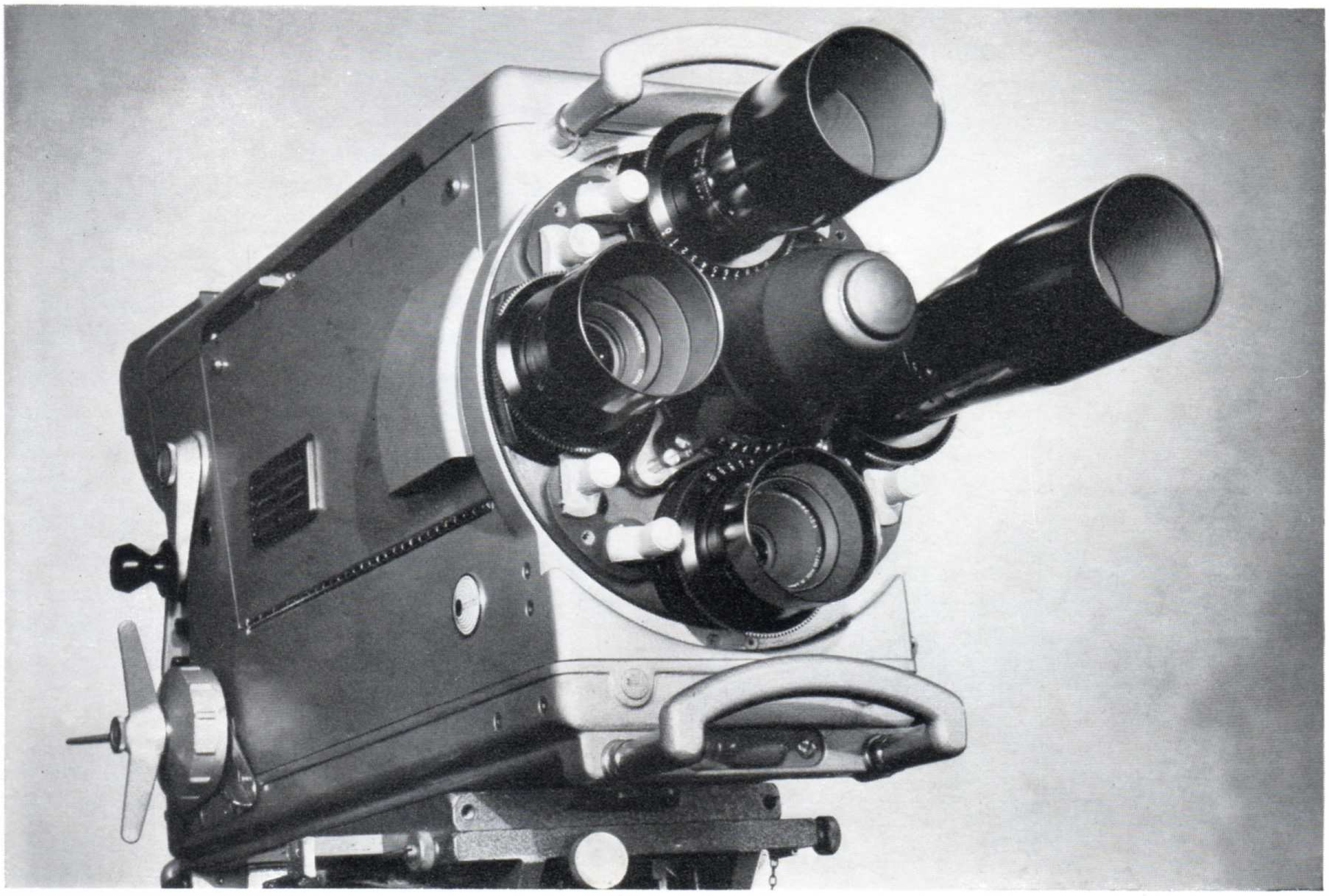
MARK IV IMAGE ORTHICON CAMERA CHANNEL

Type BD 863

- EXTREME STABILITY of operation, allowing a number of cameras to be controlled by one operator.
- SMALL SIZE, low weight and low power consumption.
- SHORT WARM-UP TIME.
- IMAGE ORBITING device extends image orthicon life.
- REMOTELY CONTROLLED iris mechanism.
- FULLY TRANSISTORIZED pre-amplifier and improved screened yoke assembly.
- TRANSISTOR COMMUNICATION CIRCUITS built into the camera channel.
- DUAL-PURPOSE equipment cases, for rack-mounted or mobile use.
- $4\frac{1}{2}$ OR 3 - INCH IMAGE ORTHICONS can be used.



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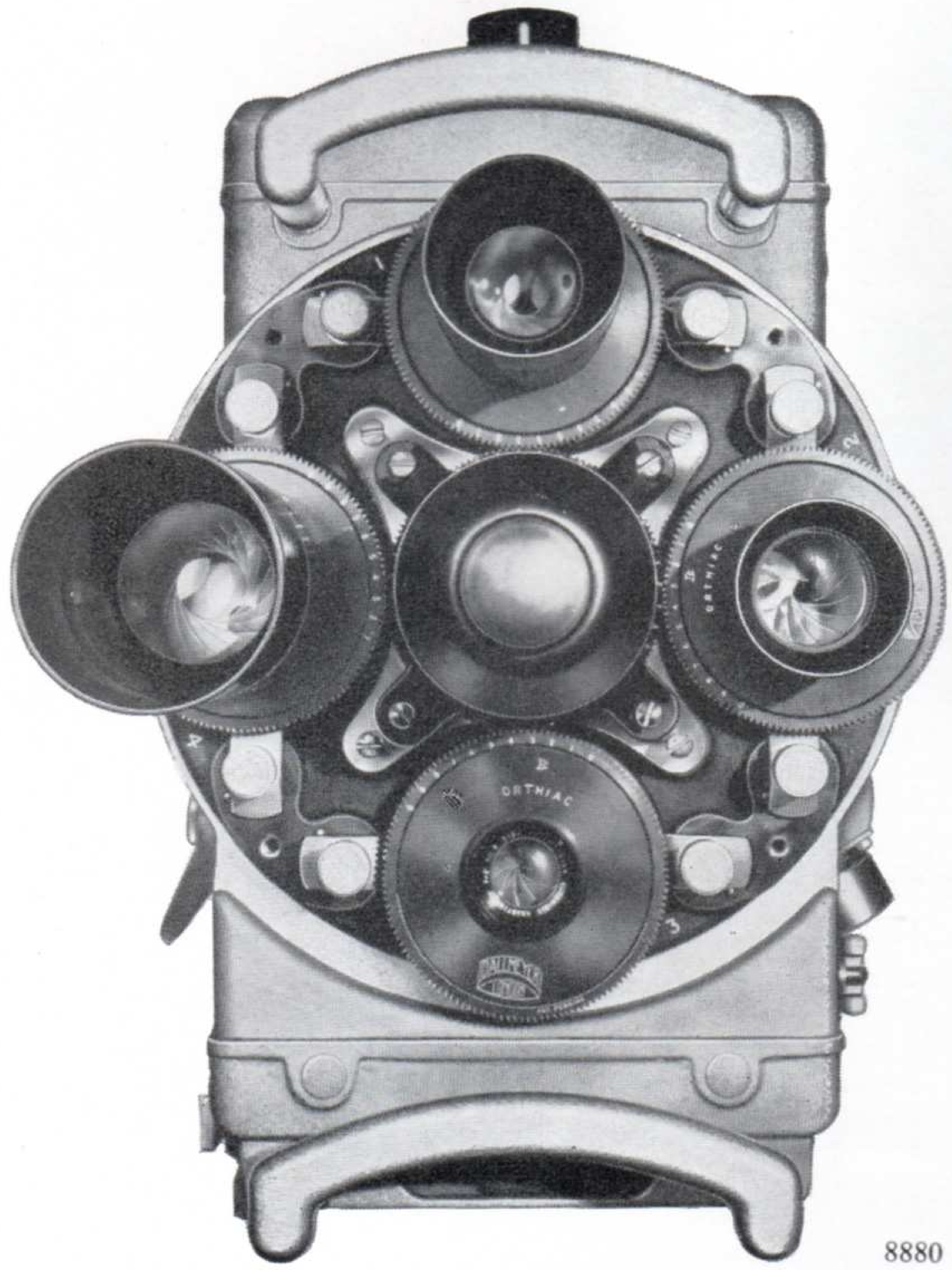

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FIG. 1. *Although narrow in width, the camera has a large-diameter turret capable of carrying a very wide range of lenses.*

IN 1951 the Marconi Company decided to adopt the $4\frac{1}{2}$-inch image orthicon as a contender for top picture quality, in competition with the other types of pick-up tube then available. Development then continued in co-operation with the English Electric Valve Company until 1955, when the $4\frac{1}{2}$-inch image orthicon was introduced with the Marconi Mark III camera channel.

Nearly one thousand Marconi $4\frac{1}{2}$-inch cameras are now in operation throughout the world, and the $4\frac{1}{2}$-inch image orthicon has been almost universally adopted.

Objectives

The first objective in designing a new $4\frac{1}{2}$-inch camera, the Mark IV, was to reduce the size and weight. Secondly, the many thousands of hours of operational experience with the Mark III had shown that the inherent stability of the $4\frac{1}{2}$-inch tube could be exploited even further to obtain truly ‘ hands-off ’ operation.

Now this stability is further enhanced in the latest design of camera, with its solid-state video pre-amplifier and fully screened yoke. This latter feature will now remove the minute picture variations effected by the earth's magnetic field. Additionally, the camera may now be operated under high magnetic field conditions.

Methods

To reach the first objective the only course open was to put less in the camera head. In the Mark IV the number of tubes was originally reduced to nine, plus two high voltage rectifiers and two small stabilizers. Now, in the latest version, three valves are replaced with transistors, reducing the number of valves in the camera head to six. This has been made possible by circuit improvement and by sending the field scanning waveform up the camera cable. The size and weight of the heater transformer is also reduced by using fewer tubes.

Stability has been improved by using design factors that include pulse stabilization, thermostatic control, supply regulators and feedback clamps, as well as the incorporation of silicon diodes, high-stability resistors and (wherever possible) the 6922/E88CC tube. This is a double triode having high performance and long life; it is used with d.c. stabilization to reduce further the effect of tube variations.

The Mark IV camera channel

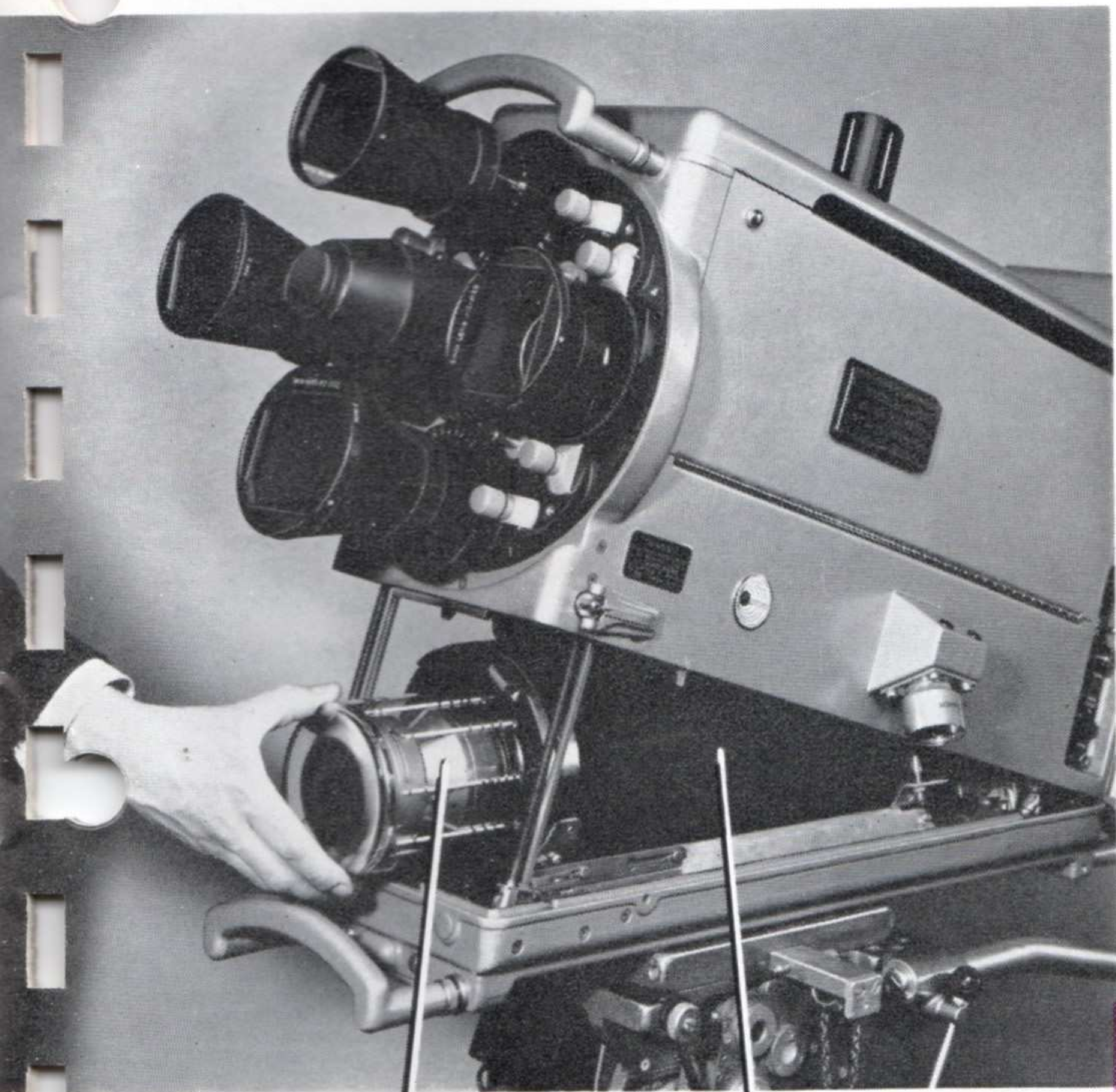
The basic Camera Channel Type BD 863 comprises the following: —

(1) Camera Type 3392
(2) Camera Control Panel Type 3393
(3) Camera Control Unit Type 5152
(4) Power Supply Unit Type 3394

CAMERA TYPE 3392

Optics

To obtain full optical flexibility, a relatively large turret with four lens positions has been designed. A simple but rugged twist catch is employed to retain the lens firmly in position



and to allow quick fitting and release.

Maximum optical alignment is maintained by raising the front of the camera to gain access to the image orthicon and yoke assembly, rather than the more conventional method of removing or displacing the entire yoke carriage. Access to the tube socket is gained by the removal of a cover plate at the rear of the camera.

The lens turret is rotated by a crank handle located immediately above the focussing knob. This handle actuates a folded geneva mechanism that provides the required simple harmonic acceleration characteristic and, in addition, gives a very accurate registration. The mechanism is fully self-adjusting to compensate automatically for any wear.

Tube mounting

The image orthicon yoke is mounted low in the camera. This assists in obtaining low-angle shots and helps to maintain a low centre of gravity. It is fitted to a carriage and supported by simple self-aligning Teflon bearings which slide on heavily chromium-plated tubes. This has the advantage of the same static and dynamic coefficient of friction and gives very smooth operation. Adjustments are provided to align the optical axis of the lens and the image orthicon tube.

Focus

The yoke is driven by a simple mechanism that provides, by virtue of its cosine law, fine control near the critical infinity-focus region. The focus knob is fully adjustable over two ranges, thus giving optimum control for both studio and outside broadcast requirements. A variable finger-tip control of friction may be operated whilst focussing which will firmly lock the yoke on any desired position when the camera is used with a zoom lens.

FIG. 2. *Ease of access to the image orthicon and yoke assembly is demonstrated on left. Controls (below) are grouped near the cameraman's hand on the right-hand side.*

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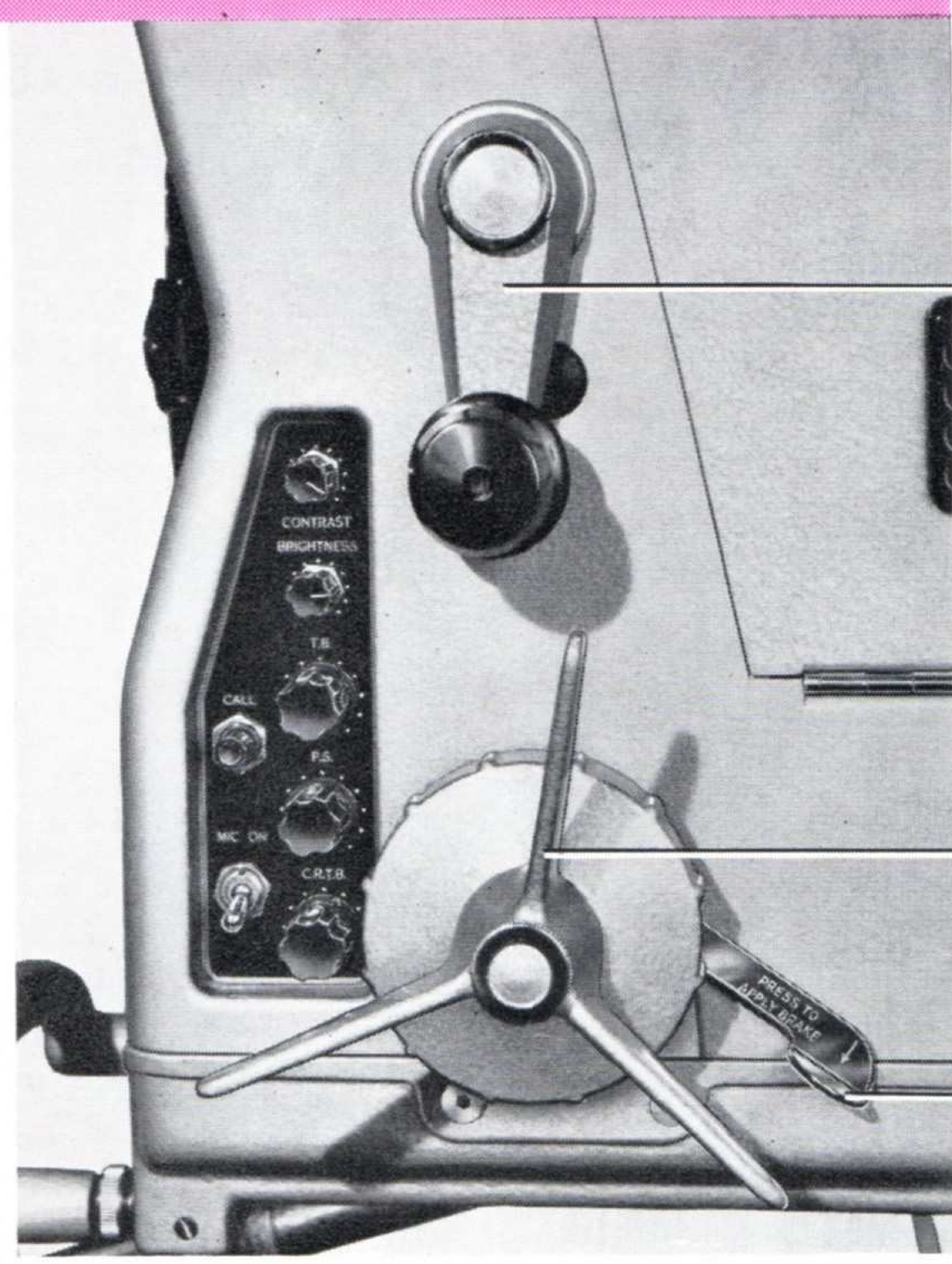

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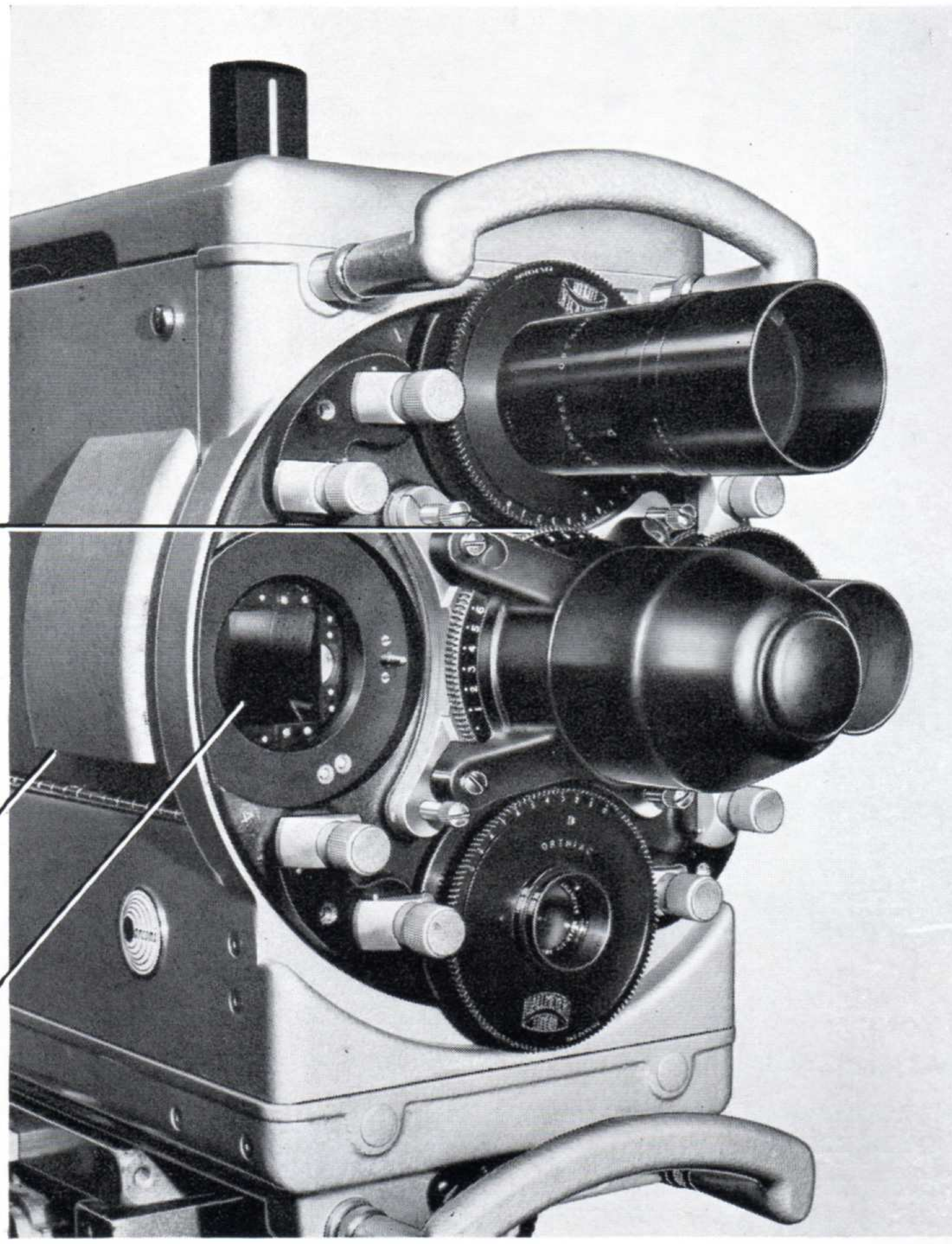
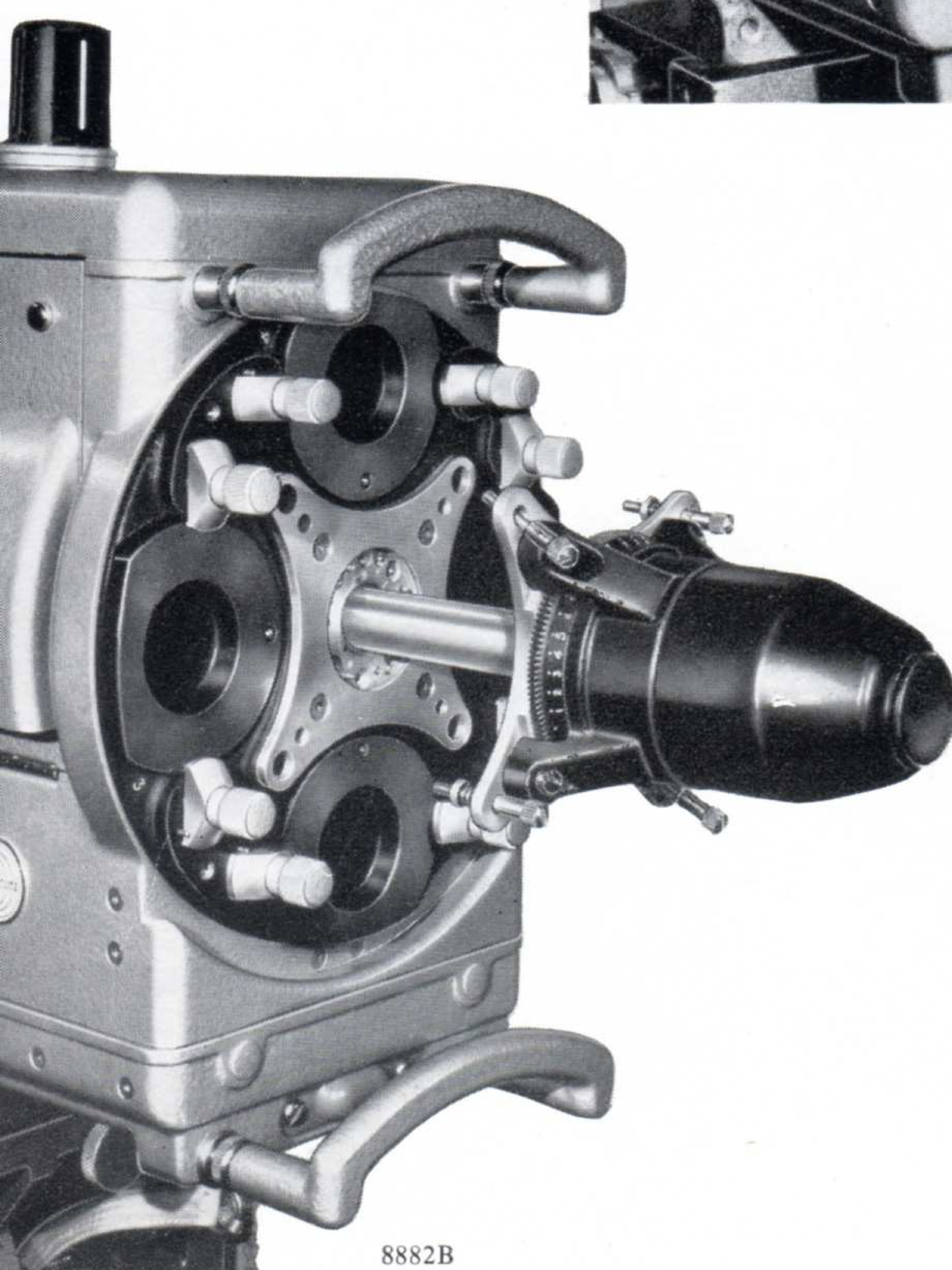


Fig. 3. Close-up views of the le turret, showing how iris gearing en- gages. The upper picture illustrates how the neutral-density or colou correction filter is mounted behi the lens. The lower picture demonstrates the access to the remote ir driving mechanism. The simp method of turret rotation permits instantaneous lens change with a minimum of effort.



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Exposure

For many years it has been realized that optimum picture quality can be obtained only by correct exposure of the image orthicon, and the exposure control is now considered to be the main operating control. In the Mark IV camera, a remote lens iris control is used in preference to a variable neutral-density filter, to avoid the loss of operational sensitivity and permit use of the maximum depth of focus commensurate with the available light.

Lenses have now been developed in which the iris is controlled by an external gear ring. This gear ring is driven by a fully positional servo which, in turn, is remotely controlled from the camera control panel position. The lenses are easily fitted to the turret in their correct position by a single locating pin and indexing marks on the central gear ring, which mate with marks upon each lens.

All lenses are driven simultaneously to the same *f* number, so that when the turret is operated, the new lens is at the same stop as the previous lens and no iris re-adjustment is required.

Behind the main turret is a filter wheel, with provision for three neutral-density or colour-correction filters, an open position and a 'capped' position. Control of the filter turret is from a sliding knob at the side of the camera.

Temperature control

Image orthicons are designed to operate at the particular temperature at which the glass offers optimum resistivity. To maintain this temperature within close limits, an automatic control system has been designed which draws air into the camera, adjusts its temperature and discharges it around the target area of the image orthicon.

A mercury contact thermometer, located near the target, senses the temperature and automatically controls the heater and blower.

When the camera is switched on, the heater and blower operate and warm the tube, making it suitable for rehearsal in a maximum of 20 minutes under extreme conditions. As soon as the temperature reaches 38°C the heater is switched off and the fan reduced to half speed. This rate of cooling matches the heat dissipation of the yoke at normal studio temperatures. Should the temperature rise above 45°C the fan speeds up; if the temperature drops below 38°C the heater will operate again.

During the warm-up time the tube potentials may be removed, whilst the normal temperature control circuits remain operational.

Image orbiting

To reduce the possibility of 'sticking' the image orthicon, an electro-magnetic orbiting system is built into the camera. The orbit is approximately 2% of the picture size and operates at a speed of one revolution per minute.

FIG. 4. *The interior of the camera, seen from either side, showing the temperature control and line scan circuits.*

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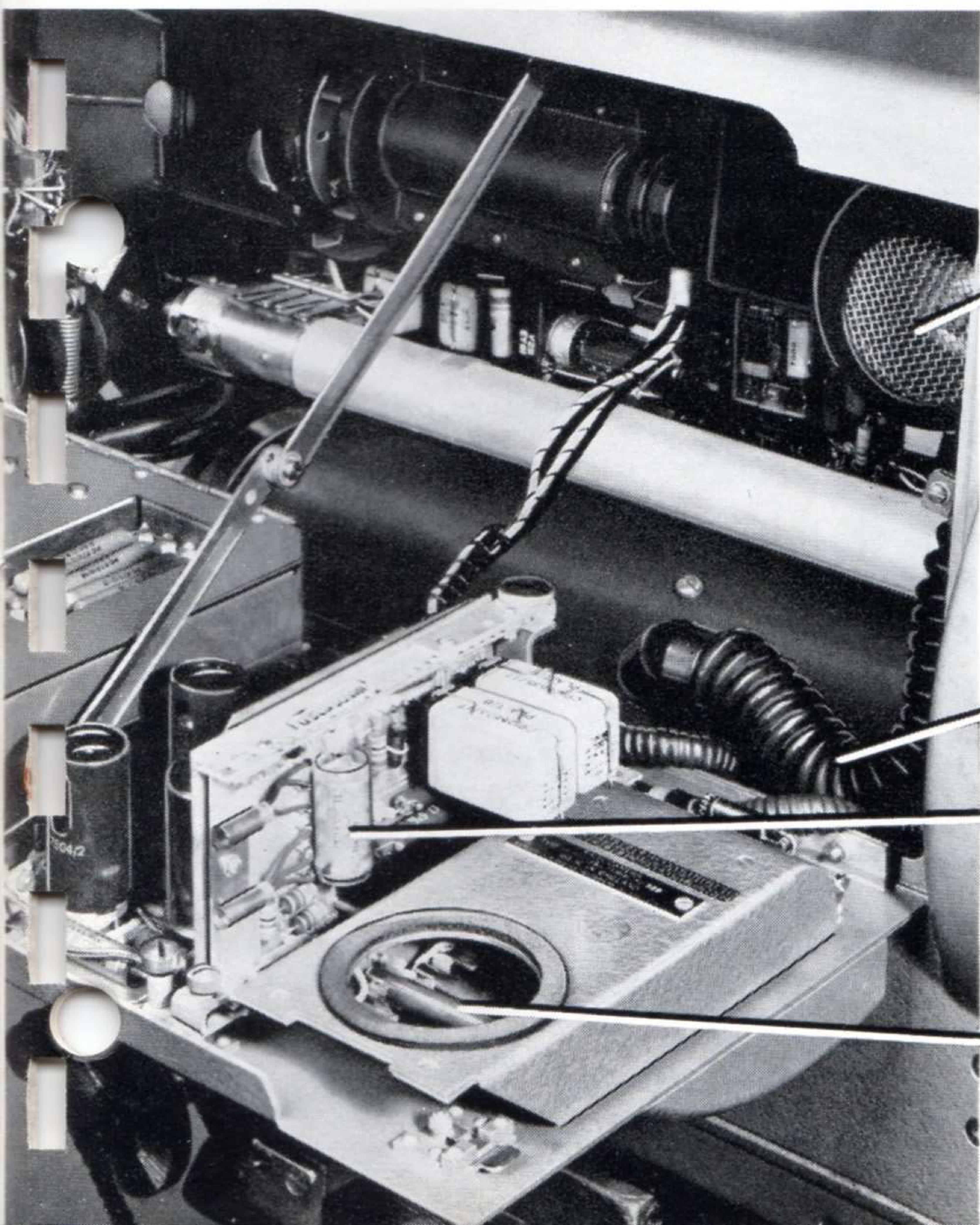

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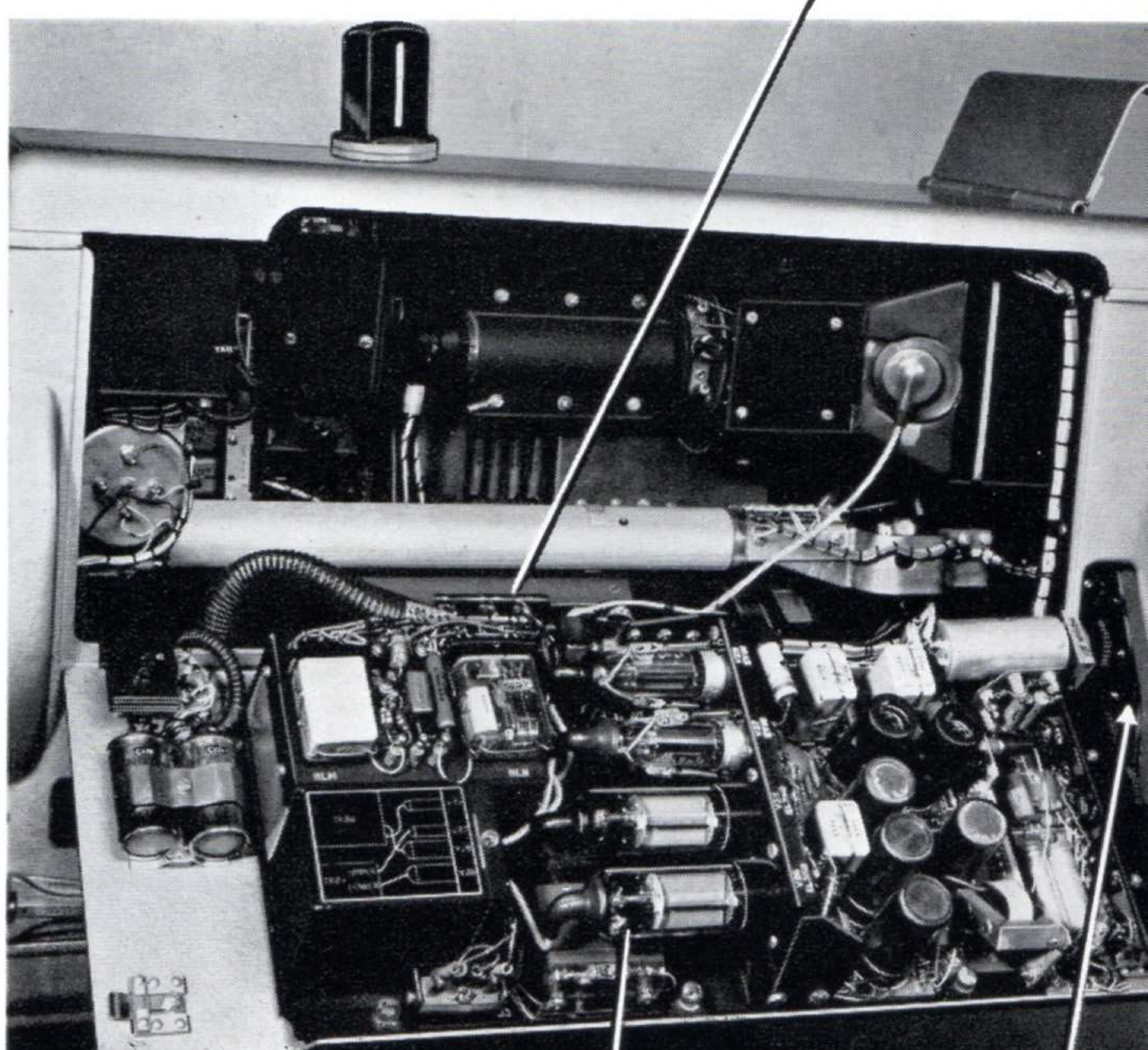

Viewfinder

A rectangular 7-inch tube, operating at 12 kV, is used to provide a high-definition picture for the viewfinder. The video feed to the viewfinder amplifier is taken from the output of the camera channel, and facilities for providing 'mixed' pictures, to assist in setting up superimposition shots, are available at the control panel.

Illuminated numbers immediately above the tube face indicate the taking lens. Additionally, two red 'on air' lights are provided. The brilliance of these lamps is fully adjustable as required by the camera man.

FIG. 5. *The viewfinder, showing the lens position indicator and 'on-air' cue lights, conveniently placed above it.*

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CAMERA CONTROL PANEL TYPE 3393

THE standard camera control position consists of the studio console housing for the Mark IV equipment, containing a Picture and Waveform Monitor Type BD 873 (described in publication TD 248) and, in the desk position beneath the monitor, the camera control panel for the rack-mounted camera control unit.

This panel contains no valves but only the passive components. The main operating controls are mounted on the edge nearest to the operator whilst the remainder, normally considered as pre-sets, are covered by a hinged lid at the rear of the panel.

For installations where it is wished to exploit fully the high stability of the camera channels, a remote control panel containing only the main operational controls is available. Thus the control of all the cameras can be placed in the hands of one senior engineer.

The operating controls centred on the Camera Control Panel Type 3393 are as follows :—

(a) *Main controls*

Lift	Mix viewfinder
Gain	Black stretch, onset 1 and 2 controls
Iris	Black stretch off, 1, 2 and 3, and Remote
CTB	
TB	Overscan
PS	Uncap
CRTB ON	Panel lamps
Mains ON	Call camera

(b) *Semi-pre-set controls* (*under cover*)

GROUP 1	GROUP 2
Test waveform switch	Field focus mod.
Horizontal scan centring normal and reverse	Decelerator
	Beam on
	Beam coarse
Vertical scan centring, normal and reverse	Beam focus coarse
	Image focus coarse
	Lift coarse
Height	Align X
Width	Auto align ON
	Align Y

GROUP 3

Sync. amplitude	Image focus fine
Set target switch	Multifocus
Target	Line shading
Beam fine	White clipper
Beam focus fine	Field shading

CAMERA CONTROL UNIT TYPE 5152 AND POWER SUPPLY UNIT TYPE 3394

PRINTED-WIRING circuits tend to occupy more surface area than the equivalent orthodox chassis, therefore a new type of rack-mounted unit has been developed to make the maximum use of rack space and the characteristics of printed-wiring boards.

The camera control unit and power supply unit are two separate boxes which can be placed side by side in a standard 19-inch rack. Each unit consists of a central vertical panel carried at the top and bottom by ball-bearing slides.

Printed-wiring boards are mounted on either

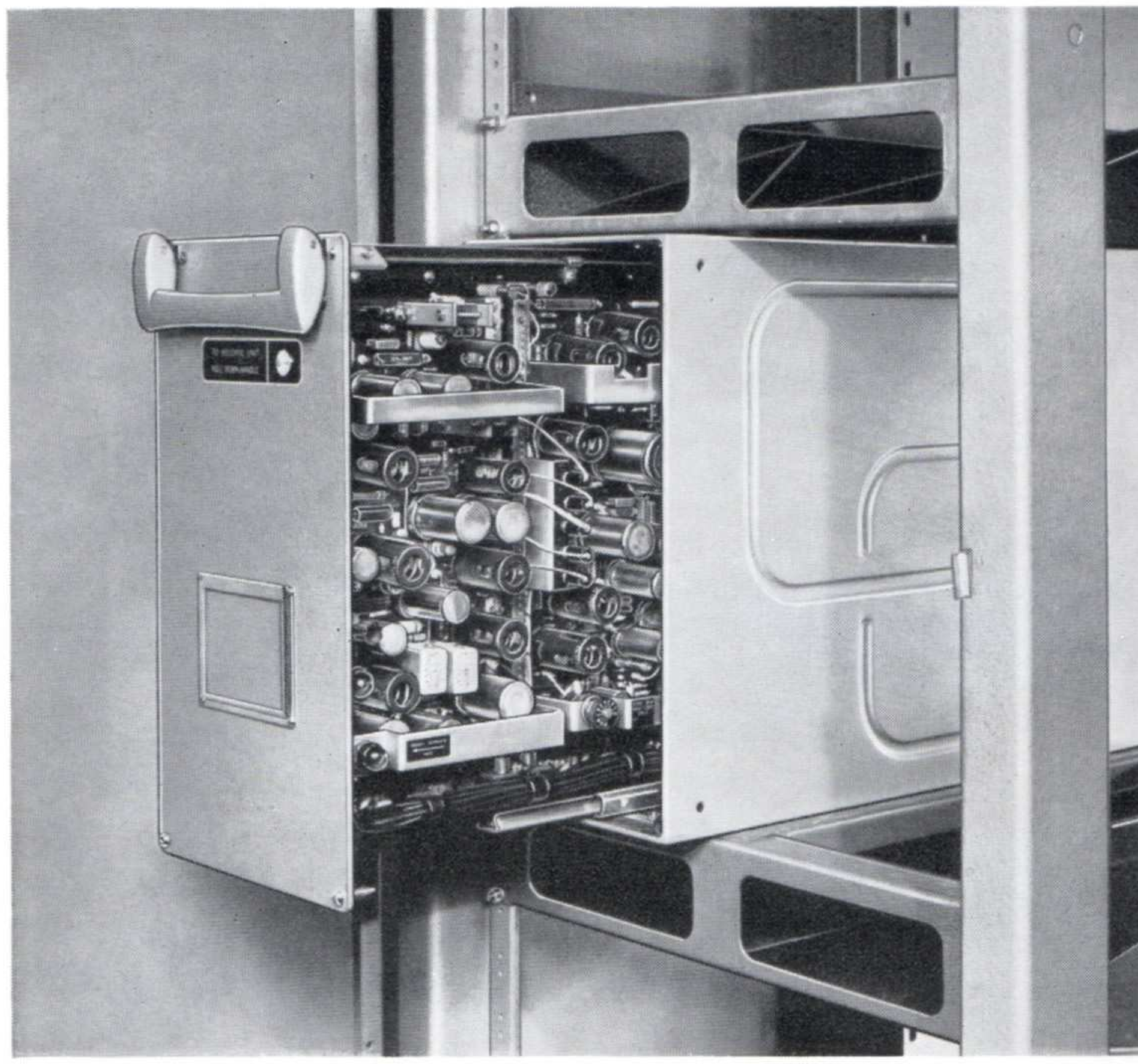

FIG. 7. *The camera control unit, rack-mounted. The power supply unit (similar) sits beside it.*

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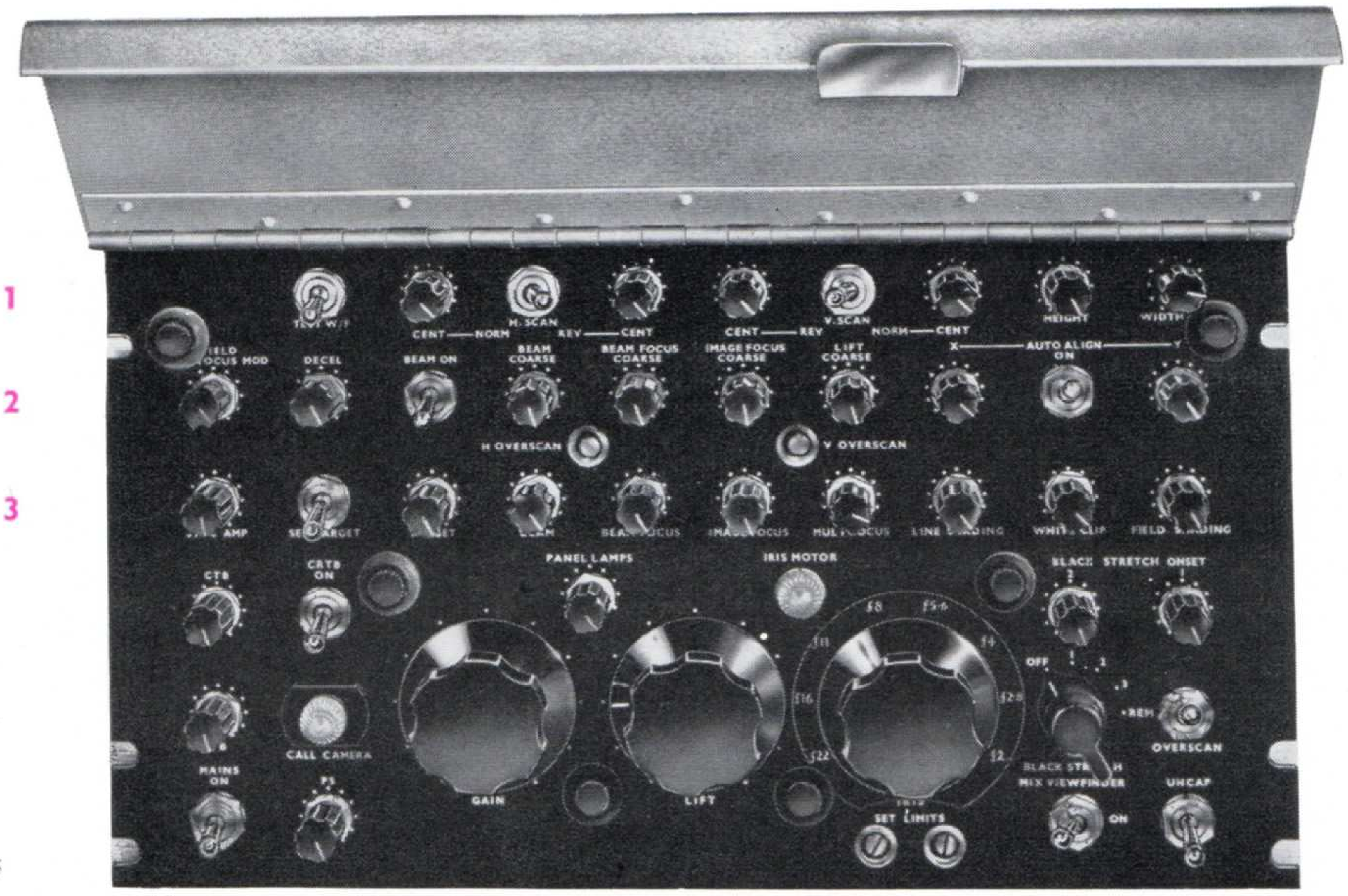
FIG. 6. *The camera control panel.*

PRESET CONTROLS: GROUP 1, GROUP 2, GROUP 3

MAIN CONTROLS



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side of the panel and are connected by plugs and sockets specially developed for this purpose. A 'swan-neck' of cables joins the printed-wiring boards to the external connectors, which are mounted on a rear panel fixed to the case. The connectors are positioned so that the cables hang downward, thus reducing fatigue both on the cables and the cabinet.

No controls appear on the front panel—all pre-sets are sited where most convenient on the boards themselves, but are easily accessible when the unit is withdrawn.

For mobile use the same printed-wiring cases are employed, fitted with top cowls, base runners and an additional carrying handle. Thus a compact suitcase unit is produced.

CIRCUIT DETAILS

THE signal from the image orthicon is fed to an input stage in the head amplifier. Feedback is used to reduce the input impedance and correct the capacity losses across the load resistor. A feedback stabilized amplifier follows the input circuit, with its d.c. conditions additionally stabilized.

This, in turn, is followed by a triple-feedback circuit, driving a further transistor to provide a positive/negative signal at the output.

The dynode supply is stabilized by a corona regulator. To reduce noise, the signal input and dynode decoupling capacitors are selected for freedom from leakage current.

At the input of the camera control unit, shading waveforms correct the camera signal. The signal is then passed through a cable correction circuit which is continuously variable over the range 0 to 1000 feet. (This control requires adjustment only when the length of cable in use is changed).

The gain of the video processing amplifier is remotely controlled from the control panel. A continuously variable phase-less aperture corrector permits accurate compensation for any loss of resolution in the 4½-inch image orthicon. The phase-less nature of this correction, coupled with the low noise of the 4½-inch image orthicon, permits over-correction to be used when high-frequency emphasis is required.

The clamp stage is very carefully designed to eliminate set-up drift. The clamp pulses are supplied from a split transformer winding and are always balanced. The pulses are derived from line drive which is returned from the camera after initiating camera scan. Thus, when long camera cables are used, the clamp pulses are equally delayed and remain correctly timed with respect to the camera video signal. This eliminates 'shutter bar' problems when scan amplitudes or centring are altered.

The clamp pulse widths are very wide to reduce the possibility of clamping on spurious signals. The inserted blanking amplitude is fixed by clamping between two d.c. references. The set-up clipper is controlled by feedback; the clamp bias is produced from an amplified pulse the size of which is proportional to the set-up.

Gamma correction is provided by reducing the current feedback to the cathode of the clamped valve. The circuit is such that reduction of the current feedback does not affect frequency response.

After d.c. insertion, the signal passes to a stage where synchronizing pulses are added if required. Three parallel 75-ohm output stages follow, one of which provides the feed to the viewfinder. The other two outputs are for the mixer and monitor. By slight alteration of the circuit these two outputs may be composite or non-composite or one of each.

The viewfinder amplifier terminates the 75-ohm line from the camera control unit with a transformer network that provides a high-frequency boost. This permits cable correction and produces additional boost which is a valuable aid to focussing. A shunt-regulated output stage provides a large linear swing to the grid

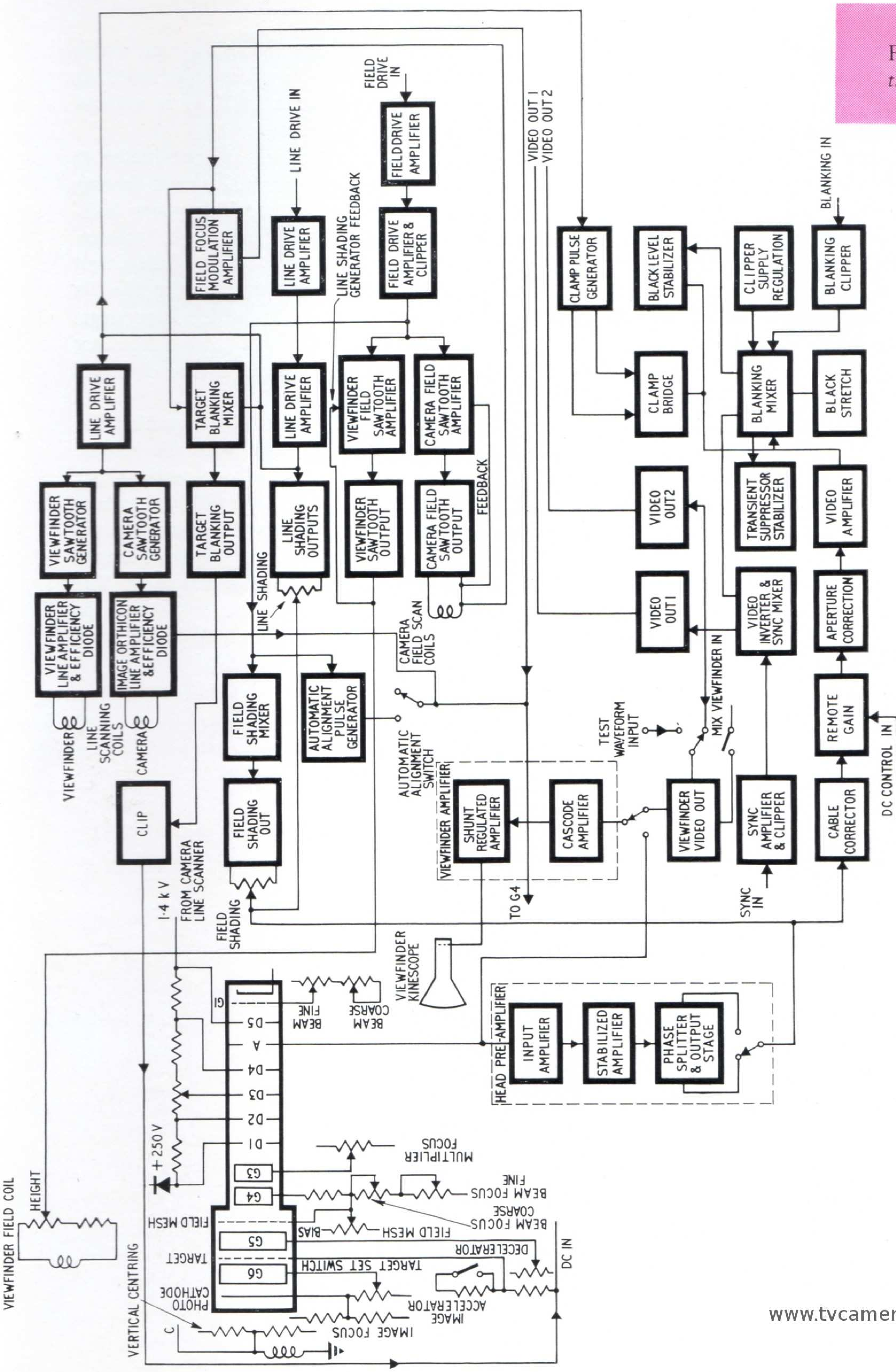


FIG. 8. *Simplified diagram of the Mark IV camera channel.*

of the viewfinder tube, producing a wide-band response. The d.c. component is maintained by a d.c. restorer.

Field scan generators for both camera and viewfinder are housed in the camera control unit. Negative feedback circuits prevent any change in linearity or amplitude when camera cable lengths are changed.

A line drive pulse is fed to a clipper on the line scan chassis. Separate discharge circuits are provided to drive the independent high-efficiency output stages for the camera and viewfinder scanning. The viewfinder output stage provides 12 kV for the viewfinder tube and the −600 volts for the image orthicon. The latter voltage is regulated by a corona stabilizer.

The camera line-scan provides the image orthicon dynode supply. This supply is used as a bias to safeguard the tube against line-scan failures. The field-scan current is sampled by a transformer which produces the bias for the camera line-scan discharge tube. Hence, if the field scan fails, the line scan is switched off and the image orthicon is biassed off. This forms a very reliable scan protection circuit which safeguards the tube against synchronizing generator failures or scanning failures without recourse to the use of relays.

The h.t. regulator utilizes a transductor to control the amount of rectified current flowing into the smoothing system. This gives half-cycle-by-half-cycle regulation of h.t. voltage, which compensates for changes in a.c. input or output load. High-frequency control is established by a type of shunt regulator stage, the combination together producing a regulator of very high efficiency without the use of banks of series regulators valves.

The power supply unit also contains the electronic circuits associated with the remote iris control. In action, the voltage on the slider of the iris control is compared with the voltage on the slider of a potentiometer attached to the iris gear ring. Any difference voltage is amplified and fed to the magnetic amplifier. The magnetic amplifier causes the iris motor to turn, rotating the iris ring potentiometer until the difference voltage is cancelled out.

ORDERING INFORMATION

When ordering please state: —

1. Television standard employed.
2. Mains voltage on which equipment is to operate.
3. If standards switching is required.
4. If for mobile or studio use.
5. Camera cue light designation required, i.e. 'Cam 1', 'Cam 2', 'Cam 3', etc.
6. $4\frac{1}{2}$-inch or 3-inch image orthicon operation.
7. If additional handbooks are required.
8. If spares are required.
9. Size and type of lenses required.
10. Length and type of camera cable required.
11. Distance between camera control unit and camera control panel.
12. If friction head is required.
13. If tripods or pedestals are required.
14. How many headsets are required.
15. How many monitor headphones are required.

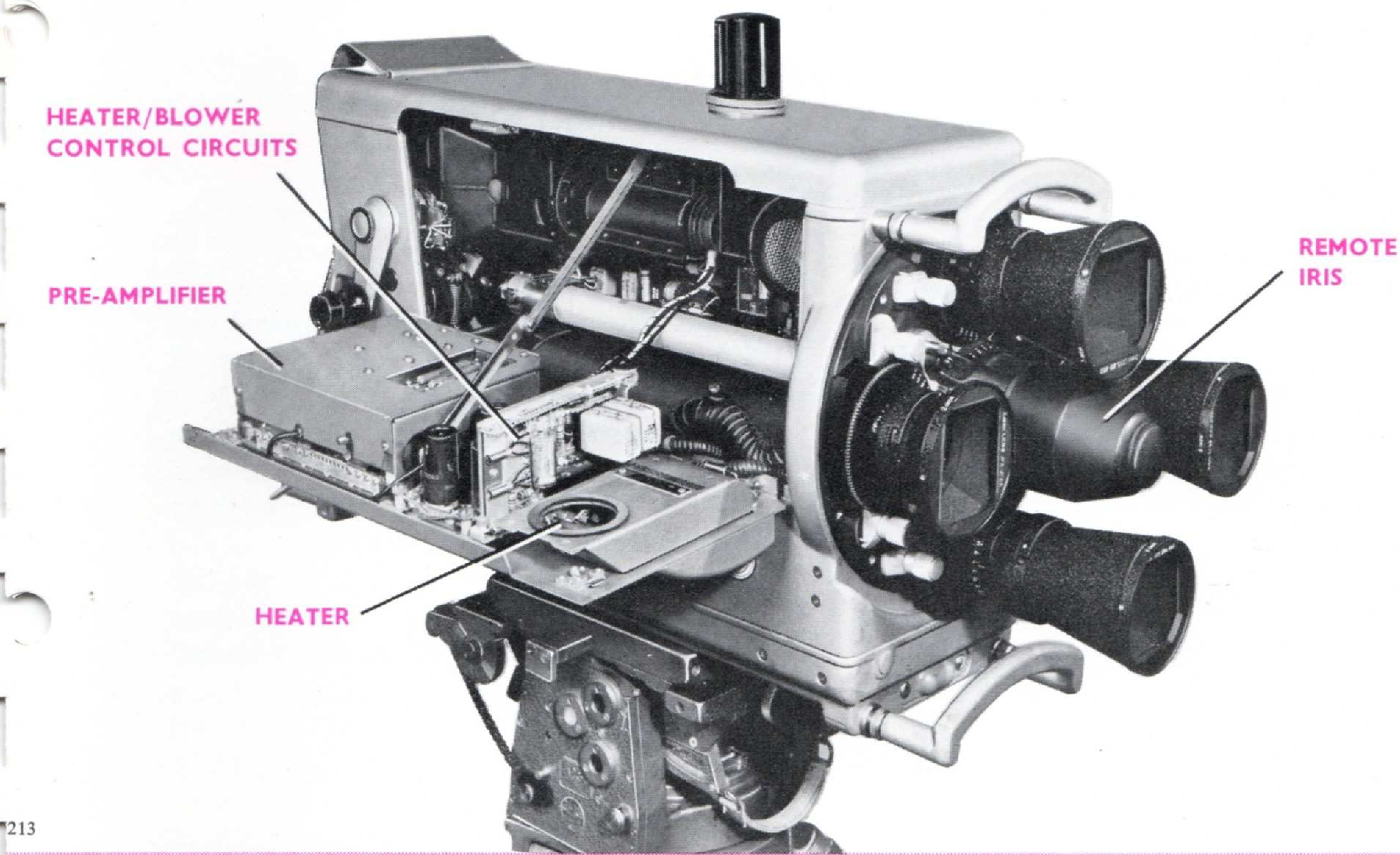
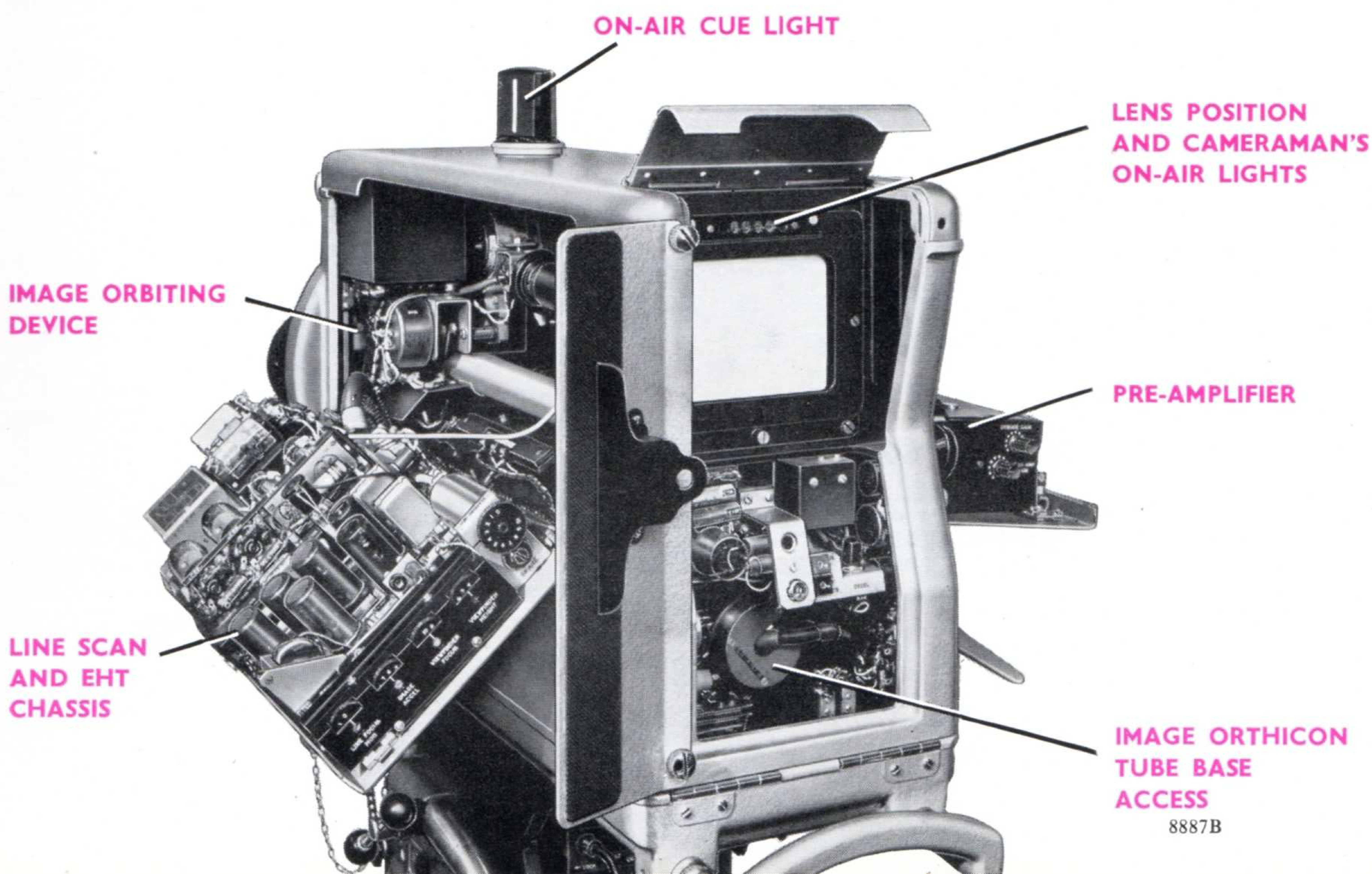


FIG. 9. *These pictures demonstrate the excellent accessibility of every part of the camera. Routine maintenance, as well as break-down periods, are therefore confined to the shortest possible time. The light-weight framework of the camera consists of magnesium alloy castings, with light-alloy top and side covers. The latter, which are hinged, carry the sub-units.*



DATA SUMMARY

INPUTS

Mains: Transformer with split primary, tapped for 100–125V and 200–250V, 50–60 c/s. Consumption 800 VA.

Pulses: Bridging co-axial input for line drive, field drive, mixed blanking and mixed sync. (for composite outputs), at standard levels.

Communications: Programme sound, production talk-back and 'on air' cue.

Control: Remote control with 25-way socket mounted on the camera control panel, giving remote control of lift, gain, lens iris and gamma.

OUTPUTS

Vision: Two standard-level signals which may be composite or non-composite as required.

Communications: Camera talkback for mixing to give mixed camera talkback.

Utilities: Connectors are sited on the side and bottom of the camera, making available mains, 250V h.t., 6·3V a.c., 'on air' cue and lens position indicator.

PERFORMANCE

Camera

Linearity: Maximum error of ±1% of picture height or width.

Geometry: Not more than 2% departure from correct raster edge.

Positional hum: Not greater than ±0·1% of picture height or width.

**Signal-to-noise ratio:* Using a 4½-inch image orthicon on 525/625 lines and a 5·1 Mc/s cut-off filter, 37–40 dB; with a 3-inch image orthicon, 31–35 dB. On 405 lines, and using a 3·6 Mc/s cut-off filter, figures are 2–3 dB better.

**Resolution:* At 400 lines per picture height, without aperture correction, using a 4½-inch image orthicon there will be 4–6 dB loss. Using a 3-inch image orthicon there will be 9–11 dB loss. The corners will not be more than 3 dB worse than the figures obtained for the same number of lines per picture height at the centre of the picture.

Aperture corrector: Continuously variable up to approximately 11 dB; peak frequency on 525/625 lines is 6·8 Mc/s, on 405 lines 4·8 Mc/s.

Gamma correction: The law may be switchable to suit particular requirements between 4–8 dB, 6–12 dB and 8–16 dB. In addition each of the two onsets is variable.

Black level stability: For mains surges of ±5% of nominal voltage, maintained for three seconds, black level variation will not exceed ±0·5% of standard composite signal. For a blanking width variation of 10%, black level will remain constant within 2% of standard composite signal.

Gain stability: For a mains surge of ±5% of nominal voltage and maintained for three seconds, change of gain will not exceed ±2%.

Viewfinder

Linearity: Maximum error of ±1% of picture height or width.

Geometry: Not more than 2% departure from correct raster edge.

Positional hum: Not greater than ±0·1% of picture height or width.

DIMENSIONS :

Camera:

Height	Wedge base to top of camera case	17in. (43 cm approx.)
Width	Over casework	9½in. (24 cm approx.)
	Over turret	12in. (30 cm approx.)
Length	Front of turret to rear of case	26½in. (67 cm approx.)

* *The performance of the camera channel whilst measuring these parameters is almost entirely dependent upon the image orthicon in use. These figures are therefore based upon the use of an 'average' tube.*

Weight 3in. version
95 lb. (43 kg approx.)
$4\frac{1}{2}$in. version
105 lb. (47 kg approx.)

Camera control unit:

(a) Rack-mounted
Height $15\frac{3}{4}$in. (40 cm approx.)
Width $8\frac{5}{8}$in. (22 cm approx.)
Depth over case
$20\frac{1}{2}$in. (52 cm approx.)
Depth over projections
$24\frac{1}{2}$in. (62 cm approx.)
Weight 53 lb. (24 kg approx.)

(b) Mobile unit
Height $18\frac{1}{4}$in. (46·5 cm approx.)
Width and depth as rack-mounted.
Weight 58lb. (26 kg approx.)

Power supply unit:

(a) Rack-mounted
Height $15\frac{3}{4}$in. (40 cm approx.)
Width $8\frac{5}{8}$in. (22 cm approx.)
Depth over case
$20\frac{1}{2}$ in. (52 cm approx.)
Depth over projections
$24\frac{1}{2}$in. (62 cm approx.)
Weight 83 lb. (38 kg approx.)

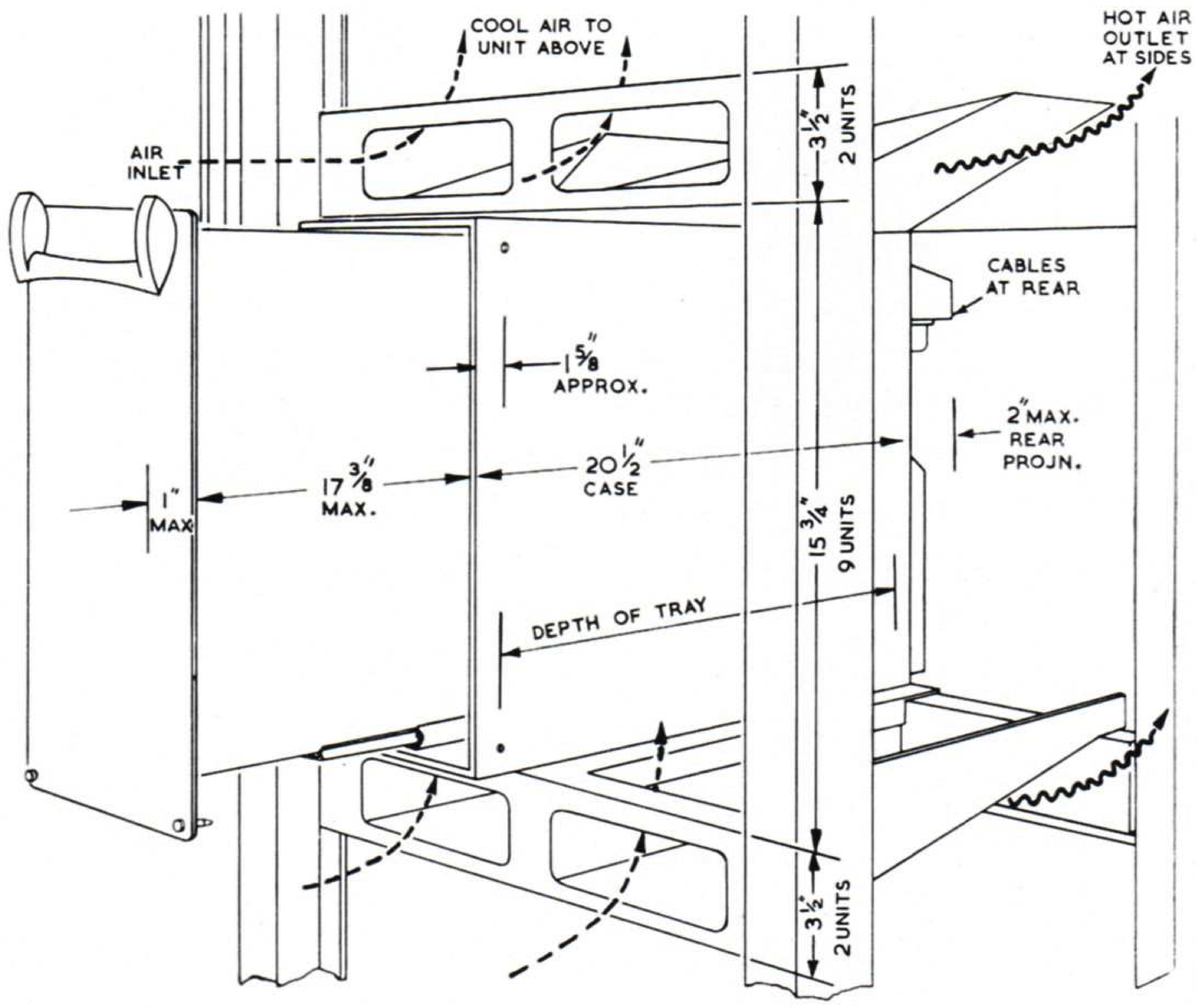
(b) Mobile unit
Height $18\frac{1}{4}$in. (46·5 cm approx.)
Width and depth as rack-mounted unit
Weight 88 lb. (48 kg approx.)

Camera control panel:
Height 8in. (18 cm approx.)
Width 14in. (31 cm approx.)
Depth 6in. (13 cm approx.)
Weight $11\frac{3}{4}$ lb. (4·8 kg approx.)

NOTE: The information given herein is typical of the performance that may be expected in practice, but is subject to confirmation at the time of ordering.

INSTALLATION DETAILS OVERLEAF →

RACK MOUNTING DETAILS



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INTERCONNECTIONS

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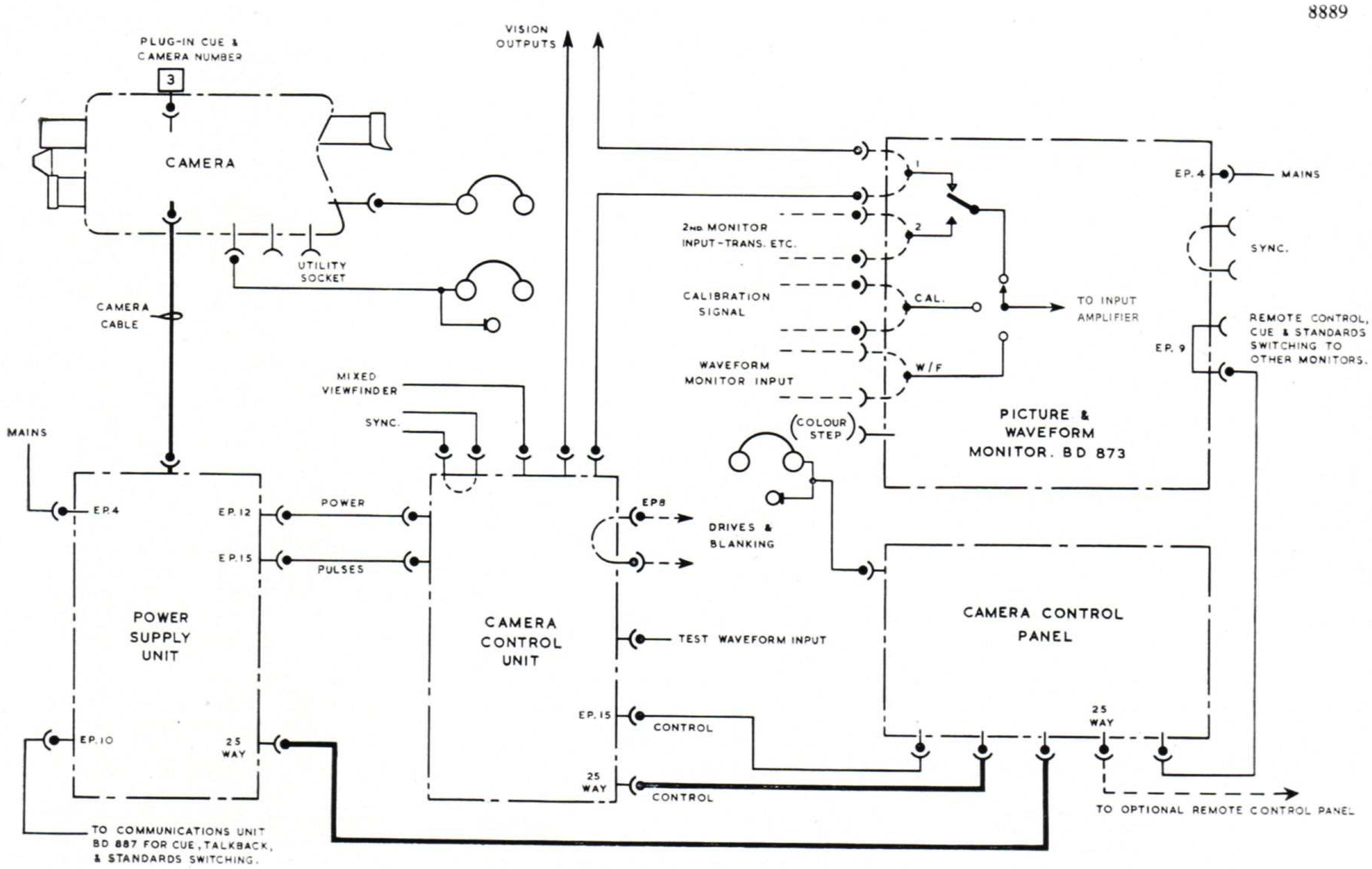

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Studio and mobile control. Typical Mark IV camera control positions, using Picture and Waveform Monitor Type BD 873, (see leaflet TD. 248) are shown here. Above is a camera control position for a large studio arrangement. Below is a Marconi 4-camera outside-broadcast unit.

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EMMY WINNER

The Mark IV camera and its pick-up tube won the 1961 award of the USA National Academy of Television Arts and Sciences, the 'Emmy' statuette—Oscar of the television industry.

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