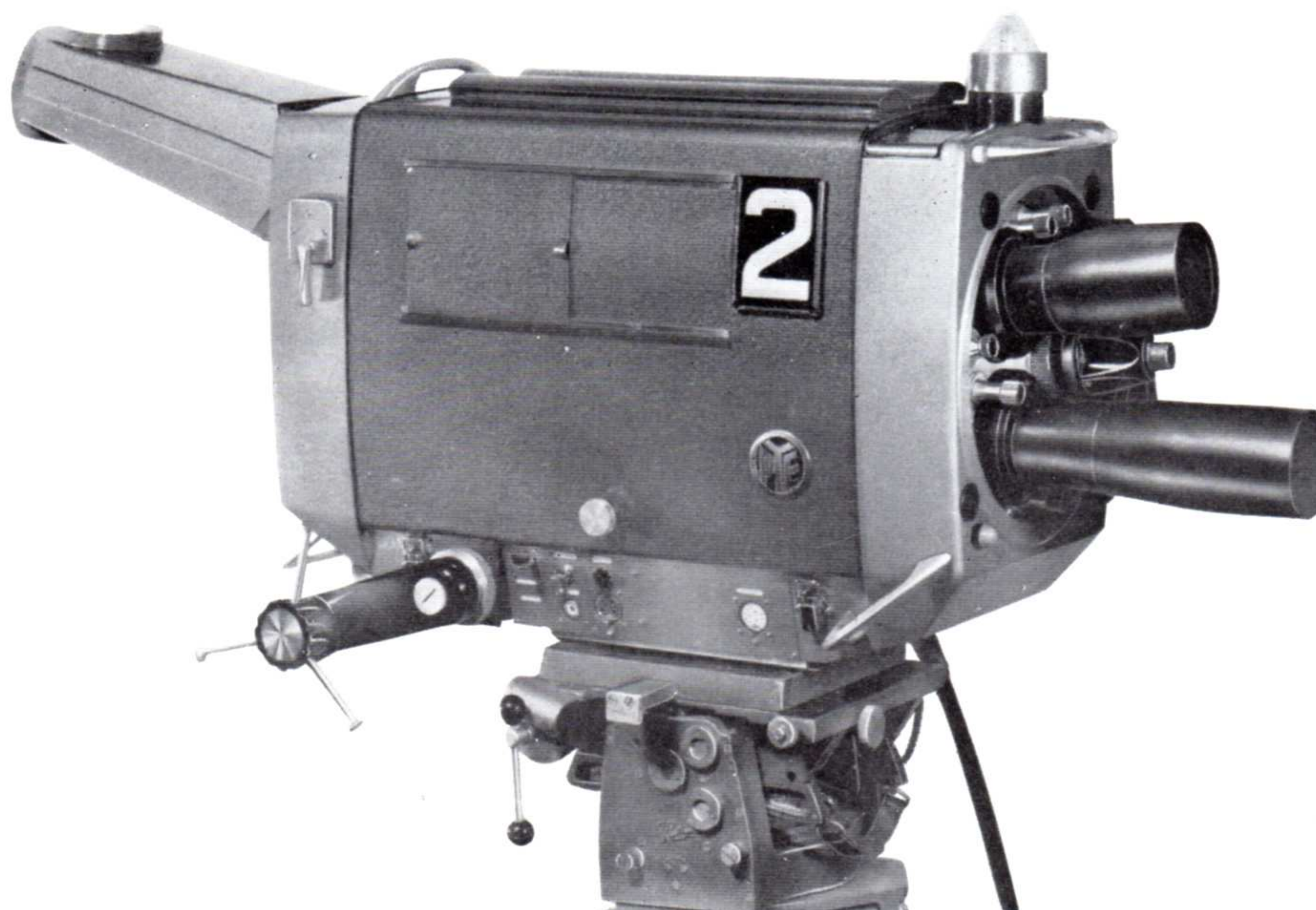




# 4 $\frac{1}{2}$ -inch Image Orthicon Camera Equipment



*The 4 $\frac{1}{2}$  inch Image Orthicon Camera showing capstan focus control*

## General Features

The primary aim in the design of this equipment has been to provide the means of obtaining consistently the finest quality pictures for television broadcasts and recordings within a wide range of production conditions and complexity in the field or in the studio. To meet this objective the following features are outstanding:—

★ *Pick-up Tube*

Employs the 4 $\frac{1}{2}$ " Image Orthicon noted for fine resolution, high signal-to-noise ratio and wide grey scale reproduction with sufficient sensitivity for outside broadcasts. A high performance yoke with temperature control has been developed to take full advantage of the capabilities of the tube.

★ *Optical Performance*

A four-lens turret of great strength supports the heaviest lenses, and is cone-shaped to take a cluster of widely different focal lengths of lenses without interference. An extensive range of high quality lenses is available, especially computed for television requirements.

★ *Control*

High-stability circuits have enabled operational controls to be reduced to a minimum, and segregated from setting-up controls, thus reducing the human error during programme time and releasing the cameraman's full attention for exacting and fast action "photography."

★ *Turret Change*

Quiet motor-driven from touch-switch which may be located on the panning handle. Minimum hand movement for rapid action.

★ *Focus Control*

By capstan knob with a range of adjustable positions to suit different cameramen, and different camera attitudes, and a drive-back eliminating device for high camera angles.

★ *Engineering and Setting-up Controls*

On separate desk-mounting panel (or case-mounting for portable use).

★ *Operational Controls*

May be operated from engineering control panel, or from a separate panel to facilitate operational control by non-technical personnel.

★ *Iris Control (Operational)*

By sensitive remote servo with fine operational control.

★ *Black Level Control (Operational)*

By ganged lift-and-gain control. Black level adjustable over a wide range without change in peak white level.

★ *Viewfinder*

Bright, artificially-sharpened picture with switching facility for registration of superimposed pictures.

★ *Co-ordination*

Full and adaptable talk-back, programme sound, and signalling facilities available to all operators, including studio-floor personnel.



- ★ *Monitoring*  
Versatile facilities for connecting picture and waveform monitors to a variety of positions, plus comparison switching of all channels to one monitor.
- ★ *Processing Circuits and Power Unit*  
Housed in drawer-type cases, which may be rack-mounted or adapted for portable use.
- ★ *Correction Circuits*  
Carefully designed aperture and gamma correction circuits compensate for inherent Image Orthicon grey scale characteristic and extend definition without noticeable fall-off to limit of the video bandwidth.
- ★ *Servicing*  
All electronic circuits instantly accessible while operating. All chassis and sub-units are plug-in with quick-release fixings and interchangeable with similar spare units. Control unit and power unit may be worked upon, or changed, without service personnel intruding upon operational control area.
- ★ *Tube Changing*  
Image Orthicon tubes fitted and removed from the rear by quick and simple method, without disturbing any optical arrangement.
- ★ *Protection*  
Full Image Orthicon protection circuits, including image orbiting, to reduce target burn. Image orbiting in all cameras may be synchronised.
- ★ *Systems Change*  
Switch selection of 405, 525 or 625 line systems for rapid repeats in tele-recording.
- ★ *Portable Use*  
Kits are available for adapting the units of the camera chain for portable use.

## EQUIPMENT ARRANGEMENT

A basic camera channel consists of:—

*A camera* containing the Image Orthicon and its yoke, the optical system, an electronic viewfinder, scanning generators for camera tube and viewfinder, a head amplifier and various auxiliary protection and signalling circuits, together with means to control the picture, focus and lens angle.

*A camera control unit* containing the main processing amplifier, drive and pulse-timing circuits, and talk-back amplifier, together with internal pre-set controls for the circuits.

*A camera power unit* containing B+ supply generators (using silicon rectifiers) feed-back stabilising amplifiers, the camera a.c. feed transformer, input supply voltage tap adjustment; metering, fuses and protection circuits.

*An Engineering Control Panel* containing passive control circuits from which the whole channel may be set up, and including also the operational controls of iris and black level.

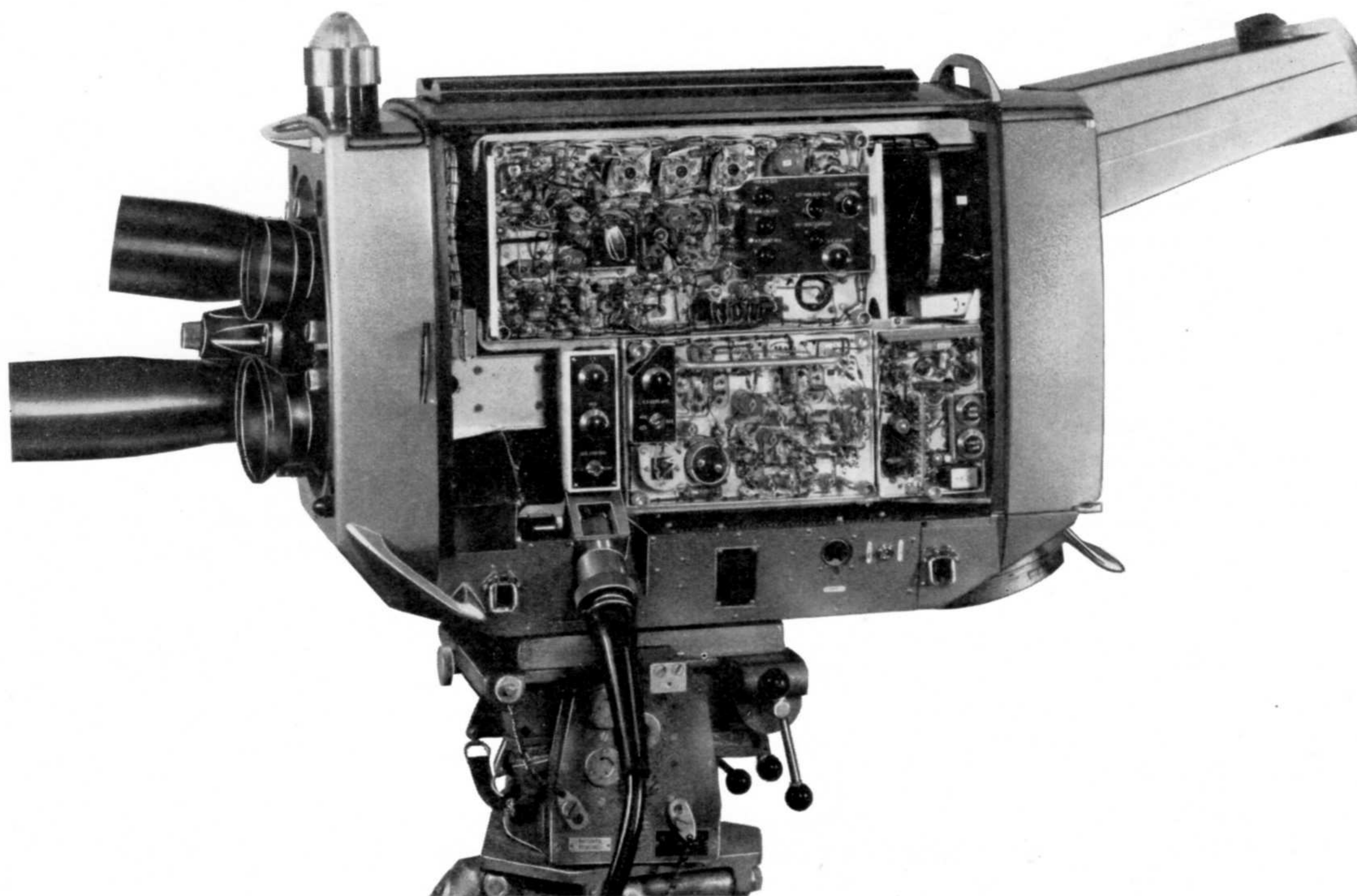
*A Picture Monitor.* (To separate order).

*A Waveform Monitor.* (To separate order).

*Interconnecting Cables* between the above units. (See equipment schedule).

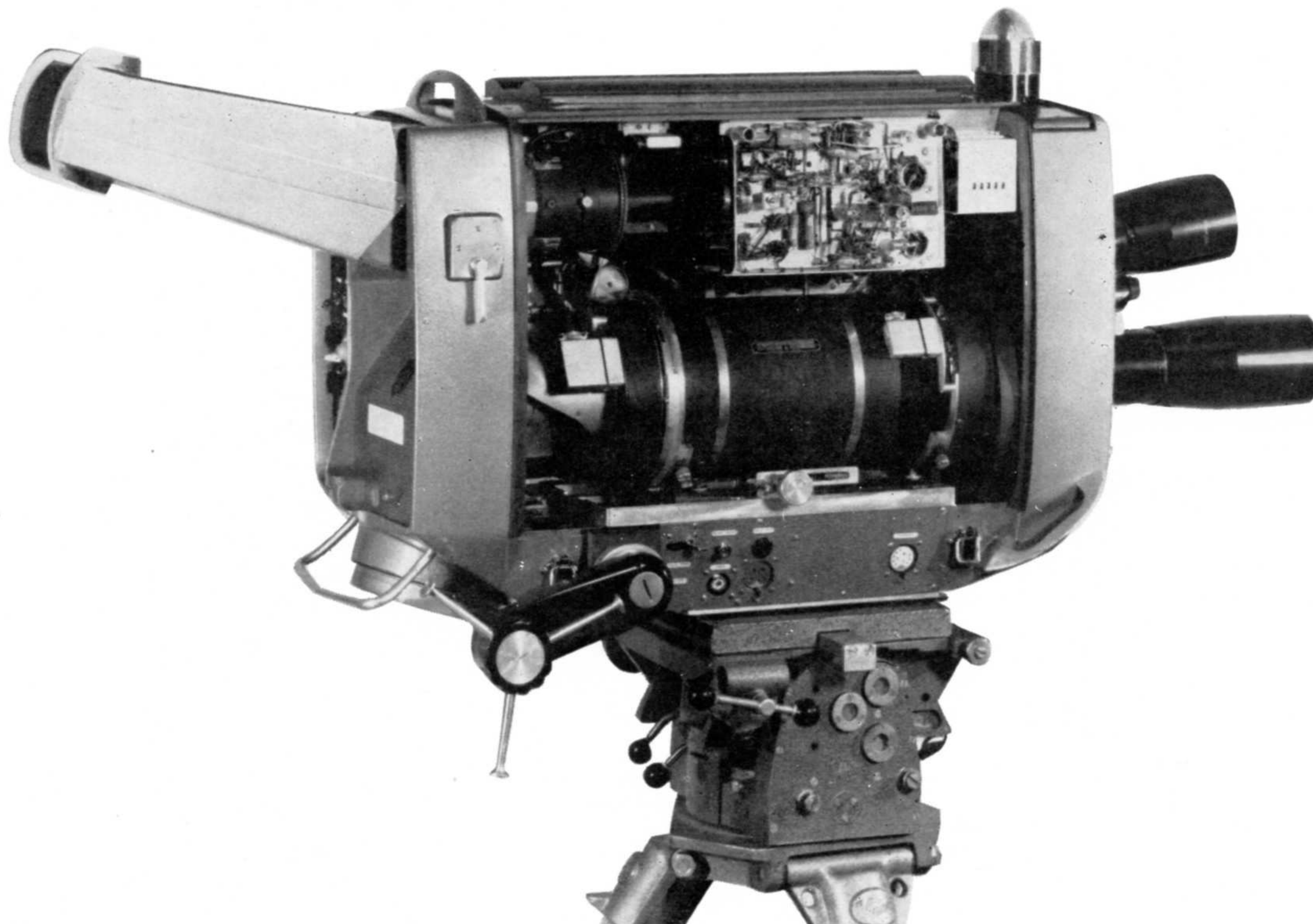
In addition to the above units an extension control panel may be used, if desired. This contains the operational controls of iris and black level, with master monitor switching facility. A talk-back jack panel would also normally be added at the control position.

A detailed equipment schedule with accessories is given on page 12.



*The camera with side panel removed showing camera cable entry, deflection circuits and head amplifier*





*Side view of camera showing Image Orthicon coil assembly and viewfinder*

#### OPERATING ADVANTAGES

The design concept of separating out the three functions of operational control, engineering setting-up, and maintenance allows the efficient employment of these separate skills. This, coupled with the extensive employment of feed-back stabilising circuits, allows the operational controls to be so reduced that one duty operator and one duty engineer are fully capable of controlling the technical quality in a multi-camera studio; thus staffing may be reduced to a minimum.

Systems switching facility allows a performance to be repeated immediately and recorded in an alternative line standard for export, while the artistes and studio set are available.

Throughout the channel only high-quality components and valves are used, none of which are operated close to their maximum rating. This makes for a high degree of reliability, but if a breakdown does occur, the chassis and sub-assembly interchange system cuts "off-air" time to a minimum. The robust construction of the camera makes it ideal for outside broadcast use, and it can operate up to 1,000 ft. (300 m) away from its control equipment. The facility for switching a test signal through the complete channel enables a number of channels to be checked for performance specification and gain settings in a very short time. By means of a switch at the operational control position, the video output of each channel may be displayed on one picture monitor and one waveform monitor. This enables all channels to be set up to a single standard without being affected by the variations between monitors.

The maximum flexibility has been designed into the equipment to allow the channel to be adapted to the broadcaster's preferred system. It is particularly adaptable to a variety of monitoring methods, talk-back systems, on air and channel availability signalling. The control panels can be fitted in a variety of ways to the user's own control consoles, and may be used at distances of up to 100 ft. (30 m) from the rack-mounted units.

#### TEST FACILITIES AND FUNCTION SWITCH

By means of an internal switch at the camera the output video socket on the camera base may be turned into a test input socket with connection to the head amplifier input. From this point the full band-width performance of the channel may be checked, using a suitable test signal generator.

A test signal waveform at standard level can be fed into the rear of the camera control unit, with loop-out facility. By means of an internal switch in the C.C.U. this may be injected into the C.C.U. input in place of the camera signal via an attenuator and filter network to simulate the characteristic of a normal C.C.U. input. In addition to the normal output sockets, two msa test monitoring points are provided in the C.C.U. By means of a function switch on the engineering control panel the test signal may be routed down the camera cable via the viewfinder video line and there injected automatically into the head amplifier input. This then checks the gain and general performance of the complete amplifier channel.

The function switch has four other positions:—

##### 2. Channel Non-Available

In this position normal operation is maintained up to the monitor video output. The transmission video is cut and a non-available indicator warns the mixer operator. In this position engineering adjustments can be made without the possibility of the channel accidentally going on air.

##### 3. Normal

Full normal transmission available.

##### 4. Cap

In this position the image section is immobilised by taking the photo-cathode 16 volts positive to target. Background shading may be neutralised when in the cap position.

##### 5. Beam Cut

In this position the image is cut and the beam switched off. This condition is also applied when the function switch is at Position (I) (Test).



The transmission channel is maintained in all switch positions except (2) but by means of an internal wiring link, the "non-available" condition may be made operative on any position other than (3).

#### PHYSICAL SPECIFICATION AND MECHANICAL ARRANGEMENT OF CAMERA

##### Construction

Elektron castings and light alloy machined parts.

##### Weight

130 lbs. (60 kg) approximately (without lens).

##### Dimensions

Height	Case 19 inches (48 cm)—overall 22 inches (56 cm)
Width	Case 12 $\frac{3}{4}$ „ (32 cm)—overall 14 „ (35 cm)
Length	Case 27 $\frac{1}{2}$ „ (70 cm)—overall 33 $\frac{1}{4}$ „ (85 cm)

*Finish:* Hammer grey with black anodising and chrome. Chassis white; Orthicon yoke and optical channel matt black.

##### Turret

Heavy duty alloy machined casting running in peripheral sleeve bearing and distortion-free under the heaviest lens loads. Driven by a.c. induction motor through two-speed gear box and perimeter spur gear.

##### C.C.U. Cable Entry

Slightly forward of centre of tilt at lower left-hand side (viewed from rear) and at 45° to horizontal.

##### Sub-Assembly Build-up

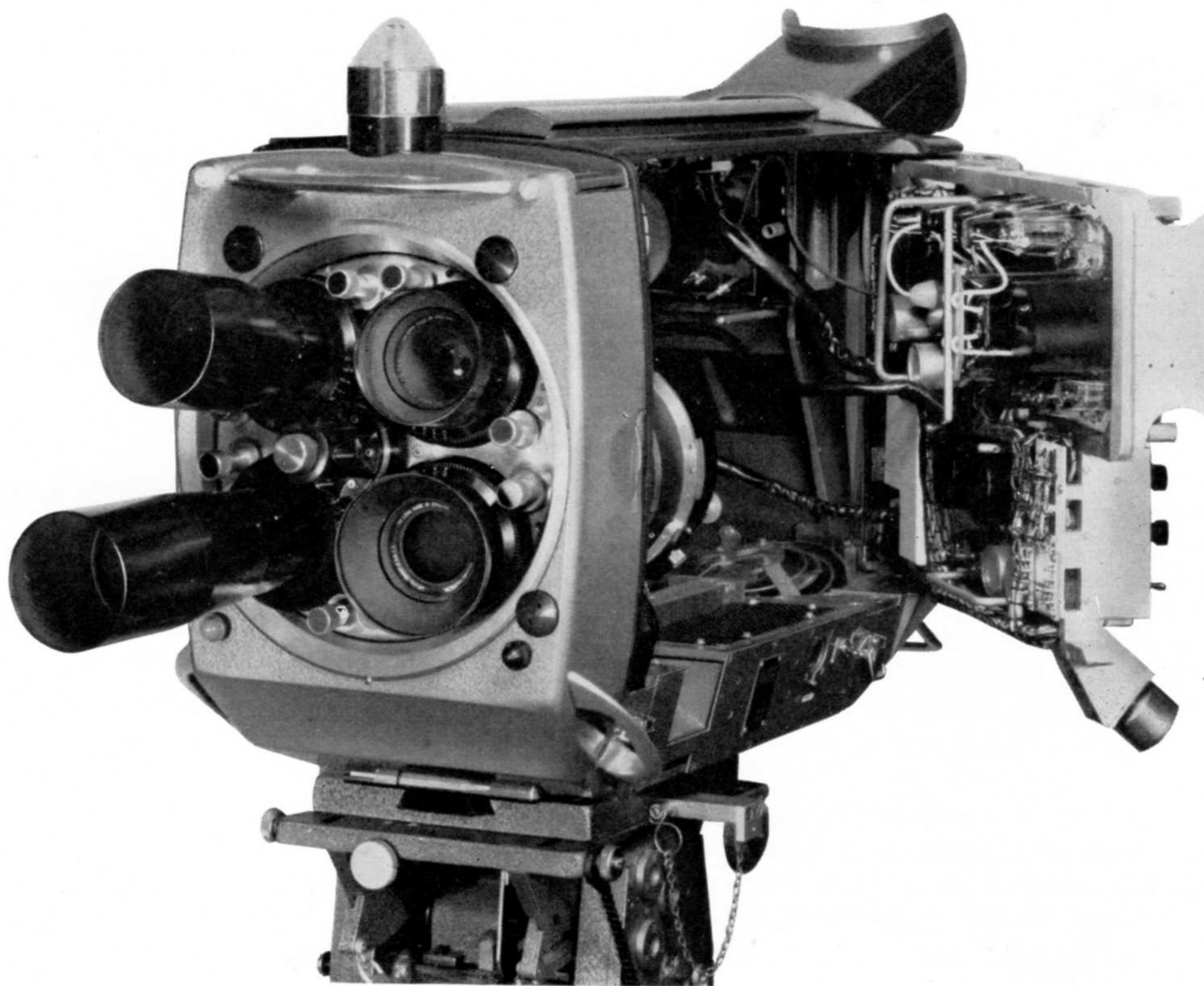
- (a) Camera frame incorporating turret and its driving mechanism and carriage for the Image Orthicon yoke with optical focussing mechanism. The camera frame also provides support and connections for the following plug-in units:—
- (b) Viewfinder C.R.T. assembly with its deflection yoke.
- (c) Viewfinder amplifier.
- (d) Image Orthicon yoke.
- (e) Chassis Frame.  
The chassis frame in turn also provides support and connections for the following plug-in units:—
- (f) Horizontal Sweep Chassis
- (g) Vertical Sweep Chassis.
- (h) Head amplifier.

All the above units may be removed and replaced without tools, and the chassis frame hinges out for servicing in situ. In addition, a plug-in talk-back unit and thermostat unit may be removed from the chassis frame, using only a screwdriver.

##### External Accessory Attachments

Means are provided for fitting either a tilting hood with cushioned eye-piece, or an open light shield to the viewfinder. Hinge supports at the rear left-hand side of the camera take a script card holder with paper clip. Each side cover has a holder for identification numerals four inches by three inches. Tapped holes in the front casting are provided to support extra-heavy lenses and optical systems, or as fixings for visual prompters, etc. Along the base are sockets for:—

- (a) Extension (Panning handle) turret control switch.
- (b) Extension indicator unit.



*Front view of camera with chassis hinged outwards*



- (c) Utility Power Outlet at either 240V or 120V AC according to station voltage standard and 100 watts rating locally fused.
- (d) Composite video outlet or test signal input.

**Mounting:**

Fitted wedge plate with four fixed positions, and directly fitting:—

Vinten heavy duty pan and tilt head.

Debrie head.

Houston Fearless head by using adaptor wedge.

**Cooling:**

By forced air blown in from underside of camera at rear. Air is passed through a dust extraction filter removable for cleaning or replacement.

**Image Orthicon Tube Changing:**

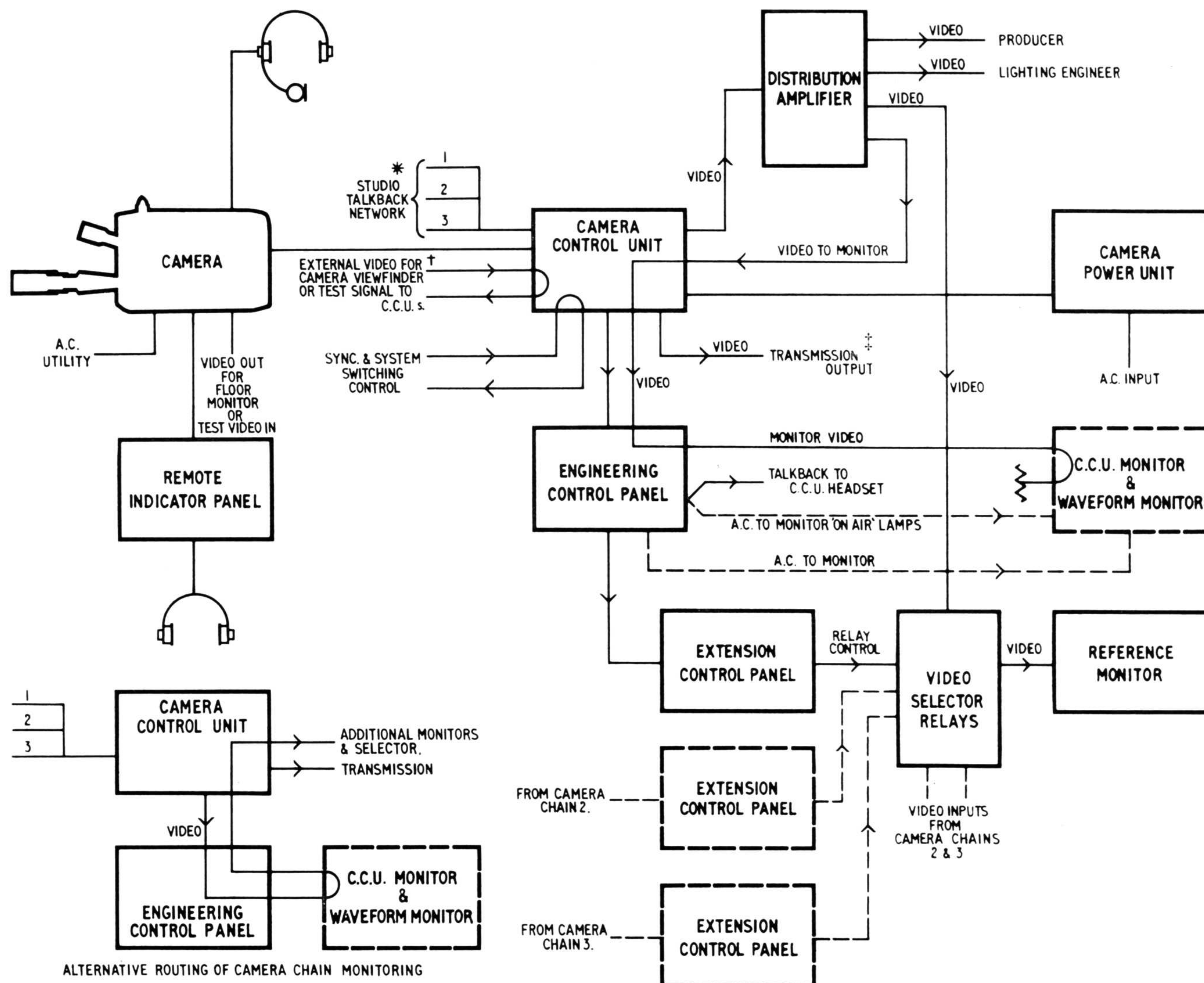
By withdrawing tube with deflection yoke through a door in the rear casting. This assembly is held in place by two spring loaded snap fasteners and connected by two sockets on flying leads—one to the Image Orthicon base and one to the deflection yoke.

**Lens Fixing:**

Automatically located, held by two captive knurled screws and provided with quick alignment markings for registration with Iris drive gear.

**Iris Drive:**

By servo induction motor mounted in centre of turret and in constant mesh with all lenses. Minimum torque capability 75 ounce inches.



The camera chain consists of the Camera, Camera Control Unit, Power Unit and Engineering Control Panel shown in a system arrangement with associated units and camera chain accessories

**NOTES:**

\*1. Producer or programme sound.

2. Omnibus (Engineering) Talkback.

3. Camera-to-Producer Talkback.

‡Transmission output to Video Mixing Unit. Also included in this cable are lines for Availability Indication, On Air Switch, and Orbiting Sync Control.

†This input may be used for the testing of each camera channel, the results being checked on the Reference Monitor and Precision Waveform Monitor.









*The studio control room at the A.T.V. Studios, Elstree. The four Extension Control panels are in the centre of the desk with the Engineering Control panels on the right*

Coaxial socket with monitor video out with second socket for looping back to extension control position.  
Coaxial socket for external video input with second socket for looping out.

#### **PHYSICAL SPECIFICATION AND MECHANICAL ARRANGEMENT OF CAMERA POWER UNIT**

Specification and description as for Camera Control Unit except for the following:—

##### **Weight**

98 lbs. (45 kg).

##### **Build-up**

The detachable chassis portion is made up of a regulator chassis, transformer chassis and a hinged rectifier chassis which may be opened out for full access while operational.

##### **Controls**

Internally mounted knob adjustments of DC supply levels and B+ switch for servicing purposes.

##### **Front Panel**

Mounts multi-range meter with 23 position switch, all circuit fuses with supply indicator lamps and channel AC master switch.

##### **Rear Panel Connectors**

Power input—4 contact Films and Equipments plug.  
Supplies out to C.C.U.—Pye 28 way socket.

##### **Adjusting taps for supply voltage**

By soldered links in rack mounted version. By tapping switch in add-on blower attachment for portable use.

#### **PHYSICAL SPECIFICATION AND MECHANICAL ARRANGEMENT OF ENGINEERING CONTROL PANEL**

##### **Construction**

Plastek panel with white lettering on matt black surface internally illuminated. All-passive circuit mounted on hinged panel below the control panel. Designed to fit into a well in a control desk. Mounting brackets to separate order.

Weight 18 lbs. (8 kg).

Dimensions Height 8½" (21 cms).

Width 14" (36 cms).

Depth 6½" (16 cms).



### Controls

#### Back Row

Centering and amplitude controls for forward and reverse horizontal and vertical scans with scan reversal switches.

#### Centre Rows

Coarse and fine controls for Beam Current, Beam Focus and Image focus. Controls for G5, Multi-Focus, Field Mesh, Alignment, Gain, Lift, White Clipper, Sync Amplitude and Target Bias.

#### Below panel Release knob

Vertical and horizontal shading.

#### Bottom (operational) rows

On-air and camera call indicators, headset gain controls, talk-back and camera call keys, power on/off switch, overscan switch, gamma control, video polarity switch and function switch. On large operating knobs at bottom centre are the Iris and Black level controls.

### Connections

By panel mounted cannon DPD type plugs and sockets to a desk mounted frame. Insertion and withdrawal by captive screw and release knob on control panel. Complete unit quickly interchangeable with another. Connectors link engineering control panel to:

- (a) Camera control Unit.
- (b) Extension Control Panel.
- (c) Talk-Back Panel.
- (d) Picture and waveform monitor video with loop back facility.
- (e) Picture and waveform monitor (power supply).

### PHYSICAL SPECIFICATION AND MECHANICAL ARRANGEMENT OF EXTENSION CONTROL PANEL

#### Construction

Matt black die cast panel with quadrant joy-stick control. Plug panel mounted beneath an open framework. Designed to fit into a well in a control desk.

Weight 10 lbs. (4.5 kg).

Dimensions Height 5½" (14 cms).

Width 8" (20 cms).

Depth 9" (23 cms).

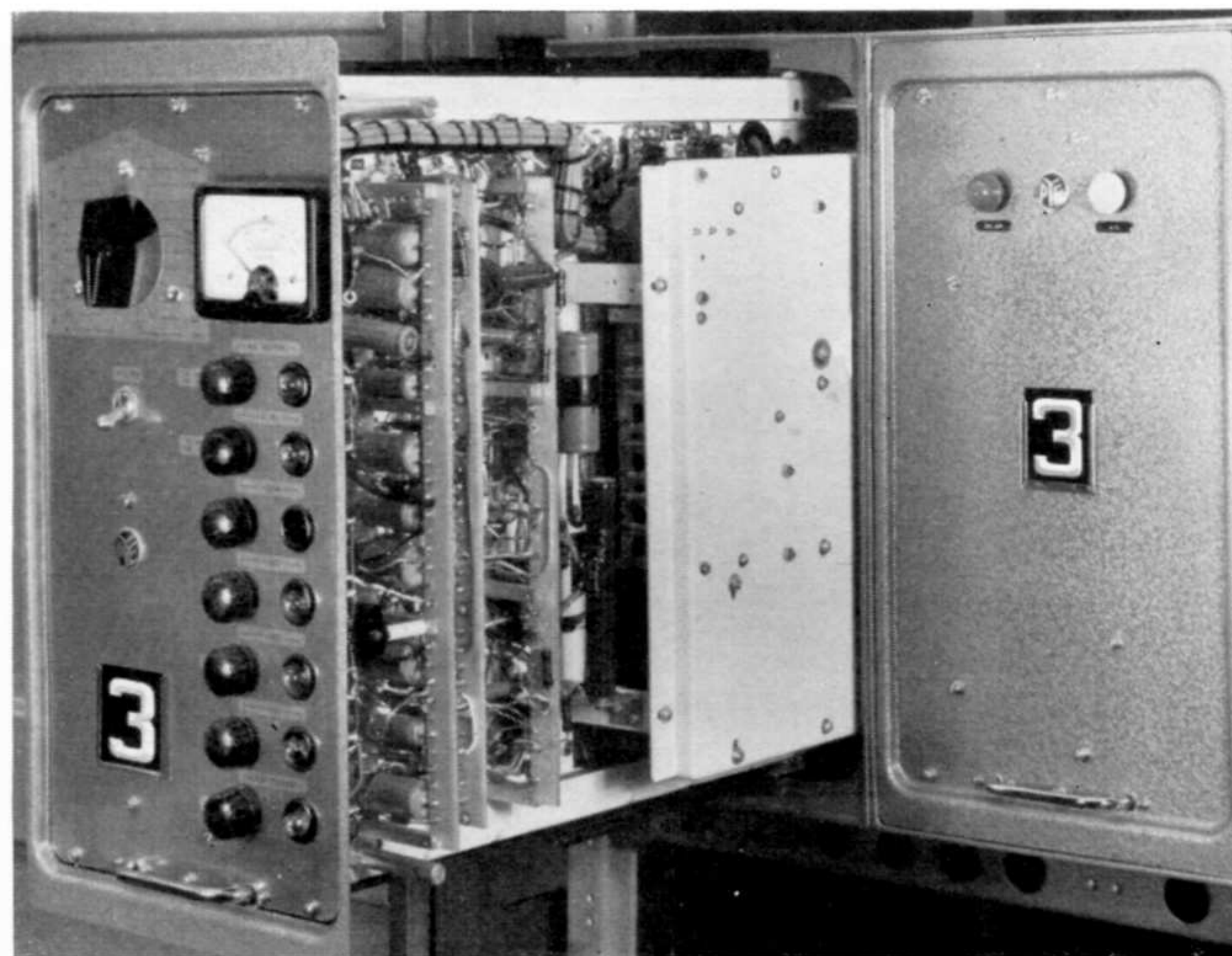
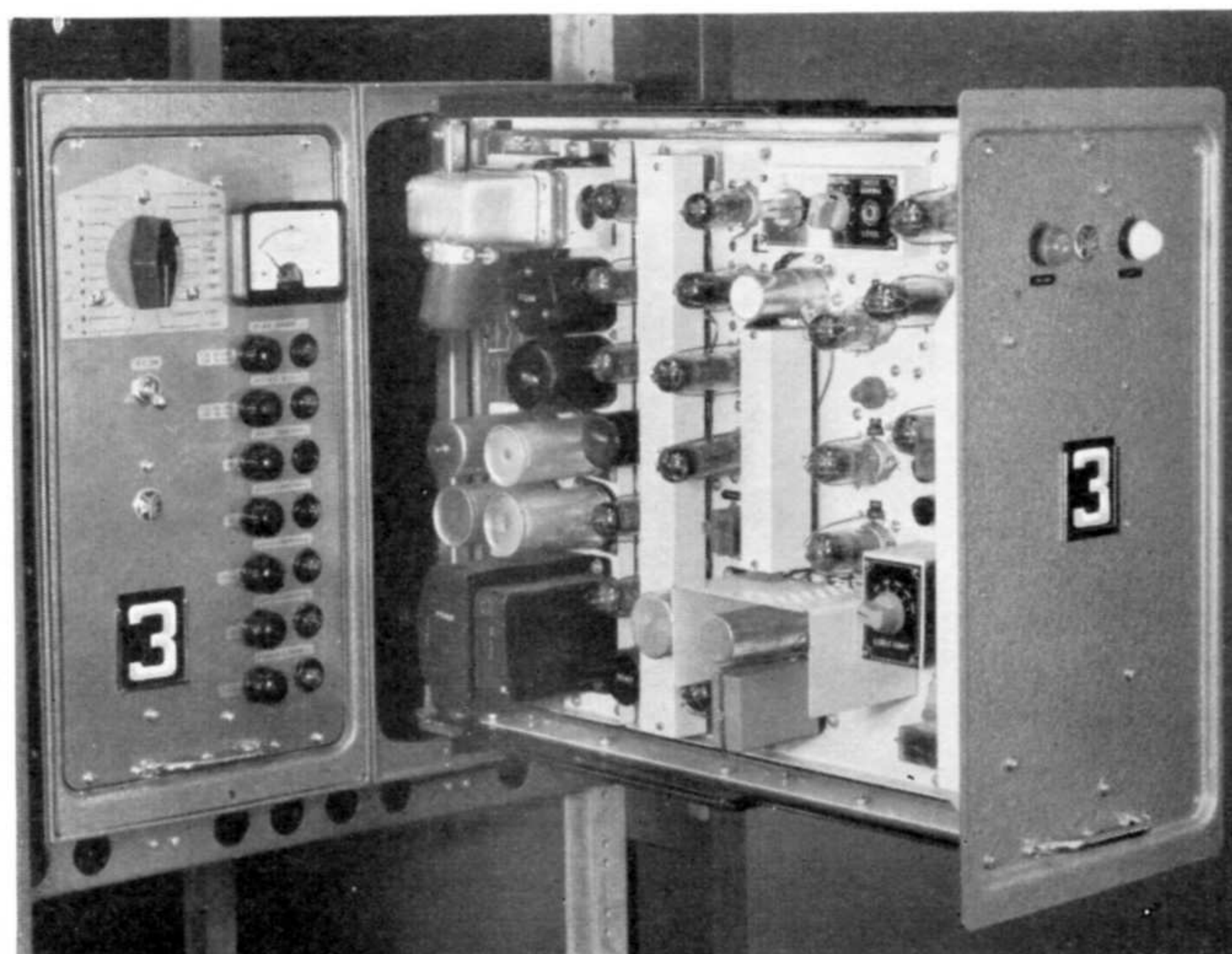
#### Controls

Joystick quadrant control of camera iris. Joystick rotation control of black-level. Switch for full iris control or fine range of two stops. Switch for returning control to Engineering panel. Press joystick to switch channel to common monitor.



*The open cubicles in the background show the Camera Control Units and Camera Power Units in a standard rack. The Control Desk is in the foreground. The installation at the A.T.V. Studios, Elstree*





*The rack-mounted Camera Control and Power Supply units are shown with the Camera Control Unit withdrawn (left), and the Power Supply Unit withdrawn (right)*

#### *Connections*

By panel mounted cannon DPD type plug and socket to a desk mounted frame. Complete unit quickly interchangeable with another. Connector links unit to Engineering Control Panel.

### **General Specification**

#### *Systems*

405 lines 50 frames, 525 lines 60 frames, 625 lines 50 frames per second, switchable.

#### *Output Signal*

Two outputs composite video, or two outputs non-composite video, or one output composite video with one output non-composite, selected by internal link. Synchronising pulses negative.

#### *Output Signal Amplitude*

1 volt p-p composite, or 0.7 volt p-p non-composite into 75 ohms.

#### *Isolation Between Video Outputs*

Greater than 40 dB up to 5 Mc/s.

#### *Camera Cable*

B.I.C.C. Mk IV with quick release couplers, maximum length 1,000 ft. (300 m).

### **SUPPLY REQUIREMENTS**

#### *Power*

950 watts approximately, at 85-135 volts, or 170-250 volts a.c., 47-65 c/s.

#### *System Waveform*

Standard vertical drive, horizontal drive, complete sync and complete blanking. Pulses negative going and between 1.5 and 5 volts amplitude into 75 ohms, with bridging-out connector.

#### *Test Video and Viewfinder Effects Signal*

1 volt p-p composite into 75 ohms, with bridging out connector.

#### *Systems Switching*

24 volts d.c., isolated from ground at 40 mA per camera channel, routed via the system wave-form cabling.

### **OPTICAL SPECIFICATION AND CONTROL**

#### *Lenses*

Standard range to B.B.C. specification TV 88 and TV 88/2, 1.1 inch (28 mm) to 22 inches. Extended focal lengths, folded lenses and zoom lenses to special order.

#### *Turret*

Four-lens, motor-driven, supported by strong peripheral bearing. Pitch circle radius of lens centres,  $3\frac{3}{16}$  inches (8.1 cm). Cone angle between facets of opposite lenses,  $12^\circ$ . Turret registration repeatable to within  $1^\circ$  of arc. Turret operation time, 0.9 second between lenses normal speed, 1.8 seconds for heavy lenses. Turret control by lever switch on right-hand side of camera, or by thumb switch on panning handle.

#### *Filters*

Five filter positions are provided on a filter turret between the lens and the image plane. One or two filters can be accommodated together at each position. Filter diameter  $2\frac{1}{4}$  inches (5.7 cm), total thickness (double filter)  $\frac{1}{8}$  inch (3 mm). Normal complement fitted: yellow, 10% transmission neutral, 1% transmission neutral, opaque disc for capping purposes. Filter turret operation by edge knob at front of camera.

#### *Iris Control*

Servo motor drive in constant mesh with all four lenses. Total aperture range (for shorter focal length lenses), f2 to f22. Time required to drive over full range, less than 5 seconds. Control sensitivity better than 10 increments per stop. Range of fine operational control (on Extension Control Panel), one stop on either side of coarse control setting. Control law, linear.

#### *Optical Focus*

Fixed lens and sliding tube carriage via mechanical linkage to capstan control at rear lower right hand side of camera. Capstan diameter 2 inches (5 cm), with three detachable 3 inch (7.6 cm) spokes, and adjustable in position. Direction of control: capstan clockwise for close-up (British home market), capstan anti-clockwise for close-up (export market). Mechanism incorporates worm transmission to prevent drive back from carriage, adjustable friction brake, and carriage lock. Carriage movement against capstan rotation follows a part-cosine law giving expanded control over the range used by short focal length lenses. Total carriage movement is  $2\frac{3}{8}$  inches (6.6 cm) from infinity focus to extreme close-up position, with  $720^\circ$  rotation of capstan. For close-up distances, lens angles and object sizes see separate lens table.

#### *Image Size*

1.6 inch (40.6 mm) diagonal at photo cathode.



#### *Diascope*

Supplied as optional extra. Power supply via slip-ring and contact on turret at 12 volts, controlled by switch on rear of camera.

### **PICTURE GEOMETRY, SCANNING SPECIFICATION AND VIEWFINDER DISPLAY**

#### *Camera Picture Geometry and Scanning Linearity*

Within  $\pm 1\%$  within a central circular portion of the raster having a diameter equal to picture height. Within  $\pm 2\%$  in remaining areas.

Differential velocity error not greater than 2%.

#### *Aspect Ratio: 4:3.*

#### *Overscan Amplitude*

Horizontal and vertical, independently adjustable, 0 to 8% on normal scan.

#### *Scan Amplitude Range (Camera and Viewfinder)*

Horizontal and vertical: minimum range  $\pm 10\%$  of normal amplitude.

#### *Scan Centring Range*

Horizontal and vertical:  $\pm 10\%$  of width and height from mid-range position, separately adjustable for normal and reverse scans.

#### *Camera and Viewfinder Scan Stability*

Within  $\pm 1\%$  of picture width and height for 5% a.c. power supply voltage change after a 30 minute warming-up period.

#### *Scan Direction*

Horizontal and vertical independently reversible from control panel position.

#### *Viewfinder Geometry and Scanning Linearity*

Within  $\pm 1\%$  within a central circular portion of the raster having a diameter equal to picture height. Within  $\pm 2\%$  in remaining areas. Differential Velocity error not greater than 2%.

This condition may be adjusted for any preferred system. When switching to an alternative line standard the horizontal scan linearity may be degraded to 4% differential error.

#### *Viewfinder Scan Centring Range*

Horizontal and vertical:  $\pm 10\%$  of width and height from mid-range position.

#### *Viewfinder Display Size*

4 $\frac{7}{8}$  by 3 $\frac{5}{8}$  inches (12 by 9 cm).

#### *Viewfinder Brightness*

200 foot Lamberts, maximum.

#### *Viewfinder E.H.T. Stability*

Less than 2% change in raster size for a brightness change of 0 to 100 ft. Lamberts.

### **VIDEO AMPLIFIER CHANNEL SPECIFICATION**

#### *Channel gain*

Sufficient to give standard output level for an Image Orthicon signal current of 4 micro-amps with 6 db. of gain in hand.

#### *Channel Linearity*

Amplitude non-linearity less than 2%. Differential Gain distortion less than 10% for any duty cycle.

#### *Channel Frequency Response*

Flat to  $\pm 0.5$  db to 7 mc/s (525 and 625 line systems) or 5 Mc/s (405 line systems) for camera cable lengths up to 400 feet. Relaxed to 1.5 db at 1,000 feet of camera cable. Head amplifier and C.C.U. amplifiers alone flat to 0.25 db within the specified bandwidth.

#### *Square Wave Tilt*

Less than 2% at 50 c/s.

#### *Stability*

Black level within  $\pm 1\%$ , white level clipper within  $\pm 2\%$  overall video gain  $\pm 1$  db for extended periods after 30 minute warm up and including mains change of up to 5%.

#### *Signal to Noise Ratio*

Channel does not worsen by more than 1 db the signal to noise ratio of the Image Orthicon.

#### *Aperture Correction*

Continually adjustable cosine law corrector with 8 db maximum boost at 5 Mc/s on 405 line systems and at 7 $\frac{1}{2}$  Mc/s on 525 and 625 line systems. Cross-over frequencies matched against roll-off characteristics of average Image Orthicon tube in camera yoke.

#### *Gamma Correction*

Black stretch continuously variable with black region gain from two to four times the gain in linear condition. Provision to switch the law to linear.

#### *White Clipper*

Adjustable between 75% and 125% peak white.

#### *Black Level Control*

By ganged gain and lift giving a range which moves picture black from 40% peak white down to 40% below system black level while maintaining picture white constant to within 5% of peak white level.

#### *Output polarity*

Positive or negative video switchable from control panel. Separate pre-set adjustment of negative video lift.

#### *Shading correction*

Horizontal and Vertical shading sawtooth signal adjustable in amplitude through zero to full video amplitude from the engineering control panel. Shading injection is before the operational gain control and is switched so that its polarity remains correct for reversal of scans and for negative picture. Shading adjustment does not affect Lift level.

#### *Pedestal*

By internal link pedestal may be added to either the main video output or to the viewfinder video feed, adjustable between 0 and 15% peak white.

#### *Hum and Spurious Signals*

50 db down on peak to peak video.

### **TALKBACK AND COMMUNICATIONS FACILITIES**

#### *Head Sets*

Separate channel ear-pieces with attached carbon microphone to Pye specification 715551 for the British home market and 715552 for export.

#### *Controls*

Separate volume controls for each ear-piece and combined microphone switch with facility selection keys on the camera rear panel and on the Engineering Control Panel.

#### *Head-set outlets*

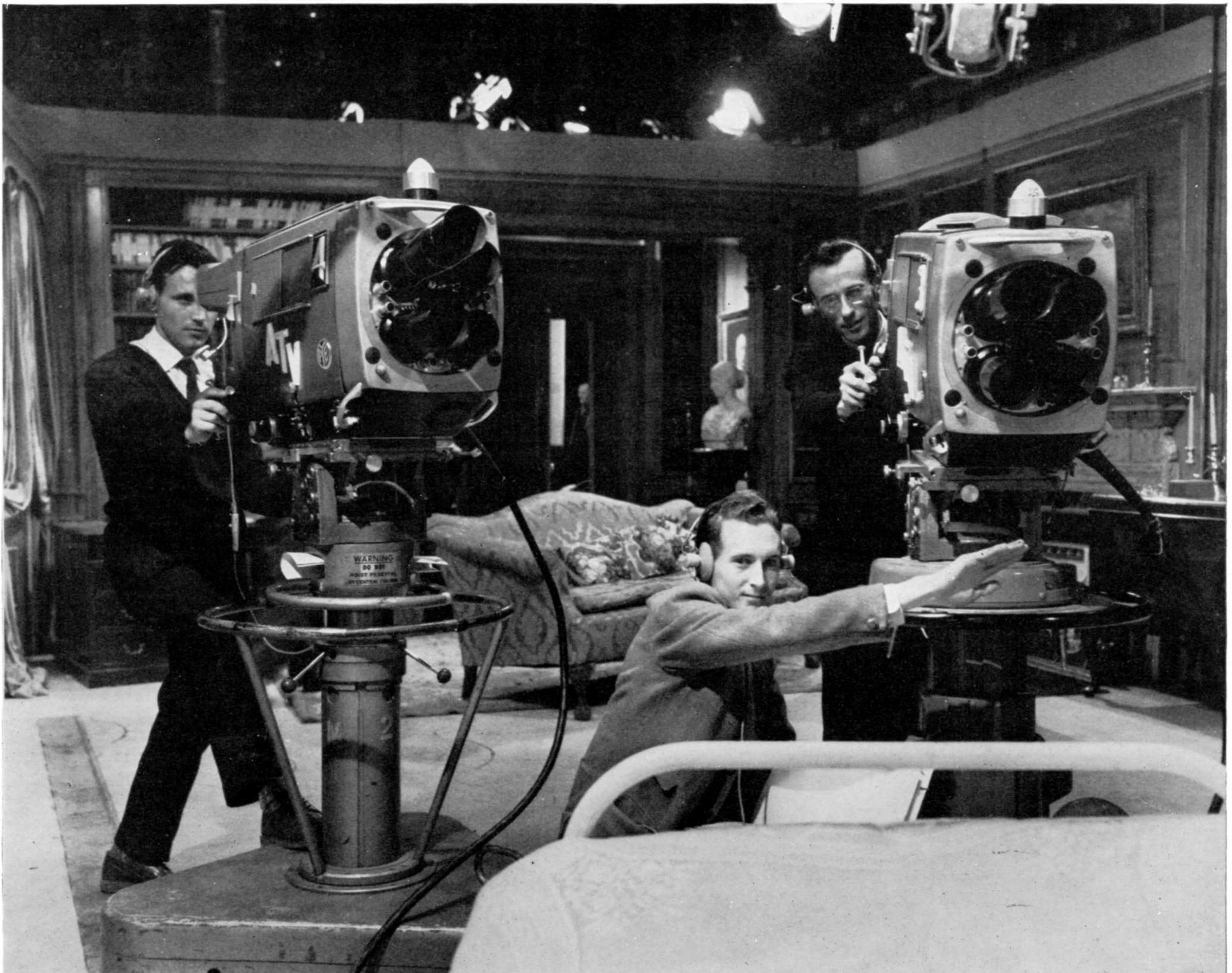
Two sets of jack sockets at rear of camera. Pye 8 way Socket from connector box on rear of Engineering Control Panel taking all talk-back and programme/producer sound to an external desk mounted jack panel. Extension socket on base of camera taking talk-back and programme/producer sound (less microphone) to extension indicator unit.

#### *Camera Switching Facilities*

One earpiece carrying programme sound or producer's instructions according to studio system. One earpiece with microphone providing by key switch selection:—

- (a) Engineering Talk-back to C.C.U. operator only or omnibus, or camera tracker.
- (b) Cameraman to Producer talk-back (non-locking).
- (c) Full listening with microphone off.





*Photograph by courtesy of A.T.V. Ltd.*

*The 4½ inch Image Orthicon cameras in action during a transmission at the A.T.V. Studios, Elstree, England*

#### *Call C.C.U.*

Push button on camera rear panel to call C.C.U. operator's attention by latching warning light on the Engineering Control Panel.

#### *Engineering Control Panel Switching Facilities*

One earpiece carrying programme sound or producer's instructions according to studio system. One earpiece with microphone providing by key switch selection:—

- (a) Engineering talk-back to camera operator.
  - (b) Omnibus talk-back on common engineering line to all operators.
  - (c) Full listening with microphone off.
- Moving key to position (a) cancels the camera calling warning light.

#### *Call Camera*

A second key operates an on air lamp flasher circuit to call camera operator's attention.

### *VIEWFINDER VIDEO AMPLIFIER AND FACILITIES*

#### *Video feed*

Fully processed composite signal fed from Camera Control Unit with pre-correction in C.C.U. for camera cable loss switched in steps of 200 feet. Added pedestal adjustable by pre-set control in C.C.U. between 0 and 15% peak white.

This enables the picture edges to be determined on captions which have been set down below picture black.

#### *Picture Source*

Switchable by key on rear of camera to originate from:

- (a) Its own camera.
- (b) An external source.
- (c) A mixture of (a) and (b).

Provided the external source is composite and at standard level there is no change in amplitude when switching between sources (a) (b) or (c).

#### *Amplifier Gain*

Sufficient to modulate C.R.T. to give high-lights of 100 ft. Lamberts with 6 db of gain in hand and controllable down to zero by contrast control on camera rear panel.

#### *Amplifier Linearity*

Amplitude non-linearity less than 2%. Differential gain distortion for any duty cycle less than 20%.

#### *Amplifier Bandwidth*

Flat  $\pm 1$  db to 7 Mc/s for camera cable length up to 400 ft. Relaxed to 3 db at 1,000 feet of cable (Figures include main amplifier channel and two way transmission in the camera cable).

#### *Low Frequency Response*

Less than 5% tilt of 50 c/s square wave.



#### *Detail Emphasis*

On 405 line systems, three position switch in the camera gives boost at 3 Mc/s of 0, 5 and 10 db respectively. On 525 and 625 line system the boost is at 4.5 Mc/s and is 0, 4 and 8 db.

#### *Black Reference*

By switch selection picture may be D.C. restored or may be A.C. coupled.

### **IMAGE ORTHICON OPERATING CONDITIONS**

#### *Total Operating Life*

Indicated by hour meter fitted to camera and switched on with gun heater.

#### *Warm-up time*

Rehearsal quality pictures after 15 minutes. Temperature and performance stability reached 30 minutes after switching on.

#### *Temperature control*

Thermostatically controlled radiant heater surrounding target region coupled with continuous air flow along full length of glass envelope entering at the gun end. Target region temperature maintained between 40°C and 45°C with no other part of the glass envelope more than 5° hotter than the target region. Pre-set adjustment to change operating temperature if desired. Target Temperature Calibrator available as optional extra.

#### *Image Capping*

Physical capping by shutter built into fixed filter turret. Electronic capping by switch at C.C.U. which holds photocathode 16 volts positive to target.

#### *Image Magnification*

1:1.5.

#### *Target Voltage*

Accurate setting by calibrated scale on Engineering Control Panel to any potential between 1 and 5 volts above cut-off. Target cut-off point adjusted independently from calibrated setting control.

#### *Focus Field*

Focus current maintained constant by high gain d.c. feedback amplifier against extended operation and up to 5% mains voltage fluctuations. High efficiency magnetic screening of yoke reduces focus variation due to panning in the earth's magnetic field to less than 1 dB change on a 400 line resolution pattern.

#### *Image Orbiting*

Approximately circular path of diameter 5% of picture height at 1 r.p.m. Provision for synchronising orbiting on all cameras. Provision for immobilising orbiting by switch on rear of camera coupled with indicator warning light. This does not destroy synchronisation.

#### *Scan Failure Protection*

By search coils integral with the tube yoke to detect presence of deflecting fields. Reduction of either vertical or horizontal scanning below 50% causes Image Orthicon beam to be cut and brings on a warning indicator lamp on the rear of the camera. Individual adjustment of cut-off sensitivity is provided.

#### *Orientation of Verticals*

Adjustment is provided to set verticals by rotating the tube with deflection yoke up to  $\pm 30^\circ$  from normally correct orientation. This setting may be locked.

#### *Alignment*

Adjustment of beam alignment is provided by two knobs on the Engineering Control Panel. By pressing either knob, a four c/s wobulation is applied to beam focus as an aid to alignment.

#### *Image and Beam Focus*

Coarse and fine focus controls on the Engineering Control Panel with pre-set G6 (accelerator) adjustment in the camera to correct image plane focus curvature, and Dynamic focus pre-set to correct for scanning field curvature.

#### *Beam Current*

Coarse and fine controls at the Engineering Control Panel with switch to cut beam while leaving all other controls set.

#### *Multiplier*

Supplied with stabilised 1,400 volts, generated at the camera. Multiplier gain adjustable by pre-set Dynode 3 voltage control in the camera.

## **Camera Chain Equipment Schedule**

### **4½-INCH IMAGE ORTHICON CAMERA**

Part No. 842131 includes:

	Part No.
Viewfinder Visor ... ..	747531
Turret Extension Switch Assembly ... ..	748254
Focus Control Handle Assembly, either	
Home Market ... ..	746502
or Overseas ... ..	749289
Cue Card Holder ... ..	749593
Headset, either	
Home Market ... ..	715551
or Overseas ... ..	715552
Films and Equipments plug EP-CG-4-12	
(mating to power take-off socket) ... ..	705047
Coaxial plug PL259A (mating to video outlet)	706682
Films and Equipments plug EP-CG-11-12	
(mating to Extension Indicator) ... ..	720729
Turret Stud tool assembly ... ..	747068
Focus Control Spanner ... ..	327770
Set of Allen keys ... ..	711363
Dust Cover ... ..	715833
Lens Aperture Cover Plate (four supplied with	
camera) ... ..	328104
Yellow filter ... ..	714551/B
10% Transmission Filter ... ..	714551
1% Transmission Filter ... ..	714551/A

### **CAMERA CONTROL UNIT**

Part No. 842382 includes:

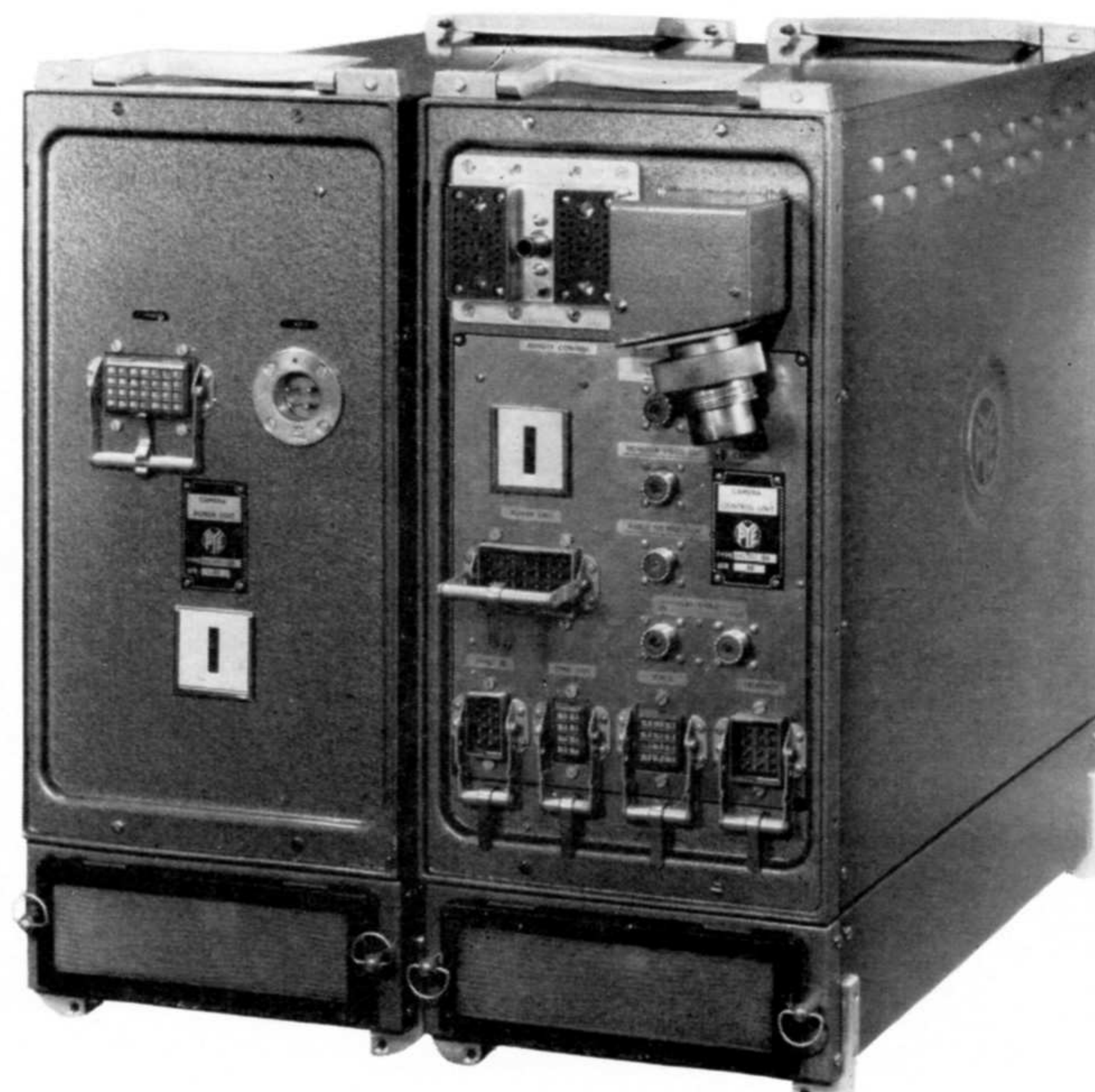
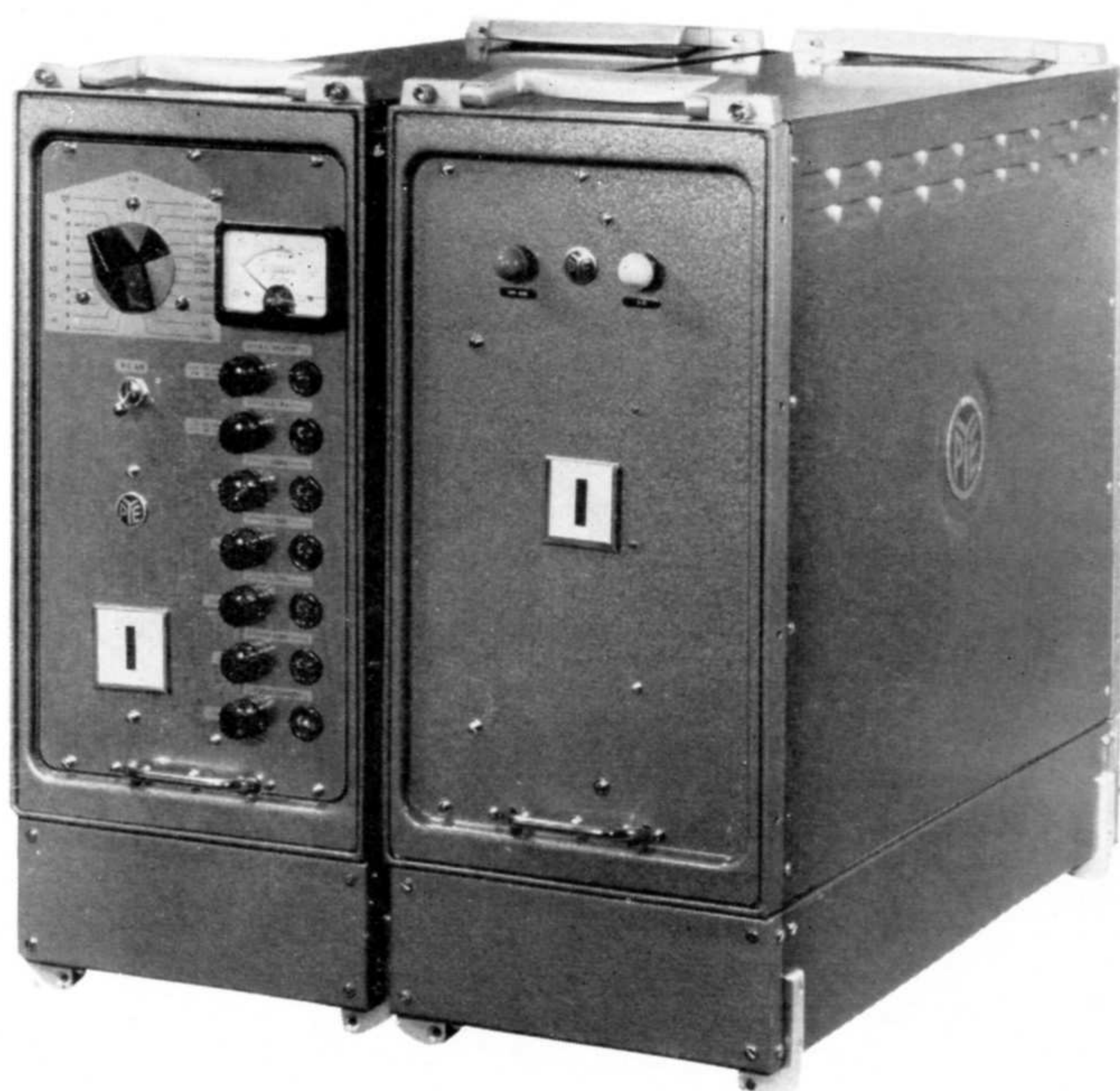
	Part No.
5 coaxial plugs PL259A (for video connection)	706682
Pye 28-contact socket (part of cable 749038	
when bought with Camera Power Unit)	
Pye 8-contact socket (for sync input line)	
Pye 8-contact plug (for sync loop out)	
Pye 12-contact socket (for talkback system)	
Pye 12-contact plug (for connection to Mixing	
Unit)	
2 sets of Unit Identification Cards (numbered	
1-6).	
Musa socket (for internal test points) ... ..	705384

### **CAMERA POWER UNIT**

Part No. 842400 includes:

Films and Equipments socket EP-4-17-S (for	
power input cable) ... ..	704776
Cable, Camera Control Unit to Camera Power	
Unit (standard length 1 ft. 6 inches (46 cm)):	749038
In longer lengths to special order	
2 Sets of Unit Identification Cards, numbered	
1 to 6	





Front and rear views of the Camera Control Unit and Camera Power Supply Unit fitted with adaptor accessory kit for portable use.

#### ENGINEERING CONTROL PANEL

Part No. 843972 includes:

Extension Control Panel Simulator (to bridge connections when Extension Control Panel is not used) ... 750645

Pye 8-contact plug (for connections to Talk-back Jack Panel)

Films and Equipments plug EP-CG-4-12 (for power supply to monitor) ... 705047

2 coaxial plugs PL259A (for video loop to monitor) ... 706682

#### Accessories

##### CAMERA

Image Orthicon Pick-up Tube EEV Type 7295 (P811) ... 860584

Image Orthicon Pick-up Tube EEV Type 7389 (P822) ... 860585

Image Orthicon Pick-up Tube Cathodeon Type C980 ... 860586

Camera Cable B.I.C.C. Mk IVB with quick release couplers ... 846186

Lengths available:

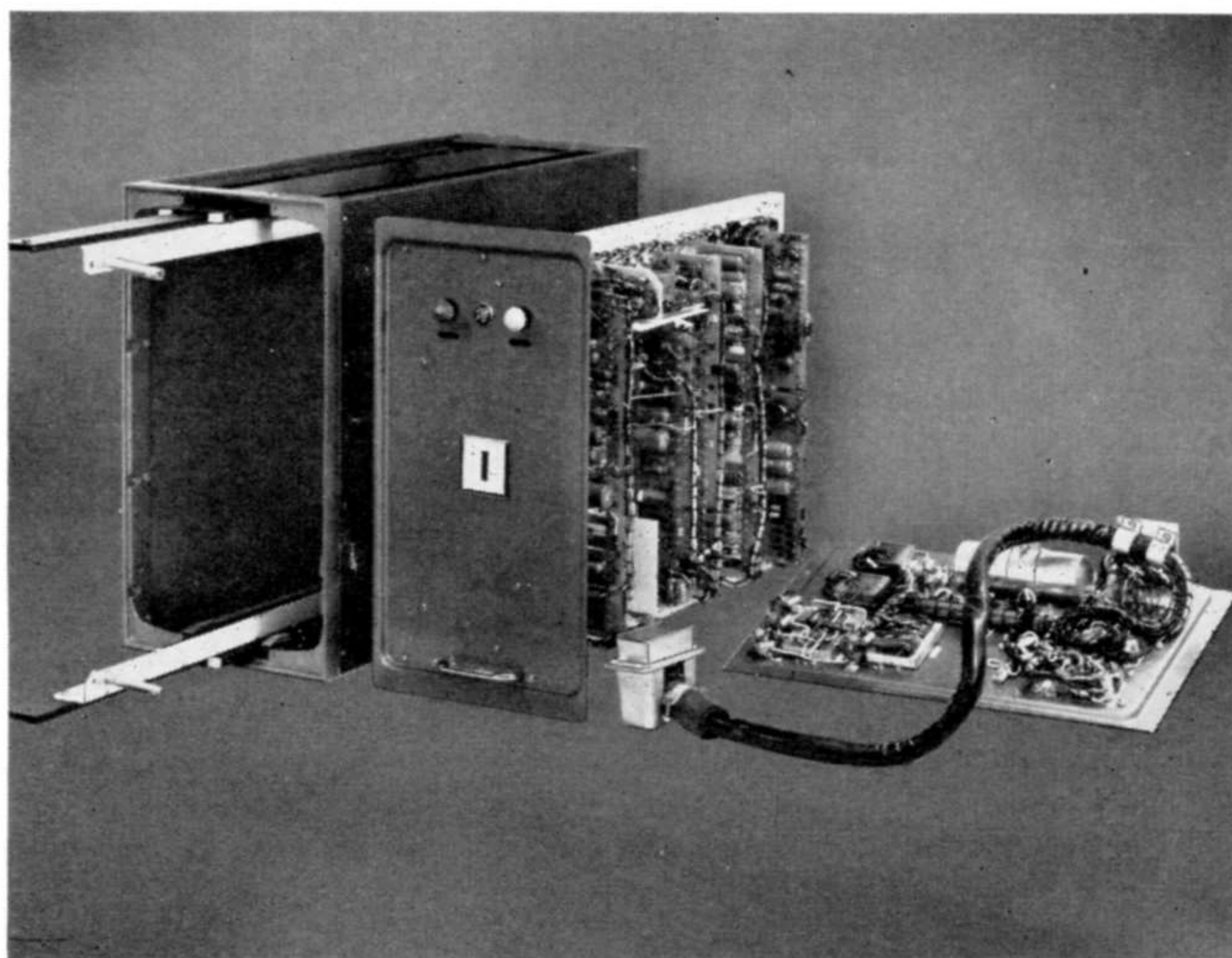
25 ft. (7.6 m)

50 ft. (15 m)

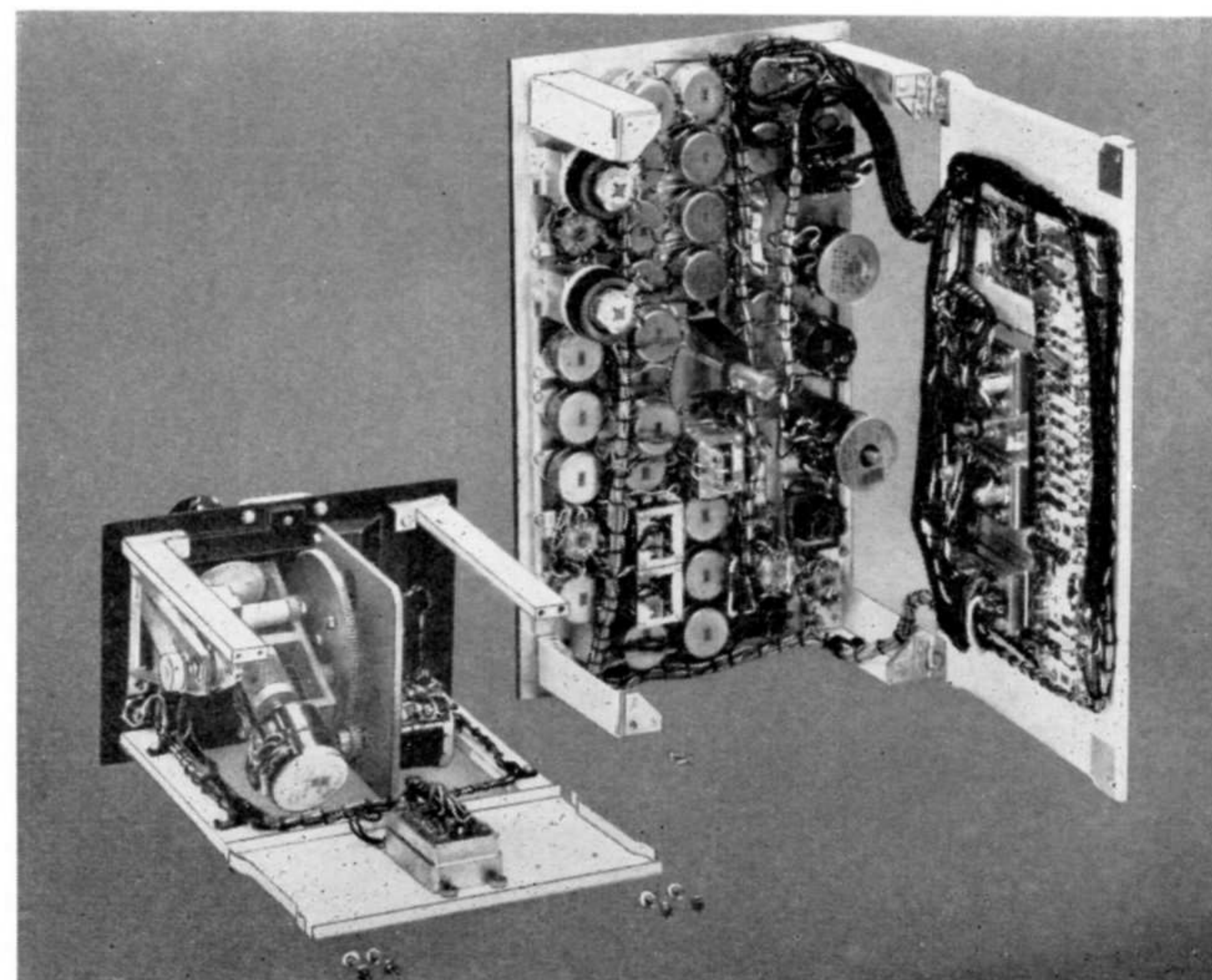
100 ft. (30 m)

200 ft. (60 m)

Note: when ordering quote part number and specify length.



Both the Camera Control Unit and the Power Supply Unit are designed for ease of servicing as shown above.



Access to the rear of the components on the Engineering Control Panel is facilitated by hinging the rear panel as shown. Any component can be removed without the necessity of removing the front panel.



Plug-in Camera Cue and Identification Lamp  
complete with numeral (1-6) ... 747343  
Note: when ordering quote part number  
and specify the numeral required.

Identification Numerals for camera side panels,  
1-6 (ordered as above) ... 711607

Extension Indicator Panel (for camera tracker)\* 844533

Headphones for above (S.T.C.) ... 715688

Thermostat Calibrator ... 844416

Viewfinder Hood (open type) ... 749732

Waterproof Camera Cover ... 715249

Houston-Fearless Wedge Adaptor\* ... 750647

Exposure Calibration Test Slide\* ... 750648

Test Slides . (Listed elsewhere).\*

Light Box for above\* ... 844517

Diascope\* ... 843868

Lenses (see separate list)

Zoom Lens for outside use (Taylor, Taylor  
and Hobson, Varotal III) with combined  
control assembly ... 842452/00

As above, but with split controls ... 842452/01

Zoom Lens for studio use (Taylor, Taylor and  
Hobson, Varotal II) with combined controls 842294

As above, but with split controls ... 842295

Optical Accessories Mounting Bar ... 843949

Single installation kit for Engineering Control  
Panels ... 750224

Double installation kit for Extension Control  
Panels ... 750225

Single installation kit for Extension Control  
Panels ... 750226

Note: Double kits are for mounting units  
one above the other.

Cable, Camera Control Unit to Engineering  
Control Panel, to specified length ... 749036

Cable, Engineering Control Panel to Ex-  
tension Control Panel, to specified length ... 749037

Cable, Synchronising Pulse Generator to  
Camera Control Unit, to specified length ... 845971

Single headphone jack box\* ... 750294

Multiple\* ,, ,, ,, ... 750295

Headset (Home Market) ... 715551

Headset (Overseas) ... 715552

Orbiting synchronising switch unit (one per  
group of camera channels)\* ... 750642

Video termination plug ... 735823

Sync termination plug ... 736957

Monitor switching unit (for comparison of  
several channels on one monitor)\* ... 750296

Loudspeaker Camera Control Unit Talkback  
System.\*

Kits for adapting the Camera Control Unit and Power  
Supply Unit for portable use are available. Provision is  
also made for mounting the control panels in portable form.

## CONTROL EQUIPMENT

Extension Control Panel ... 843976

Rack-mounting support assembly (for Camera  
Control Unit and Camera Power Unit  
mounted side-by-side) ... 750646

Double installation kit for Engineering Control  
Panels ... 750223

## Spares Kits

Kits of valves and transistors, and kits of  
selected spare components are available for all  
units, including accessories.

\* To Special Order

Manufacturer	Pye Part Number	Lens Aperture and Focal Length	Horizontal Angle	Extreme Close-up Capability	
				Object Distance	Object width to Fill Picture
T.T-H. ...	714951	Ortal, 1.1", f2	60°	—	—
T.T-H. ...	714942	Ortal, 1 3/8", f2.8	50°	2.1" (5.3 cm)	0.675" (1.7 cm)
Dallmeyer ...	714961	Orthiac, 1 3/8", f3.7	50°	2.1" (5.3 cm)	0.675" (1.7 cm)
T.T-H. ...	714943	Ortal, 2", f2	34°	3.5" (8.9 cm)	0.97" (2.5 cm)
Dallmeyer ...	714955	Orthiac, 2", f1.9	34°	3.5" (8.9 cm)	0.97" (2.5 cm)
T.T-H. ...	714944	Ortal, 3", f2	23°	6.5" (16.5 cm)	1.5" (3.8 cm)
Dallmeyer ...	714956	Orthiac, 3", f1.9	23°	6.5" (16.5 cm)	1.5" (3.8 cm)
T.T-H. ...	714945	Ortal, 5", f2.8	14°	14.5" (36.8 cm)	2.5" (6.3 cm)
Dallmeyer ...	714957	Orthiac, 5", f2.8	14°	14.5" (36.8 cm)	2.5" (6.3 cm)
T.T-H. ...	714446	Ortal, 8", f4	9°	2 ft. 10" (86 cm)	4" (10 cm)
Dallmeyer ...	714958	Orthiac, 8", f4	9°	2 ft. 10" (86 cm)	4" (10 cm)
Dallmeyer ...	714959	Orthiac, 12", f4.5	6°	5 ft. 7" (170 cm)	6" (15 cm)
T.T-H. ...	714947	Ortal, 12 1/2", f4	5.7°	6 ft. (183 cm)	6.1" (15.5 cm)
T.T-H. ...	714948	Ortal, 16", f4	4.5°	9 ft. 6" (290 cm)	9.7" (24.6 cm)
Dallmeyer ...	714960	Orthiac, 17", f5.6	4.3°	10 ft. 6" (3.2 m)	10" (25.4 cm)
T.T-H. ...	714949	Ortal, 22", f5.6	3.2°	16 ft. 6" (5.1 m)	10.8" (27.4 cm)



# Transfer Characteristic Correction of 4½-inch Image Orthicon Tubes

## General

The output signal of an Image Orthicon tube is a non-linear function with respect to light input, most of the non-linearity being concentrated in the highlight region of the signal. Taking into account the non-linear distortion produced by receivers, which is not complimentary, there is a need for correction, so that the final viewed image bears a close resemblance to the transmitted scene.

While analysing Image Orthicon tube characteristics, it has been found that the black level output, related to blanking level, is a variable, and is dependent on the mean lighting of the transmitted scene, while the high light output level is virtually independent of the mean light value. This variation in black level is in effect a change of modulation depth, caused by halation in the image section of the tube. It can be shown that the light transfer characteristic is independent of mean light level, if the blanking level, black level, and white level ratios can be restored to a standard value. This restoration can be achieved with a control called "Black Level", the function of which will be described later.

Having effected this type of correction, a standard light transfer correction can be applied to obtain the best result.

## DEFINITIONS

### Contrast Range

The ratio between signals at extreme levels, i.e. white and black. The signals can be either light levels or video signal levels.

### Point Gamma

When considering a very small part of a non-linear transfer characteristic as a power law, point gamma is the power of the transfer law in that point, and this is of particular use in defining the "knee" of the Image Orthicon tube characteristic.

### Mean Gamma

When considering the transfer characteristic over the entire contrast range as an approximation to a true power law, the mean gamma is the power at this transfer law.

### Relationship between Contrast Range and Mean Gamma

If the transmitted contrast range of a scene is changed by any method which does not alter the original scene, a change of mean gamma always occurs. Conversely, it is impossible to alter the mean gamma without affecting the transmitted contrast range. This means that it is necessary to alter the transfer correction, if it is desired to transmit a contrast range that is different from the scene contrast range.

### Overall Gamma

This is the mean power of the transfer law of a system, which can be either a camera chain, a receiver, or the combination of both.

### Tube "Knee"

This is defined as the point of the light transfer characteristic where the point gamma is 0.5.

### Gamma Values

As these are always power laws, they can simply be multiplied together:

Camera: 0.5, Receiver: 2.0

Overall System:  $0.5 \times 2 = 1$

## Tube Transfer Characteristic

The tube point gamma varies from 0.5 at the knee, to 0.2 at double the knee light level (one lens stop over), and is unity for light levels less than half the knee light level (one lens stop below).

These figures relate to large area transfer, because for very small areas of highlight the apparent point gamma is much higher (0.4-0.7) owing to "edge effect". This effect is a form of "throw-off" from black areas into white areas due to variation of target point capacitance with scene content.

Neither the mean nor the point gamma varies with tube potentials, so that the choice of potentials such as target bias is governed entirely by considerations like signal-to-noise ratio, resolution, the possibility of beam flutter in certain instances, tube life and edge effect.

The tube black level related to tube blanking level, can vary from zero for an almost fully black image to nearly 25% of the blanking to white level signal, when the image is almost fully white.

The white level output is virtually constant (related to blanking level), and the very small variation is easily corrected by slight alteration of the light level fed into the tube (which is normally done by controlling the lens iris).

## Receiver Overall Gamma

Owing to the effect of ambient lighting falling on the tube screen, causing a change of contrast range, the overall gamma is usually 1.5. It is only 2, or higher, when viewed in a fully blackened room, which is never a normal viewing condition.

## Camera Overall Gamma

As it is normal to have unity gamma for a complete system (i.e. camera input to viewed image), it is necessary to correct a camera chain to a mean gamma of 0.7, the product of 1.5 and 0.7 being approximately unity.

To obtain this mean gamma value, a correction is required, which will alter the point gamma at every level to approximately 0.7. As the pick-up tube point gamma varies over a very wide range, it is obvious that the correction curve should have a point gamma range from 0.7 for signals near black, to 1.2 for the tube knee, and even higher. It is found to be very undesirable to have this correction in the highlights, as "edge effects" are very accentuated (see above). The best compromise is to correct the blacks to a point gamma of 0.7, keeping the highest point gamma for the highlights without resorting to white stretch.

It will be appreciated that any correction curve is far removed from a power law.

When considering the interaction between gamma and contrast range, the following principles have been observed in designing the equipment.

1. To Provide a camera chain overall gamma of 0.7, which can be maintained when the transmitted contrast range varies between  $\frac{1}{3}$  and 3 times the scene contrast range.
2. To allow for an adjustment of overall gamma between 0.5 and 0.8 when the transmitted contrast range is identical to the scene contrast range.



It has been possible to design correction networks which permit an adjustment over these ranges. By utilising two networks of different correction values, and combining the outputs in an electronic mixing network, any intermediate value is obtainable. A linear position is provided, to allow exposure setting of the Image Orthicon tube to be carried out.

As this method of correction depends on a certain tube transfer characteristic, it is necessary to expose the tube always to the same point, and this is achieved as follows:

The tube is exposed to a test chart, which has several areas of known light transmission. By adjustment of light level and video gain it is possible to obtain certain signal levels, which are stated for a definite exposure. By fixing the video amplifier gain at this point, and adjusting the light level only by means of iris control, a known highlight exposure of the tube is always maintained.

The equipment stability is such that this setting can be maintained over long periods of operation.

### *Black Level Correction*

It was stated earlier that there is a large drift of tube black level with mean light level, without changing the white level. In addition there is the requirement of altering the transmitted contrast range, without affecting the highlight level, and this may be extended to severe clipping of scene black when transmitting caption cards, etc.

At the same time the video gain of the chain must have a pre-determined value, due to exposure control, so that independent adjustment of lift and video gain is completely excluded. Instead, a new control has been introduced, which adjusts the picture black level only relative to blanking level, while keeping the 100% white level entirely undisturbed.

This makes for very easy operation, as the white level is determined solely by light control, and black level (which is now the contrast range adjustment) by this new control. As one is independent of the other, simplicity of operation is achieved, and owing to the accurate tube exposure control that is achieved, it is possible to obtain the full benefits of the improved picture quality of 4½" Image Orthicon tubes.



*Photograph by courtesy of A.T.V. Ltd.*

*The Pye 4½ inch Image Orthicon Camera*

PYE T.V.T. LIMITED

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