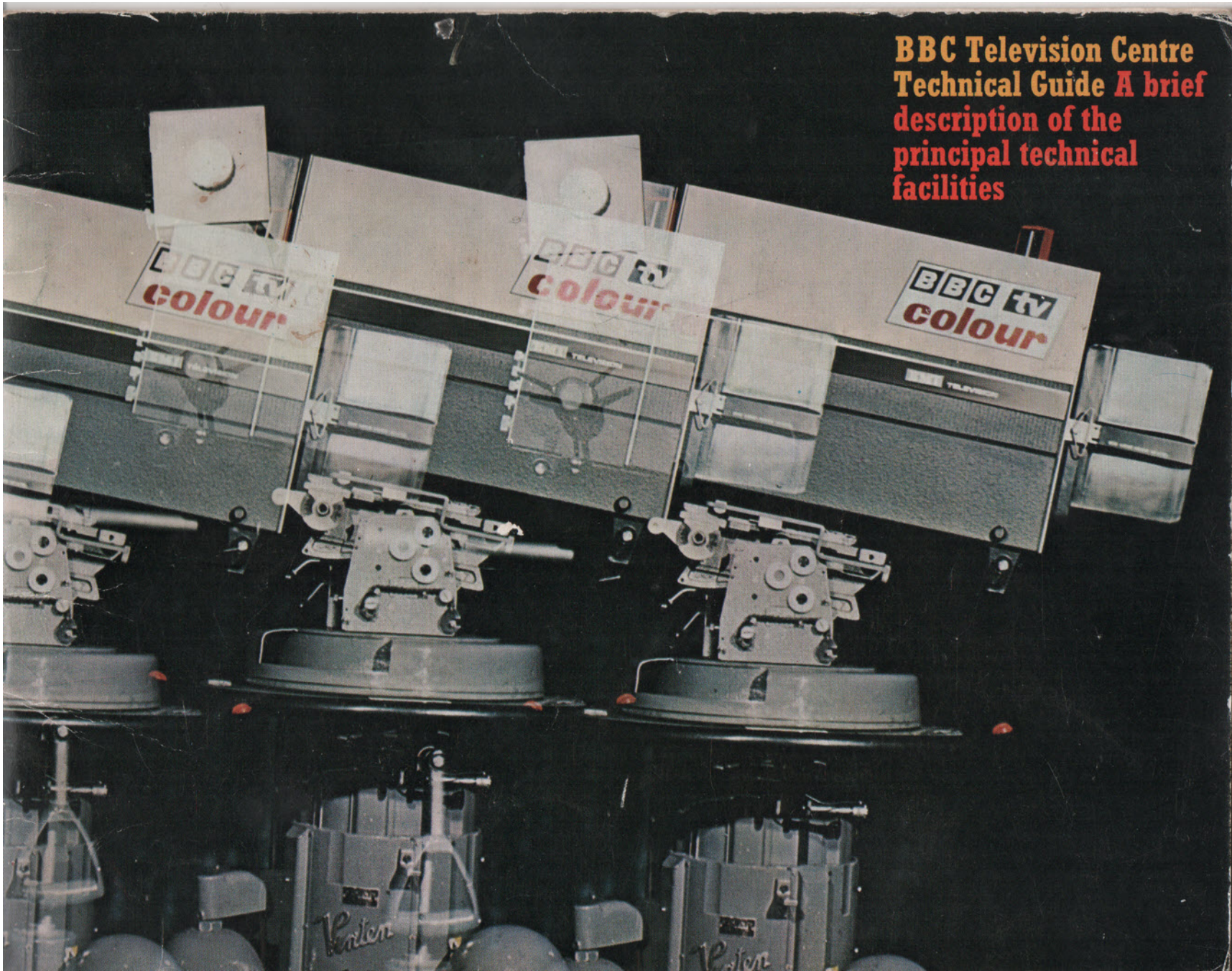
BBC Television Centre Technical Guide A brief description of the principal technical facilities



BBC Television Centre Technical Guide

British Broadcasting Corporation

Introduction

The BBC Television Centre at Shepherd's Bush is the nucleus of the Corporation's television service although it does not represent all London-based television activities and there are other Regional Television Centres. The London Centre houses the *Presentation Suite* and here the two networks BBC1 and BBC2, which are the main structure of the BBC's service, are "put together" and controlled. Regional services often *opt out* from the networks and substitute locally-generated material but, when such regional programmes are to be included in the Network programme, they are sent first to London and routed to the appropriate *Network Control* in the Presentation Suite.

Apart from this Suite the Centre contains 8 of the 14 London production studios, the major installations of recording and reproducing equipment (video tape, film and telecine), television standards-conversion equipment, the London terminal of the Eurovision network and the News service which previously was housed at Alexandra Palace.

Television programme material is fed into the Centre and out to the networks via a Switching Centre which is situated in Broadcasting House but associated sound signals are routed independently via London Control Room which also is in Broadcasting House. The BBC is experimenting with a system which could enable the sound signal to be coded and incorporated in the video signal thus eliminating this dual distribution but such a system would be used only for internal distribution and would not be broadcast.

Although the sole purpose of the Centre is the generation, compilation, distribution and control of the BBC television service the building itself incorporates of necessity the following other large-scale aspects of general engineering :

Power The Centre may draw up to 5 MW of power from the London Electricity Board and this is distributed via a ring-main system which uses 7 sub-stations. A small diesel generator plant is provided to guard against complete mains failure but this can supply only specific equipment for maintaining an emergency service.

Ventilation Ultimately most of the power fed into the Centre is converted to heat and so a large air conditioning plant is required to cope with the varying conditions that are set up throughout the building in studios and other technical areas ; for example, the conditions in a studio vary from no dissipation when the studio is not in use to a dissipation of several hundred kilowatts when the studio lights are operating.

Communications Television Centre covers a site of about 13 acres and extends both above and below ground to a total of 13 floor-levels. About 10 different television activities are carried out each in a multiplicity of suites and the smooth working of the system depends on the swift passage of information. The normal telephone service provides

access to any of the Corporation's premises and this is backed-up in technical areas by engineering telephones and microphone/loudspeaker intercom systems. In other areas use is made also of teleprinters, internal and external postal facilities, messengers and a fleet of vehicles.

House Services When touring a complex like Television Centre it is easy to concentrate on the television aspects and to overlook the many auxiliary services that are essential to the functioning of the building. Some of the 5 MW input power is required for lighting, ventilating, general purposes and for such things as automatic fire-alarm systems, emergency lighting installations and catering equipment. Lifts are required for passengers and for light and heavy goods. Water and drainage are required for wash rooms, kitchens, some technical areas, fire-fighting and sprinkler equipment. Central heating is required in offices and storage areas. The buildings and site must be maintained and, occasionally, re-organised to meet the changing needs of the service.

Access Approach to the buildings is required for pedestrians, cars, light and heavy goods vehicles and fire appliances ; movement between and around the buildings is required for small vehicles handling scenery and other equipment ; covered ways between buildings, both bridges and tunnels, are required for pedestrians (for example, costumed artistes wishing to reach the restaurant).

Catering Extensive restaurant and refreshment facilities are a necessity in a complex like the Centre. Technical staff must be on duty while studios are in use but often these same staff can service equipment only during the normal meal breaks. Equally, costumed artistes must be catered for on the premises. The Restaurant Block provides three restaurants each of which offers a different type of service. Refreshments are available throughout the buildings from vending machines, tea bars and trolley services.

Stores A great deal of spare equipment (electronic, electrical, mechanical, optical, production, properties, building, cleaning, catering) must be held at the Centre and some of these stores require air conditioning ; e.g. video recording tapes stretch and shrink with changes in air temperature or humidity and such deformation impairs the usefulness of a recorded tape.

Scenery Scenery is manufactured in the Scenery Block where space and handling equipment are required comparable to those in a studio. Temporary storage is required also because some of the scenery is used in other London studios.

Workshops and Machinery Well equipped workshops for working wood, metal and plastic are required for the manufacture, repair and maintenance of equipment that ranges from the delicate mechanisms of optical instruments to heavy mechanical-handling devices.

This brochure describes only the television-engineering aspects of Television Centre. These divide into distinct areas of activity which, sometimes, are bounded physically also. The interconnections of these areas are complex and only the main features of each area are described in the following pages.

Planning of the Buildings

Planning for Television Centre began in 1949 when television in the U.K. consisted of a single BBC channel in black and white and it was necessary to provide for the considerable expansion and development that was envisaged and has since taken place. The 13-acre site is irregular in shape and will eventually be filled by a circular main building surrounded by a ring of studios and with three auxiliary buildings and a spur radiating from it.

The main building forms a ring around a central garden so that all office accommodation has natural light and air. The ring is broken at ground-floor and first-floor levels by a colonnade which gives access to the garden from the forecourt. At one end of this colonnade the North Hall provides the main pedestrian access and contains the reception desk, cloakrooms, lifts and staircase and also escalators to the basement dressing-rooms. Opposite the North Hall is a South Hall which provides an entrance from the central garden with a second staircase and lifts ; it also connects with the goods entrance under the Central Wedge to provide a rear entrance to the building.

The first floor of this ring is mostly taken up by technical areas for the studios and the second floor is mainly auxiliary technical areas and technical stores. Above this is office accommodation.

Personnel are concentrated in the ring and they have access to the studios at the inner ends thus keeping walking distances to a minimum. Entrances to the studio floors are grouped in three assembly areas (designated red, blue and green) each of which has a tea bar, vending machines and toilets. The assembly areas open to the central garden through which studio audiences are admitted.

The movement of goods and scenery is restricted to the outside of the ring where it is segregated from pedestrians ; the greater distances to be travelled are of little consequence to vehicular traffic. At the outer ends of the studios large fire-proof doors connect with a covered roadway intended for the movement of scenery and this connects also with the Scenery Block. Outside the scenery runway an open ring-road provides a way round the perimeter of the buildings and this must be kept clear as a fire-access road. The road is bridged at second-floor level to provide a covered footway to the Restaurant Block and two covered ways to the Scenery Block. There is also a foot tunnel to the Restaurant Block at basement level and several service tunnels.

Between Studios 3 and 4 is a 5-storey structure known as the Central Wedge because it houses most of the technical areas that are referred to collectively as Central Area. At ground-floor level this wedge constitutes the goods reception area and rear entrance to the main building. Above this are the Telecine Area on two floors, the Central Apparatus Room, the Presentation Suite and the Standards Conversion Area.

Other wedge-shaped areas between the studios are used for technical and non-technical storage and for lighting switch-rooms. Above the technical

areas of Studios 2, 5 and 7 small building spurs provide extra office accommodation.

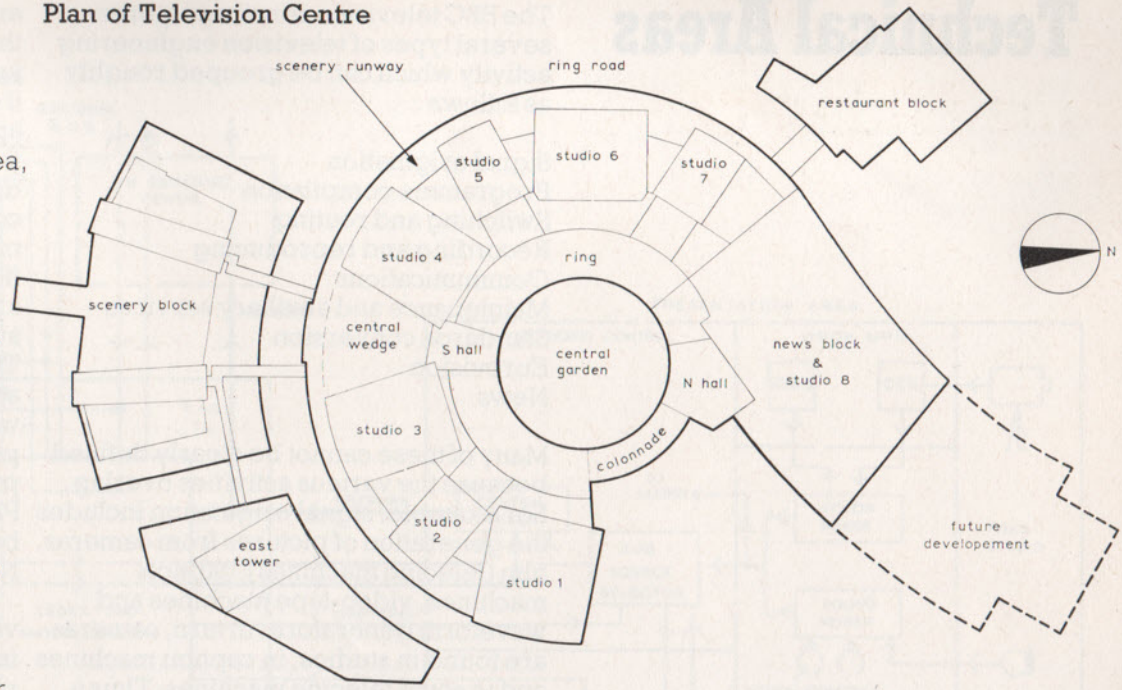
The Video Tape-recording Area is housed below the central garden at basement level ; another basement area, below Studio 6, is used for television film-recording. Also, below Studio 1, there is a battery room and the PABX telephone installation. The air-conditioning plant is beneath the scenery runway and the air intake above it. The main-building power sub-stations are also above the runway over the air intakes.

The Scenery Block has offices for design staff and, in the basement, the boiler plant but the main engineering interests here are two power sub-stations and a 60-Hz generating plant to supply equipment operating on American television standards.

The 13-storey building designated East Tower is topped by an office tower which carries radio-link equipment and television receiving aerials on the roofs. At lower levels it houses also a power sub-station, film cutting and handling suites, the studio mechanical workshops, house-services workshops and the emergency-power generator. The building is linked with the Scenery Block by a covered footway at second-floor level and this connects with one of the footways to the main block.

The first section of the main spur came into use in the Autumn of 1969 and, apart from Studio 8, houses the Television News service. The remaining section, shown by the broken line, is for future development.

Plan of Television Centre



Technical Areas

The BBC television service requires several types of television engineering activity which can be grouped roughly as follows :

Signal origination
Programme compilation
Switching and routing
Recording and reproducing
Communications
Maintenance and auxiliary services
Standards conversion
Eurovision
News

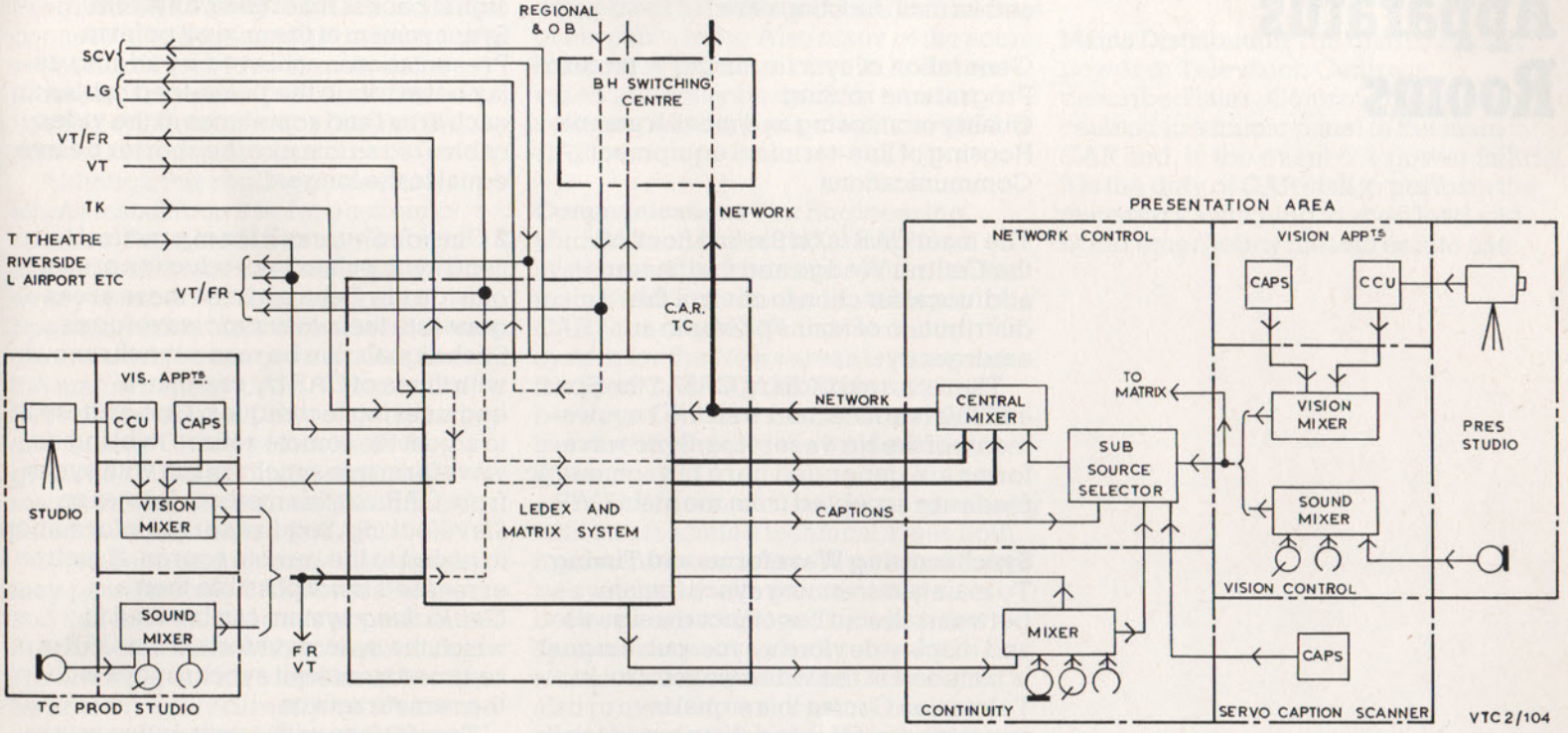
Many of these cannot be clearly defined because the various activities overlap. For example, signal origination includes the generation of pictures from cameras, film (telecine machines), caption machines, video-tape machines and waveform generators ; in turn, cameras are found in studios, in caption machines and in some telecine machines. Thus a signal source may consist of a camera in a studio, a camera in a telecine or caption machine or of video-tape, caption and telecine machines which do not use cameras. Again the video-tape machine can act as a destination which is used to record signals generated by any of the above sources.

All signal sources and display equipment must be operated in synchronism and so the logical place to start tracing the signal chain is at a point before the signal-origination equipment where timing (or synchronising) waveforms are generated. This is the Central Apparatus Room (CAR) where several sets of synchronising waveforms are generated and distributed around the building. However CAR is more than just the start of the signal chain because it contains also the switching and routing apparatus by means of which programme sources are connected to destinations. The signal chain commences in CAR with the generation of pulses, moves thence to a studio or film/tape area in which video signals are generated, back to CAR for switching and thence to a destination. This destination may be a studio taking an insert from a video tape machine and which is itself sending a finished programme to CAR ; in CAR this programme could be routed to the Presentation Suite from which it is sent back yet again to CAR to be fed to the Network.

Other complexities arise because video tape-recorders are both recording machines (destinations) and reproducing machines (sources) ; standards converters act simultaneously as both destination and source (picture only) ; the Eurovision network can be a source, a destination or both at once. The communication network is part of all technical areas.

For simplicity of operation equipment of a kind is collected together in areas and the best way of following a tour is to consider in turn each of these areas. The following pages give brief descriptions of these areas.

Simplified Block Diagram showing some of the Signal Paths that can be set up between the various Technical Areas



Central Apparatus Rooms

Purpose of CAR In general a central apparatus room contains apparatus which is common to all technical areas and its main functions are :

Generation of synchronising waveforms
Programme routing
Quality monitoring and measurements
Housing of line-terminal equipment
Communications

The main CAR is on the 3rd floor of the Central Wedge and this has an additional function to control the distribution of mains power in an emergency.

There is a subsidiary CAR in the Spur and this is concerned with the requirements of the News service. Sync waveforms are generated here but some sync feeds are accepted from the main CAR.

Synchronising Waveforms and Timing To maintain scanning synchronism between all sources of picture signals and display devices a sync-pulse signal is included in the video waveform. In Television Centre this signal is generated in CAR and distributed to all technical areas via coaxial cables. Two difficulties have to be overcome :

1 *Timing of Internal Sources* In the Presentation Area, where various signals are finally assembled into a complete programme, all signals must arrive with syncs exactly coincident in time otherwise viewers suffer considerable annoyance from temporary break-up of their picture each time a programme switch is made. Distances from CAR to each signal source vary and so the time taken to send a sync waveform to each and to receive a video signal back is inherently different. Synchronism at the mixing point in Presentation is achieved by adding delay networks in the pulse-feed cables to each area (and sometimes in the video cables) so as to make the shorter delays equal to the longest.

2 *Outside Sources* It is not practical to send sync pulses to production areas outside the Centre and so these areas generate their own sync waveforms. Such signals can be made synchronous with those of CAR by one of two engineering techniques. One of these is to adjust the remote source to bring its waveform into synchronism with syncs from CAR but this method, known as *Slavelocking*, requires error information to be fed to the remote source. If such an error feed is not possible then a *Genlocking* system can be used in which the sync waveform from CAR is re-timed to make it synchronous with the remote source.

To interfere with a sync-pulse waveform as is required for genlocking involves disturbance to all timed equipment operating from that pulse system and so CAR generates several sets of pulses which are used for different purposes. One set is maintained strictly for the transmission chain and the others can be synchronised to it if necessary.

Sync waveforms are generated for all line-standards in use at the Centre. All these pulse waveforms are distributed

via a relay matrix system which is controlled from the main desk in CAR.

Programme Routing Signal sources are connected to destinations by means of a relay matrix for video signals and a uniselector system for sound. The two routing systems are separate but the control system is integrated.

Although this routing system is a single installation it is, for economic reasons, restricted in its operation in that all destinations are not available to every source. For this reason the operating controls are divided between the areas which use given routes through the matrix namely CAR, Presentation Suite, International Control, Monitoring and Quality Check positions. Programme routes set up through the matrix can be traced using an illuminated indicator board in CAR.

It has been said already that signals may pass through CAR several times and that they must always appear in the Presentation Suite with correct timing. For example, a video tape machine must be able to replay directly into Presentation or indirectly via a studio. Thus automatic switching is incorporated to adjust the signal-path delays accordingly.

Monitoring and Measurement Routine measurements and checks are performed at the two measurements positions on the main desk in CAR. The function of Quality Check is to keep a constant watch on all signals generated in Television Centre and to report any observed failings so that action can be taken immediately.

Line-terminal Equipment Incoming lines both sound and video are connected to equalising and amplifying equipment to make good the deficiences of the cable links. Also many of the sound lines carry phantom circuits and some video lines may be used for carrier systems. All this equipment is housed in CAR.

Communications The Engineering Manual Exchange (EMX) telephone system and the intercom system for the main building is housed in the main CAR ; a second EMX and intercom system for the News areas is housed in the Spur CAR (SCAR). There is a link between CAR and the SCAR and SCAR has direct access to the Presentation Suite.

An EMX connects its CAR permanently with all associated technical areas both inside and outside the Centre and it can be switched to allow connections between subscribers. The intercom systems connect with all relevant technical areas inside the Centre and also provide direct contacts between certain areas with reference to CAR ; intercom systems can handle several conversations simultaneously without interference.

Another telephone system, known as Routed Control Lines, provides telephone links between technical areas which have been connected via the routing system ; these links are operative only while a given programme route is set up through the matrix.

There is another intercom system between the main CAR and the Switching Centre in Broadcasting House. CAR also has extension telephones from the standard PABX system.

Mains Distribution The distribution of power in Television Centre is described later. Control of the system is centred in a mimic panel in the main CAR and, in the event of a power failure, it is the duty of CAR staff to perform the necessary switching to shed load and bring emergency measures into use.

Studios

Television Centre has two types of television studio but these differ more in the manner of their use than in their technical equipment. The eight production studios are intended for mounting normal productions using artistes, scenery, properties, film or tape recordings together with special electronic effects which are equivalent to the film industry's trick photography. The second type is a small studio intended mainly for televising comparatively static scenes such as announcers in vision, small discussion groups and weather forecasts ; such studios are found in Presentation and in the News area.

The Production studios are also varied in their type. Studios 2, 5 and 7 are small in area and in height and are intended for small productions ; studio 5 is equipped specially for schools broadcasts. Studios 3, 4 and 6 are larger studios with more (but not different) facilities and can be used either for fairly large productions or to accommodate a studio audience as well. Studios 1 and 8 are very large with enough height to cope with large sets.

All feeds into a studio are routed via the matrix in CAR ; the main output from a studio returns to CAR but there is a permanent feed from each studio to the television recording area. Studio equipment is conveniently divided into four groups :

Video
Sound
Lighting
Communications

Video The primary function of a television studio is to convert a scene into an electric signal and so the most important items are the television cameras. Most story telling, news reporting, discussion and entertainment in general requires eventually to move outside the confines of a studio and thus it is necessary to use film inserts also as a means of originating a signal. The advent of the video tape-recorder has created a great change in production techniques and often scenes are pre-recorded for use later in a programme ; such devices can solve an otherwise impossible problem in changing costume for example. Signals are obtained also from outside sources such as the Eurovision network and from caption scanners (although these last are no more than cameras looking at the required captions).

Thus a studio not only originates video signals but has to mix various signals so as to produce a single coherent story. The second important item in a studio is therefore the video mixer. This apparatus enables a producer to cut abruptly from one signal source to another, to fade one source and bring in another, to fade one source at the same time as he brings in another (cross-fading or mixing) or to superimpose two or more sources. The mixer usually incorporates the special-effects equipment which enables two sources to be combined in special ways ; e.g. by making a hole in one picture and inserting the corresponding area of the other into that hole (inlay or overlay), by dividing each picture into similar parts

Overhead View of the Production Control Room in Studio 7. Vision mixer at the mixer-control panel in the centre ; producer (facing talk-back microphone) and secretary at left ; technical panel at right

and joining the desired parts (split-screen) or by moving the position of the join in a split-screen or inlay picture (wipe).

But the mixer does more than just combine signals ; some important engineering fuctions are built into it and it performs these automatically. For example there is a risk when switching between signal sources, that the synchronising waveform may be interrupted with consequent annoyance to viewers. The mixer examines all signals fed to it and will not perform a mixing operation unless the two sets of sync waveforms involved are synchronous ; there are warning lamps to indicate when a prospective mix is unhealthy. Again, a sudden cut between two sources can cause interference effects which appear as flashes on the viewing screen and so the mixer responds to instructions only during the blanked part of the signal (which normally appears off the edge of the viewers screen) ; the blanked part of the signal is gated out and so the interference is removed. If the producer fades all his signal sources so as to produce an all-black picture the mixer ensures that an immaculate sync waveform remains as the studio output signal.

The producer and his staff sit at the mixing desk in the Production Control Room on the first floor and look down into the studio through large sound-proof windows. However, the mixing desk does not contain the mixer and it does not handle video signals. The panels carry remote controls and the mixer proper is housed on racks in the Vision Apparatus Room (VAR).

The mixer is large and complicated but most of the space in the vision apparatus room is occupied by camera equipment. The device on the studio floor which is usually referred to as a camera is in fact only a small part of one ; it contains only the optical system and the camera tube or tubes with items of circuitry which must be mounted alongside. In monochrome cameras the optics consist of a lens system and a mechanical means of moving it relative to the tube for focus adjustment. In colour cameras there are two or three additional tubes and a dichroic prism block which splits the incoming light into three colour constituents. Modern colour cameras use photo-conductive tubes.

The remainder of each camera, known as the camera control unit (CCU), is rack mounted in the apparatus room but the controls are brought out to a remote-control panel. Control panels for all cameras, both production and caption, are mounted on the studio engineer's desk together with test and measuring equipment. The cameras are aligned before use so that they produce identical pictures of the same scene.

A small range of control over camera gain, lift (picture brightness) and iris setting is made available on a second remote-control panel which is mounted at the lighting-and-vision-control position usually next to the production control room. The lighting engineer endeavours to adjust the lights so that cameras produce pictures which match for brightness and contrast ; these limited camera controls are used to help as necessary.

As many as six cameras may be used on large productions and these cameras are constantly moved. Care must be taken to see that camera cables do not become tangled. To facilitate the planning of camera movements a large number of camera-connection points are provided around the studio walls ; a patching panel is provided in the technical area so that each CCU can be plugged to a selected wall point and so connect with its appropriate camera head.

There are several types of caption scanner in use at the Centre and a technical description of them all fills a book. In general a studio requirement is to load a collection of slides into a machine and be able to reproduce them in turn as a video signal. The slides are changed by remote control from the video mixing desk and can be either cut or faded in the manner of other video sources.

The usual studio caption scanner employs two slide-handling machines which project in turn into a vidicon camera. Each machine contains a magazine of slides with even numbered slides in one machine and odd numbered slides in the other. While one machine is projecting a slide the other machine is changing to the next. A third machine is sometimes provided which is capable of projecting a moving film strip.

In some studios the slides are available in sequence only but in others, and in areas such as Presentation, a random-access facility is provided.

For colour working captions are provided either from colour-caption scanners or from monochrome caption scanners working in conjunction with a colour-synthesising device.

Sound The primary sources of sound signals in a television studio are of course the studio microphones but, as with the video, signals must be accepted also from film and video-tape sources, outside sources and from sound disc and tape-recorders. The sound engineer too has special effects equipment such as the gun-shot generator. Thus a sound-mixing desk is required as well as the video-mixing desk.

The mixer, amplifiers, gramophone, tape equipment and echo-selection facilities are housed in the Sound Control Room (SCR) next to the production control room where the sound supervisor has a direct view into the studio and also has visual contact with the producer. There is a sound-proof window between the two control rooms but this can be lowered by pressing a button on either desk. Modern sound-mixing desks differ from the video-mixing desks in that remote control is not employed and the amplifiers are housed in the desk.

The problems of sound in a television studio differ from those in a sound-only studio. The multiplicity of sets, the aesthetic requirements of studio layout and the need often to keep microphones out of shot make sound balance difficult to achieve. Other problems such as the placing of a microphone in the middle of a song and dance group can be solved by pre-recording the sound but, during the show, it is necessary to play the recording on the studio floor as well as feed it through the mixer.

The sound supervisor cannot work with the freedom of a sound-only man because his efforts must be co-ordinated with those of the video-mixer operator. The necessity of controlling his crew both on the studio floor and in the SCR, of watching the artistes and listening to the producer means that he relies heavily on the studio communication systems.

One other difference between television studios and sound-only studios has emerged. Sound studios are set aside for particular types of use (for example drama or music) and they are treated acoustically to suit that particular use. A television studio, however, is both large and expensive and presents a peculiar problem to the acoustic engineer in that the studio contents cannot be specified. The lighting equipment, television equipment, scenery, audience and distance from performers to microphone are all variable. In an effort to adjust the reverberation time of studios a sound system known as Ambiophony has been installed in which a studio output can be fed back with variable delays to a number of loudspeakers positioned around the studio. Ambiophony and echo facilities differ in that echo is applied in varying degree to individual sound channels of the mixer.

Lighting The task of the lighting engineer is to place and adjust the studio lights so as to produce artistic and realistic reproduction of each of the many sets and usually on more than one camera at a time. Where a large number of sets are crowded together the problem of spill lighting occurs where lights from one set unbalance the lighting on an adjacent set. This, combined with the need to keep within the rated power dissipation, means that lights must be switched on only when required. Thus a large production involves switching and dimming actions on a large number of lanterns.

To help with this task the lanterns are connected to a remote-control switching and dimming system. During rehearsal the lighting engineer adjusts each lantern from a control console until the required effect is obtained ; information about the control settings is then stored in a memory device so that any particular lighting arrangement can be re-called by pressing a single button.

The lanterns in use are a dual purpose type which provides hard lighting from one side and soft lighting from the other. Lanterns are mounted on lengths of metal tube known as barrels which can be raised or lowered by remote control using electric hoists. Power sockets are mounted on each barrel and the sockets in use are connected via a patching panel to the required channel of the control console.

A major difficulty in lighting sets for colour television is that dimming a lantern must not change its colour temperature. Lanterns contain several lamps and dimming is achieved by switching out some of these.

Communications The working of a

television studio depends on the concerted efforts of many people :

Camera operators, microphone operators, artistes and producer's assistant(s) on the studio floor.
Vision mixer, sound mixer, gram/tape operator, lighting engineer, studio engineer and producer in the studio technical areas.
Telecine and video-tape operators in other technical areas.
Other artistes, commentators and technical staff in outside production premises or outside-broadcast sites.

Few of these people are able to talk directly to each other and many cannot see each other ; thus a comprehensive and flexible communication system is a necessity. Studio Communications can be divided roughly into six types :

1 Production talkback
2 Camera talkback
3 Sound talkback
4 Lighting talkback
5 General talkback
6 Telephones

1 Everything that the producer says is picked up by a microphone and fed into the Producer's Talkback circuit. This is fed to loudspeakers in all technical areas associated with the studio, to the headphones of each camera and sound operator in the studio and to a small transmitter which radiates the talkback into the studio on a v.h.f. channel. The producer's assistant on the studio floor, who is responsible for studio organisation and discipline, carries a self-contained pocket receiver with which he can listen to the producer's talkback and so relay instructions and cues to the studio. During rehearsal he can talk to the producer over one of the studio microphones but, during transmission, he must rely on a wall-mounted intercom position. This 'reverse talkback' can also be used by a producer when working on the studio floor.

2 Each camera operator wears headphones and these are fed with producer's talkback. Additionally two-way communication is possible between the camera operator and either the studio engineer's desk or the lighting-and-vision-control position without interfering with the producer's talkback circuit. This facility is used mostly when aligning cameras and when fault finding. If required, studio sound output can be fed to the camera operator.

3 Operators handling microphones also wear headphones fed with producer's talkback and, if required, studio sound output. Additionally the sound supervisor can call the microphone operators without breaking into the producer's talkback circuit ; this also is a two-way facility.

4 A talkback system links the lighting engineer with various positions manned by electricians ; this also is fed with producer's talkback. Additionally the lighting engineer has a telephone link with the studio floor, the dimmer room and the lighting gallery.

5 The term General Talkback has been used here to cover a multitude of minor facilities. Staff at any of the controlling positions can break into the producer's talkback circuit or can put this facility on to a loudspeaker in the studio ; loudspeaker talkback is however muted during transmission. The producer can extend his talkback system to call artistes dressing rooms, the assembly area and any source or destination routed to the studio.

6 In each production control room there is a small telephone exchange panel to which engineering telephones and routed telephones are connected. Each technical area of the studio is a subscriber to this panel.

Noddy – the Servo-controlled Caption Scanner in Presentation. The floodlights are operated remotely from the mixer control desk


WE WILL CONTINUE IN SOUND
UNTIL NORMAL VISION
CAN BE RESTORED
2
TEMPORARY
FAULT
BBC
THERE IS
INTERFERENCE
ON PICTURE
THERE IS
INTERFERENCE
ON SOUND
EVERSHED
POWER-OPTICS
2
BBC TUESDAY
2
BBC
2
BBC
2
BBC

Presentation

Presentation Area contains two Presentation Suites, one for BBC1 and the other for BBC2. Each suite consists of a Network Control, a Presentation Studio, a Continuity, a Caption Room and technical areas associated with each of these.

The purpose of this area is to accept programme material from all sources, to generate linking material using the presentation studio and then to compile a continuous service for feeding to the network system.

Network Control (NC) Network Control is the compilation point. This room closely resembles theproduction control room of a studio in that it contains a mixing desk, audio and video monitors and a communication/technical position ; indeed its function is much the same as that of a studio production control room except that its inputs are finished productions instead of primary signal sources such as camera outputs.

Two respects in which NC and a production control room differ are in the mixer and caption facilities. This 'Central Mixer' is not used for continual cutting and mixing between successive shots but rather as a switch between sources of finished material. Hence, although it retains the cutting, mixing and split-screen facilities for video, it can operate simultaneously on both the sound and video contributions. Also, when sources are routed to this mixer from the matrix routing system in CAR, extra delay networks must be switched to adjust the video timing between sources which feed directly and those which feed indirectly via a studio.

Another accessory to this mixer is a Cue Dot Generator which is used to insert a cue mark in the top left-hand corner of the output picture just before a programme change ; removal of this dot is the signal for the next contributor to go ahead. Network Control relies heavily on captions which are used to :

Identify the network between contributions and during periods such as trade transmissions
To provide test-card and other test signals
To introduce programmes
To give time checks
To give viewers visual warnings and apologies when a breakdown occurs or when there is interference with the transmitted signal.

Standard identification, breakdown and apology captions can be held as small transparent slides in the magazine of a standard slide projector and scanner with the added facility of random access. However some captions such as clocks consist of working models and many other special-purpose and one-off captions are easily and quickly made as large opaque drawings. A special scanner has been developed for televising these which uses a servo-controlled vidicon camera that can be directed at any of 12 caption positions by pressing buttons ; its pan and tilt action has earned it the affectionate title of Noddy.
All inputs to the Central Mixer are routed via the matrix in CAR or, via a local

routing system, from the Presentation area. The diagram on page 7 shows the interconnections between CAR, a production studio, other sources of programme material and a Presentation Suite. The diagram shows :

A feed from a video tape-recorder (VT) fed via the matrix to the production studio
The output from the production studio, and the output from a studio in the BBC premises at Lime Grove (LG), fed via the matrix to the Central Mixer
The output from the Central Mixer fed, via CAR, to the Switching Centre in Broadcasting House for onward transmission to the network ; a monitoring feed is taken to the matrix.
The Central Mixer can also accept feeds from the Presentation Studio, Continuity and the caption equipment.

Presentation Studio A presentation Studio is basically the same as a production studio but its facilities are commensurate with its reduced size and commitments. Sound, video and lighting control are all housed in one control room with a view into both the studio and the associated Network Control. The output is fed usually to the associated NC but it may be fed via the CAR matrix to the other NC or indirectly via either of the Continuities.

Continuity Suite The Continuity Suite contains two identical Continuity rooms and a common caption room. Each Continuity contains a sound-and-video mixing desk, caption facilities, a microphone, gram and tape machines, communication equipment and monitoring facilities. A Continuity has a two-fold purpose :
It is the source of sound-only linking material with or without captions.
It can take over the functions of NC during periods such as trade transmissions and so release NC for maintenance and other engineering work. To fulfill these purposes each Continuity can operate in two ways :

As a source and mixing point which feeds a finished programme either to NC or directly to CAR
As a source feeding the Central Mixer at which point the NC operators mix the linking material with other contributions.

A Continuity is manned by only one person who both operates the desk and makes announcements as required.

Television Recording

Film and Video Tape The earliest method of storing television signals was to record on film using synchronised cine cameras to photograph each field as it was presented on a monitor screen. The difficulties encountered in this technique arise from the different natures of the instantaneous optical picture for which the cine camera is designed and the point-by-point or quantised picture which is displayed on a monitor screen by a moving spot of light.

Basically the problem is to pull down the film by one frame and to lock it in the gate in the relatively short time of the field-blanking interval. An early solution was to suppress one of the fields in each interlaced picture and to use the time thus gained for pull-down ; obviously this method degrades the recorded picture. Modern equipment does in fact achieve a fast pull-down and may sacrifice only a small part of each field immediately after the blanking period.

The greatest disadvantage of film recording is the impossibility of a playback until the film has been chemically processed. A great advantage is that, as a source of recorded information, film is not tied to any specific line or field standard and can also be projected optically. It differs of course from standard film in that its frame-repetition rate is 25 per second instead of 24 per second but this is not significant in the U.K.

Magnetic-tape recording of television signals is a powerful production tool because it affords instant playback facilities. The problems here are basically two :

The inherent noise level and the physics of magnetic recording limit the available bandwidth to about 10 octaves; the bandwidth of even a 405-line television signal is greater than 18 octaves.
The high frequencies in a video signal require a high relative speed between the recording head and the tape.

In the recorders used at Television Centre the first problem is overcome by translating the video signal up the frequency spectrum; i.e. it is modulated on to a carrier of about 5 MHz using frequency modulation and the resulting signal has an overall bandwidth of about 3 or 4 octaves.

The second problem is overcome by using transverse scanning. A tape, about 2 inches wide, is pulled through a recording-head assembly at about 15 inches per second. The tape is held by suction against a guide which shapes it around a drum that is rotated at about 15,000 r.p.m. This drum carries four recording/playback heads spaced around its periphery and these are swept across the tape at a relative speed in excess of 1,500 inches per second. As each head transverses the tape the f.m. signal is switched to it electronically. The same process is used to recover the recorded information and the head outputs are switched to re-assemble the continuous f.m. signal.

Very accurate servo control of both the tape motion and the head-drum rotation is necessary during playback to find and follow the recorded tracks. This is only realisable in practice by controlling the recording process also and a control track is laid down which marks the edge of the tape in much the same way as sprocket holes locate a film. Final timing adjustments, to give a control accurate enough for the reproduction of colour pictures, is achieved using electronically adjusted delay lines.

Sound is recorded in the normal manner along the other edge of the tape but it is staggered with respect to the associated video recording. Thus, when editing a tape, there are two points to be considered:

A The tape must be cut and joined so that the field interlace sequence is not disturbed.
B The tape must be cut so as not to disturb the sound signal.

Requirement **A** is met by marking alternate field sync signals with a pulse on the control track; this pulse can be made visible by treating the tape surface with a magnetic developer solution. Problem **B** can be dealt with when necessary by re-recording the sound track, editing it and then dubbing it back on to the edited video tape.

Telecine Telecine machines are used to scan film stock and to produce a corresponding video signal. The frame rate of standard film corresponds roughly to the picture rate of a television system and so each frame must be scanned twice to produce the two interlaced fields. The telecine machine, unlike the film projector, does not have to project a complete picture and so the intermittent film motion through an optical gate is not required. The film is run through the machine in continuous motion and the scanning waveforms are modified to compensate for this motion; in some machines the scanning correction is achieved optically by means of a rotating prism or mirror drum.

Film Recording Area This area, below Studio 6, accommodates machines which record on either 16-mm or 35-mm film. Each machine is housed in a cubicle which provides acoustic separation. Each cubicle is equipped also with monitoring and measuring facilities, test-waveform generators and the usual communications equipment.
Each cubicle receives feeds of the sound and video signals to be recorded, test alignment waveforms and a set of pulses which are required for the test-waveform generators housed in the cubicle.

Sound can be recorded either optically on the film (comopt recording) or magnetically on a separate magnetic film (sepmag recording) and several sepmag machines can be used simultaneously if required. Markers can be applied to both the sound and video recordings for use in playback. The sepmag machines are grouped together in bays in the centre of the area and are operated under remote control. The film recorders too can be operated remotely from any of the editor's rooms in the centre of the area.

To record a programme which has a duration greater than can be accommodated on a single magazine of film it is necessary to use two machines so that

one records while the other is re-loading. For this purpose a means of synchronising the two machines must be provided and various communication links are required between them. To enable any two machines to work together a routing system must be available to switch these control circuits. Intercom and telephone circuits, such as those already described, are provided to CAR and other television recording areas.

Production film is not processed at the Centre but small lengths of test film which are required quickly can be developed in a wet darkroom provided for the purpose. Other darkrooms are provided for loading and un-loading film.

Video Tape-recording Area This area, below the central garden, contains transverse-scanning tape recorders that can handle video signals on any line standard in either monochrome or colour. Each machine was originally housed in a separate cubicle but the latest practice is to group them in pairs. Each cubicle has monitoring and measuring facilities and accepts feeds of pulses from a pulse-routing matrix in the apparatus area.

Signal feeds, which come direct from each studio or source (not through the CAR matrix), can be fed to as many as three machines simultaneously over a distribution system known as the Record Routing which also feeds the film-recording area. Machines operating in the playback mode feed the CAR matrix as sources over a second distribution system known as the Replay Routing. This incorporates apparatus known as duplexers each of which enables two machines to feed a single destination on one line with change-over facilities and provides the necessary equipment for them to share the communication channels.

The video-tape and film recording areas are classed together as Television Recording Area and the video-tape apparatus room contains equipment which is common to both ; e.g. line termination and pulse distribution equipment.

Telecine Area This area occupies two floors of the Central Wedge and contains both 16-mm and 35-mm machines which can televise both monochrome and colour film. Each machine, with a sepmag sound reproducing machine, is housed in its own cubicle and feeds the CAR matrix via a duplexer which is similar to that of the video tape machines. These machines can also feed CAR through a simplexer when duplex working is not required ; the simplexer is necessary to add in the communication and signalling circuits. Additionally there are direct feeds to viewing rooms.

Telecine machines can be operated remotely from a studio or other area by d.c. signalling circuits with forward and re-wind facilities. Metallic contacts punched into the edge of the film operate the necessary sensing circuits. Such arrangements greatly reduce the number of staff required to operate this large area.

An Electronic Field-store Standards Converter

Standards Conversion

A monochrome television picture is made up by tracing a spot of light, which varies in intensity, across a screen until the screen area is filled with the lines ; for a colour picture three such spots are used. The number of lines used to fill the area, the order in which the lines are traced and the number of complete pictures presented to the eye each second is a matter for choice and, inevitably, a matter for compromise.

Television systems in different parts of the world were developed in parallel and different compromises coupled with different thinking has produced several sets of ''television standards''. With the creation of the Eurovision Network and satellite communication systems it has become possible to exchange live and recorded programmes between countries and so a means is required for converting video signals of one standard to video signals of another standard without the enforced delay of processing film.

The earliest standards converter, known as an image converter, was simply a camera operating on the desired standard which was set up to view a monitor displaying the input signal with the originating standard. Because the scanning beams of the display tube and the camera tube did not move in synchronism, display tubes with a rather long after-glow were needed to store the input signal until the camera was ready to scan it. This caused blurring of quickly moving images. When a change of field-repetition rate is required the beat between field frequencies is sufficiently low to cause a

serious flicker component ; this was corrected by adding a white bar at one side of the picture and using this to control an a.g.c. loop.

The picture degradation caused by such converters becomes less tolerable as the quality and variety of television pictures is improved and, in the BBC, electronic standards converters now completely replace the image converters.

It was mentioned with the image converters that the two scanning beams do not move in synchronism ; any given element of a picture may be presented at a different time in the input and output pictures and so some form of storage is inherent in any standards converter. For converting between standards using a common field repetition rate a storage time equal to the duration of one input line is sufficient and such converters are known as Line-store Standards Converters. For converting between standards with different field repetition rates a storage time equal to the duration of one input field is required and these converters are known as Field-store Converters. Equipment for transcoding between different colour systems (NTSC, PAL, SECAM) is also required.

The input video signal is chopped up by a synchronised high-speed electronic switch and each element is fed into a separate filter section in which it is stored. A second high-speed switch, operating at the appropriate synchronised speed, samples the stores and re-assembles a complete and continuous video signal. Unwanted lines and/or fields must be discarded ; new lines and/or fields to fill gaps must be generated by interpolation.

The Standards Conversion Area (SCV) is on the fifth floor of the Central Wedge and contains a number of different standards converters. Some of these convert from a smaller to a larger number of lines (up-converters), and some convert from a larger to a smaller number of lines (down-converters) and a few are capable of working in either direction. The area obtains video signals from, and feeds video signals back to, the routing matrix in CAR. Sound signals associated with these programmes do not pass through this area although a monitoring feed is provided. There are the usual pulse-distribution, communication, test and measurement facilities.

International Control

The International Control (IC) was established originally to facilitate the handling and control of television programmes incoming from and outgoing to the Eurovision network and this is still its main function. However, with the advent of the satellite communications, its use has become considerably extended.

Normally both sound and video signals pass through this area without cutting or mixing operations except for test signals and, on multiple-commentary programmes, for opening and closing captions or breakdown captions. However the area is used sometimes as a master control point.

Video signals both to and from Europe are carried by radio link to the G.P.O. station at Tolsford Hill in Kent and from thence to the French PTT station at Loos in Northern France. Sound is carried by normal Post Office circuits.

International Control, like most control rooms, consists mainly of a large number of equipment items (amplifiers, monitors, measuring equipment and communication facilities) which are used in various combinations as required by circumstances and the individual operators. It is divided roughly into two parts : an operational area and an apparatus area.

Another area, the International Commentary Area (ICA) ,is associated with IC. This provides up to 20 booths in which commentators may view a programme and each give his commentary in a specific language. Comprehensive communication facilities are provided. Only 10 booths are fully equipped but all are cabled and, if required, the remaining booths are equipped with Outside Broadcast apparatus.

International Control can handle incoming and outgoing signals simultaneously if required. For incoming programmes IC acts mainly in a monitoring role and the programme lines are likely to pass through CAR only with just monitoring feeds available in IC ; engineering telephone lines are routed through IC. Much of the programme material passing through IC must be routed through the Standards Conversion area.

International Control in the Presentation Area. Video equipment (foreground), sound and then communications with a second video position round the corner; grams, tape and rack-mounted equipment in the background

News

The large spur built on the north side of the main building is entirely occupied by the Television News Service except for the intrusion of Studio 8 at ground and first-floor levels. Basically the equipment used by the News service does not differ from that in the remainder of the Centre but, because of the totally different method of working, the emphasis on various items is different.

Normal production methods in television require much forward planning, preparation and rehearsals but the News is essentially an off-the-cuff service. The majority of planning for news takes the form of daily conferences in which groups of people gathered in conference rooms scattered about this country and the Continent (Eurovision) are connected by a sound talkback system and, on occasion, by a video link also.

News is received by all the usual methods the most important of which are teleprinter, facsimile, telephone, film and the Eurovision network. The inclusion of an item in a news broadcast depends on the importance and age of that item and on the importance of the particular broadcast.

The main areas into which the Spur can be divided are :

Spur Central Apparatus Room (SCAR)
News Room
News Studios
Telecine (spur)
Video Tape (spur)
Film Processing (spur)
Film Cutting, Dubbing and Reviewing (spur)
Sound Recording
Dubbing Suite
Technical Workshops (spur)

The spur central apparatus room is similar in function to the main CAR in that it generates pulses to supplement pulse feeds from the main CAR, routes programme material, contains an EMX and an intercom, monitors all signals and carries out measurements. It also contains a mimic panel from which part of the power-distribution system can be controlled. All incoming teleprinter lines pass through SCAR.

The News Room is the hub of the news service and its function is to collect, assess and collate news items. It houses the teleprinter and fascimile equipment ; it is equipped with both monochrome and colour picture monitors for viewing programme feeds ; it is equipped with a monochrome television camera and suitable lighting so that in-vision news summaries and news flashes can be fed either to the mixer of a news studio or directly to SCAR (if required, these facilities can be extended for colour working) ; it has an area that can be set aside for conference purposes.

The News Studios are similar in their technical equipment to any production studio but their purpose is to present news programmes. Signal sources for these studios are cameras (including the News Room camera) which can be controlled remotely, captions, video tape, telecine and outside-broadcast or regional contributions. Special synchronising facilities are provided so that these sources can be selected

rapidly on-air as is required by the News service. All news-service captions are generated in a common caption room and caption signals can be synchronised rapidly with the waveform selected as the mixer output. There are two News Studios in normal use but a third, fully cabled, doubles as a conference room.

Film processing, cutting and dubbing facilities are necessary to the News service because of the speed required and the enormous quantities of film involved. The Dubbing Suite has comprehensive facilities which enable a complete programme to be assembled on video tape from various contributions on tape, film, captions or live sources.

The functions of the remaining technical areas in the spur are similar to those of their counterparts in the main building.

In the basement of the spur there is garage space for the News Outside-broadcast vehicles. A programme link is provided between the basement and SCAR which can be used, for example, by mobile video tape-recorders. When these vehicles are operational a v.h.f. communication link is set up between them and SCAR.

The Lighting-and-Vision-control Room of Studio 7. The two lighting-control panels are at the left-hand side of the desk with indicator panel suspended above. Remote controls for five cameras and the intercom panel are at the right

Communications

The communications networks of the Centre connect with every technical area and so they are described as a separate system. In all there are nine communications circuits :

PABX This is a 5,000 subscriber automatic branch exchange which is installed and maintained by the Post Office. It serves both technical and non-technical areas. Dialling facilities are extended to exchanges in other BBC premises in the London area and also to the public telephone system.

EMX There are two engineering manual exchanges, one in CAR which serves the main building and the other in SCAR which serves the spur. Each of these provides 200 permanent telephone circuits connecting with all relevant technical areas both inside and outside Television Centre. CAR and other Central areas are also subscribers to the spur EMX.

In large technical areas such as Telecine and Video-recording the EMX line terminates on local switchboards which connect the local control point with each machine cubicle and also to other technical areas.

Main Intercom There are two of these intercom systems (one in each central apparatus room) and again the Central Area subscribes to the spur system. These are microphone/loudspeaker systems which can handle several conversations simultaneously but they connect only areas within the Centre. In News areas of high ambient noise level the microphone and loudspeaker can be supplanted by a telephone handset and this is done automatically when the handset is lifted from its cradle.

Routed Control Lines These are direct telephone links set up between two areas connected as a programme route through either the main routing system or a record-routing system.

Buzzers This is another routed facility which provides a two-way buzzer circuit between telecine or video tape machines (replay only) and any studio.

Maintenance Intercom This is a 20-way microphone/loudspeaker system which connects all maintenance areas. It can handle one conversation at a time but all subscribers can join in as required.

Studio Talkback and Communications Facilities are provided in each production area for communication between local control positions, operators, studio floor and producer. Studio talkback can be fed also to any source or destination to which the studio may be routed.

Broadcasting House Intercom A simple two-way microphone/loudspeaker system which connects Broadcasting House Switching Centre and CAR.

Restaurant Paging and PA System PABX operators can call on loudspeakers in restaurants at the Centre and at BBC Lime Grove and Riverside premises. At the Centre the paging equipment can be used as a local public-address system.

Video Tape-recording Machines in a Transmission Suite. The central console holds monitoring and test equipment

Power

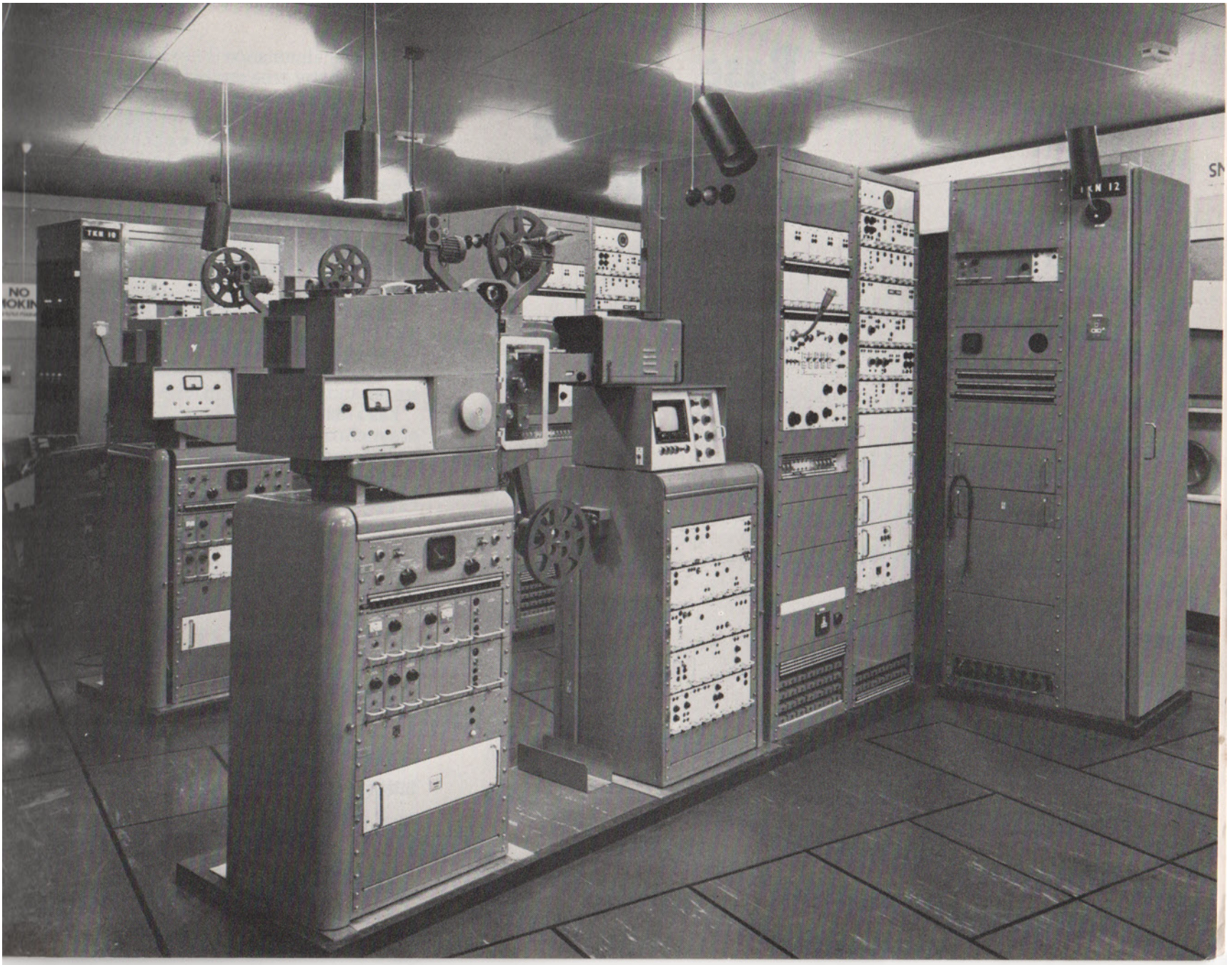
Power is supplied to Television Centre at 11 kV with a maximum load of 5 MW. A primary distribution system at 11 kV incorporates 7 sub-stations in which the supply is transformed to 415V 3-phase for distribution on a 4-wire system.

The supply is taken from the London Electricity Board via two feeders incoming to a sub-station in the Scenery Block. Either feeder can carry the total load and a third feeder, which has a capacity of 2 MW, can be brought into use after the two main feeders have been disconnected. There is a sub-station also in the East Tower and another in the Restaurant Block ; the remaining four sub-stations are incorporated in an 11-kV ring main in the main building.

Each sub-station can be controlled remotely from a mimic panel in the main CAR ; control of sub-stations 1, 3 and 4 can be switched to subsidiary mimic panels in Studios 2 and 6 and in SCAR respectively. Should there be a power failure then the meters on the CAR mimic panel will show whether power is available on the emergency feeder ; if so then load must be shed before this feeder can be switched into use. If the power failure is total then the entire load is shed and only designated areas and machines can be fed (via local switching) from a Diesel generator set. The Diesel engine starts automatically when a power failure has lasted for 3 seconds and the set can supply a full load of 100 kW after a further period of 9 seconds.

The change to Diesel-generated supply is automatic but, when mains has been restored, reversion takes place by manual switching as convenient.

Three of the eleven Telecine Machines in the News Telecine Area. There is accommodation for fifteen machines in all


TKN 10
TKN 12

Base Maintenance and Stores

First line maintenance is normally carried out by area engineers either with the equipment still in service or in local maintenance rooms. Serious problems and occasional work overloads are dealt with by base maintenance areas which are situated on the second floor of the main ring. There are three of these areas : Video Maintenance which handles cameras and associated equipment, Monitor Maintenance which handles display equipment, Sound Maintenance which handles all sound equipment. There is also an Optical and Camera-tube Test Room. Adjacent to these areas is the general technical stores and the valve and tube stores.

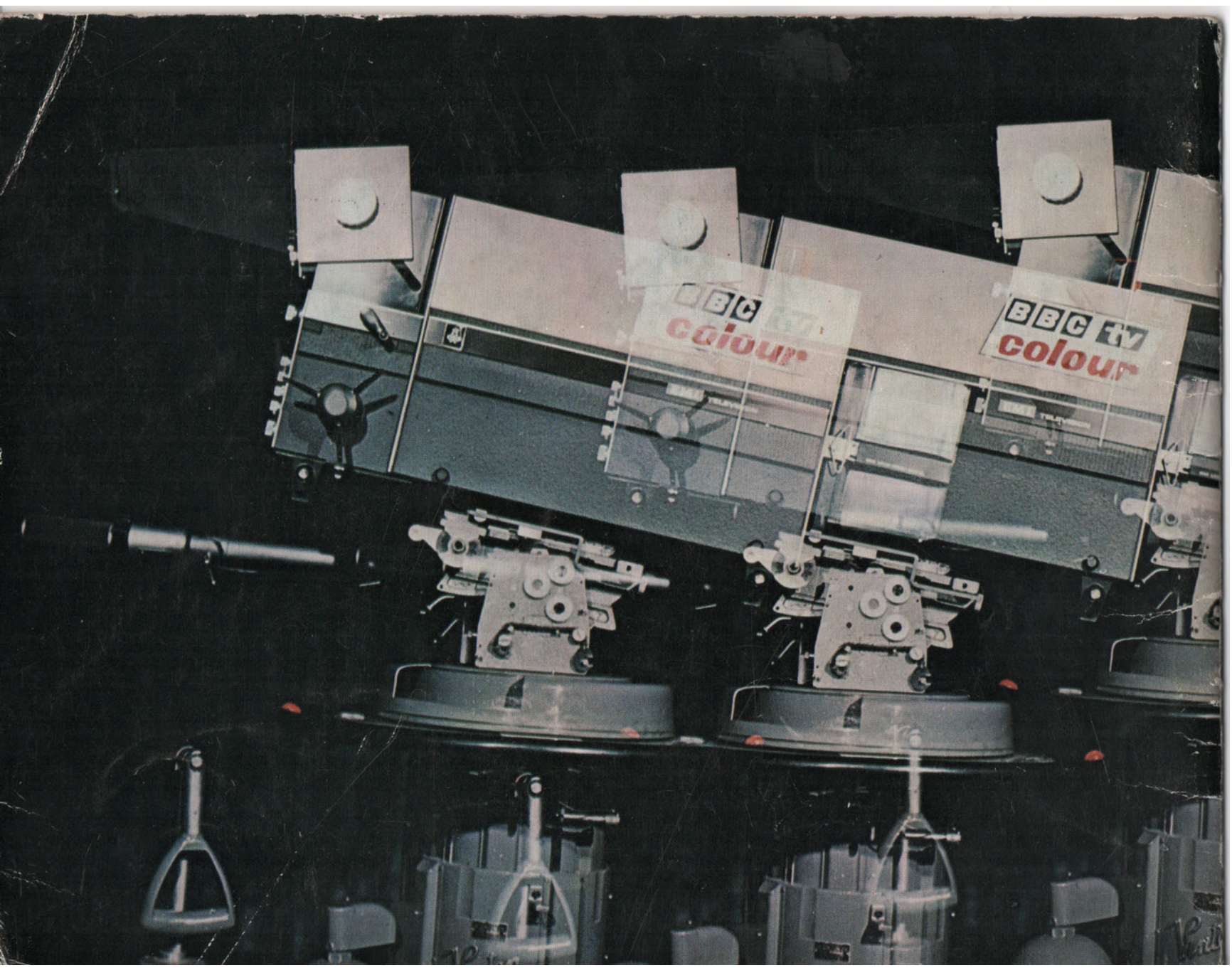
Base maintenance areas require feeds of synchronising waveforms, video and sound signals. They are connected also to other maintenance rooms by the Maintenance Intercom system.

Published by the
British Broadcasting Corporation
35 Marylebone High Street
London W1M 4AA

SBN 563 102411

First published 1970

Printed in England by
TWP Services Limited London


BBC
colour
BBC TV
colour