as a second mode of operation, with all its benefits, including color and monochrome tapes of particularly high quality, and multiple generation video dubs.

Features now standard on the TR-4, as on all RCA TV tape equipment, include air-lubricated tape guides, magnetic tone wheel, solid state control system, built-in switchlock and two-speed operation. Accessories available include Pixlock, automatic timing control, cue record and playback, electronic splicing and drop-out compensator. The TR-4 is the only recorder of its kind that's adaptable to color operation. And standardized modules in this and other RCA TV Tape Recorders assure high quality, easy maintenance, and simplicity in adding accessories.

For full particulars, write to Radio Corporation of America, Bureau de Controle, 118 Rue du Rhone, Geneva, Switzerland; or RCA International Division, Dept. 200A, Central and Terminal Avenues, Clark, New Jersey, U.S.A.

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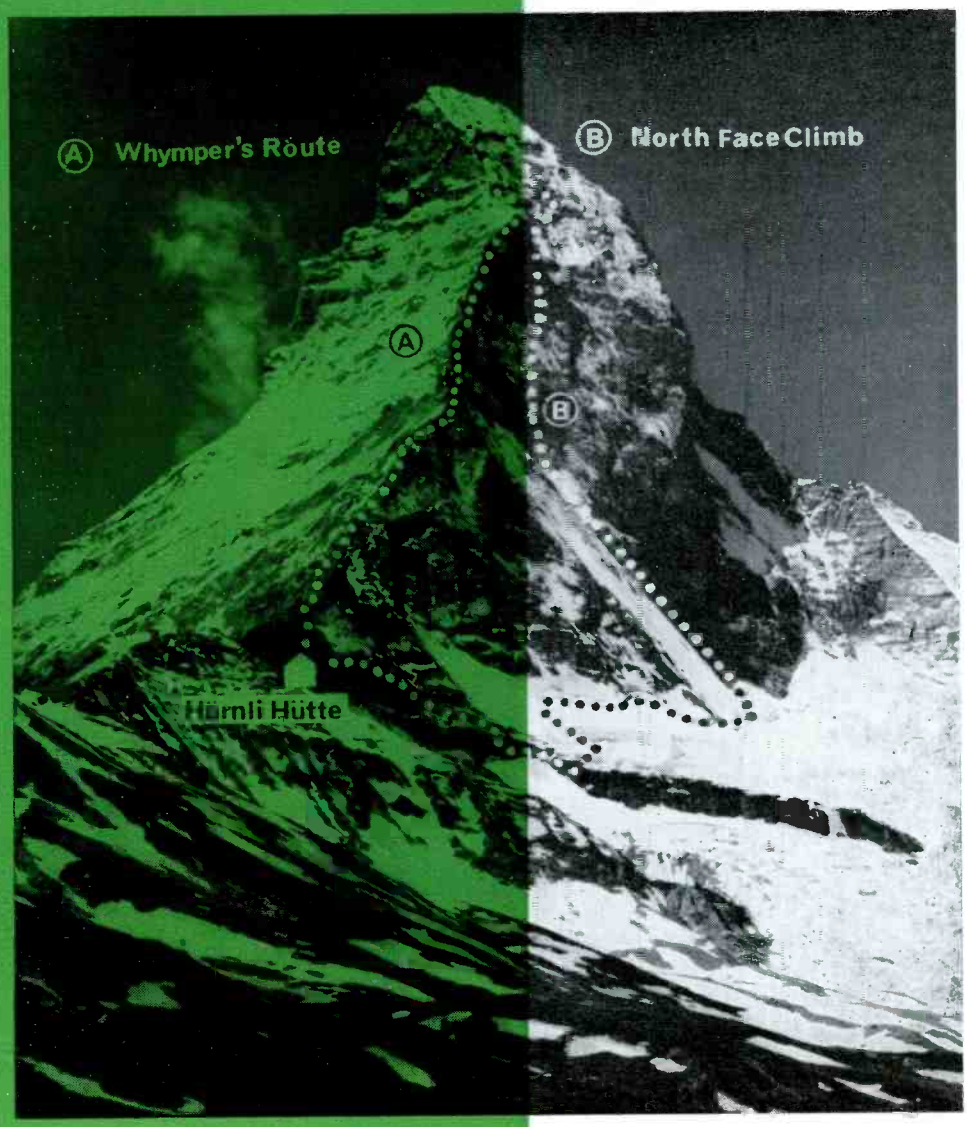
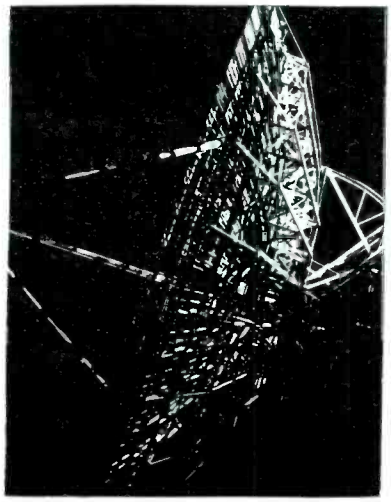


advertisers

One of the greatest tests so far for radio TV cameras was the massive OB coverage of an ascent of the Matterhorn involving television organisations of several countries, the operation was probably one of the most successful OB operations. The illustration shows route taken by climbers and cameramen. A report on the operation appears on page 557.

OUTLOOK



This 'Community Antenna' trend

ONE fact will not appear startling to those who keep their ears close to the ground or (as the Irishman might have said) even a foot or two below the ground, since that is where so many miles of relay-TV coaxial cable lie buried. And the fact itself is that there are now more than 1,400 CATV systems currently operating throughout the United States and Canada.

CATV (Community Antenna Television) is arising almost as a new television science in its own right. These wired, piped and microwave-linked networks extend from Toronto to New Mexico, from New York to Columbia, Mississippi: and of course also from Brighton to New Brighton. While few British relay-TV systems cover more than a few square miles in some enterprising municipal housing estates, in other countries the extent of community antenna networks is astonishing. Until quite recently the Entron system in Altoona, Pennsylvania, contained more coaxial cable—all 300 miles of it—than any other system in the country.

Now a new record is set in Texas (perhaps not unnaturally) where Ameco of Phoenix, Arizona, have planned a huge single CATV system embracing 460 miles of electronic linkage. If this is the coming trend, how can such vast networks be planned? Says Joe Derocher, head of Ameco's System Design department: 'No longer can we design a system without visualisation of the many aspects of the whole system. When layouts were small enough to be contained on one drafting table, design was relatively simple. Much more time must be spent in engineering, cable routing, feasibility studies and site inspection with larger layouts. . . .' Obviously all this cannot be done on the office desk. When faced with a 460-mile project, Ameco were invited by their own local college in Arizona to use the gymnasium floor as a planning area for a 60-ft by 40-ft mock up of a design scale of 1 to 200. On this vast 'map' the 83 major sections of the CATV network were planned, and nine men from the design section of Ameco spent over 500 man-hours in original layout, plus 48 hours in checking and verification of the system's technical features and accuracy, plus a further two weeks to prepare the bill of materials needed for construction.

This is a vivid demonstration of some of the complexities which go along with the development and growth of the CATV industry. And these characteristics will be more and more in evidence as larger systems are planned and built.

As Stanley M. Searle states in TV & Communications (a professional journal for the cable television industry): 'It is not inconceivable at this time to consider systems of well over 500 miles in cable length, even one of 1,000 miles. System designers must plan now to be able to handle such an assignment. Such a large system could, and no doubt will, require further improvements over present design techniques. Already the larger systems in operation demonstrate the need for a central location of the receiving site (or in some cases multiple receiving sites) fed by intra-city microwave. Many CATV operators are demanding systems planned for ease of maintenance, shorter cascades, and with greater operating safety margins than were required even a year ago. These designs naturally include the latest in techniques, construction practices, engineering advancement, and solid-state technological advances. The CATV industry has reached the stage where it no longer thinks small. . . .'

Unfortunately this is not true of other countries, where relay-TV experts are still bogged down over the hoary old arguments about the relative advantages of VHF and HF relay systems, and where restrictive practices such as those envinced by the British Postmaster General prevent private relay companies from unfettered use of microwave links.

Exciting technical developments are possible in CATV. It is foolish to imagine the cable television industry is restricted to wiring up a circuit with coaxial cable. Overseas extensive microwave linking is essential, and one leading manufacturer has produced for the 'cable' industry a microwave link operating anywhere between 3.7 and 11.7 Gc, able to handle colour TV and 1,200 normal channels, using klystrons and travelling wave tubes at the transmitter and most advanced remodulating and IF heterodyne equipment. By contrast, a Broadway research laboratory has come up with a G-line transmission system carrying microwave **by wire.** This is already working over a distance of 35 miles across the Yucca Valley, a single VHF G-line replacing microwave-by-air or twin-line or coaxial cable. The G-line accepts channels 2 to 13 FM, and the average loss is better than 9 dB per mile. This is a genuine breakthrough in surface conduction, being low loss and broad band, and the basic instrumentation is so simple that arrangements have been made for local TV engineers to build their own G-lines from kits, or even to rent complete microwave-on-wire equipment.

At this moment many cable TV systems throughout the world are involved in ugly disputes arising from power politics. For example, the US supreme Court has been asked to deal with applications from owners of a number of small local-station television services who claim they have been forced off the air by the advent of bigger local cable systems. An expert commenting on an FCC decision says: 'An axiom in journalism is that people are most curious about what is closest at hand The competent local station, in carrying neighbourhood news and events, is most likely to get the greatest amount of attention. In studies that have been made of the stations that have left the air, the coming of a CATV system has never been shown, satisfactorily, to be the cause of such a demise.' In another disputed matter, CBS and the TelePrompTer Corporation found themselves involved in a legal difference of opinion, CBS slapping on a test case, with other plaintiffs, alleging that a CATV network infringed upon programme copyrights. TelePrompTer retorted that not only was no copyright violated by relaying TV, but that CBS themselves, by denying CATV rights, were violating both the Federal anti-trust laws and the Federal Communications Act! And there for the moment, as the lawyers say, the matter rests. Here we cannot concern ourselves with the bristling legal problems of CATV, which must differ from nation to nation. But we are deeply concerned about the technical future of relay systems. With welded aluminium sheath coaxial cable, with G-line microwave-on-wire and with forward-looking klystron-impelled microwave links, the CATV industry can aid broadcasting executives to bring a wider, better programme service to the public.

John Dickson Ph.D.

...it's the new 1/2 INCH vidicon from EMI

It deserves it—this new EMI ½ inch diameter vidicon. Small size compared with the conventional 1 inch vidicon enables it to be used in small lightweight cameras, or in the chrominance channels of a colour camera. This ½ inch separate-mesh tube has a performance comparable to the classic type of 1 inch vidicon, the exceptional resolution being obtained by operating the separate-mesh electrode positive with respect to the wall anode. (Under typical operating conditions the depth of modulation at 400 TV lines is over 45%) The tube may be operated with excess beam currents without loss of focus so that overload signals can be accommodated. This enables the vidicon to handle a wide range of light levels without adjustment of the beam control. The target layer has high sensitivity, short lag and a panchromatic spectral response. This tube is of robust construction and employs a low wattage heater. Further details available on request.

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EE309

Home videotape recorder

A NEW line of home videotape recording systems that will make immediately-playable high quality recordings of live action or television broadcasts for home viewing has been introduced by Ampex Corporation.

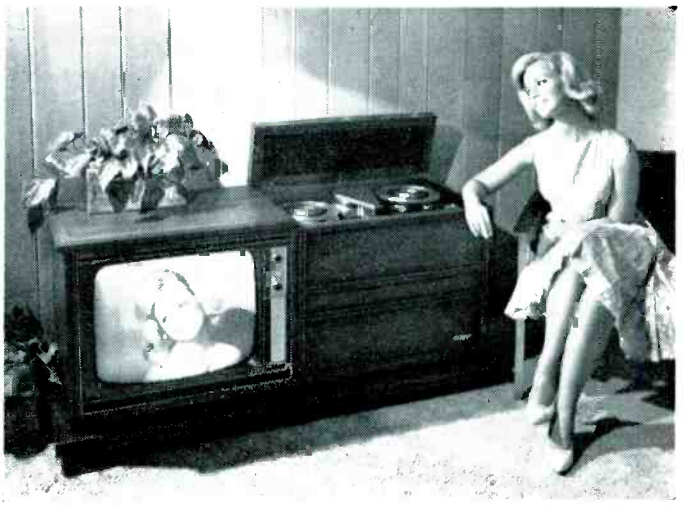
The new Ampex line is built around a compact videotape recorder, which retails at $1,95.00 in a one-speed table top model, $1,295.00 for a two-speed model. Four furniture console systems, including the recorder, television camera, television receiver and related accessories range in price from $1,795.00 to $2,495.00, depending on choice of one-speed or two-speed recorders and colour or black and white receivers.

William E. Roberts, Ampex president and chief executive officer, said, 'This new line will be the leader in a broad new field of home entertainment possibilities. We anticipate the world market for home videotape recording equipment will grow from approximately $10,000,000 next year to well over $100,000,000 by 1970.'

AMPEX HOME VIDEOTAPE RECORDER: New Ampex home videotape recorder will be offered in two-speed configuration, for $1,295.00. At higher tape speed (9.6 inches per second) recorder will produce high quality pictures compatible with future colour recorders. Slower speed (4.8 inches per second) produces high quality black and white pictures, reduces tape consumption by half. At slower speed two hours of programme material may be recorded on a single 9½ inch reel of one-inch-wide video tape. Tape cost: $64.95.

The new line will be produced here in suburban Elk Grove Village by the Ampex Consumer and Educational Products division, with initial deliveries to begin in the fall.

Roberts said the new videotape recorder makes high quality black and white television pictures and is also designed for interchangeability with future colour recorders. 'Future demand for colour television recorders in the home market is inevitable,' Roberts stated. 'We have designed our initial entry with a high quality standard compatible with future colour units. This means that the owner may confidently develop a library of black and white television recordings without fear that they will be unplayable on successive generations of Ampex colour equipment.'



INSTANT MOVIES: Immediately playable video tapes of home activities may be made with the new Ampex home videotape recording system. Furniture console contains compact videotape recorder, television receiver, camera and related accessories. Console systems start at $1,795.00; table top recorders start at $1,095.00.

The videotape recorder is approximately the size of a conventional audio tape recorder. One-inch-wide Ampex magnetic tape moves past rotary recording and playback heads at a speed of 9.6 inches per second (ips) to provide high frequency performance with relatively low tape consumption. A second speed of 4.8 ips also will be offered, cutting tape consumption in half and providing good quality recordings not compatible with colour.

The recorder will play back black and white television programmes through nearly any home television receiver, either colour or black and white, with addition of special connection components (estimated cost installed, $25.00). No internal modification of receiver circuitry is necessary. In addition, the high performance of the recorder permits good quality pictures on popular large-screen receivers. All recorders will be interchangeable with each other: thus tapes made on one machine may be played back on any other.

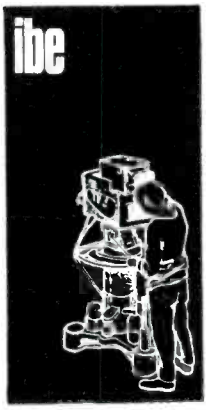
Roberts said the high performance of the low-cost recorder results from a major innovation in the design of helical video recording heads. The recorder uses an air foil head assembly which permits higher time base stability than previous helical recording heads. The recorder has a maximum frequency response of 3.2 megacycles at its higher operating speed; more than 2 megacycles at the slower speed.

At 9.6 inches per second, it will record an hour of television, both picture and sound, on a single, 2,900-foot reel of one-inch-wide video tape; at 4.8 ips, two hours. The recorder uses high quality Ampex video tape, specially developed for use with the new unit. Cost per 2,900-foot reel (9½ inches in diameter) is $64.95. Tape will also be marketed in shorter lengths for $39.95 (half an hour at 9.6 ips, an hour at 4.8 ips) and $9.95 (6 or 12 minutes respectively).

'Tape costs at the higher standard are approximately half that of an equivalent amount of processed 8-mm colour-sound movie film,' Roberts pointed out. 'At the slower speed, the cost advantage is even more dramatic. And, most important, tapes are immediately playable without processing and may be erased and re-used hundreds of time.'

Roberts said Ampex will offer a selection of vidicon television cameras of its own design, as well as accessory lenses, microphones, cable and all elements needed for various recording and playback uses.

Early in 1966 an educational closed circuit recording system built around the new recorder will be offered for a wide range of uses in schools, industrial training, medical diagnosis and sports.



International news

New company

J. PAUL AUDET, Illinois, USA, formerly Mid-West Regional Sales Manager of Gencom Division, Whittaker Corporation, is annoucing formation of a new company, International Broadcast Industries. IBI will represent the interests of EMI Electronics Ltd, of England, for sale and service in the United States for all EMI broadcast and recording equipment, camera tubes, video recording tape, etc.

IBI is also establishing manufacturing facilities in the mid-west for production and fabrication of broadcast equipment such as video switching systems, audio, pulse assignment and distribution, house monitoring, inter-communications, etc. Solid-state, modular equipment will be offered to broadcast, CCTV and CATV users. For those interested in automation, systems based on memory core, computer type technology, will be a product of IBI.

Associated with Audet is Peter Jackson, formerly Eastern Regional Manager for Gencom. Staffing of the new organisation is now in progress, with commitments received for many key manufacturing and engineering positions. Formal announcements of these executive appointments will be made in succeeding weeks as they occur.

IBI may be contacted c/o Mr Audet of Chicago Heights, Illinois, (312)754-0387, or c/o Mr Jackson at Glen Cove, LI, New York, (516) 671-4615. Cables and telegrams should be addressed c/o IBICO, Chicago Heights, Illinois.

Permanent offices will be established at New York, Chicago, and Los Angeles or San Francisco just as soon as suitable facilities can be obtained. Other locations are also being considered.

Merged

FOLLOWING a very successful trading year, the two major closed circuit television marketing organisations in the Pye Group have been merged into one Company, now trading as Pye HDT Ltd. (The initials stand for High Definition Television).

This Company will plan, manufacture and sell closed circuit television equipment for industry, commerce and education together with teaching machines, language laboratories and schools' television receivers as well as other audio-visual aids.

The Company has been formed by combining the Industrial Division of Pye Telecommunications Ltd with the original HDT Company, whose reputation in the educational field is already well-established.

Order

IN ENGLAND British Insulated Callender's Construction Co Ltd has received an order from the British Broadcasting Corporation valued at over £160,000 for the design, supply and erection of a 950 ft television mast at Waltham-on-the-Wolds near Melton Mowbray. The design makes provision for the mounting of a 100 ft cantilever aerial for UHF and also for future re-engineering of VHF aerials. The mast will be completely different from any previously ordered by the BBC as it will use only steel cylindrical construction. The diameter will be 7 ft 6 ins.

Most television masts erected in this country have been of the lattice type but cylindrical construction, in many cases, has more to offer. In particular, access to all aerials mounted on the mast is possible in the worst weather conditions and a greater load can be supported by the mast column for an equivalent weight of structural steelwork. Feeder cables and ancillary equipment are completely enclosed inside the mast column, and this together with an internal lift will provide considerable advantages in simplyfying and speeding up maintenance and the addition of new equipment.

Artificial lighting will be fitted inside the mast and provision will be made for screening the externally mounted aerials by means of glass fibre shrouds. Specially developed erection methods will be used and a new type of self-climbing derrick will lift the curved steel segments into position. The fabrication and hot-dip galvanising of the steelwork will be carried out by another member of the BICC Group, Painter Bros Ltd of Hereford.

Amateur

THE German Amateur Radio Club (DARC) will be organising a special feature at the German Radio Show to be held in the Killesberg grounds, Stuttgart, from August 27 to September 5 1965. A television station built to conform with European transmission standards will be transmitting, on the 70 cm Amateur Band, programmes filmed with a camera built—like the station—by the amateurs themselves. Programmes will be received on the communal aerial in the Fair grounds and translated to another channel so that television sets being demonstrated in the Radio Show will be able to pick up these amateur shows as a fourth programme.

Renamed

STRATTON & COMPANY LTD, manufacturers of the Eddystone range of professional radio communication receivers and accessories since 1923, has now been officially renamed Eddystone Radio Ltd. This follows the announcement last March that the Stratton radio interests had been acquired from Laughton & Sons Ltd, by English Electric, and that the company would be operated as a subsidiary of The Marconi Company.

The board of directors of the new company will consist of F. N. Sutherland, Deputy Chairman and Managing Director of The Marconi Company, who will be the Chairman of Eddystone Radio Ltd; R. Telford, General Manager of The Marconi Company; H. N. Cox, formerly Technical Director of Stratton; and A. C. Edwards, formerly Commercial Director of Stratton. Cox and Edwards will retain executive responsibility for the new company, and the existing structure will be disturbed as little as possible.

Eddystone Radio produce a range of radio receivers which covers the frequency scale from 10 kc/s to 1000 Mc/s. The company has a world-wide reputation, and Eddystone receivers have been sold in practically every country in the world. Over 50% of the output is now sold directly into the export market, and considerably more passes indirectly through other companies such as Marconi, who themselves export equipment bought from Eddystone.

Leaflet

A NEW LEAFLET describing the EMI Mono Stereo Recording Console Type 10404 has recently been published by EMI Electronics Ltd.

This console provides all facilities for the complete control and mixing of the outputs of up to eight microphones and two line inputs simultaneously, together with individual channel echo control, into one or two group outputs.

Ergonomic design ensures correct layout of the controls for convenient and efficient operation with maximum visibility.

The equipment can be used for both monophonic recording and stereo-recording. Stereophonic recording is achieved by the stereosonic system or by the spaced microphone system; either can be selected by operation of a switch.

Copies of the leaflet are available on application to Publicity Department, EMI Electronics Ltd, Hayes, Middlesex.

Exhibition

AUDIX LIMITED, of Stansted, England, are holding a private exhibition at the Tavistock Hotel, London from Monday to Thursday September 6—9 inclusive. Their range of equipment being exhibited will include rack mounted assemblies, amplifiers, mixer units, consoles, etc, for all sound and PA installations.

Bermuda

BERMUDA is to have a second commercial television programme. The new station, ZFBTV, due to go on the air this month, will give viewers 42 hours extra television each week. Pye TVT Limited of Cambridge, England, have been awarded a contract through Thomson Television (International) Ltd, to supply the complete station. This includes a 3 kilowatt 525-line Band III transmitter, together with associated mast and aerial equipment. The studio centre will be provided with vidicon cameras and telecine units.

Italian deal

ON JUNE 8, two directors of Ilford Ltd Motion Pictures Products Division, Leslie Wheeler (Managing Director) and Clifford Read (Sales Manager) went to Rome to close a deal with Mole-Richardson Italy, represented by Umberto Marroncini (Managing Director) for the sale of Ilford negatives and magnetic films in Italy.

NEW developments

For desert operation

■ DEVELOPMENT of a new closed-circuit television system designed for desert operations or wherever heat and bright light are a challenge has been announced by Cohu Eelectronics, Inc, San Diego, Calif.

The Cohu 2000 series miniaturised camera is equipped with a sun hood that cuts temperatures up to 25 degrees on the camera barrel; an automatic shutter to protect the vidicon tube when the camera is not turned on; a sun filter to prevent harmful direct rays of the sun from reaching the vidicon, and a 10:1 zoom lens for long-distance viewing.

The camera is three inches in diameter and 18 inches long including the 10:1 zoom lens.

Cohu's 2000 series camera is available in 10 or 20 megacycle bandwidths; with 525, 729, 873 and 945-line scanning patterns; with integral or detached camera control units, and with built-in or external fixed focus or zoom lenses.

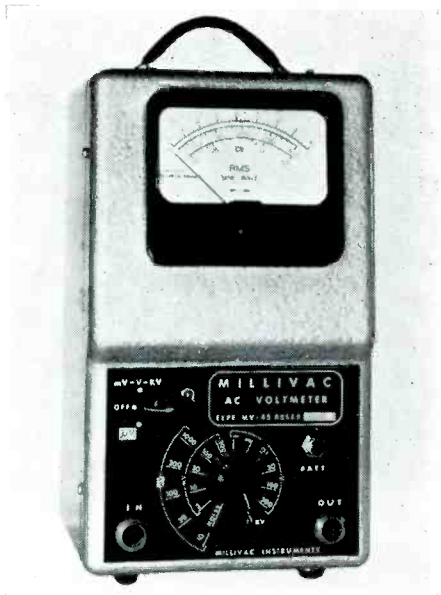
Low-level

■ THE Millivac type MV-45A Microvoltmeter is a unique low-level audio frequency instrument based on an advanced transistor amplifier circuit with unusually low noise level.

Available in the United Kingdom through Claude Lyons Ltd it is the most sensitive AF microvoltmeter obtainable, with full scale ranges of 10 μV to 1,000 V in a 1-3-10 relationship. Frequency range is 10 c/s to 150 kc/s and accuracy 2% of full scale on all except the lowest (2μV—10 μV) range, where it is 3%. Input impedance is 10 kΩ on the 10 μV range, 100 kΩ on the 30 μV to 1 mV ranges, 1 MΩ on ranges between 3 mV and 300 V, and 3.3 MΩ on the 1 kV range.

As an amplifier, the MV-45A provides a maximum available gain of 40 db with 5 kΩ output impedance and noise level with shorted input of less than 0.6 μV RMS for the 10 c/s to 150 kc/s band.

The fact that the MV-45A is battery operated is particularly valuable since it eliminates earth loops and feedback of hum from the measuring instrument into the equipment under test.



Wide-range bridge

■ A NEW WIDE-RANGE BRIDGE by Wayne Kerr brings 0.1 per cent accuracy to capacitance and conductance measurement between 100 kc/s and 1 Mc/s, and it can be operated with reducing accuracy up to 5 Mc/s. The B201 is fully portable, including battery (or rectifier), plug-in source and detector units, standards and a null meter. Internal modulation at 1,000 c/s and a detector outlet jack provide facilities for headphones, and front-panel controls permit the signal level and detector gain to be adjusted. Overall coverage is 0.0001 pF to 0.1 μF and 0.001 μMho to 1 Mho (1Ω to 1,000 MΩ).

Design of the instrument is based on the use of transformers for accurate voltage and current ratios by means of which the Unknown is compared with internal capacitance and conductance standards. Provision of a neutral terminal on the special design of connection block enables three-terminal measurements to be made. Frequencies of the plug-in source and detector units at present available are 100 kc/s and 1 Mc/s, but dummy units permit external equipment to be connected for measurements over the range 100 kc/s to 5 Mc/s.

The B201, which is available for immediate delivery, is 12 inches square by 5 inches high and weighs 12 lb.

Synchronous motor

■ F & B/CECO, INC announces the availability of the first synchronous motor specifically developed for the 16 mm Eclair NPR camera.

Designed and manufactured in F & B/CECO's own shops, the new Eclair Sync Motor is completely noiseless, and at 3.75 lbs actually weighs 10 ozs less than the constant speed motor.

Highlights of the new motor are its extreme versatility, drawing only 45 watts from a 110 volt AC power source makes it ideal for portable battery use, and optional gearing adapts the motor to 25 frames per second, and/or 50 cycles, if desired.

The powerful new motor will always run in sync. Exhaustive laboratory tests have shown that even with a voltage drop as low as 70 volts, sync was maintained.

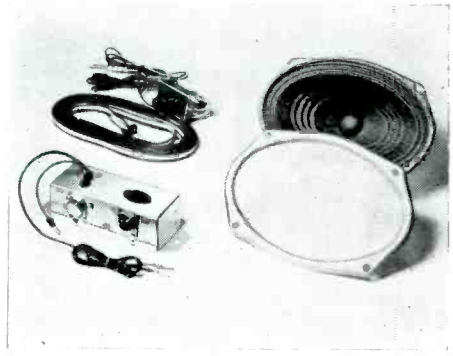
This new motor is available for rental or sale at all F & B/CECO, Inc offices. Price is $650.00. It is available for immediate delivery.

'Babe'

■ CLEVELAND ELECTRONICS, INC announces the availability of their 'Babe,' an all-transistor Reverberation Kit for use with 12-volt negative ground car radios. The Cletron Reverberation 300 Series simulates live music hall performance by giving the listener the illusion of being surrounded by music. This feeling is accomplished by the use of an electromechanical mechanism which reverberates the incoming sound. The sound is then amplified and transmitted through a separate speaker so that the listener enjoys an excitingly new depth dimension in sound.

Power supply is 12.6 dc (negative ground) (with a four watt power output and an idle current of 0.25 amps; includes a complete fader control between speakers with switch on normal; a complete fader control between speaker with switch on reverb. Compact in size, measuring 6" x 2" x 2½". Eliminates 'Bongo' or other road noises; reduces all electrical noises; less distortion to rear seat speaker by 3 db. Eliminates alternator noises.

There are two type kits: the Cletron Standard Kit, Model RU-304, for those automobiles not requiring speaker and grille; and the Cletron Deluxe Kit, Model RU-301, for those automobiles requiring speaker and grille.

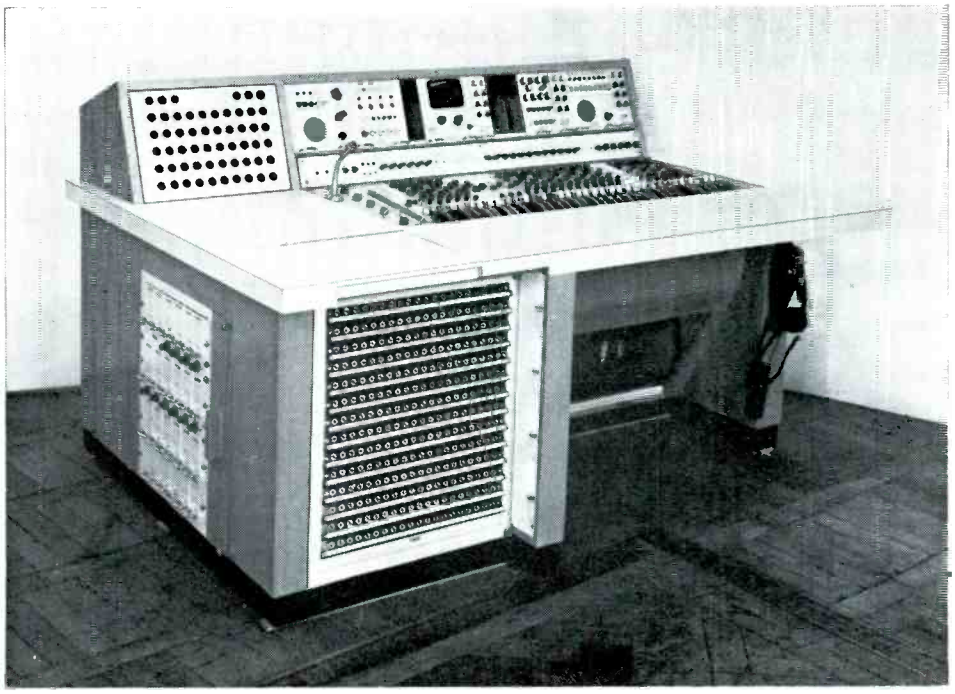


Off-air receivers

A NEW LEAFLET describing EMI Off-Air Receivers Type 675, 675/1 and and 676 has recently been issued by EMI Electronics Ltd.

These receivers, which are in widespread use by broadcasting authorities in Britain and throughout the world, are employed for the continuous radio frequency monitoring of television signals at fixed stations or in mobile or outside broadcast applications.

They operate on any channel within Band I and Band IIII. Each provides three independent vision and three independent sound outputs, at standard levels, from television transmissions employing vestigal sideband systems of the receiver attenuation type. In addition, a separate output is provided to operate a loudspeaker for local monitoring purposes.



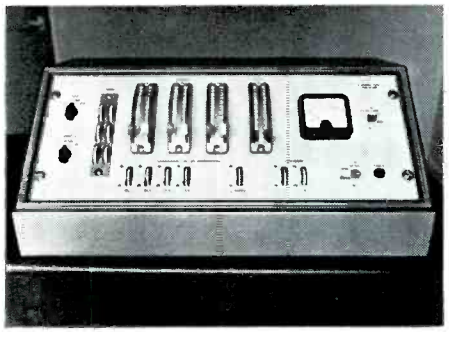
Transportable

A NEW six channel transportable mixing equipment suitable for six channel monophonic or 3 x 3 stereophonic operation is announced by Elcom.

The unit incorporates input switching on two channels with impedance selection for microphones, tape or auxiliary inputs together with four channels suitable to accept 30/200 ohm microphones. Tone equalisation is provided for also on two channels.

Two programme outputs at 600 ohm 0 dbm are provided. Other facilities include echo send on four channels with two echo return lines, all individually controlled. Pre-fade listen on all channels, phonejack and VU meter are also provided. The unit is complete with its own power unit.

The technical specification is up to the highest standard required by recording, broadcasting and film authorities.



Television sound mixers

Three new solid-state television sound mixers with plug-in modular units are announced by EMI Electronics Ltd (see photo above).

Television sound mixer Type 9001 is an eight-channel mixer suitable for fitting into the combined vision and sound desk of a small television studio. Type 9002 is a 16-channel mixer for handling programme sound in a medium-size television studio, and Type 9003 is a 24-channel mixer for a large television studio.

These mixers give very low noise performance, and comprehensive jackfield and listen facilities are provided. The 16-channel and 24-channel mixers incorporate echo circuits, and there is space in all three for fitting optional facilities such as effects for imitating telephone sound, and equalisers for microphone frequency response correction.

The flexibility of the modular system permits the construction of custom-built sound mixers as well as these standard types.

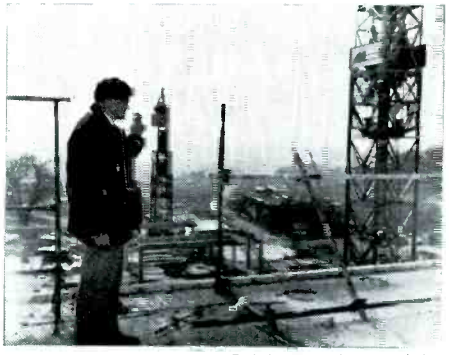
Picture shows sound mixer type 9000 series.

Two-way radio

The value of radiotelephones for relaying messages across building and civil engineering sites is rapidly being discovered. They are not merely a convenience but a very significant economy measure, since they can save an enormous amount of time. A constant communication link with site headquarters is valuable, too, for sorting out queries and keeping the men on the job up-to-date with latest happenings and requirements.

The weatherproof Pye 'Bantam' is an ideal radiotelephone for the builder and constructor. Weighing only four lbs, it can be slung over the shoulder in its leather case. In addition to its built-in loudspeaker it has a combined microphone and earpiece—excellent for listening to messages under noisy conditions such as in crane cockpits.

The picture shows a 'Bantam' in use on the Essex University site at Colchester, by Modular Concrete.



Pye also make radiotelephones for all vehicles, including ruggedised water-proof types for all motorcycles, trucks, bulldozers and other heavy-duty outdoor conveyors.

MARCONI SUCCESS AT AUDIO VISUAL EXHIBITION

FIFTEEN major educational establishments in the United Kingdom have ordered television systems based on a new series of fully transistorised closed-circuit television cameras which was introduced by The Marconi Company at the Educational Foundation for Visual Aids Exhibition in February of this year.

In addition to this, orders for more than 450 of these cameras have been received from the United States, Australia and Canada. The new cameras were demonstrated on stands N1 and N2 at the National Audio Visual Exhibition—NAVEX/65—at Whitelands College, Putney.

The Department of Education and Science has recently nominated 11 teacher training colleges to take part in an evaluation of educational television. Before the introduction of this new camera, four of these colleges were already committed to other systems. Of the seven remaining colleges, five have now chosen Marconi systems incorporating the new camera. These five installations are described briefly below.

The new series has been designed with the particular needs of educationists in mind. Two versions are available. The first, type V322 A, is a basic camera unit, while the second, type V322 B, has an integral high brightness viewfinder, and provides facilities comparable with a high quality broadcast equipment.

Both versions are extremely simple to operate, and the complex of controls associated with earlier television systems has been virtually eliminated, leaving only the ON/OFF switch, a focus control and iris adjustment. No additional control unit is necessary for normal operation. Once the camera has been switched on; the lens iris adjusted for satisfactory contrast and the focus control set to give the sharpest picture, the camera is completely automatic. The automatic circuitry will maintain a completely stable picture and will handle changes in light level of as much as 2000:1 without attention from an operator.

A very high focusing flux is used for the vidicon tube to provide a significant increase in the resolution limit of the tube. The camera has been designed to accept the new 'separate mesh' vidicon tubes which provide improved uniformity, and enhance resolution in the corners of the picture. The camera will also accept normal vidicon tubes.

A simple lens turret and a full range of standard lenses is used with the V322 B version of the series.

THE CAMERA

The camera is fully transistorised throughout and apart from the vidicon tube and its scanning yoke, all the electronic circuitry including power supplies is contained on only two printed circuit boards.

These boards are mounted on either side of the camera case, and can be hinged downwards for easy access, or detachment.

The yoke assembly for the standard 1 inch vidicon tube is moved in the fore-and-aft direction for focusing. This is controlled either by a three spoke capstan at the right hand side of the rear of the camera, or by a lead screw on the camera back plate. A unique method of mounting the vidicon tube ensures that it is mounted rigidly and accurately with respect to the yoke assembly.

The most important electrical feature of this camera is the automatic black-level control circuit, a circuit patented by The Marconi Company. This circuit, which relies upon a combination of 'theoretical' and 'real' black-level references, overcomes the problem of black-level drift, the most serious barrier to the realisation of a fully automatic television camera.

Automatic sensitivity control, in the form of an automatic target voltage regulating circuit, is incorporated to complement the black-level control. Together, these two features offer a degree of operational simplicity which has hitherto been unobtainable. All operational controls are eliminated, with the exception of the ON/OFF switch and lens focus.

External synchronising drives may be used to give a 2:1 interlace which then allows any number of cameras to be used in a network.

The output from the camera may be provided either as a video signal, or in the form of modulated rf. A choice of three adjustable, pre-tuned frequencies in the range 50-88 Mc/s is provided.

THE VIEWFINDER

The viewfinder is an integral part of the V322 B studio camera. It has a 7-inch (17.8 cm) high brightness picture tube which is used with a specially developed deflection yoke to ensure geometrical accuracy comparable with that of the camera. The other major viewfinder components are contained on a single printed circuit board, mounted at the side of the unit for ease of access. Driving pulses are obtained from the camera, but the scanning circuits are isolated in other respects, to avoid interaction between the camera and the viewfinder. The brightness and contrast controls are mounted extrenally, next to the tube face. while all other controls are considered as pre-set, and are mounted internally.

Apart from the high voltage rectifier, and the cathode ray tube, the viewfinder unit is fully transistorised.

THE LENS TURRET

The lens turret is used normally with the V322 B version and replaces the single lens mounting plate. The turret will accept four 'type C' vidicon lenses. These are located by a positive indexing mechanism, numbered to identify the lens in use.

NAVEX 65 SCOOP REPORT

Britain's biggest conference on audio-visual aids in education held jointly with 'Navex 65,' the biggest-ever exhibition of electronic and other technical video aids, has just closed its doors.

Organised by the National Committee and Education Foundation at London's Whitelands College, the Conference and Navex 65 were opened by Mr R. E. Prentice, MP, Minister of State for Education and Science. Speakers from the United States and many leading European countries were heard at the Conference, and over a hundred exhibitors brought to Navex 65 spectacular new headlines in the realm of educational audio and TV.

Representatives of INTERNATIONAL BROADCAST ENGINEER probed Navex 65 in view of its national TV importance, and next month's edition will carry a complete technical survey.

INSTANT SYNC!

First details of a new synchronous film recorder which will streamline TV newsfilm recording techniques...

by Christopher Jones

STEPPING OFF a Boeing jetliner at London Airport recently was an American TV film camera crew on the first stage of a special European assignment. . . .

Nothing very unusual about that, of course; after all, overseas film and TV units fly into London Airport almost daily. What was unusual, however, was that, apart from a lightweight tripod, only **three** main items of equipment were to be used: the new self-blimped 16 mm Arriflex,* a 'Sun-Gun' (quartz) portable lighting unit—**and a new battery-operated 16 mm magnetic film recorder designed to operate in absolute synchronism with the Arri !**

Just three main items of equipment! How times are changing! Once upon a TV newsfilm assignment, a camera crew would be seen struggling with heavy sound recording apparatus, an equally heavy studio spotlight (or lights!) complete with stands, and an even heavier soundproofed camera 'blimp,' to say nothing of heavy cables, inter-connecting plugs, clapper-board, etc,

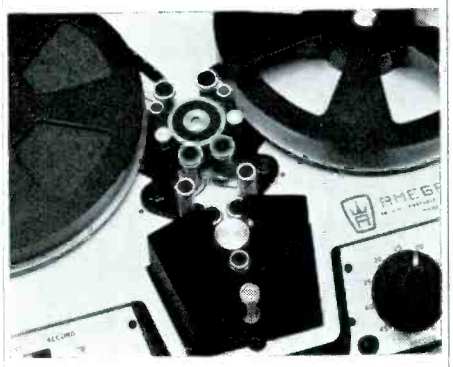
Amega M-3 16mm portable synchronous film recorder.

etc, etc . . . ! All that paraphernalia, just for a two-minute interview with some sulky-looking upstart of an 'actress' whom nobody seems to have heard of anyway!

The trend in recent years, however, has been very much towards lightweight, battery-operated equipment, and this month I am able to bring you the first full report of yet another exciting item of portable TV film equipment: a battery-operated synchronous film recorder.

This revolutionary new recorder comes from the Amega Corporation, of 11817 Wicks Street, Sun Valley, California; Amega Corporation is an affiliate company of the Omega Engineering Company, which has supplied American industry

Amega's unique film 'movement' utilises instrumentation-type drive for studio-quality sound recording.



with electronic equipment and components for nearly 20 years.

Regular readers of INTERNATIONAL BROADCAST ENGINEER will recall that, in last November's issue, I brought exclusive details of two other magnetic film recorders from the Amega stable: one 16 mm portable recorder, and one heavy-duty studio recorder available either for 16 mm, 17.5 mm or 35 mm film. Both of these recorders — models A and M-2 respectively — were, however, designed for AC mains use only.

Notwithstanding the fact that these studio recorders have, within a very short period of time, met with enormous success throughout the world, it has been evident to Amega executives for some time now that these mains-operated models would not meet the stringent requirements of fast-moving TV news units, who must frequently operate away from AC mains sources; moreover, these studio recorders, portable as they undoubtedly are for normal TV film work, are just not portable enough for news work . . . Newsmen want a recorder that can be neatly tucked under an airplane seat!

Amega Corporation was thus presented with a challenge: to design and manufacture an over-the-shoulder **battery-operated** 16 mm film recorder to run in exact synchronism with a battery-operated 16 mm film camera, such as the new Arriflex.

For years, leading sound engineers in the film and TV industry have wondered whether it would be technically possible to synchronise a battery-operated film camera directly with a battery-operated magnetic film recorder, without having to resort to the time-wasting 'transfer' process. But, so far, this has been possible only by pulsing the camera speed frequency on to $\frac{1}{4}$" tape, which must, of course, later be transferred on to 16 mm or 35 mm magnetic film before editing can commence.

We are, of course, a long way from what is surely the dream of all electrical engineers—a DC-operated synchronous motor — so Amega's backroom boys decided to find some way of inducing an AC current to drive a synchronous motor. They reasoned, quite logically, that if an AC current could be generated within the recorder, it would be a comparatively simple matter to control the speed of the synchronous motor by means of the camera pulse frequency.

Such was the basic design philosophy.

But, despite Amega Corporation's optimistic outlook, doubts were expressed in certain quarters of the industry as to whether an AC current could be generated in such a restricted space.

But Amega's research team were to come up with a vital component: **a miniaturised solid-state inverter, which was to be the heart of Amega's newest recorder—model M-3.**

I asked William H. Stutz, sales manager of Amega Corporation, just what advantages the new equipment possessed. He told me: 'The outstanding feature of our new recorder is its built-in solid-state inverter, which changes the DC (battery) current to AC current. By this means, it is now possible—for the very first time—to synchronise **any** film camera direct to a magnetic film recorder by pulse frequency control, so that the recorder will always be running at **exactly** the same speed as the camera.

'Nickel-cadmium batteries drive a synchronous motor through the miniaturised solid-state inverter; the speed of this sync motor is governed by the pulse frequency from the camera, or by the M-3's built-in pulse generator, so that perfect lip-sync is achieved at all times!'

Stutz continued: 'Another important facility of our new recorder, which is an inherent feature of all our equipment, is, of course, interchangeability of parts. We have provided the sound engineer with facilities for the interchange of head assemblies and amplifier modules, without the need for any complicated wiring. Furthermore, the M-3 can readily be used with any suitably-modified film camera—in the studio or on location. Our new synchronous recording system is, without doubt, the ultimate for present-day audio technology, and is a rugged and thoroughly professional unit in every sense of the word.' He emphasised that recording directly on 16 mm magnetic film will eliminate the transcription process which is necessary when using $\frac{1}{4}$" tape—and that this would mean savings both in time and money.

I enquired whether the Amega Corporation had any premonitions in launching a new magnetic **film** recorder at a time when $\frac{1}{4}$" tape and sync pulse (pilot-tone) camera generators were all the rage with film and TV producers throughout the world. Stutz admitted that $\frac{1}{4}$" tape had certainly become extremely popular in the past few years, but added: 'Most producers, after the novelty of $\frac{1}{4}$" tape and sync pulse control has worn off, have become more critical of the tape equipment and have experienced difficulty making repairs, etc.

'An additional problem is the cost of sound transfer and the time delay before the sound can be synchronised to the picture for 'double-system' playback. Initially, it seems less expensive to use $\frac{1}{4}$" tape. However, with dubbing fees going up all the time, we see an opportunity for a large market using sprocket-driven magnetic film recording equipment.'

It is expected that this new recorder—**which weighs less than 22 pounds complete with batteries and film**—will prove invaluable with TV film units being jet-flown to the remote corners of the globe, as the equipment can be put into operation literally **in seconds!**

Dealing firstly with the purely mechanical aspects of this 'space age' recorder, I found that the film deck accepts up to 400 ft of standard fully-coated 16 mm magnetic film, giving a maximum running time of 11 minutes at 24 frames per second. Since magnetic film is generally supplied on a plastic bobbin (core), rather than on a reel, loading is greatly facilitated by the use of special split-apart instrumentation-type spools, which somewhat resemble the well-known videotape spools.

In accordance with international practice, film is loaded on the left hand spool, passes through the sprocket-drive head unit and its associated dampening rollers, and is taken up on the right-hand spool; two 'gates,' one on each side of the sprocket drive, spring open for ease of threading.

Stutz told me that the user has the choice either of edge- or centre-track magnetic heads. However, it is expected that, in accordance with accepted professional film and TV sound practice, the centre-track head will be used almost exclusively for all original recordings. But, of course, either can be used, as the whole head assembly is of the plug-in type, with azimuth adjustment.

During operation, a hinged lid covers the film

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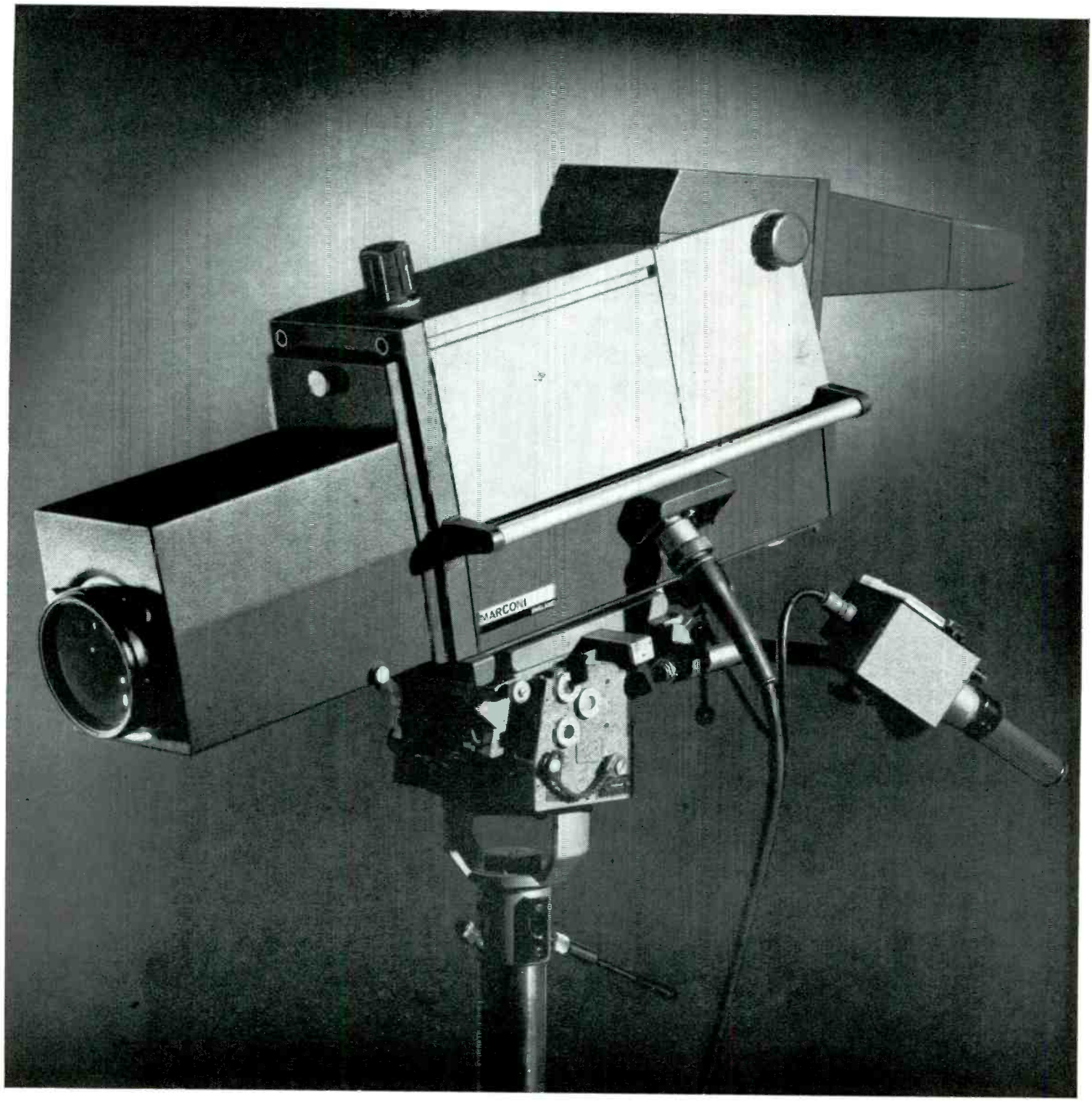
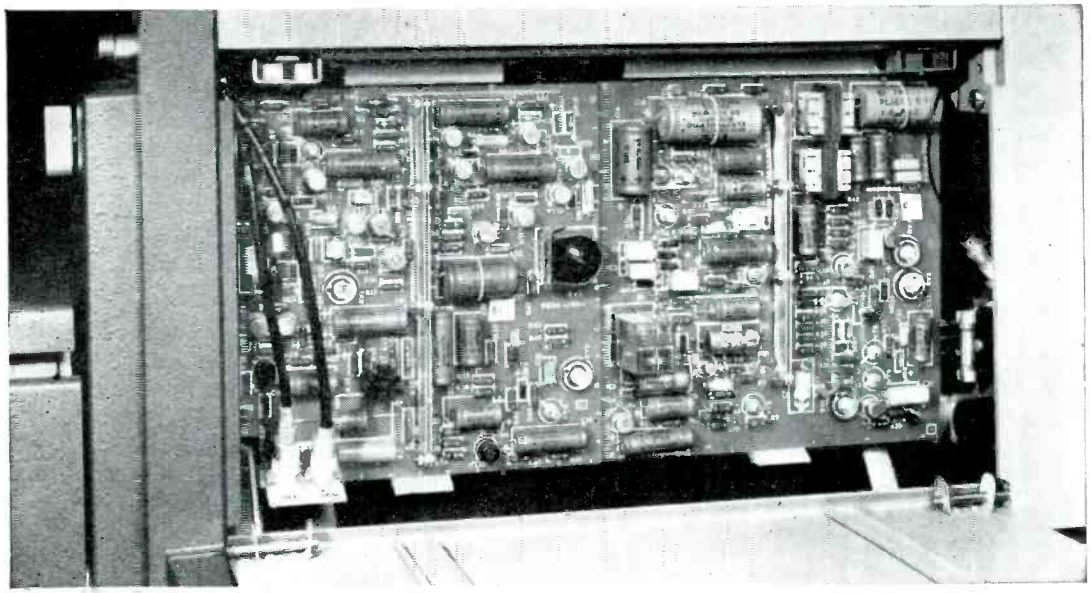
The new Marconi



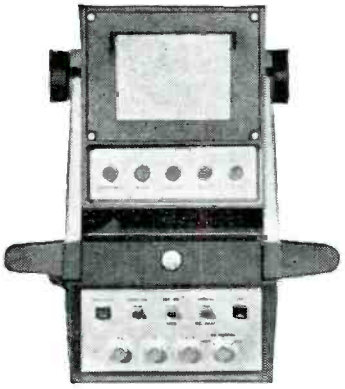
The smallest, lightest 4½ in. Image Orthicon Camera in production as simple to operate as an ordinary amateur photographic camera

MARK V solid-state television camera

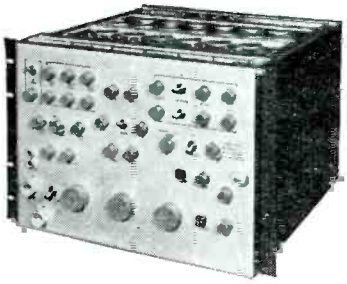
The latest and most advanced in the line of 4½ in. Image Orthicon Cameras produced by Marconi's, who pioneered the use of this type of camera and have sold more than all other manufacturers put together.



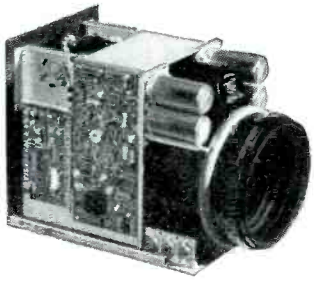
ALL SOLID STATE
Silicon transistors used throughout the chain to give outstanding stability and reliability. Constant output ensured despite mains variations, temperature changes or external fields. Easy access for tube changing. No image orthicon setting up controls.



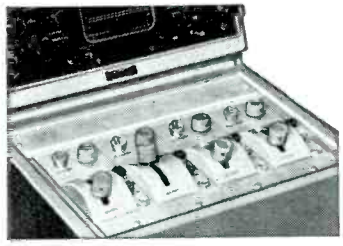
TILTING VIEWFINDER
Ensures most comfortable viewing position for all camera angles. Detachable up to 30 ft. from camera. Brilliant picture (200 ft.-Lamberts). Camera, external or mixed signals available at cameraman's choice.



OUTSTANDING PACKAGING
Single rack mounting camera control unit, control panel and power supply. Circuitry contained in seven plug-in printed wiring modules, giving easy front access for maintenance.



INTEGRATED ZOOM LENSES
Choice of servo or manually controlled zoom lenses gives infinitely variable focal length for exact picture framing. Simplified camera operation and improved programme continuity.



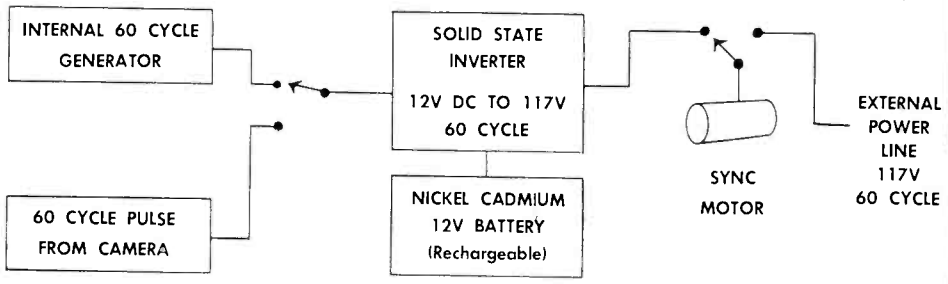
SIMPLE CONTROL
Simple compact control panel, four of which can be mounted on a console desk gives complete 'hands off' operation.

Marconi television systems

The Marconi Company Limited, Broadcasting Division, Chelmsford, Essex, England LTD/B66

Instant Sync — continued

Block schematic of Amega's M-3 recorder clearly illustrates the principles of operation. Recorder may be switched for (i) sync pulse recording, (ii) 'wild' recording, and (iii) AC mains operation.



deck, and this serves to soundproof the recorder during a 'take,' a point that will be especially appreciated by sound film engineers on cramped interior locations, or where the recorder must be operated in close proximity to the film camera. Of course, on exteriors, and particularly when the recorder is operated at a distance from the camera, the M-3 recorder may be operated with the lid open, as motor noise isn't then such a menace. On news operations, when equipment must frequently be operated in the rain, and sometimes in very dusty surroundings, it will prove no less convenient to use the recorder with the lid closed, I was told.

Turning now to the operator's control panel, I found this to be conveniently slanted to allow easy access during both shoulder-slung operation and normal operation. On the right-hand panel will be found a very sensibly-proportioned RECORD GAIN control knob, which is easily manipulated by a gloved hand in cold weather. A slider switch enables the sound engineer to change from the external (camera) 60-cycle pulse signal to the M-3's own transistorised frequency generator for 'wild' recording, while a SYNC MOTOR switch controls the drive motor in the forward mode only.

The left-hand control panel features a standard VU meter and BATTERY TEST buttons both for the Amplifier power supply and for the Inverter power supply. Also provided are three slider switches: (i) RECORD/PLAYBACK switch, (ii) FILM/DIRECT switch for monitoring, and (iii) a FORWARD/REVERSE switch for spooling. A PLAYBACK GAIN knob completes the operator's controls on the front panel.

It almost goes without saying that the M-3 recorder uses **solid-state transistorised amplifier modules**, which are, of course, interchangeable. They have special enclosures to protect the miniaturised components under all operating conditions, and in addition the transistors are heat-protected by a special circuit to ensure the utmost reliability. On the front of the recorder, below the control panel, a removable cover plate provides access to the plug-in module compartment. As will be seen in the illustration, this houses five plug-in modules: Bias Oscillator, Playback pre-amplifier, one spare pre-amplifier, Record pre-amplifier and a Microphone pre-amplifier.

An Amega development engineer pointed out that the audio circuitry and components are basically the same as those on the Amega studio recorders, and that the use of plug-in modules permits the sound engineer to maintain the equipment to a large degree. Miniaturisation, I was assured, has meant no compromise in audio quality.

Two microphone inputs are provided: one for a low-impedance microphone of either 50 or 250 ohms with 90 dB gain, and also a 20 KΩ bridge input with 20 dB gain (for bridging a 600 ohm line).

Stutz, who last year celebrated his 25th anniversary in the sound recording business, pointed out that the Microphone Input channel has DIALOGUE/MUSIC equalisation, which may be selected by means of a switch located on the input panel of the recorder, whilst monitoring of the recorded signal may be achieved by listening in on headphones (a 'PHONES OUTPUT socket being conveniently situated on the audio connector panel on the right-hand side of the recorder).

An Amega technician took up the story: 'The sound engineer can switch instantly from the incoming signal to the off-film recording by a quick flick of the Film/Direct switch on the front panel, whilst at the same time observing a VU meter, which has the standard 'A' scale. Thus it is possible to compare the signal **before** it has been recorded, and **after**—when it is on the film —with only a fraction of a second's delay!'

A sensible design feature, I thought, was the placing of the connector panel at the right-hand end of the recorder, so that cables will trail the operator during shoulder-slung operation. This panel is recessed, and has provision for the following audio and power connections: Microphone Input, Bridge Input, 'Phones Output; External AC power, Battery Charger, Camera Sync Pulse input. Also to be found here are the Dialogue/Music switch, Monitor Gain control and an Internal/External Power switch.

The audio specification of the Amega M-3 is impressive for a portable 16 mm film recorder. The Frequency Response is quoted as being from 50—10,000 c/s ±2 dB, with less than 1% total harmonic distortion from the recorded film. I found the Signal-to-Noise ratio to be better than 50 dB, while the film deck's unique instrumentation-type drive has kept the Wow and Flutter figure to less than 0.15% rms in all bands (0.2% overall).

I was surprised to learn that one set of batteries will provide for approximately one hour's continuous recording (or up to six 400 ft rolls of film), before recharging is necessary. Recharging time is 12—14 hours, and for this Amega supply their own charger. Hard-pressed TV film units on overseas locations will, of course, find it more convenient to keep a supply of spare batteries on hand, since there will invariably be neither time nor facilities for recharging. A Battery Test button, situated alongside the VU meter, should read 0 VU when fully charged.

I asked Stutz whether his company was planning to introduce a 17.5 mm or 35 mm model for use in conjunction with 35 mm motion picture cameras, but was told that no such model was planned at the moment. However, there is absolutely no reason why the 16 mm Amega recorder should not be used in conjunction with a 35 mm camera, and then 'synched-up' on a 16/35 synchroniser, or, better still, edited on a dual-gauge editing machine; alternatively, the 16 mm track could always be transferred to 35 mm magnetic to simplify editing.

The introduction of this revolutionary new film recorder may well set a precedent—certainly as far as TV films are concerned—for recording all original sound on 16 mm magnetic film, particularly as the audio quality of the M-3 is equal to the SMPTE standards for 35 mm! Moreover, since practically all original telefilm sound is sync dialogue, there would seem to be little point recording it directly on 35 mm magnetic.

What is probably most advantageous about this technique is that there is no need to resort to 'clap-sticks' for synchronisation. In fact, on

Plug-in modules are interchangeable between microphone pre-amplifier, record amplifier and playback pre-amplifier. Bias oscillator and one spare module complete amplifier section.

TV film location work in particular, production techniques will be greatly simplified. Thanks to the built-in electronic 'slating' facility of Arriflex, Mitchell SSR-16 and other cameras, a built-in marker-light 'fogs' a frame of film at the beginning of each Sound 'take,' while a special 'slate' pulse is recorded on the magnetic sound film (corresponding to the 'fogged' frame). Back at the studio, the magnetic film can be run down on a synchroniser while the picture negative is being processed. For the film editor, it is only a matter of finding the 'slating' pulse—by means of the synchroniser's magnetic head—and putting a Sync mark (punched hole or Chinagraph) on the cell-side. Then, when the picture film has come off the processing machine, this can be quickly synchronised to the sound by marking the 'fogged' frames, after which editing can commence. It's as simple as that!

Perhaps the most striking example of the vital part this new recorder will play in television film production will be for **colour** TV films. Whereas one can record 'single-system' sound on pre-striped black-and-white negative or reversal film, it is another kettle of fish where colour films are concerned. Taking as an example one of the most popular professional 16mm colour (camera) films, Ektachrome Commercial (Type 7255), I understand from a major British film laboratory that it is still not possible to process this low-contrast colour reversal film **when it has been pre-striped**, as dissolution of the magnetic stripe is liable to occur with, need I add, disastrous results to the picture. So the only really satisfactory method when filming on Ektachrome Commercial—and, for that matter, most other 16 mm professional colour stocks—is to record 'double-system.'

So also it is on 35 mm, although here there is an additional problem: there is, as yet, no international standard for the sound separation on single-system magnetic sound cameras, which, of course, rules out 'single-system' sound filming altogether. But, here again, pulse synchronisation with the new Amega recorder will prove to be a highly efficient method of 'double-system' record- ▶

Instant Sync — continued

The equipment in use: the sound recordist (left) 'gets a level' on the M-3 while the cameraman lines up the 16 mm Arriflex. Both camera and recorder are battery-operated—and the only connection between the two is a sync lead !

ing both for cinema and television film production, and whether in colour or black-and-white. To think, 35 mm films used to be made using 'monster' cameras and a truck-load of heavy recording equipment, both of which had to be synchronously interlocked on **3-phase** AC mains, while sync marks were provided by special arrangement with the clapper-boy! The same production quality can now be obtained by using a battery-operated 35 mm camera—such as the Arriflex—with nothing more than a sync lead to the Amega recorder!

An Amega engineer explained that the M-3's salient-pole synchronous motor is gear-coupled to the drive sprocket, thus ensuring that absolute sync is achieved from the camera's 60-cycle pulse signal; this signal is amplified through the inverter and controls the speed of the synchronous motor.

Now this may sound paradoxical! How, you ask, can a synchronous motor be anything but a synchronous motor? The answer is that, whereas a mains-operated synchronous motor is governed by the very constant mains frequency (50 or 60 c/s, depending on where you live), in the Amega recorder it has been necessary to allow for minor camera speed fluctuations. So, although the optimum pulse frequency is 60 c/s at 24 frames per second (standard sound speed), if the camera speed were to drop to, say, 23 fps, the pulse frequency would be correspondingly lower, namely, 57.5 c/s; on the other hand, if it were to rise to, say, 24½ fps, the pulse frequency would rise to 61.25 c/s. **With the Amega system, the recorder always runs at exactly the same speed as the camera—frame for frame, in fact!**

'With the Amega M-3 monitoring directly from the film,' I was told, 'the operator is constantly aware of any speed fluctuations or malfunctions of the camera. **In other words, he is listening to exactly what he would have from a transfer from ¼" tape back at the studio.**'

Stutz, who previously was in charge of manufacturing at Magnasync Corporation, Hollywood, explained that, when the M-3 is used as a portable, the recorder will not run until the pulse is received from the camera; for 'wild' sound, though, the recorder's built-in frequency generator permits its use for synchronous sound recording with no external source of power or frequency regulation. Mains power will, of course, operate the synchronous motor for conventional 'double-system' recording, when both camera and recorder are locked to the mains frequency.

It must be stressed that sound quality will be entirely dependent on the speed of the camera, and that any deviation from the correct camera speed will give rise to an audible change in pitch. However, this can be safeguarded against by utilising a 24/25 fps **constant-speed** motor, in preference to the oft-used variable-speed motor. Rank Studio Equipment Ltd of London, for instance, market a transistorised governor-controlled DC motor (for the Arriflex) with an accuracy of better than ± 0.0015% !

Moreover, with the new Arriflex 16M-BL (originally designated the model Q), it has now become possible for the first time to alter the camera speed from 24 to 25 fps at the flick of a lever—and without exchanging motors! Thus it will be possible for cameramen to use one motor only, whether they are shooting for television or for the cinema.

What all this adds up to, in fact, is that, when using the new 16 mm Arriflex and the Amega M-3 'in the field,' 100% sync can be achieved with no more than a pulse sync cable connecting the two.

At this stage in the proceedings, you may be wondering: 'Why record 'double-system' when single-system Sound Cameras are the predominant choice of the world's television film units?' Why, indeed? The practice of recording sound directly on the magnetic edge-stripe of the 16 mm camera film has been in vogue for some years now, and has found particular favour with television news organisations. But its biggest disadvantage is the fact that, on TV news in particular, time considerations usually indicate 'lap-cutting,' with the result that there is an objectionable 28-frame overlap, which makes all but 'hack' film editors wince! When time permits, the preferred practice is to 'transfer' (ie re-record) the camera sound track on to centre-track 16 mm magnetic film, so that both sound and picture can be cut in 'level sync.' When this method is used, some TV stations run the SEPMAG track on a special magnetic film playback machine, which is run in synchronous electrical interlock with the telecine apparatus. However, since the budget of most TV companies does not extend to such 'luxuries,' the only alternative is to erase the original camera soundtrack (preferably on a bulk eraser), and transfer-back the SEPMAG track on to the original camera edge-stripe—a task which any competent sound engineer can accomplish without any noticeable degradation in audio quality.

Although considerable emphasis has been laid in this report on the M-3 recorder's use with the Arriflex camera, it should be pointed out that this recorder can be used with **any** 16 mm or 35 mm motion picture camera which has been suitably modified for pulse synchronisation. 35 mm cameras such as the Newall camera (in the Raby blimp) and the Mitchell BNC are two examples of studio cameras used by the TV film industry, which have, in the past, been modified for sync pulse, and which have responded well to this surgery! However, these were originally modified for use with ¼" tape, but doubtless these same cameras will now be used (without alteration) in conjunction with the new Amega recorder.

It is interesting also to note that a number of TV newsfilm units have even had their 16 mm **single-system** Sound Cameras modified for pulse sync! Such cameras as the Auricon Pro-1200

Checking batteries before location shooting on roof of building.

and the new Mitchell SSR-16 are classic examples of self-blimped 16 mm TV news cameras which can be obtained with pulse facilities, thereby enabling them to be used either for 'single-system' or 'double-system' operation. . . . You pays your money and you takes your choice!

Although the first M-3's are being supplied for 60-cycle use, I learn that 60-cycle models will be available shortly for European users, but Stutz pointed out that, for countries also on 220-240 volt mains, a small step-down transformer would have to be used (when not using batteries), since all models will be for 110-120 volts only.

Amega Corporation are expecting a big demand for their new equipment and are gearing themselves for quantity production. But the indications are that this demand could well prove overwhelming initially, so television film units are advised to place orders early to avoid possible disappointment.

Clearly, Amega executives have great faith in the future of magnetic film recording, despite the recent trend to pilot-tone recording on $\frac{1}{4}$" tape. With the introduction of their new M-3 film recorder, $\frac{1}{4}$" tape (for film use) is now almost bound to go down in the popularity poll. . . .

Indeed, some engineers believe that this amazing new development may well sound the death-knell of camera pulse sync on conventional unperforated $\frac{1}{4}$" tape! Only time will tell!

* International Broadcast Engineer, Oct 1964

Satellite communications and broadcasting politics:

Belgian refusal to carry commercial traffic jeopardises historic transmission

by Rod Allen

IT IS TRUE to say that technological advance is the tool of political advantage; but when politics interfere with technological advance, the results can be disastrous.

This thought is prompted by experience of the problems which surrounded satellite Early Bird's latest historic 'first' seen in England last month, when the London national newspaper, the *Daily Mail*, sponsored the first ever live broadcast TV commercial to be transmitted over the new satellite.

What seemed a relatively simple project soon became fraught with political problems, developing as it did at the same time as the international wrangling over the proposed charges for the use of Early Bird. I spoke to the people in charge of the project and was present in the London control area at the time of this historic transmission; and it seemed to me to be a miracle in more ways than one that the 2½-minute spot ever got onto Britain's ITV network.

Ten weeks prior to transmission, Geoffrey Golden, head of publicity for the company which publishes the London Daily Mail, Associated Newspapers, submitted to his directors an idea for the first live transatlantic television commercial. He suggested that it might be apt if this commercial were to be transmitted on the eve of the centenary of the birth of Alfred Harmsworth, later Lord Northcliffe, founder of the *Daily Mail*. It so happened that this date coincided with the day when scientists at the Jet Propulsion Laboratory, Pasadena, Calif, were all set to re-establish contact with the American space probe Mariner-IV, which was later to relay back photographs of the surface of Mars over 135 million miles of space to the waiting experts in Pasadena.

Accordingly a plan was approved whereby a live commercial would be transmitted from the Jet Propulsion Laboratory in Pasadena, tying in with an exclusive report in the following day's *Daily Mail* of the developments in Pasadena, from the *Mail's* New York bureau chief, Jeffrey Blyth, who would also present the commercial from Pasadena. Total cost, including booking time on all of Britain's 14 commercial stations for the 2½-minute commercial, would amount to over $30,000, apart from creative and technical personnel.

Early Bird was to be booked for half-an-hour by the London Television company, ATV, which was providing technical facilities for the whole operation for the *Daily Mail*.

Then came bombshell number one: the proposed scale of charges published by COMSAT for the use of the satellite proved to be too high for the likes of the members of the European Broadcasting Union, of which ATV is one. Accordingly, the EBU recommended its members to boycott the satellite completely — and such, rightly, is the Union's power that ATV had to tell the *Daily Mail* that it was unable to book Early Bird for the commercial.

Thus the complicated booking procedures for the satellite went into the unfamiliar hands of the *Daily Mail's* executives.

On June 28, therefore, negotiations were opened with COMSAT and the British Post Office and the American cable companies who would carry the signals from Pasadena to Andover, Maine. KNXT-TV, Los Angeles, in conjunction with CBS Television was to handle production facilities in the States.

Negotiations were finally completed, and, with under ten days to transmission time, all systems looked to be 'go.' The signal was to be received by the ground station at Raisting, W Germany, and routed by microwave link of Eurovision via France to London. It was important that the pictures should avoid Belgium and the Eurovision control centre in Brussels, as the Belgian authorities had blandly announced that they were not prepared to handle commercial traffic. This presented an additional problem which was to produce an unforeseen headache on the night of transmission. Britain's ground-station at Goonhilly Down, Cornwall, was scheduled to be on operational standby that night—Wednesday, June 14, 1965.

Then fell bombshell number two: COMSAT had been given until the previous Thursday to present its final tariff for approval by the American Federal Communications Commission. Thursday midnight came and went, and still COMSAT's Board of Directors had not decided on the scale of charges for the satellite. Early Bird transmissions were suspended; all seemed to be doomed to failure. As lawyers argued the legal situation, word reached London that the FCC had given COMSAT another ten days to decide: this period ran out well after transmission date—and the project was saved.

The *Daily Mail's* advertising agency meantime finalised airtime bookings: the network was alerted to take the commercial at 22.34 on the Wednesday night; lines were to be kept open for an additional 10 seconds over the 2 minutes 30 seconds booked in case of failure or late start.

At around five on the evening of transmission, a handful of apprehensive people began to gather at ATV's presentation suite in Foley Street, in the West End of London. Peter Page, the *Daily Mail's* assistant head of publicity, was there to supervise the whole operation and liaise with Geoffrey Golden over the transatlantic telephone; Bill Stewart an ATV staff programme director, was in charge of creative work at the studio, ex-newscaster Huw Thomas was there to introduce the transmission from London. Others present included sales representatives from ATV and the usual studio personnel.

At 20.00, a standby tape was made, in case of total failure of the transatlantic link. It went off perfectly, and was laced up on a reserve Ampex with a fervent prayer that it would never have to be used. At the same time, three permanent telephone cable circuits were opened with Pasadena to afford continuous immediate contact between Pasadena and the production gallery, the master control and the script control section at Foley Street. These were to be in continuous use—at $8.40 a minute!—until after transmission.

After the standby tape and a few last minute script amendments — British TV legislation is such that two executives from the Independent Television Authority and the Independent Television Companies' Association had to be present to approve all changes in 'copy'—the agonising waiting period began. Not until 22.10 would the anxious engineers know whether Early Bird was 'go' or not—just 24 minutes before transmission time. In those 24 minutes, a perfect standby 'live' tape had to be made. This would run simultaneous with the live transmission, and was to

Mammoth Eurovision remote

British and Swiss TV engineers collaborate to conquer the Matterhorn by television

by Charles Nicholas
Zermatt, Switzerland

LAST MONTH the Eurovision network saw the culmination of an impressive joint operation by the British Broadcasting Corporation, the Swiss Broadcasting Corporation and the Swiss Army in the form of the first live TV outside broadcast from the summit of the 14,780-ft Matterhorn in the Swiss Alps.

According to BBC executive producer Alan Chivers, it was 'the diciest outside broadcast I've ever attempted.' And was not just the height and dangerous conditions that made it dicey. For it was the first time that any programme had relied to such a great extent on the use of portable radio cameras for it main content.

The programme was planned to coincide with the centenary of the first ever ascent of the Matterhorn by the controversial English mountaineer Edward Whymper.

Keys to the success of the whole operation were two small French LEP radio cameras and a rather larger Japanese Ikegami radio camera. It was from these cameras that the major proportion of the programme was to originate, for only by use of small portable equipment could the producer obtain the vital close shots of the mountaineering team.

The programme was to be seen on Wednesday July 14 simultaneously in Switzerland, France, Germany, Denmark, Sweden, Italy, E Germany, Norway, Yugoslavia and the United Kingdom. The US ABC network was also showing videotapes of the programme flown to the States.

Yet on the Tuesday previous, it seemed that the whole programme was doomed to failure. Two days of vital preparations had already been lost because of a violent snowstorm on the mountain which marooned producer Chivers in the 10,000-ft Hoernli Hutte. It was a race against time to get the broadcast on the air when on the Tuesday the storm cleared.

Says Chivers: 'Radio cameras have always been somewhat temperamental, but without them we shall only get long shots from the Swiss image orthicons based on key positions around the Matterhorn.'

Operating the two French radio cameras were two teams of professional photographers and mountaineers. While the photographer wielded the camera, his colleague, the mountaineers, had to aim the transmitter pack back towards the receiving point as the transmitter operated on line of sight only.

At the time of transmission, there were some 46 to 50 television personnel up the mountain. These included six BBC engineers, two BBC production staff, one BBC programme assistant, two transmitter operators, three radio camera operators, one commentator, 30 or 40 Swiss engineers—as well as a sizeable portion of the Swiss Army which was assisting in the operation by flying in some three tons of equipment for the transmission. Said a Swiss Army spokesman: 'We are taking the opportunity of this occasion to try, under actual operational conditions, new equipment that is being developed for use in mountain warfare.'

Chivers emphasised the co-operative aspect of this production as well as the low real cost of the operation: all but a small portion of the costs would be recouped by Eurovision and American sales of the programme within a few days of transmission.

Said Chivers: 'There is a 50/50 chance of the programme being a success.' Yet 'Men Against the Matterhorn' (its English title) was a hundred per cent success, and on that day Wednesday July 14, another television 'first' was chalked up on the scoreboard of broadcasting engineering achievements.

Satellite communications and broadcasting politics — continued

have been punched up at any time during transmission in the case of on-air Early Bird failure.

At 20.00 programme sound was established. We heard a Californian engineer give last-minute instructions about talk-back gain control settings, and all was set for picture to come on at 22.10.

22.10 came and went and with it came bombshell number three.

It became immediately apparent to the engineers that there was total video failure.

A quick phone call told the tense assembly that the picture had been misrouted out of Raisting into Brussels: and in view of the Belgian ruling on commercial traffic previously mentioned, there was no feed from the Eurovision centre in Brussels.

Britain's Post Office stepped in at this stage, fortunately, and immediately gave London a feed from Goonhilly Down ground station, on operational standby at the time. Only a minute or two behind schedule, the picture appeared on our monitors, loud and clear from Pasadena. Thanks to the Post Office, the commercial could go ahead.

Immediately, a standby take was gone for. It was a disaster, and quite unusuable. As the seconds ticked all-too-quickly by, a segment of the script was hurriedly re-written, and read over to Pasadena. Under ten minutes before transmission a second take was made, and pronounced OK. This, too, was laced onto a standby Ampex, which would run in sync with the 'live' commercial.

News of the death of Adlai Stevenson, which had come into the control room a little previously, had raised fears that the British networks would require the trans-atlantic circuit for obituary material; at literally the last minute it became apparent that they would not need the circuit. But CBS did want a return circuit immediately after the transmission for the reception of obit material from the BBC.

At 22.34 precisely, the network programme faded, and was replaced by a station ident. Exactly five seconds later, we were on the air, and the face of presenter Huw Thomas was seen all over the country. And a few seconds after that, Jeffrey Blyth in sunny Pasadena was also seen. The commercal was a technical—and a creative—success.

But it was a success against all the odds. The greatest technological advance in television since television began had been almost rendered invalid by political wranglings. Only through adroit manoeuvring by those in charge of the transmission and a well-timed intervention by Britain's Post Office did this, the first live transatlantic TV commercial, ever get on the air.

One is tempted to ask whether the television politicians — in any country — are always completely fair to their colleagues in the studios.

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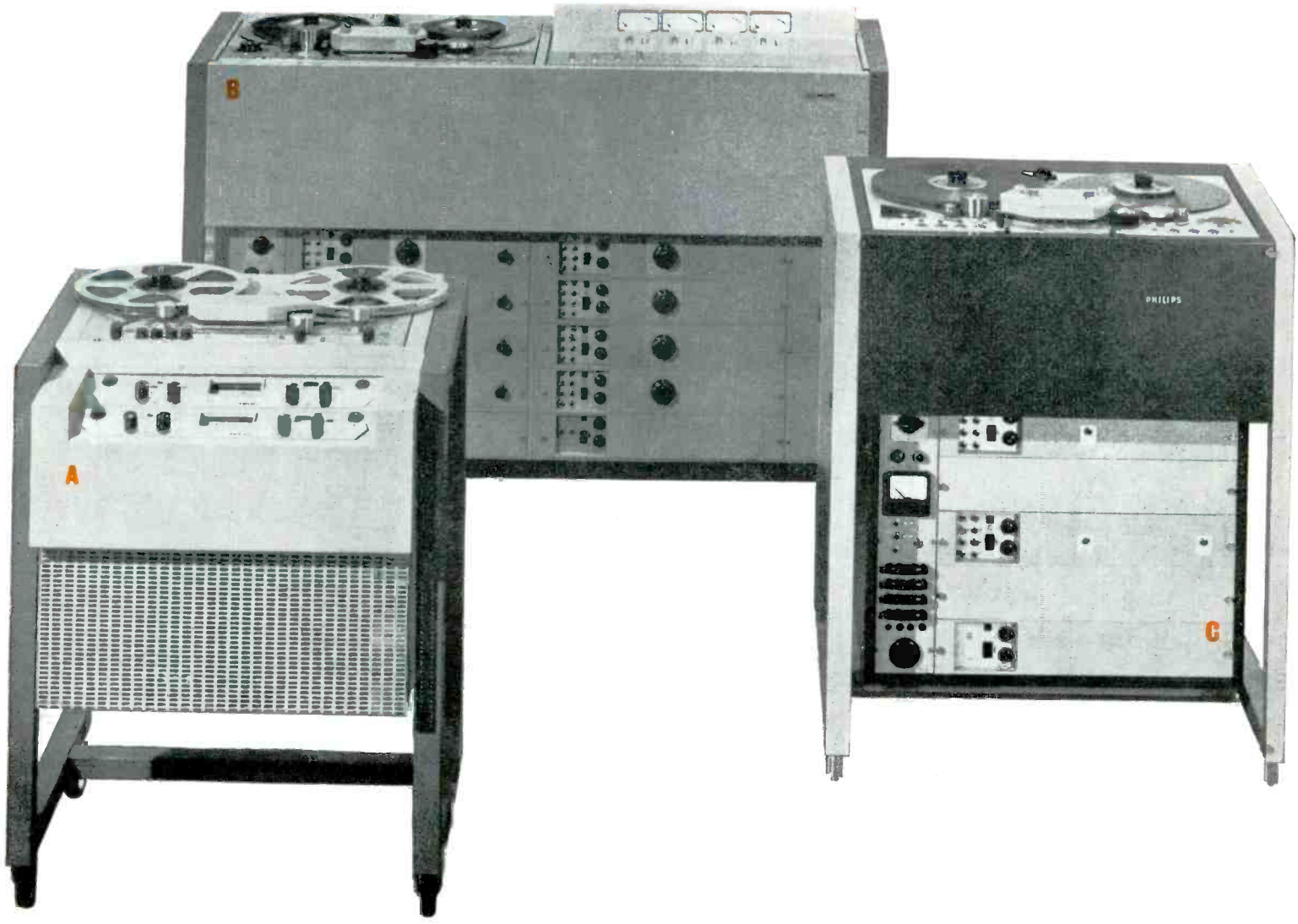

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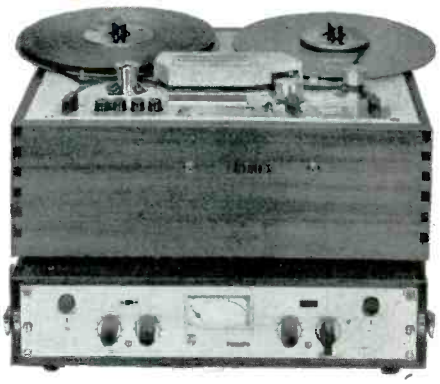

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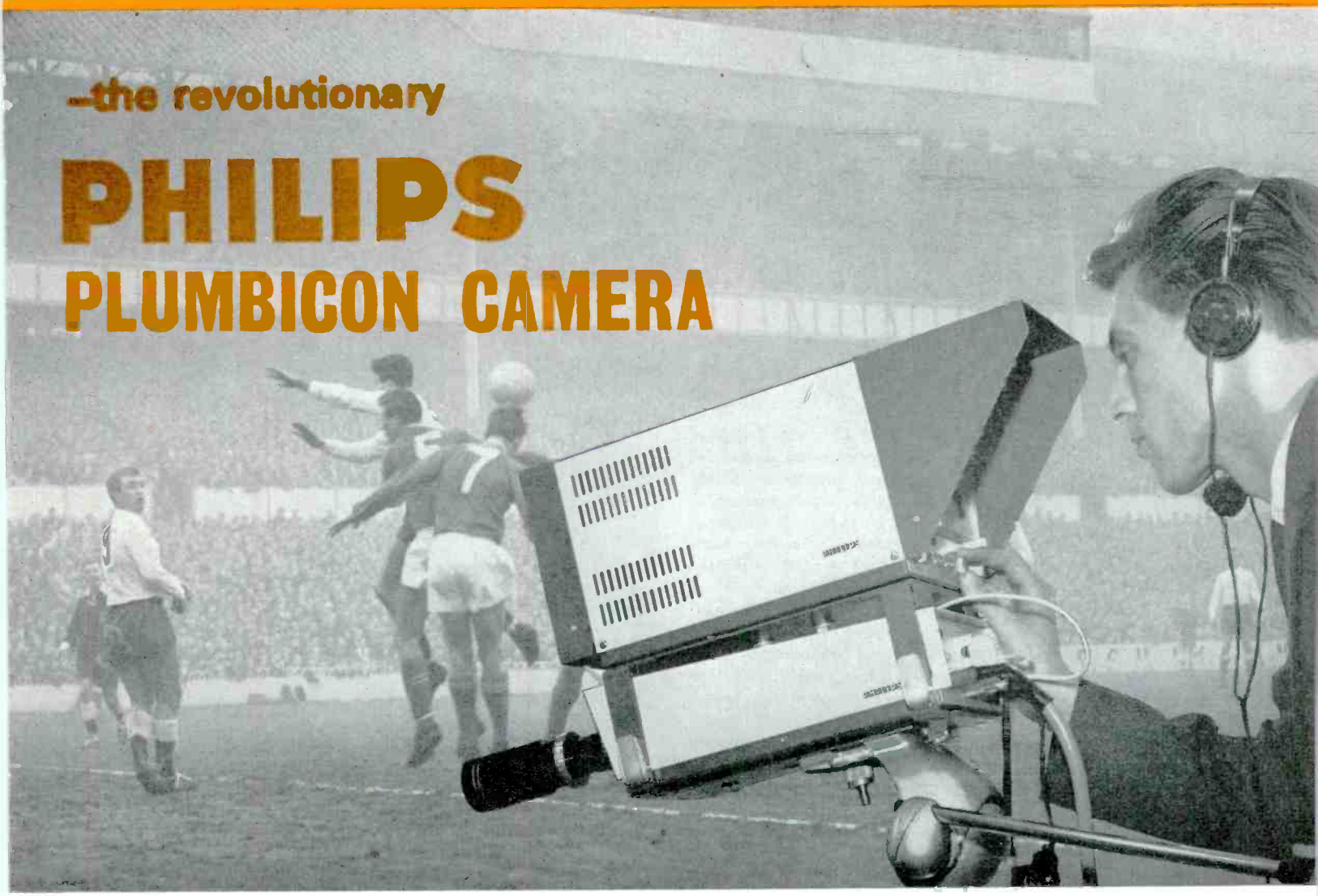

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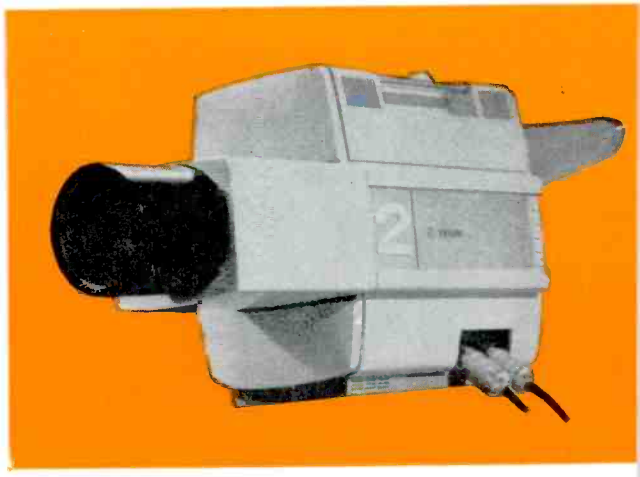

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TROPOSPHERIC SCATTER MULTICHANNEL COMMUNICATIONS

*** 'It is an international problem,' said Dr John Dickson, in the December 1964 edition of International Broadcast Engineer, describing 'trop scatter' and the work of Mr D. B. KENNETT who in 1960 joined the Communications Division of The Marconi Company. Now here is an edited version of a master survey of tropospheric scatter techniques by Mr D. B. Kennett, BSc (Eng) himself, compiled just before he left The Marconi Company to take up an appointment in Dar es Salaam as Executive Engineer with the East African Posts and Telecommunications Administration . . . an area of the world where 'trop scatter' is of prime importance. The following paper summarises his Marconi experience, when Mr Kennett spent two years in Nigeria carrying out multichannel installation projects. His later Marconi work as a Systems and Project Planning Engineer was particularly concerned with multi-channel tropospheric scatter systems, on which he writes with exclusive first-hand experience.**

* * *

by D. B. Kennett BSc. (Eng.) AKC

* * *

EXISTING VHF and microwave multichannel radio links suffer from the disadvantage that several repeater stations are required if large distances are to be covered. In areas where the centres of population are separated by distances of the order of 200 and 300 miles and the intervening land area has a very low population density, these intermediate repeater stations (on the average every 45 miles) represent a definite liability, and a means of communication not requiring these intermediate stations becomes desirable.

For a small number of channels, HF circuits may be employed, but for larger capacity systems a method of multi-channel radio communication not restricted by the horizon is required. The past decade has witnessed a practical and economical solution to this problem by *utilising the tropospheric scatter mode of propagation of UHF and SHF radio waves.*

The advantages of a tropospheric scatter radio system may be summarised as follows:

(a) Direct communication without intermediate repeater stations between places spaced approximately 200/300 miles apart.

(b) A decrease of 3 : 1 or 4 : 1 in the number of stations required to cover a given large distance.

(c) Multichannel communication across large stretches of water (over inland lakes or to off-shore islands, for example), or between areas separated by mountain ranges.

(d) It is ideally suited to the communications require-

ments of areas with a low density of population.
(e) Less maintenance of staff is required per route-mile than for a conventional VHF or microwave link over the same route.
(f) Territories controlled by another administration may be crossed.
(g) There are no repeater stations which, particularly in isolated locations, may be vulnerable and difficult to maintain.

TROPOSPHERIC SCATTER PHENOMENON

Workers in several countries have carried out systematic programmes of investigation into the propagation beyond the horizon of radio waves at frequencies above about 100 Mc/s. These have proved that signals are received at median levels which are fairly consistent in magnitude, and greatly in excess of those predicted by 'smooth earth difraction' theory. The signals exhibit fading characteristics which are a combination of slow and fast fading. The slow or long-term fading has a distribution which approximates to log-normal (that is, a normal probability law in decibels). The standard deviation of this distribution varies between 2 and 10 dB depending on the path. The fast fading, which is considered in sampling times of one to 15 minutes, may be represented by a Rayleigh distribution.

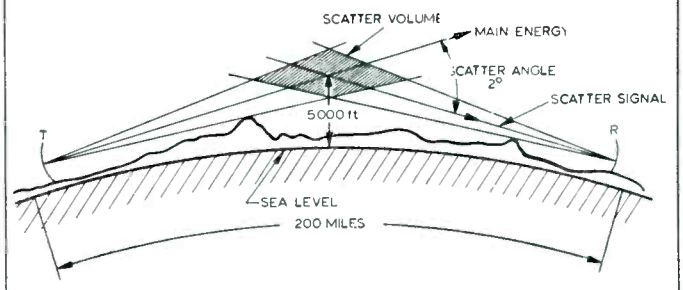
There is a fair measure of agreement[1] that the phenomenon may best be explained as being caused by a process of scattering from random irregularities in the atmosphere associated with variations in its refractive index.

For certain times of day and seasons of the year, the scatter phenomenon may more properly be called reflection, and sometimes no distinction can be made between 'forward scatter' from a turbulent atmosphere and the addition of 'incoherent reflection' from patchy elevated layers. The scattered signal may arrive at the earth's surface over several different paths, resulting in the rapid variations both in time and space. The transmitted signal is generally restricted to a beam of one degree or so in width by a high-gain aerial, and this beam is deflected towards the earth as a result of the reduction of refractive index of the upper atmosphere. The general deflection of the whole beam is affected by changes in the total water vapour content, and so has a diurnal and seasonal variation. This gives rise to the slow or long-term fading which is affected strongly by the regional climate, being most favourable in tropical oceanic regions. **It will be appreciated, therefore, that terrain irregularities, climate and weather play principal roles in determining the strength and fading properties of a tropospheric scatter signal.**

Differences in received signal of a few decibels can alter the reliability by an order of magnitude, so it is essential to be able estimate received signals accurately. A controlling factor of the received signal level is the 'long-term medium path attenuation' which is dependent upon the scatter angle.

Typical values of scatter angle are from one to four-deg (ie 17.5 to about 70 milliradians). Since each degree increase of scatter angle introduces an extra 10 dB loss in the transmission path, it will be appreciated that the system planner's constant aim should be to keep the scatter angle small. It is desirable if possible to select aerial sites in such a way that the beam forms a slightly negative angle with

Diagram of a tropospheric scatter path, showing how the scatter volume is controlled by aerial horizons.



the tangent to the earth's surface at the site. Where nearby obstacles make a positive elevation unavoidable, the angle must be kept to a minimum as a slight elevation of two or three radians entails an additional loss of several decibels.

The scatter angle having been established, the long-term median path attenuation may now be calculated. The precise evaluation of long-term median path attenuations has been the subject of works by several authors, and involves lengthy calculation.[2] However, typical figures for this long-term median path attenuation, for a frequency of 900 Mc/s over 200 miles, are of the order of 200 dB, of which approximately 70 dB is the scatter loss.

It has already been shown that the troposcopic scatter signal is statistical in nature and subject to slow and rapid fading characteristics. By calculating the long-term median path attenuation for the worst month of the year (based on the minimum monthly mean value) a value of median path attenuation relating to the bottom of the slow fading characteristic—the worst condition—may be obtained. It then becomes necessary to evaluate the rapid or short-term fading, which is evident in sampling times ranging from 1 to 15 minutes. In practice the two fadings are inseparable because the signal received is always a combination, which may be called the instantaneous signal. A set of instantaneous signal fading distribution curves for various scatter angles may be drawn by means of a statistical combination of both fast and slow fading distributions. From these curves the fading margin required for a specific reliability may be assessed.

Typical fading margins required, referred to median, for a non-diversity system (that is, one receiver only) for a 2-deg scatter angle are of the order of 13 dB for 90 per cent reliability, 23 dB for 99 per cent, and 33 dB for 99.9 per cent reliability.

This means that for a system to operate successfully for 99.9 per cent of the worst month of the year it must be able to accommodate a fade of 33 dB below the monthly median level. Since the median path attenuation is already of the order of 200 dB it follows that the system must be ▶

[1] P. L. RICE, A. G. LONGLEY and K. A. NORTON: 'Prediction of the Cumulative Distribution with time of Ground Wave and Tropospheric Wave Transmission Loss. **National Bureau of Standards** Technical Note No 15, July 1959.

[2] A clear-cut example was given by the author in **Point to Point** Telecommunications, Vol 8, No 2, using the empirical formulae described by L. P. Yeh in **Trans IRE**, CS-8, No 3, Sept 1960.

Tropospheric scatter—continued

able to accommodate a path attenuation of the order of 233 dB. On a system of high reliability, some means of reducing the effective depth of fade becomes an economic necessity, and this is achieved by using diversity techniques.

Since the scattered signal arrives at the earth's surface over several different paths, rapid variations both in time and space occur. It is found that signals received by two different aerials, separated by a distance of approximately 100 wavelengths, are substantially uncorrelated and may be utilised to reduce the fading margin.[3] This system is known as 'space diversity' and is very effective. Signals received on widely-separated frequencies (10 Mc/s separation at 900 Mc/s) also exhibit a lack of correlation of fading, and may be similarly used to form a 'frequency diversity' system. The use of frequency diversity requires the allocation of twice the number of operating frequencies for any given system, but this disadvantage is considerably offset by the extra system reliability brought about by the necessary duplication of equipment. Space and frequency diversity' system. The use of frequency diversity requires gether, to give double or quadruple diversity operation, depending on the path length and required system performance. Reference to the previous example for a two-deg scatter angle, by using quadruple diversity reception the fading margin for 99.9 per cent reliability is reduced from 33 dB to 17 dB, which results in very considerable economies in equipment requirements.

Irrespective of the method by which the separate received signals in a diversity system are obtained, two principle techniques may be used. These are 'selector diversity' and 'combination diversity.'

With selector diversity, the quality of the signals from each receiving system is compared and the best signal selected by switching. However, it can be shown that by combining all the signals received, a signal-to-noise ratio can be obtained which is better than that from any one of the receivers alone. This system is known as combination diversity and relies upon the fact that the noise components are random in character and add in rms fashion, whereas the signals add linearly. The maximum improvement occurs when the individual receiver outputs have the same signal-to-noise ratio: for quadruple diversity the maximum improvement is 6 dB. This improvement in performance, together with the absence of switching clicks and transients introduced by the selector method, has established the diversity combiner as the preferred technique.

Combination of the diversity paths may be carried out either at the intermediate frequency or at the baseband frequency; that is to say either before or after detection. Pre-detection combination, at IF, has the effect of improving the reliability of a system, or reducing the fading margin required, by effectively reducing the threshold level of the receivers. This most desirable effect is extremely difficult to achieve in practice, due to the very stringent phase and frequency stability criteria, and consequently post-detection combination is frequently used.

Post-detection combination does not affect the fading margin required, or the the threshold level, but improves the post-detection signal/thermal noise ratio per channel. This improvement—known as 'combiner gain,' for median conditions relative to a non-diversity system—is generally taken at 1.5 dB for a dual diversity system and 4 dB for a quadruple diversity system.

METHOD OF MODULATION

Since tropospheric scatter links will often be used to extend the range of existing multichannel radio-telephone systems, it is essential to ensure mutual compatibility between systems. This has led to the adoption of FM with frequency-division multiplex, which are the established modulation techniques used for line-of-sight links. However, SSB modulation has been considered for specialised applications.[4]

Calculations show that, allowing for actual aerial gains, and feeder losses, there is little variation in the level of the signal received from a transmitter of fixed power feeding an aerial of fixed size, over paths of from 100 to 300 miles in length, for the frequency range 600 to 5,000 Mc/s. Whilst frequencies throughout this range have been used in practice, the difficulty of obtaining sufficient power at the higher frequencies, coupled with actual aerial gains lower than the theoretical figures, has tended to favour the use of the lower section of this band for long-distance links.

TRANSMITTING SYSTEM

The transmitting system consists of a drive unit and an RF amplifier. A typical drive unit accepts two inputs, the multiplex signal composed of the telephone channels and the engineers' order wire (EOW) channel used for technical and control purposes, which includes pilot and monitoring tones. These two inputs are fed to a frequency modulator, via emphasis networks if required, which after frequency multiplication provides an FM signal at the standard intermediate frequency of 70 Mc/s. An automatic frequency control circuit (AFC) ensures that the carrier frequency is controlled within the necessary limits. This 70 Mc/s modulated signal is then mixed with the output from a crystal-controlled oscillator to produce, after further amplification, the output signal in the 900 Mc/s band at a level of up to 10 watts.

A typical RF amplifier accepts a modulated RF input at the radiated frequency at a level of 5—10 watts, and raises the level of this signal to 1 kW, 10 kW or even 100 kW. Considerations of power requirements and operating costs have tended to favour the 1-kW amplifier in practice for civil use, even though this may mean reduced system-reliability or reduced performance.

The high power amplifier represents the main departure from accepted line-of-sight equipment parameters, and seems to be regarded by some potential users of tropospheric scatter systems as a maintenance hazard or heavy liability.

However, with the change from the conventional triode or tetrode amplifiers (with their inherent weaknesses at high power) to the simple, highly stable and reliable klystron amplifier, maintenance requirements and costs are reduced to an acceptable level. In grid-controlled valves, transit time sets a limit to the highest frequency that can be amplified efficiently. Other effects such as grid-emission and cathode bombardment become more troublesome as

[3] Cf G. L. Grisdale and D. A. Paynter: 'A Tropospheric Scatter Link Over a 200-mile Path: Point to Point Telecommunications, Vol 5, No 1, Oct 1960.

[4] M. Telford: Communications Potentialities of Tropospheric Scatter, Point to Point Telecommunications, Vol 1, No 2, Feb 1957.

the spacing between electrodes is reduced in an attempt to reduce the transit time. The mechanical rigidity of the klystron cavity assembly ensures a mechanically and electrically stable unit which, once tuned, requires no further adjustment for periods of three or four months. Since neutralisation circuits are unnecessary and there is no interaction between cavities when tuning, a klystron transmitter may be tuned in less than ten minutes. With klystron lives of over 15,000 hours achieved in field service, it will be appreciated that the klystron transmitter is a reliable and economical proposition and is particlarly suited to remote, unattended operation.

RECEIVING SYSTEM

A conventional design of receiver may be used, but the range of reliability of a tropospheric scatter system may be increased by inserting low-noise amplifiers between the aerial and conventional receivers.

The type of low-noise amplifier most commonly used is the parametric amplifier which relies upon the variation with applied voltage of the capacitance of a diode. (See R. Rowland and P. J. Cott's 'Parametric Amplifiers, in Point to Point Telecommunications, February 1962.) Since the amplification that takes place is solely due to the variation of a capacitative reactance, very little resistive noise is introduced, and noise factors of the order of 2.5 dB, associated with gains of 20 dB, are achieved. Tunnel diode low-noise amplifiers are now finding increasing application, especially at high frequencies.

To achieve quadruple diversity operation, two transmitters and four receivers are connected to two aerials spaced approximately 100 wavelengths apart. To ensure proper isolation between transmitters and receivers, bandpass filters and diplexers are used, together with cross-polarized feed horn assemblies. The transmitters feed the same pair of aerials used for reception, and it is advantageous to polarise the transmit and received signals mutually at right-angles. Parabolic aerials ranging from 30 to 120 ft in diameter are used.

QUADRUPLE DIVERSITY SYSTEM

The design of a tropospheric scatter system depends not only on the required circuit performance and reliability, which is governed by path attenuation and equipment parameters, but also on the provision of a very high overall equipment reliability. This high reliability is essential, as in territories for which troposcopic scatter communication is most suited, skilled personnel are at *a* premium. Whilst high reliability is built into the equipment at the design stage (for example, by replacing the conventional fuses with inverse time-delay circuit-breakers), it is most desirable to duplicate the equipment at each station. This may be done most effectively by using a quadruple diversity system; this enables the duplicated equipment to be actively used as a part of the quadruple diversity system, which itself improves circuit performance and reliability, by reducing effective fading margins as previously considered. In such a quadruple diversity system, the baseband signal is fed to two drive units which drive two transmitters operating on different frequencies, feeding two aerials. At the receiving station, two aerials each receive both transmitted frequencies, which are fed to four separate receivers the outputs of which are combined to reproduce the baseband signal.

Complete duplication of equipment is achieved by providing a standby combiner and line amplifier, which may automatically be switched into circuit should the working unit fail. It will be readily apparent that this system offers a high degree of system reliability.

For example, in the event of a transmitter failure the system continues to operate as a dual space-diversity system. Should a receiver fail, the system again continues to operate but with a reduced order of diversity. Apart from the obvious advantage that traffic is not entirely lost, this enables an engineer at a central point to guide the technician on the site concerning the location and repair of the fault.

The situation often arises where a limited channel capacity is required initially, capable of later expansion. The capital outlay on such a project may be conveniently spread over a period of time by initially installing a dual diversity system with narrow receiver bandwidths suitable for a low-capacity system, and then enlarging the system to quadruple diversity with broadband receivers, suitable for a higher channel capacity, at a later date.

ECONOMIC SYSTEM DESIGN

The reduced number of stations in a tropospheric scatter system (compared with a line-of-sight system covering the same distance) brings about considerable savings in the capital cost of buildings, access roads, radio equipment and power supply plant. However, these savings are partly offset by the higher initial cost of the equipment required for tropospheric scatter stations.

It is this relatively high initial cost that frequently leads to a compromise in system design between capital outlay, channel capacity, and circuit reliability and performance. This compromise has been considered by the CCIR for several years. In the documents of the latest Plenary Assembly in Geneva, 1963 (CCIR Recommendations No 397, Xth Plenary Assembly, Vol IV) the CCIR recommends that the mean noise power for a tropospheric scatter system should not exceed the figures laid down for a line-of-sight system, where this can be done *without excessive difficulty*. Where this performance cannot so be met, the CCIR recommends the following conditions:

> 'The mean psophometric power during one minute must not exceed 25,000 pW for more than 20 per cent of any month; the mean psophometric power during any one minute must not exceed 63,000 pW for more than 0.5 per cent of any month . . .'

It must be stressed, however, that tropospheric scatter systems do not *necessarily provide* circuits of lower quality than those obtainable with line-of-sight systems, but it is often a better economic proposition to provide several telephone channels of medium quality than to provide a few high-quality circuits. The advantage of the long range of tropospheric scatter systems enables several telephone channels to be provided for communities which were previously without any form of communication, and clearly several circuits of slightly reduced quality are better than no circuits at all! Therefore, while tropospheric scatter radio links may be engineered to give the same performance as line-of-sight links, they also enable circuits of slightly reduced quality to be established over long distances of difficult terrain. The multichannel circuits so established are of much better quality than those provided by HF.

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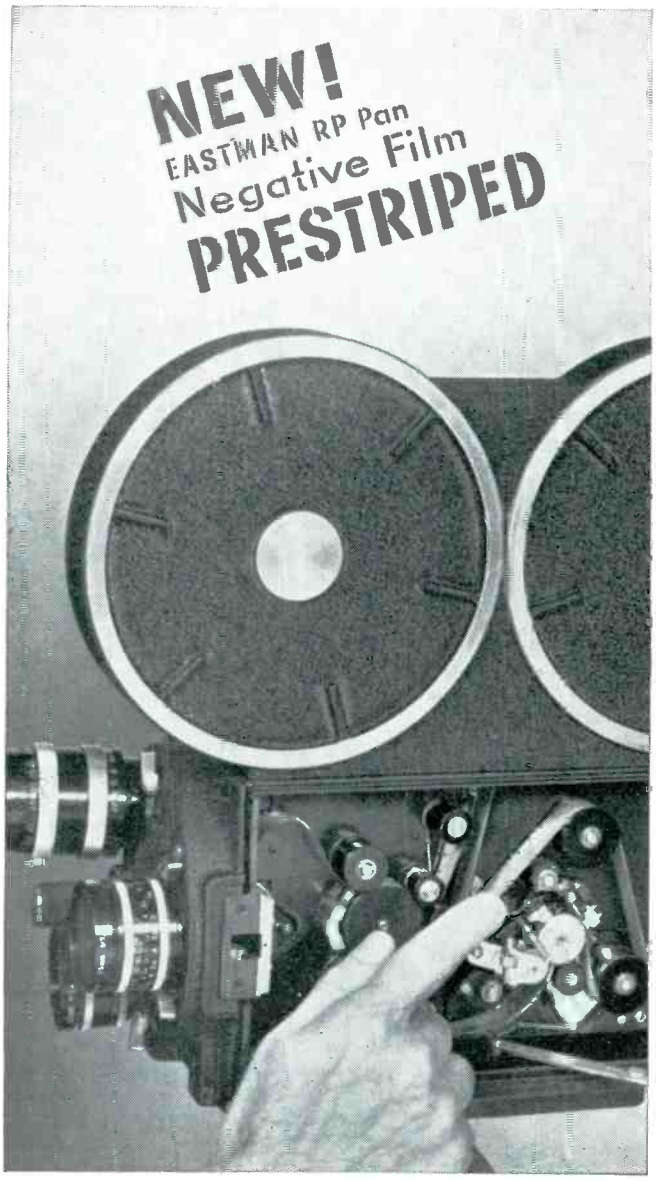

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Survey of the present state of Colour television in Europe

DENNIS G. PACKHAM, who has compiled this technical survey on the present state of colour television in Europe, has been the Chief Engineer of Tyne Tees Television Limited since 1958. He is the British Independent Television Companies Association Representative on the Committee Consultative International de Radiodiffusion Study Group 10 (Broadcasting). He is also the ITCA Representative on the European Broadcasting Union Ad Hoc Group on Colour Television, Sub-Group 6. He is also a Member of the ITCA Technical Committee; a Member of the ITA Technical Sub-Committee of the Standing Consultative Committee; and the ITCA Representative on the EBU Working Party G and Sub-Groups G1, G2 and G3 (Tape and film recording).

Work has been going on in Europe since 1962 aimed at producing a common colour television standard. Three systems of colour television are being considered—the European version of the American NTSC system, the French SECAM system, and the West German PAL system. As recently as April last, at the Vienna Meeting of CCIR Study Group II, no agreement was reached.

This paper attempts to survey the colour systems concerned, and the work carried out over the last few years, which has led up to the present stalemate situation.

EBU Ad Hoc Group on Colour Television

In 1962 those member countries of the European Broadcasting Union actively concerned with the development of colour television, formed a group of technical representatives known as the EBU Ad Hoc Group on Colour Television. These engineers, who occupy senior positions in their particular spheres, represent all aspects of television broadcasting, the various PTT administrations, the broadcasting authorities and companies, broadcast equipment manufacturers and receiver manufacturers.

The Ad Hoc Group, in turn, set up six Sub-Groups of technical experts to examine the various particular problems of colour television in the fields of transmitters, receivers, network links, studio equipment, propagation, and general systems characteristics.

Since the formation of the Ad Hoc Group and its six Sub-Groups, a very large amount of work, demonstrations and field trials have been carried out with the aim of providing enough information for a definite choice of colour system for Europe.

Over 200 technical documents and reports have been prepared by the Sub-Groups, and three major summarising reports prepared by the Ad Hoc Group itself, the last of these reports being issued in February, 1965, in time for the meeting in April in Vienna.

The Vienna meeting was of the Study Group II of the Committee Consultative International de Radiodiffusion. The CCIR is a constituent body of the International Telecommunications Union, which is a permanent organ of the United Nations. The CCIR deals with international standards concerning all broadcasting activities. Study Group II specifically concerns itself with television.

Any decision, therefore, on international standards for colour television for the 625 line countries in Europe and throughout the world, must come from the ITU, based on a recommendation by the CCIR.

A meeting of Study Group II took place early in 1964 in London, and no decision was reached. The Vienna meeting in April also failed to reach agreement, and further consideration will be given to this problem at the Oslo meeting in June 1966.

Just prior to the Vienna meeting, however, agreement was announced between France and the Soviet Union for the development and use of the French SECAM system.

The concerted view in the United Kingdom was that the NTSC system is the most suitable for the United Kingdom and the rest of Europe. Several of the other European countries, notably Italy, West Germany, and Switzerland, favoured the PAL system.

Below are summarised the technical problems and characteristics of the three colour systems concerned.

The Three Colour Systems

The three colour systems mentioned above, which are being considered as a future European standard system, are basically similar in technique, but have certain definite differences which account for their different performance characteristics.

The three systems are all compatible with existing black and white television. A viewer receiving a transmitted colour programme on a black and white receiver will see the picture displayed in black and white. There will be very little difference between this picture and the present black and white pictures. The viewer who owns a colour receiver however, will see the programme in colour. If the programme is being transmitted in black and white, then the colour receiver will display this as a black and white picture.

The introduction of any of the three systems into the existing monochrome services, will therefore not make any present-day receivers out of date.

This compatibility is an essential requirement of any practical colour television transmission system.

The three systems have in common the basic method of colour transmission. Putting this into non-technical terms, the scene in the studio is split up into its primary colours—red, green and blue. The three colour signals produced by the camera are combined together to form the 'luminance' signal and the 'chrominance' signal. The luminance signal represents the brightness of the different parts of the picture and is that signal which is used by the black and white receiver to reproduce the original scene in black and white. The chrominance signal represents the colouring information in the picture, and when added to the luminance signal in the colour receiver, will reproduce the original scene in the correct colours.

All three colour systems produce these two colour signals and add them together for transmission to the viewer. The difference between the three systems is in the way in which the chrominance signal is formed. This results in the composite colour television signal behaving differently for each of the systems when trans-

▶ *to page 568*

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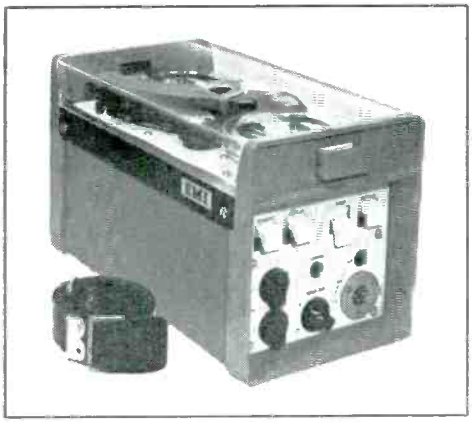

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Survey of colour television in Europe—continued

mitted through the television network from camera to viewer's receiver.

The main characteristics of the three systems may be summarised as follows:

(1) Under perfect conditions, all three systems work well and produce almost equally good colour pictures.

(2) *Receiver Costs.* The cost of colour receivers differs very little from one system to another. Recent figures given are 350 dollars for the factory cost of an NTSC receiver. The equivalent SECAM receiver may be between 1% and 5% higher cost, and the equivalent PAL receiver 3% to 6% higher cost.

The higher costs of the SECAM and PAL receivers are due to the extra complication in them compared with the basic NTSC receiver.

(3) *Receiver Operation.* The operation of the colour receiver differs from one system to another. In addition to the normal controls of brightness and contrast, the NTSC receiver may have a further two controls, 'hue' and 'saturation.' The hue control varies the actual colour of the picture, and the saturation control varies the amount of colour from zero through pastel shades to very bright colours. These two controls are necessary on an NTSC receiver, but can be incorporated in automatic form if desired.

The SECAM receiver does not need these two controls.

In the PAL receiver, certain simple types need the two controls, as with the NTSC receiver, whereas the more complex PAL receiver needs only saturation.

It is a matter of personal preference as to whether the hue control is desirable on the receiver. It allows the viewer to set the colour to his own personal taste. On the other hand it is an added complication.

Recent extensive tests carried out by BREMA with colour receivers installed in 127 homes, show that viewers are capable of operating NTSC colour receivers with the full complement of controls.

(4) *Studio Operations.* There is little difference between the systems in the operation of them in the television studio. The only major problem, which is now being solved, is the difficulty of recording the NTSC signal on early types of video tape recorders. The SECAM picture may be recorded on existing black and white video tape recorders. The PAL picture requires a slightly more complex recorder, whilst the NTSC picture requires a machine of even greater complexity. However, the newer types of recording machines now on the market are capable of handling all three systems with little difficulty and problems which existed two years ago, of recording the NTSC picture, have been solved.

(5) *Network Links.* The major reason for the development of SECAM system in France in the early 1950's was to try to ease the technical requirements for the performance of inter-city television links capable of handling colour pictures. The NTSC system is more susceptible to certain types of distortion which appear on television land line and radio links.

However, links of recent design are capable of handling all three colour systems and recent developments by the BBC and the GPO have produced automatic correctors to correct the varying distortions which occur on very long distance networks of the Eurovision type. Recent tests between London and Rome and back, and London and Moscow have shown the success of these developments.

These very long distance tests, up to ten thousand kilometres, have in fact shown up faults in the transmission of SECAM pictures, which were not evident from earlier tests on medium length networks.

In general then, it can be said that with modern automatic correction techniques over normal 625 line links in use in this country and on the continent, all three systems may behandled.

(6) *Transmitter Coverage.* The population or area covered by a transmitter carrying colour television pictures is very similar to that for black and white. The three colour systems do have certain different characteristics.

In mountainous areas, such as Switzerland, the order of preference is SECAM best and NTSC the worst, with the PAL system lying somewhere in between. For normal country, such as exists mainly in the United Kingdom, the SECAM coverage is slightly inferior to NTSC and PAL.

This is because as the limits of the transmitter area are reached, the picture is degraded. With NTSC and PAL this progressively increases, the greater the distance from the transmitter. With SECAM a definite point is reached where the picture breaks up and becomes unusable.

Overall, therefore, there is little to choose between the systems in this respect, with a slight preference for NTSC and PAL in the non-mountainous countries.

(7 *International Programme Exchange.* The international exchange of colour television programmes may be carried out in several ways: by direct link—using land lines, radio links, or communications satellites—by colour film or by colour video tape.

The first and last of these methods require that both the sender and the recipient of the programme material are using the same colour television standard. The line standards must also be the same, as well as the colour system.

In the case of black and white programmes, where line standards are different between the sender and the recipient of the programme, for instance in the transmission of American programmes to this country via the Early Bird satellite, a line standards converter is needed. There is at present no line standards converter for use with colour pictures.

Where conversion is required between pictures of one colour system and another at the same line standard, this is technically feasible. These colour converters, or trans-coders as they are known, take in a picture from one of the colour systems, and send out the same picture 're-coded' into the required system. All converters produce some degradation of quality, however slight. The development of line standards converters for colour programmes is proceeding, but will be several years before they exist in practice.

Some Final Thoughts

In choosing a standard of colour television for Europe, we are also deciding the system for the whole 625-line area, which includes the Middle and Far East and Australasia, as well as the continent of Europe. We already have two major world standards of black and white television—the American 525 line system and the European 625 line system. In my view we should endeavour not to create the same situation in colour standards.

The American NTSC system has been in operation in the United States for eleven years, and although it has certain deficiencies, these are well known and either have been, or in the process of being overcome by technological development. The NTSC system has a greater long term capability than the SECAM system in terms of ultimate picture quality and adaptablity to new techniques. It is basically a simpler system than either SECAM or PAL and results in a lower receiver cost to the public.

The introduction of the synchronous communications satellite has meant that the need for a world television standard is more pressing than ever before. Many engineers are seriously considering that the ultimate solution to the world standardisation of colour, and black and white television, would be the adoption in Europe of the American 525 line system, and the ultimatse abandonment of all other standards.

The adoption in Europe of anything other than NTSC (although this applies less to the PAL system than it does to SECAM) would mitigate against the ultimate world standardisation of a colour system.

The agreement already reached between France and the Soviet Union for the development and use of the SECAM system means that *the chance of adopting NTSC in Europe is now virtually nil. It could well be however, that the PAL system will be a compromise acceptable to those countries who do not wish to adopt SECAM.*

The lack of a common agreement will inevitably result in considerable technical problems in the future.

A new Heat-Developable Motion-Picture Print Film

A dry photographic system applicable to the motion-picture, television and educational film industries, Metro-Kalver, is described. The system is based upon the phenomenon of light scattering accomplished within a film of thermoplastic resin coated upon a base of transparent polyester. This basic system of photography ultilises ultraviolet exposure and heat development. Details about its departure from traditional motion-picture print materials and procedures are outlined. Developmental tests and equipment are discussed.

by Noel R. Bacon and Robert B. Lindemeyer

The Basic Kalvar Process

The Kalvar Photographic Process is based upon the phenomenon of light scattering, rather than upon that of light absorption as in conventional silver halide materials. The two cases are compared in Fig 1, where the incident light is absorbed by the silver grains within the developed silver halide film and the incident light is reflected and refracted by the scattering centres within the developed Kalvar film. The film consists of a thermoplastic resin, coated upon a base of transparent polyester. Within the thermoplastic resin, which is normally coated to a thickness of slightly less than 0.0005 in, an ultraviolet-sensitive compound is uniformly dispersed. These molecules of sensitiser are shown as black dots in Fig 2. Upon exposure to ultraviolet radiation, this photosensitive diazonium salt is decomposed, releasing nitrogen and other volatile products. The internal pressures created by these decomposition products within the thermoplastic vehicle constitute a 'latent image' of internal stresses. Upon application of heat, the resin crystallites soften and the gaseous decomposition products expand. A reorientation and ordered recrystallisation of the polymer into microscopic vesicles takes place. These vesicles, since they are of a different index of refraction than the surrounding medium, scatter light incident upon them and thus constitute the image. The light-scattering vesicles vary in size from less than 0.5 micron to 2 microns in diameter. Unlike the bubbles that might be formed in gelatin by a similar method, they consist of cavities enclosed by a shell of more highly ordered crystallites than the surrounding medium. As a result, the vesicles are highly resistant to environmental changes and mechanical stresses and provide an extremely stable image.

Sensitivity and Exposure

Kalvar film is not a camera stock. It is a comparatively low-speed material with primary photosensitivity in the near ultraviolet, peaking at 3,850 A. The amount of radiation required to produce maximum density at this wavelength is about 200 milliwatt-sec/sq cm. The spectral response curve in Fig 3 shows that the photosensitivity is not limited to a narrow peak but extends from below 3,500 to above 4,300. The film is not photographically sensitive to ordinary levels of visible light for short periods of time. Exposure times are determined only by the amount of time required to absorb the 200 milliwatt/sec sq cm of actinic radiation. Times of less than 1/100 sec have provided adequate exposure. One user of substantial amounts of heat-developable microfilm working with a variable aperture, continuous contact printer-processor is currently operating at a speed of 170 ft/mi.

Medium- to high-pressure mercury-vapour lamps which have a high intrinsic brightness, coupled with a desirable spectral output, have proved to be efficient light sources. A high-pressure air-cooled mercury-vapour lamp rated at approximately 1,000 W is currently employed on one of the developmental motion-picture printer-processors.

Latent-Image Stability

The temperature of the film during exposure should not exceed 110 F. Temperatures above this will result in a higher diffusion rate of the latent-image-forming gas, with subsequent reduction of the maximum density obtained.

Since the latent image is comprised of a given amount of gaseous nitrogen, it has a definite decay time dependent on the permeability of the emulsion's thermoplastic vehicle to nitrogen. The decay time can be adjusted by adding modifiers to the basic vehicle resin to increase or decrease its permeability. A current heat-

▶

a new heat-developable motion-picture print film—continued

developable microfilm has a latent-image diffusion item of less than 30-sec and is finding useful application as a reversal processed material. Metro-Kalvar motion-picture emulsions require approximately eight hours for the latent-image gas to escape completely. Experiments show that the film should be developed within three minutes after exposure.

Since one of the film's major features is its simplicity of development by heat alone, this short latent-image life is no problem. All equipment provides for continous development immediately following exposure and as an integral part of the machine. The inherent latent-image decay precludes the design of printing equipment employing the 'down one side —back the other' configuration as currently used in several 35/22mm high-speed motion-picture printer applications.

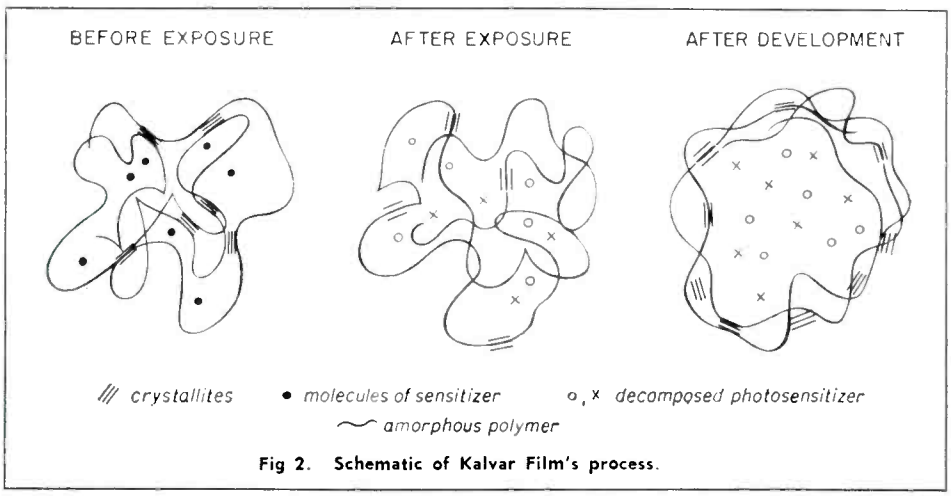


Fig 2. Schematic of Kalvar Film's process.

Development and Image Stability

Kalvar film is developed by heat. Any method of heating the film sufficiently will produce the image. A wide variety of techniques have been employed, including heated rollers, heated platens and even forced hot air. The calculated energy requirement to develop the image is approximately 0.635 watt-sec/sq cm/mil thickness of the film.

The grey scale of the light-absorption (silver) type of photographic image is a function of both exposure and development; the grey scale of the light-scattering type of image is primarily a function of exposure. To ensure optimum image characteristics and stability, development must be held within relatively narrow limits. Development times are closely related to development temperatures because total development occurs at a fixed heat level whether that level is reached in seconds or milliseconds. Experimentation has shown a requirement for the emulsion to come to a temperature of 240 F. This temperature was arrived at by comparing the three curves shown in Fig 4. It can be seen that as the development temperature increases, the background density of the image decreases until approximately 220 F is reached. The upper curve, showing net visual projection density, increases rapidly to approximately 180 F, after which only limited increase is noted from higher development temperature. The dotted line, reflecting the relationship of development temperature to thermal stability of the image, is somewhat more critical. This curve shows the loss in net visual projection density after the developed film has been subjected to 150 F for 4 hours. Design and selection of development heat sources for the desired high-speed operation of the motion-picture printer-processors has required careful consideration of heat transfer characteristics and machine speed vs dwell-time variables.

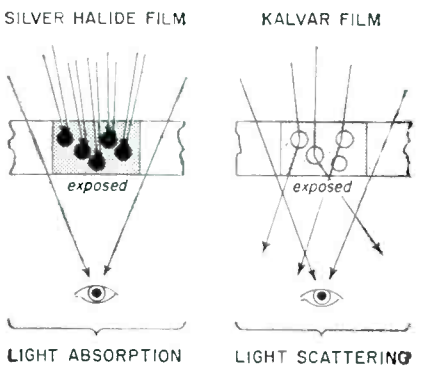


Fig 1. Comparison of the two systems of photography.

Current practice employs a revolving Teflon-coated aluminium drum with heat provided by a 500-W electric blanket laminated to the inside perimeter of the drum. A precision thermostat controls temperature to ± 2 F of the desired setting.

Fixing and Image Stability

As with most photographic processes, a fixing technique for the heat-developed film provides for image permanence. After exposure and development the nonlight-struck areas of the film still contain undecomposed sensitiser. The fixing technique consists of exposing the film overall to ultraviolet light. Applying about four times the amount required for maximum exposure completely decomposes the residual sensitiser. The film must then be protected from temperatures in excess of 150 F for a few hours to permit the gas to diffuse completely from the film. The properly exposed, developed and fixed image is one of the most stable of all photographic images. The thermal stability of the image is closely related to the development temperature, as discussed earlier in this report.

Medium- and high-pressure mercury-vapour lamps, which have proved successful for initial exposure, function equally well for the overall fixing exposure.

Sensitometric Characteristics of Light-Scattering Films

As a consequence of the unique characteristics of these light-scattering films, the sensitometric units and standards currently used in silver halide photography do not apply directly to this type of photography. For example, the metre-candle-second exposure units used to express ASA speeds of silver materials are founded on the relative visibility curve of the human eye and obviously cannot be used for heat-developable films, which are sensitive to wavelengths outside the visible spectrum.

Similarly, the familiar sensitometric terms, such as density and contrast, must be redefined when applied to the properties of light-scattering materials. The degree of opacity of the exposed and developed Kalvar image can be measured in terms of diffuse transmission density as outlined in ASA PH2.19-1959. How-

ever, when light is incident on the exposed and developed film sample, part of the light is absorbed, part is reflected and part is transmitted; the transmitted and reflected light is highly scattered. The visual diffuse transmission densities of the film are quite low. In fact, the characteristic curve of a typical Kalvar motion-picture emulsion based on visual diffuse densities has an average gamma of 0.35 and a density range of about 0.60. To those unfamiliar with the light-scattering type of photographic image this immediately indicates an extremely low contrast material with limited density range.

For a photographic medium depending on light absorption, the diffuse density is close to the specular or projection density. This is not true for a light-scattering system as may be seen in the generalised schematic, Fig 5. In any practical use, a photographic material is viewed or projected through an aperture of finite dimensions, here labelled *A*. In the light-scattering system a substantial portion of the transmitted light is scattered outside the angle over which light is collected by the effective aperture. At the same time, the effective density of the heat-developed film strongly depends upon the cone angle subtended by the light-gathering element, whether it be the eye, a projector lens or the photosensitive receptor of a densitometer. This is shown in Fig 6 where the effective or projection density for various apertures is plotted against the logarithm of the exposure.

These characteristics have been taken into consideration in the design and development of new measuring techniques for the photometric evaluation and process control of Kalvar photography. The primary objectives in the development of these new techniques have been to provide measurements that will readily correlate with the traditions and experience of the photographic industry and that will accurately represent the product's capabilities in ultimate projection viewing.

This departure of ultimate use conditions from the conditions during diffuse density measurement is of concern in all types of photography. The American Standards Association Committee on Sensitometry is currently giving careful consideration to this problem. A recently created ASA Subcommittee, PH2-28, has been charged with the responsibility of revising the Diffuse Transmission Density Standard to include other types of density such as projection density. The Kalvar Corporation is playing an active role on that subcommittee.

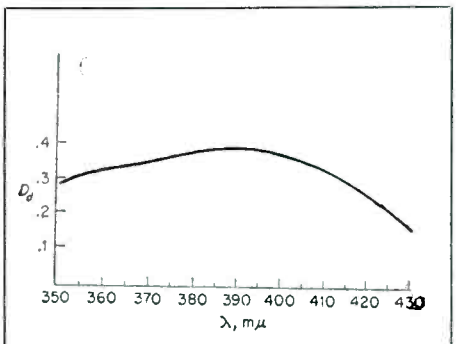


Fig 3. Spectral response of Kalvar film.

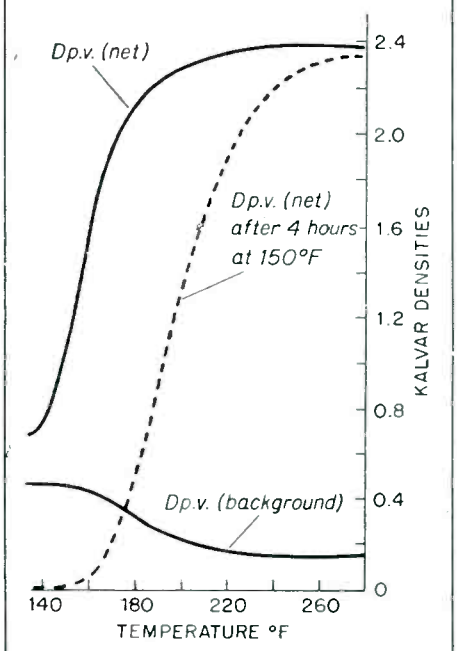


Fig 4. Kalvar film densities with constant exposure and development time, varying development temperature. Dpv = density projection visual.

Practical Sensitometry and Control Techniques

Current techniques employed to provide sensitometric evaluation of various Kalvar emulsions and process control represent only a slight modification of procedures widely used in the photographic industry.

A sensitometer is used to expose strips for basic emulsion characteristic evaluation. This unit employs an ultraviolet light source carefully positioned in relation to a curved aperture containing a calibrated density modulated wedge.

Exposures are developed on a small laboratory hot-roller capable of maintaining set development temperatures to ±2 F.

Sensitometric strips are read on either a standard motion-picture densitometer providing visual diffuse transmission densities or a projection reading densitometer with modified aperture providing readings directly relatable to ultimate projection conditions. These readings are plotted in a standard H & D characteristic curve for routine evaluation of speed, gamma, density and exposure scales. These same readout and evaluation techniques are employed for process control where the sensitometric strips are exposed and developed on the Metro-Kalvar Motion Picture Printer-Processor under varying conditions of machine speed and light intensity.

Research and Development

The technology of silver halide photography has been evolving for over a hundred years. The light-scattering principle of image formation has been known for nearly the same length of time; but it is polymer chemistry that has provided the means to create light-scattering images in a practical way. Metro-Kalvar was

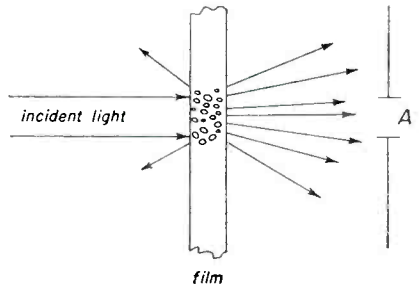


Fig 5. Schematic of function of Kalvar density.

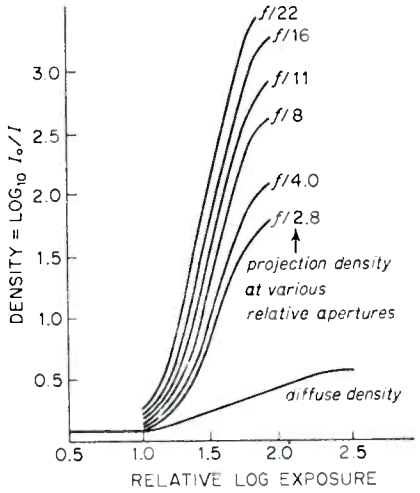


Fig 6. Projection density as a function of aperture.

formed by Metro-Goldwyn-Mayer and the Kalvar Corporation to adapt the Kalvar Process to the motion-picture, television and educational film industries.

Progress toward that goal has included basic research and formulation of appropriate film emulsions at the Kalvar Corporation in New Orleans and design, fabrication and testing of bread-board printing and processing equipment at the MGM Laboratories in Culver City. The manufacture of a pre-production prototype 16mm printer-processor has begun at Calvin Productions in Kansas City. The specifications for this machine include a desk top model, an operating speed of 70 ft/min, separate sound and picture printing heads and 1,200-ft film capacities.

Research has been conducted on the problems of splicing the polyester-based films. The cements employed with conventional film splicing are ineffective with polyesters: however, tape splicing has been used with excellent results. High-strength values are retained, since the tape employed is also polyester.

Conclusion

In conclusion, it is appropriate to set forth the major advantages of the Metro-Kalvar System:

(1) With maximum sensitivity in the near ultraviolet region, the need for a darkroom is eliminated.

(2) It is a dry process, requiring no chemicals for processing, because heat alone develops the image.

(3) The basic formulation of materials provides for prolonged shelf life and convenient storage conditions.

(4) The unique structure and distribution of the light-scattering image affords high resolution, excellent image stability and grain-free projection characteristics.

(5) The combination of a predominantly thermoplastic emulsion and a tough polyester base provides for a scratch-resistant, long-wearing film.

(6) The standard 3-mil thickness of the high-strength polyester base allows 1,000 ft of film to be wound on a standard 600-ft reel.

(7) The combined process of exposure and development provides immediate access to results.

Discussion

George Lewin (Army Pictorial Centre): Is it possible to put this Kalvar emulsion on conventional cellulose acetate base?

Mr Bacon: It is.

Mr Lewin: Do you arrive at the optimum exposure for your soundtrack by cross-modulation or inter-modulation tests?

Walter G. Eggers (MGM Laboratories Inc): Conventional cross-modulation tests have not proven, at this moment, of any value as far as Kalvar film is concerned. The densitometry of Kalvar is a new field, and the numbers we derive from a densitometer that has been developed for Kalvar film are not meaningful in the same sense that silver halide densities are. When we try to draw a cancellation curve we are, in some cases, comparing oranges against apples, because the two densities: that is, the density of the silver optical transfer and the Kalvar print have to be measured by different parameters. We have, however, investigated this by means of listening tests. I might ask you a question: What did you think of the sound on this particular print?

Mr Lewin: Well, I felt that the sound was quite adequate. Was it area or density track?

Mr Eggers: That's variable area.

Mr Lewin: And is it reproduced with a conventional photoelectric cell?

Mr Eggers: The conventional cell.

Mr Lewin: Have you been successful with the variable-density track as well as area?

Dr Robert T. Nieset (Metro-Kalvar): No work has been done on variable-density pursuits. You can see that, with the limited maximum density we had, the dynamic range on variable-density recording with Kalvar would be pretty small at the present time. I'd like to add one other comment: since the soundhead always looks at the soundtrack with a much smaller physical aperture than does a projector lens, the control of exposure with relationship to sound and picture is not as critical as it would be in the silver case. The density of the soundtrack, because it's being used with such a small aperture, is always much higher than the density of the projected image.

This paper was first published in the Journal of the Society of Motion Picture and Television Engineers and IBE is grateful for the opportunity to reproduce it here.

Coming Events

AUGUST

24–27 IEEE WESCON Show, San Francisco.

25 to September 4 International Radio Show, Earls Court.

27 to September 5 German Radio Show, Stuttgart.

30 to September 1 IEEE International Symposium Antennas and Propagation, Washington, D.C.

SEPTEMBER

7–11 International Industrial Electronics Exhibition, Basle, Switzerland.

9–11 IEEE Industrial Electronics & Control Instrumentation Conference, Philadelphia.

9–19 International Salon of Radio and Television, Paris.

12–18 International Congress on High Speed Photography, Zurich, Switzerland. (National Committee for High Speed Photography, Institute of Physics & The Physical Society, 47 Belgrave Square, London, SW1.)

13–18 Engineering Materials & Design Exhibition & Conference, Olympia, London.

16–17 IEEE Joint Eng. Management Conference, New York.

17 to October 3 British Exhibition, Tokyo.

22–24 IEEE International Convention on Military Electronics, Washington, D.C.

28 to October 1 European Symposium & Exhibition on Medical Electronics, Brighton.

28 to October 2 Institution of Electronics Annual Convention & Exhibition, Manchester.

OCTOBER

4–6 International Canadian Electronics Conference and Exhibition, Toronto.

6–17 Communications International Fair, Genoa.

18–23 The 1st International Festival of Television in Hong Kong.

21–22 IEEE Electron Devices Meeting. Washington, D.C.

25–27 IEEE Electronics Conference, Chicago.

31 to November 5 SMPTE Exhibition and Convention, Montreal.

NOVEMBER

15–20 Industrial Photographic and Television Exhibition, Earls Court, London.

DECEMBER

1–3 14th Technical Symposium on Technical Progress in Communication wires and cables, Ashbury Park, New Jersey, USA.

4–7 9th International Visual Communications Congress, Detroit, USA.

TELEVISION PROGRAMMES ON FILM—

by Roger J. Ross

IMAGE FORMATION in film is a two-stage process. First, the film is exposed to light. In this stage, invisible latent images are formed in the light-sensitive layer. Later on, at any convenient time, the film is chemically treated in a processing stage to obtain the final visible images. Basically, this is an orderly process, in that if a film is always exposed in the same way, and given the same degree of development, the same density will always be obtained. In practice, of course, it is very difficult to maintain precisely reproducible image-forming conditions. Film characteristics change slightly from batch-to-batch and with age; the amount of exposure the film receives is influenced by many factors, and the degree of development can be accurately controlled only with the greatest difficulty. Because successful motion picture making does not require close control of image densities, film laboratories have not been obliged to adopt modern industrial process control methods. While it is quite true that strict control measures are applied, especially in the larger laboratories, in some phases of the process, such as negative development (gamma), and the centre point in the picture printer scale, this is done mainly in the interests of efficient and economical laboratory operation.

The nature and extent of processing variations that may be encountered in a particular laboratory will depend on the type of work that is being performed, as well as the skill and experience of the laboratory management and staff. Because of the highly individualistic manner in which laboratory operations are carried on, it is unlikely that any two laboratories could be found providing identical processing conditions.

A certain amount of variation in processing conditions from hour-to-hour and day-to-day occurs in every laboratory, large or small, but these variations are likely to be much greater in small laboratories. Most laboratories operate with large volumes of recirculated developer solution. As the developer is pumped through the recirculating system, a replenisher solution is added, compounded in such a way as to counterbalance changes that are taking place in the chemical composition of the developer as it reacts with exposed film.

In the larger laboratories, facilities are usually provided for routine chemical analysis of developer solutions, and from information obtained in this way, appropriate adjustments are made in the composition of the replenisher and its rate of flow, to maintain the desired chemical balance in the circulating system. Smaller laboratories may not be able to provide staff and equipment for chemical analysis. In these circumstances, the usual practice is to check the process at frequent intervals by developing sensitometric test strips. Variations in image-forming conditions can be readily detected in this way, but the causes of the variations can only be surmised.

Sensitometric Testing Methods

Fig 1 shows the result of a sensitometric test of negative processing conditions. To obtain the curve shown in this illustration, a strip of negative film was exposed in a sensitometer, the film was processed with the machine operating in the normal manner, the steps of the processed strip were measured with a densitometer, the densities were plotted on graph paper opposite the corresponding sensitometer exposure step numbers, and a smooth line was drawn through the plotted points. This curve is a graphical representation of the response of the film to the particular conditions of development at the time the test was made. The sensitometer provides a fixed scale of exposures, increasing as a rule from step-to-step by a factor of 1.41. On this scale the exposure is doubled for every second step.

The value of this method of analysis can be readily demonstrated by processing a number of sensitometric strips, the conditions of processing being altered for each strip. In making tests of this kind it is very important that film to be exposed in the sensitometer is taken from the same roll, and the basic exposure level in the sensitometer remains exactly the same for all of the strips. The simplest form of processing variation that might be tested is the effects of altering the time of development of the film. Fig 2 shows the results of such a test. This illustration indicates that as the time of development is increased, the angle at which the curve lies on the graph also increases.

By extending the central straight line portion of the curve to intersect the exposure scale along the bottom of the graph, this angle may be measured and expressed in terms of gamma (γ) — the development factor. An angle of 45 deg corresponds with a gamma of 1.0. Normally, motion picture negatives are processed to a gamma of 0.6 to 0.7. The negative characteristic curve shown in Fig 1 has a gamma midway between these values—0.65.

Analysing Film Process Variables

Some types of negative film are more sensitive than others—that is, the speed is higher. In Fig 3, characteristic curves for three typical negative fifilms are shown. It can be readily seen in this illustration that a given amount of exposure as indicated on the exposure scale of the graph results in higher densities as the speed of the film increases. Thus, the characteristic curve for the film with the highest speed is displaced towards the left on the graph—in the direction of less exposure.

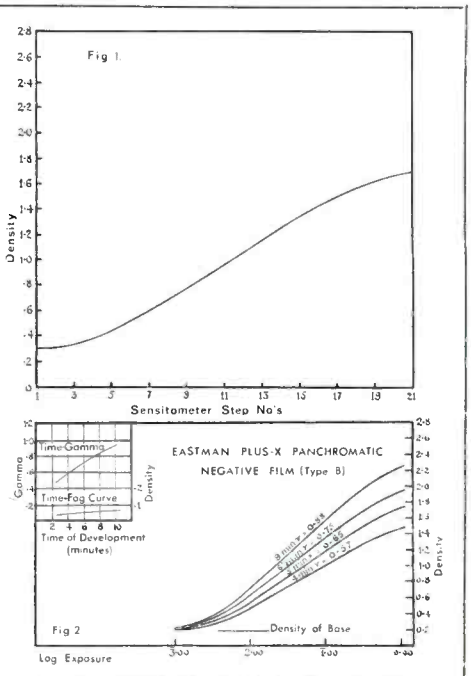
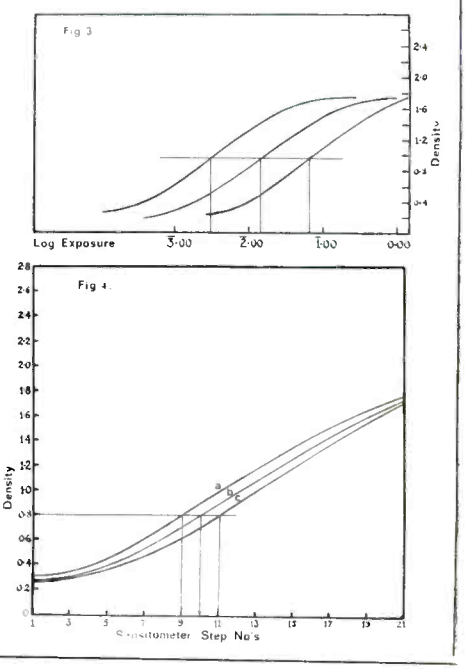


Fig 1. Standard negative characteristic curve.

Fig 2. Effects of altering negative developing time.

Fig 3. Three negative films with different speeds.

Fig 4. Effects of processing on film speed —same type of film developed in three different laboratories.



Part 3–Setting up a Standardised Film Process

In this illustration the three films have been developed to the same gamma. But if strips of film of these three different types were developed together for the same length of time, different values of gamma would be obtained. This means that the time of development must be altered for each type of film being processed, to obtain the same value of gamma at all times.

The sensitivity of a film to exposure (speed) is primarily a characteristic of the emulsion, as shown in Fig 3. However, film speed can be affected to a considerable extent by processing conditions. This is illustrated in a striking manner in Fig 4. Here we see the results of a test in which three strips of film from the same roll were processed in different laboratories. The displacement of the curves on the graph in relation to the exposure scale indicates that speed is dependent not only on emulsion characteristics but on processing conditions as well.

These are actual measurements of negative processing conditions in three medium-size motion picture service laboratories. If a roll of film were to be exposed in a camera, cut into three parts and sent to these laboratories for processing, the densities of the resulting images would obviously be quite different. This is not a serious problem in normal motion picture work, however, since it is customary for all negatives for a production to be sent to one laboratory for processing.

A significant factor affecting film speed is the bromide content of the developer. It can be readily demonstrated that, as the bromide content is increased, the film characteristic curve will be shifted towards the right of the graph, in the direction of lower film speed. Other factors, too, influence film speed, but so little is known about this aspect of processing that consideration is seldom given to the possibility of deliberating shifting the characteristic curve on the graph by means of adjustments in the chemical composition of the developer. In any event, it would be very difficult to make adjustments of this kind in large volumes of recirculated developer. The usual practice in large-scale motion picture operations is to make camera tests before undertaking a film production, so that the exposure for the film in the camera may be adjusted to conform with prevailing processing conditions in the laboratory. Because of the way in which the exposure for motion picture negatives is normally determined, considerable variations in the level of exposure for given scene elements are quite likely to occur. When a processed negative is examined with the eye, it may be found to be too light or too dark, in comparison with what is considered to be a normal or average negative, but it would be very difficult to estimate whether this was caused by an error in exposure, or in processing the negative. The usual practice is to compensate for incorrectly exposed or processed negatives by modifying the exposure level in the printer, when prints are being made from the negatives.

Control of Picture Image Densities

Conventional processing methods are capable of producing excellent motion picture presentations in direct projection on a theatre screen, but it should be obvious from the foregoing very brief description that accurate control of maximum and minimum densities of picture images cannot be achieved in this way. An entirely different approach is needed to conform with television requirements. By applying relatively simple process control procedures, advantage can be taken of the inherent reproducibility of the film system, and a standard film characteristic for television programme production can be established.

Because both exposure and processing contribute to image formation, appropriate control measures must be applied in each of these stages. When the negative film is being exposed in the camera, the exposure must be calculated from light measurement in the scene areas that will be represented by the maximum and minimum densities in the negative. These are the areas, by the way, which will produce, in the reproduction of the film in telecine, the essential peak white and black level signal voltages. To correctly expose the negatives, a spot photometer is required, capable of making accurate measurements in small scene areas.

Negative processing conditions must be adjusted to conform with a standard negative film characteristic. The curve shown in Fig 1 might be utilised for purposes of illustration as a standard negative characteristic. This curve represents a medium-speed negative film, widely used in television programme production. To determine whether a particular processing condition conforms with the standard, a sensitometric test strip is processed, and the two curves are compared. It should be noted at this point that the basic exposure level in the sensitometer used for exposing the test strip must be the same as that with which the standard negative characteristic was established.

Fig 5 shows how the luminance range of a typical scene may be located on the standard negative characteristic by means of spot photometer measurements and suitable adjustment of the camera lens aperture. The lightest and darkest scene areas are located at the points marked 'x' on the curve, and the corresponding densities at these points are the maximum and minium densities in the negative picture images.

Next, the negative must be printed on positive film stock, and the positive print must be processed. A typical positive film characteristic is shown in Fig 6. The gamma in this case is 2.65, approximately midway in the gamma range com-

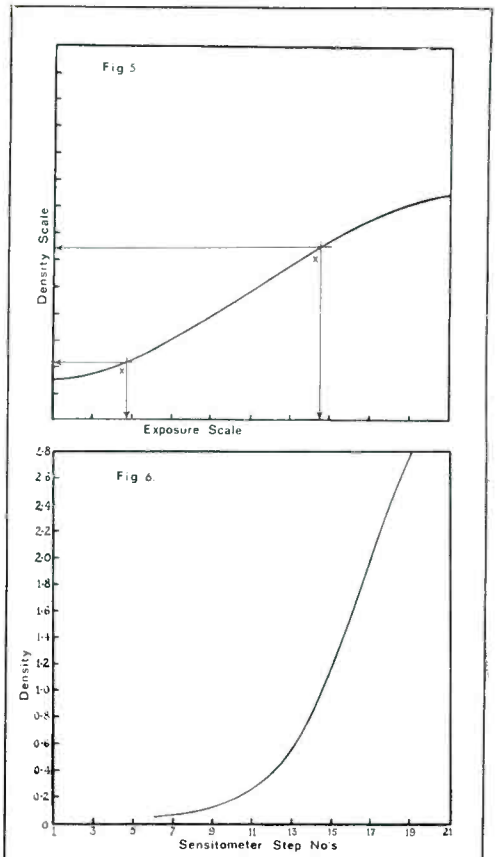
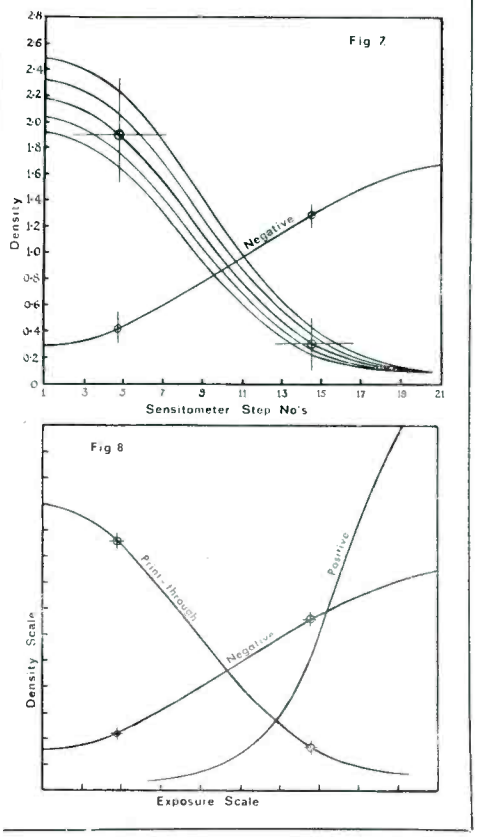


Fig 5. Portion of negative characteristic curve occupied by a typical outdoor scene.

Fig 6. Standard positive characteristic curve.

Fig 7. Family of print-through curves.

Fig 8. Diagram of the standard film process, including negative, positive and print-through curves.



monly employed in the motion picture industry. This curve might be adopted for purposes of illustration as the standard positive characteristic. Here again, the positive processing conditions must be adjusted to conform with the standard characteristic.

When the standard positive characteristic has been established, a negative sensitometric strip corresponding with the standard negative characteristic shown in Fig 1 is printed on positive film over a range of printer exposure settings. After the print has been processed in the standard manner, the family of print-through curves should be plotted on a graph as shown in Fig 7. It is now a simple matter to select the printer exposure setting with which the desired maximum and minimum print densities will be obtained. Fig 8 shows how these calculations are made. The curve obtained at the selected printer exposure setting now becomes the standard print-through characteristic.

Here we have a 'blueprint' for a film process that is compatible with the television reproducing system described in previous articles in this series. With a film process operated in this manner, as shown in diagram form in Fig 8, it is not only possible to maintain specified maximum and minimum picture densities in television film programs, but also to locate scene elements of particular interest, such as faces, at any desired level in the picture grey scale.

Constant Density Laboratory Process

Before a standardised film process as shown in Fig 8 can be adopted, drastic changes in conventional motion picture practices will be required. First—and most important—the responsibility of the laboratory must be limited to maintaining the standard negative, positive and print-through characteristics, irrespective of the appearance of picture images. Second, the responsibility of the cameraman and programme production crew must be extended to ensure that negatives are correctly exposed for the standardised process.

To maintain precise reproducibility of image-forming conditions in the laboratory, major changes in familiar processing and printing practices will be needed. In a paper by this writer in the November 1959 issue of SMPTE Journal, 'Constant Density Laboratory Process for Television Film,' control methods were described, applicable to small processing machines of conventional design. A technique of developer management was outlined, with which excellent uniformity could be achieved. A replenisher solution with the same composition as that used to fill the machine tank at the start was run into the machine at a rate sufficient to maintain the bromide content of the developer at a specified level. A simple bromide analysis procedure was employed for this purpose. Despite the marked simplification in the processing operation made possible with this method, an excessive amount of time and effort had to be devoted to the detection, analysis and correction of processing variations.

Viscous-Layer Processing

Subsequently, in 1960, the Eastman Kodak Co announced the viscous-layer processing method, and during the SMPTE Technical Conference in Toronto that year, a machine specially designed for the purpose was shown for the first time. This method of film development has the advantage that replenished solutions are not required, and no agitation factor is involved.

The Eastman 16 mm Viscomat Processor is illustrated in Fig 9. This machine operates at standard motion picture sound speed of 36 feet per minute. Processing solutions are specially prepared formulations, packaged ready for use in the machine. The viscous solutions are coated on the emulsion surface of the film by an applicator, in an atmosphere saturated with water vapour, at a temperature of 130° F. The time of treatment in the developing section of the machine is adjustable from 2½ to 7 seconds. This is the only machine adjustment available for altering the sensitometric characteristics of the film images.

Viscous-layer processing represents the first major change in film processing practices in 35 years. Because this method of processing permits push-button operation of the film process, radical changes in film production techniques can be expected within the next few years. One of the first casualties will be the old-fashioned motion picture laboratory, with its pipes, tanks, wet floors, and dark, dingy atmosphere.

But by far the most important advantage of the viscous-layer processing method is its precise reproducibility. With this method it is a simple matter to set up a film process with standard characteristics. These characteristics can easily be maintained over long periods of time at any location where viscous-layer processing facilities are available. This will permit film to be sent to any convenient location for processing, with the assurance that it will always receive the same treatment. Thus, any variations that may occur in picture densities can be attributed directly to errors in film exposure.

In television news film operations, exposed film often has to be shipped thousands of miles to the home station for processing. Portable push-button viscous-layer processing machines could be set up in any convenient location as important news situations develop, to permit immediate, on-the-spot processing of film stories. In the not-too-distant future, television film programme production crews may be provided with their own processing facilities, in the form of a viscous-layer processor installed in a small van. With this arrangement, negatives could be developed immediately following exposure in the camera, checked for faults or physical damage, and played back in a small portable electronic reproducer for the production crew.

The standard film characteristics that can be maintained so easily with viscous-layer processing will undoubtedly facilitate the early adoption of a standard overall film-television transfer characteristic. By suitable adjustment of the film or telecine characteristic, it should be possible to consistently achieve distortion-free transfer of the picture grey scale between the two systems.

The next step in the overall standardisation of the film process is the adjustment of film exposure at the taking camera. Utilising standard negative, positive and print-through characteristics, it should be possible to so adjust lighting on the scene and exposure of the film that video waveforms with the desired characteristics will be obtained at the output of the telecine reproducer. This highly interesting subject will be taken up in the next article in this series.

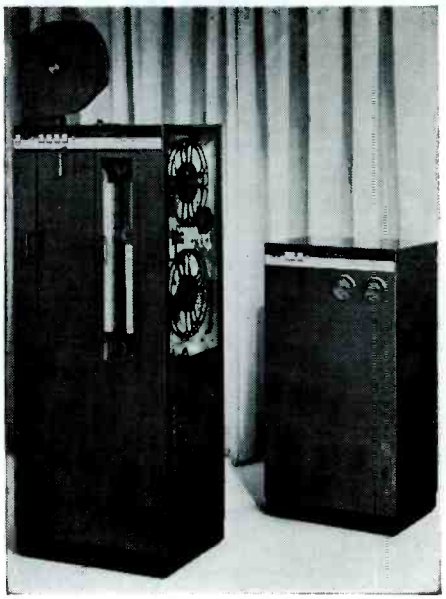


Fig 9. Eastman 16 mm Viscomat Processor.

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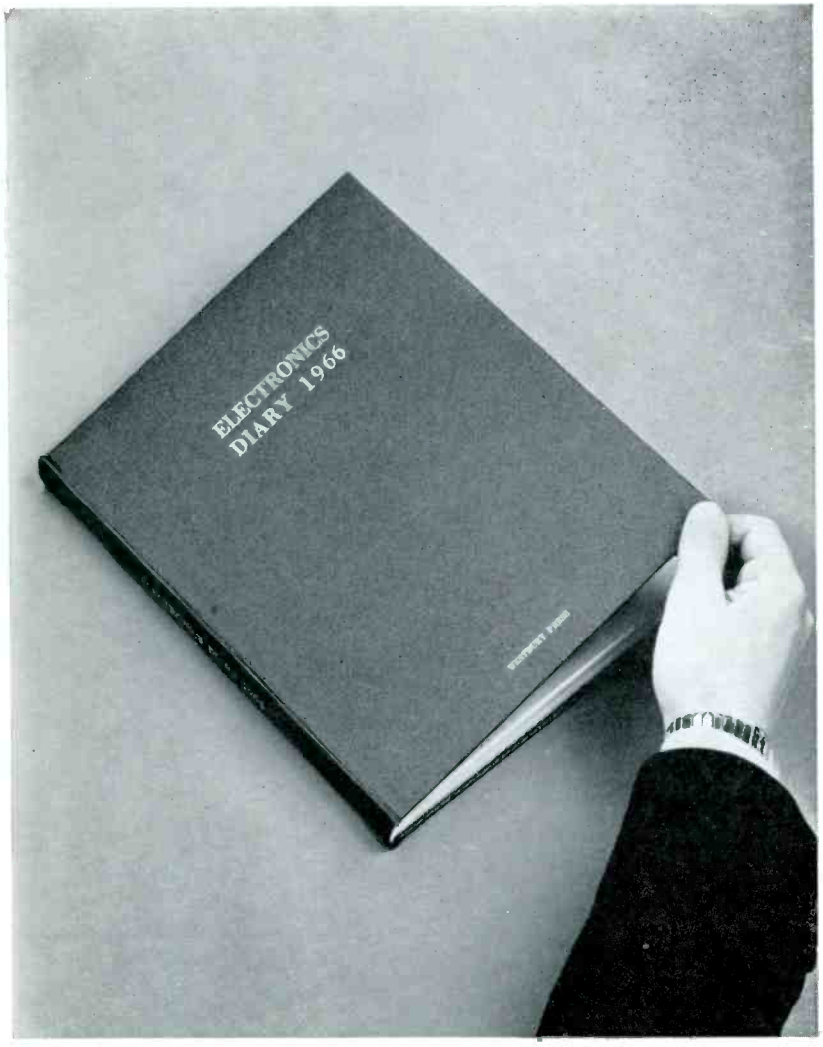

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