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FOUR YEARS OF THE MARK IV

THE FIRST MARK IV CAMERA CHANNEL was shipped in July 1959 and now, 4½ years later, over 600 have been sent to all corners of the world. During this time, a programme of modification and improvement has been going on, and at the same time television engineers with many broadcasting organizations have been making more and more use of the potential in quality offered by the 4½-in. Image Orthicon. Improved definition and better signal-to-noise ratio have been more and more fully exploited and the remarkable stability of the channel has led to the practical realization of the "hands off" technique.

In the first issue of *Sound and Vision broadcasting* B. M. Poole, who designed the camera, described it and the Mark IV channel.[1] It was designed with the following characteristics:

(a) Performance and stability to exploit the 4½-in. tube.
(b) A camera as simple to control as a high-grade photographic camera.
(c) The minimum number of valves at operational positions.
(d) All electronics easily replaceable in blocks.
(e) Line-up procedure to be possible from the camera control panel alone without employing a cameraman.
(f) Facility for conversion from one standard to another.

While the original version of the camera was very successful and the finest available at the time, a considerable number of modifications have been incorporated since. These have resulted from one or more of the following causes:

(1) Special requirements for a particular use.
(2) Improvements resulting from technological progress and to further the achievement of the original design targets.
(3) Improvements for manufacturing reasons.
(4) Replacement of obsolescent components.

In the event, all these have resulted in certain recognizable changes in the camera in the field. They can be identified by the copper screening boxes round the head amplifier; the modified iris servo system; the introduction of the standards switchable power supply unit and camera control unit, common to both the Image Orthicon and Vidicon camera channels; the new slip ring system; the switchable camera and now the Edition J which includes a fully screened yoke and a solid state head amplifier.

SPECIAL REQUIREMENTS

Some customers require modification to their camera channels because of special circumstances of operation, or to fit in with existing operating techniques which are different from those for which the camera channel was designed. A good example is the outside broadcast unit supplied to Switzerland[2] where the cameras, being required to operate in an ambient temperature of −20°C, had a special heater winding fitted round the image section of the yoke.

Perhaps the best examples of operating techniques peculiar to the individual customers are to be found in the communication circuitry of the channel. Some customers, for example, do not feed programme sound to their cameras, while others employ a technique similar to telephone practice, using anti-sidetone coils. Again, when certain facilities are not called for, a line or lines in the camera cable are made available and a balanced

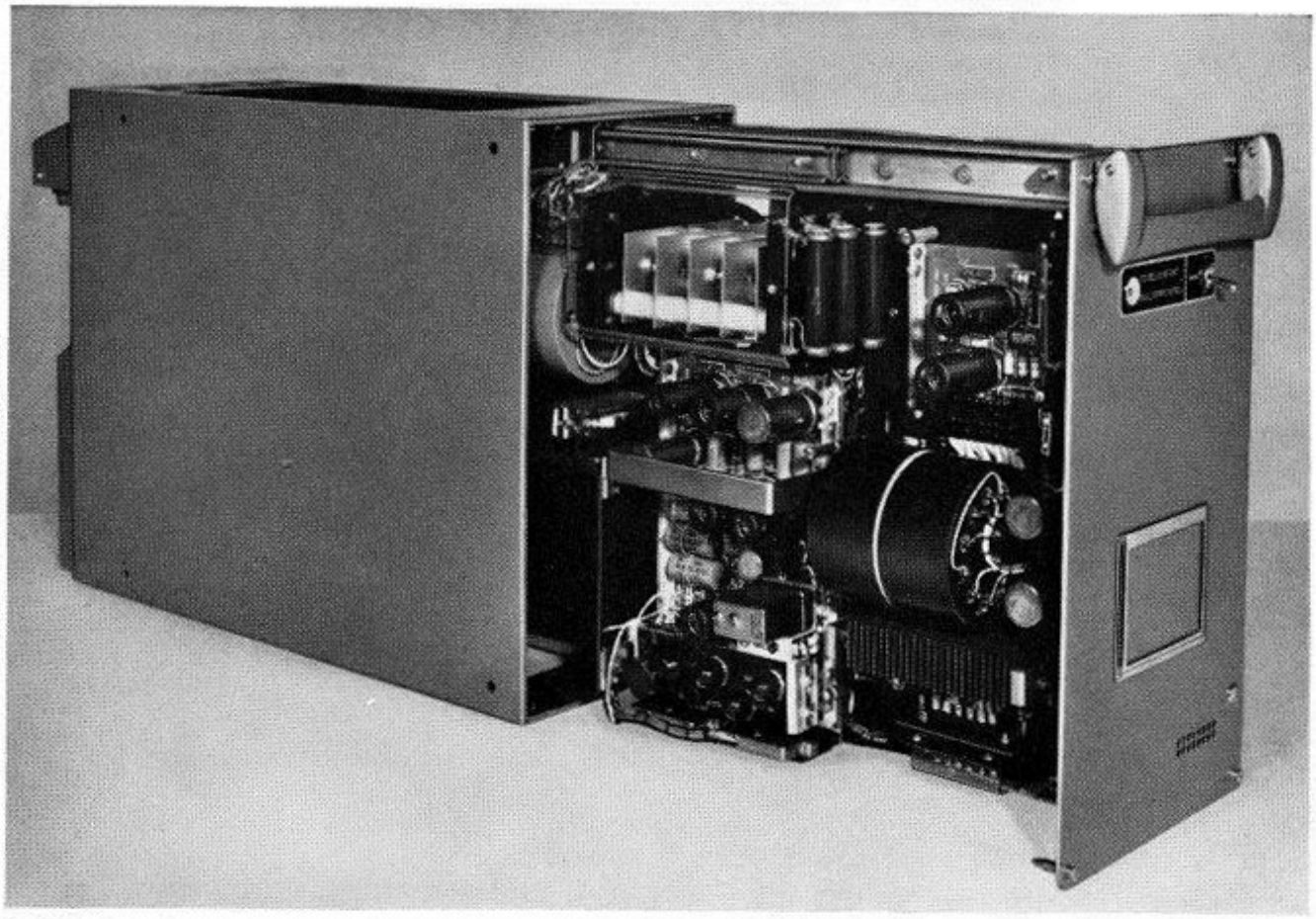

Fig. 1. The Power Supply unit of the Mark IV Camera chain, showing the silicon rectifiers at the top left.

talk-back system is possible. Cue lights, too, can be thought of under the heading of communications, and sometimes special cue lights have been incorporated.

Remote iris and the fixed filter wheel facilities, which were designed as optional extras originally, have now become standard. Another special modification was a picture "ripple" effect, which allowed a signal to be fed to the channel to give an effect suitable for "dream" introductions. Modified black stretch laws have been asked for, and a special form of plug-in construction for the camera control units and power supplies has been developed in particular for the BBC.

TECHNOLOGICAL PROGRESS

Since the camera was first developed, a number of new components have appeared or been proved to be reliable. Where the use of these has been shown to effect an improvement in performance, reliability or cost, they have been introduced. Most significant is the introduction of silicon rectifiers to replace the original selenium units in the power supply units (Fig. 1). Silicon rectifiers were unproven when the power supply was designed and early experience had shown inability to withstand surges. The metal rectifiers, however, proved to have a comparatively short life when operated in high ambient temperatures, so a change was made. As always when introducing modifications, compatibility with existing equipment was of the utmost importance. The replacement rectifier unit became a direct electrical replacement and, with the exception of some small additional surge protection components, fitted in the space vacated on removing the original rectifiers. In a similar manner, the two high-voltage diodes in the camera line scan chassis have been changed to silicon types, and here the handling of fast flyback pulses presented special problems. It is hoped that a cheaper version of the dynode supply rectifier will soon be obtainable.

EHT leads have always been a problem in camera design, and when it was found that a special cable with moulded connectors could be obtained, it was introduced.

Typical of mechanical modifications were the improvements to the iris mechanism. If the iris system was incorrectly set up electrically, or the lenses were wrongly fitted in their mounts, the system could jam. Improvements were made to the system to reduce the risk of jamming and provision made to clear it in the event of mis-operation (Fig. 2). The strain of service showed that the coupling was unreliable, and a new and more robust device in a tougher type of nylon was introduced.

A modification may be largely mechanical, but for electrical reasons, and the copper screening box of the head amplifier is an example of this.

MANUFACTURE

Most modification requirements arising from manufacture are found in the initial production run when the manufacturing drawings are proved. Later on, as a result of experience in manufacture and when the problem of tolerances becomes clearer, certain design changes may become desirable. High manufacturing costs or a high reject rate for certain components may

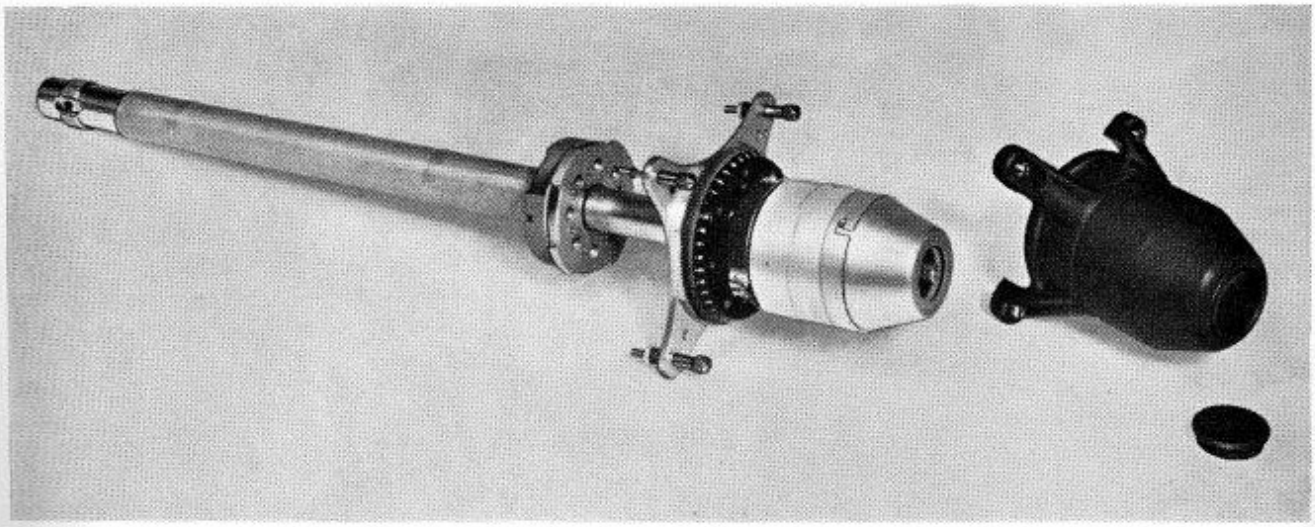

Fig. 2. The modified slip ring assembly and remote iris motor. The cap on the motor cover is removable to give access to the motor shaft.

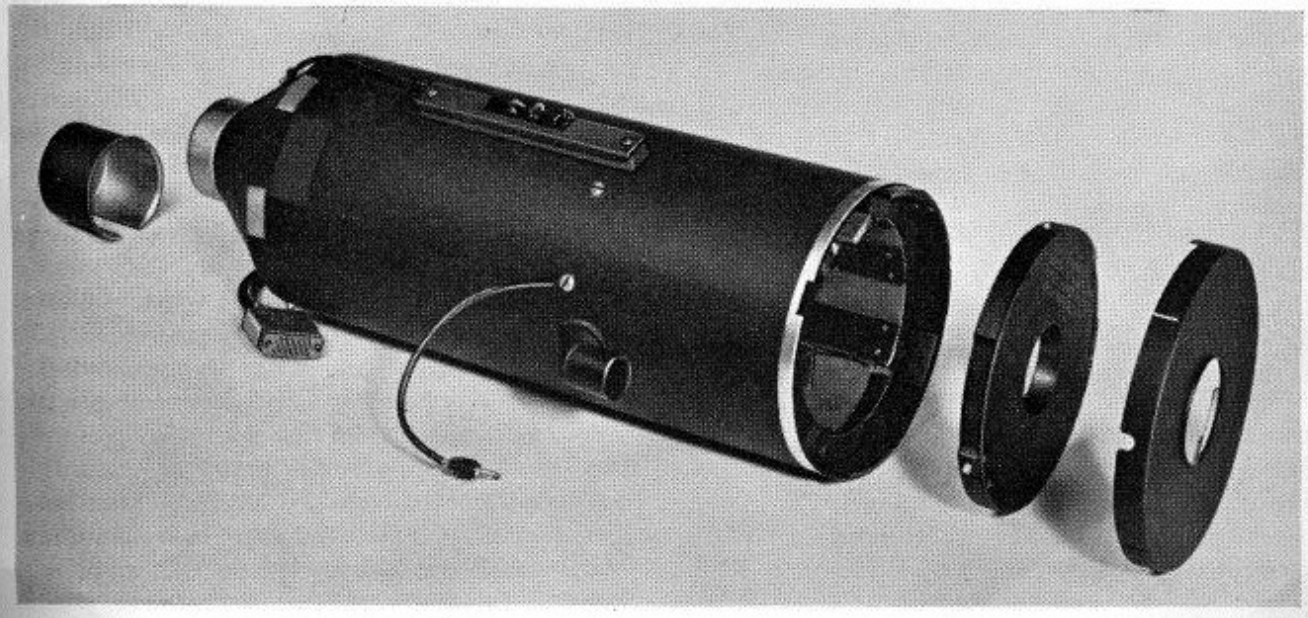

Fig. 3. The yoke screen as used on the Mark IV Edition J.

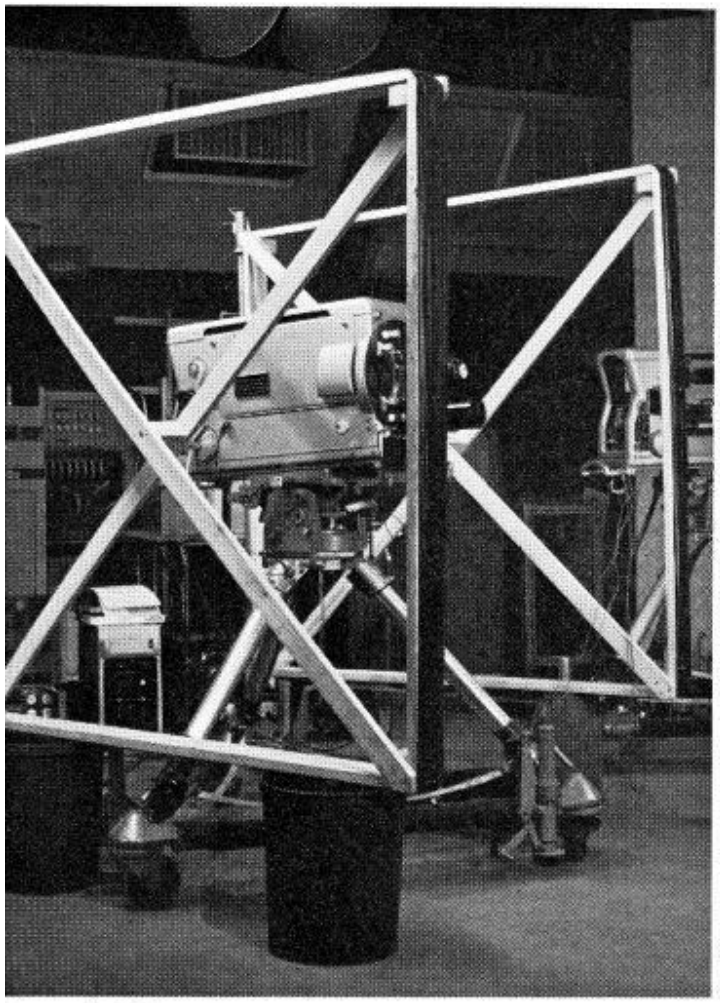

Fig. 4. The coil used to simulate the conditions found at Studio 50.

point to the need for a change. As an example, the line scan transformer, which performed satisfactorily in development, could not be made in quantity to the exacting specification laid down. The coil winder, the assembler, the operator who impregnates it, all want a tolerance to work to, on top of the tolerance of the raw materials. The camera mains transformer now has an electrostatic screen which was not fitted originally. A screen was required for the Vidicon camera and for standardization, the same transformer is now used in the Image Orthicon channel.

OBSOLESCENCE

Sufficient stocks for future requirements may be retained when enough warning of the withdrawal of a component is given. Some cases have, however, already occurred of components which have changed in some respect from their initial performance or construction. These changes do not always represent a deterioration. In some cases, however, the change may not be tolerable, and in these cases negotiations with the manufacturer of the component may result in continued or special supplies. An example of this concerned the iris servo motor, batches of which arrived with an increased degree of electrical commutation noise. The blower motor manufacturer changed his method of construction which resulted in a motor with an inferior running life. Discussion with the manufacturer resulted in a motor with improved bearings, and this, together with a modification to the method of clamping, resulted in a better product.

FURTHERING THE ORIGINAL DESIGN OBJECTIVES

All modifications, large or small, contribute to the further development of the channel. However, the biggest step in improving the camera resulted in Edition J, which is the basic camera now in production. In addition to all the comparatively minor improvements introduced over the last 4 years, this camera has a fully screened yoke and viewfinder and a solid-state head amplifier. As these two changes are the most significant made recently, they will be dealt with in some detail.

SCREENED YOKE

The focusing field of some 60 gauss in the yoke of the Mark IV camera is stabilized to a very high order of accuracy, and the effect of the addition or subtraction of quite a small field, such as the horizontal component of the earth's magnetic field, is enough to disturb the critical focus of which the equipment is capable. It became the practice to set up camera channels with cameras facing east and west so that the error introduced by the earth's field was split about the optimum setting of the yoke field. It was while this problem was being studied that the Columbia Broadcasting System announced that they were to re-equip their Studio 50 in New York with $4\frac{1}{2}$-in. Image Orthicon camera channels.

Studio 50 is a Broadway theatre, and as such offers unique opportunities for television presentation. The stage, however, backs on to a power distribution centre for part of the New York subway system, and report had it that the leakage magnetic fields on the stage were of the order of 5–8 gauss (approximately 20–30 times the earth's field). An engineer was, therefore, despatched to New York to assess the problem. Matters were worse than expected. Not only did the magnetic field reach 10 gauss, but every time a train entered or left the section, the strength of the field

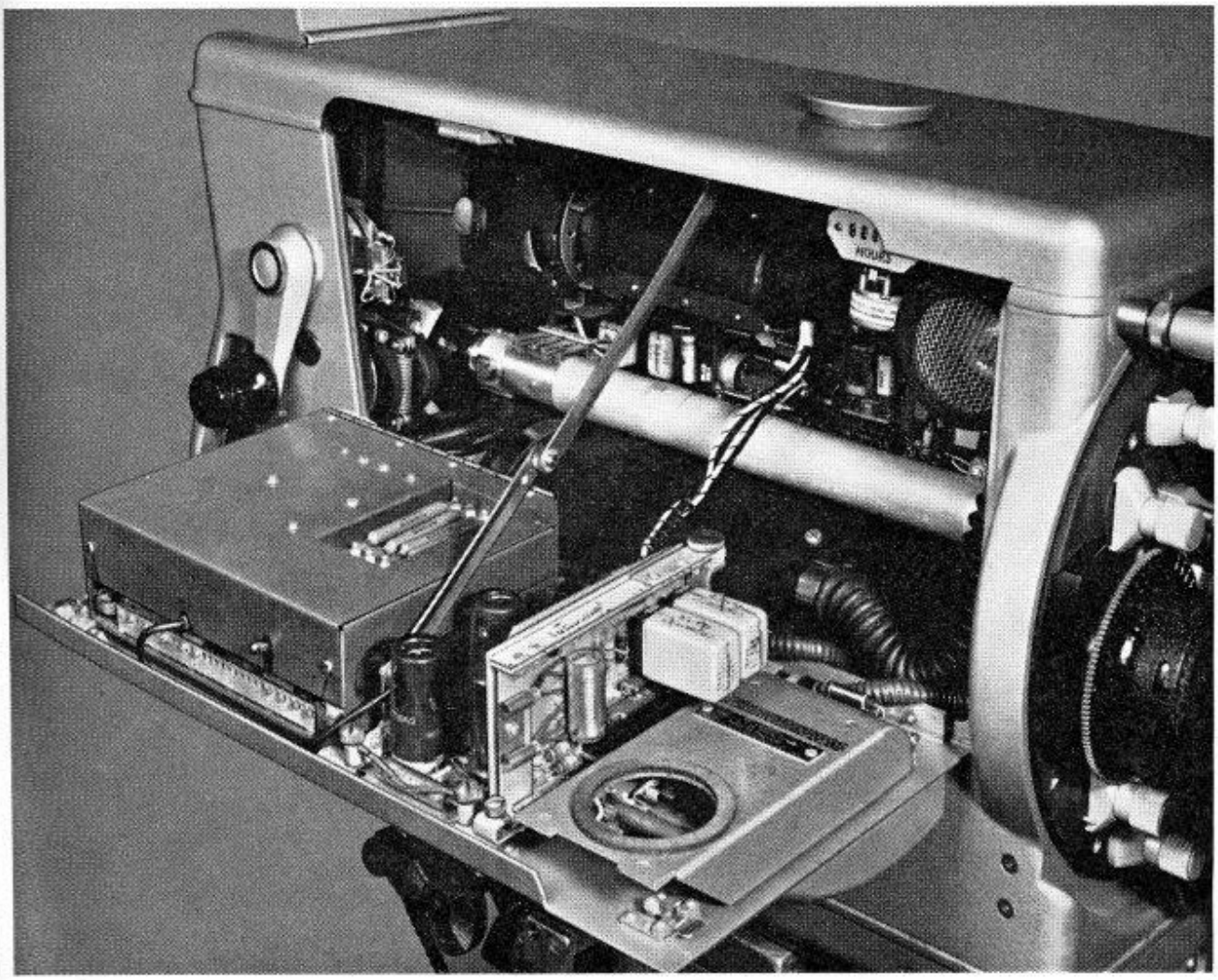

Fig. 5. The right-hand-side cover hinged down to show the solid-state pre-amplifier unit's copper cover.

changed suddenly, and added to the transient changes was a fairly large 25-cycle component. Anyone who has any experience of operating a 60-field system in a 50-cycle mains area can imagine the effects this produced. It is no exaggeration to say that during the rush hour the pictures from a normal channel had the appearance of being governed by the proverbial "flea on a hot brick". One thing was clear: if an answer could be found to this problem the effects of local fields elsewhere in the world would no longer be a problem in relation to resolution.

Two weeks were spent in Studio 50 experimenting and measuring, with the generous help and advice of CBS engineers. At the end of this period it was fairly clear what was wanted to cure the problem, but what was not so clear was how it was to be achieved.

Back in England, it was the mechanical engineers and drawing office who had to solve the problems associated with getting a satisfactorily screened yoke into the camera (Fig. 3). Naturally, some minor modifications had to be carried out to the camera body to get the new screened yoke in, and the yoke mounting had to be changed. It was also necessary to put a magnetic screen round the viewfinder tube as even this was badly affected by the Studio 50 conditions. While these modifications were being carried out, the opportunity was also taken to improve certain other features; the picture geometry was improved and the correction system was made simpler. The viewfinder tube was moved back some $\frac{3}{4}$ in. to improve the viewing from oblique angles. While the design of the yoke was being carried out a 4-ft cube of magnetic field was being made with two 4-ft square coils, each carrying some 10 A of DC. By quickly reversing the current,

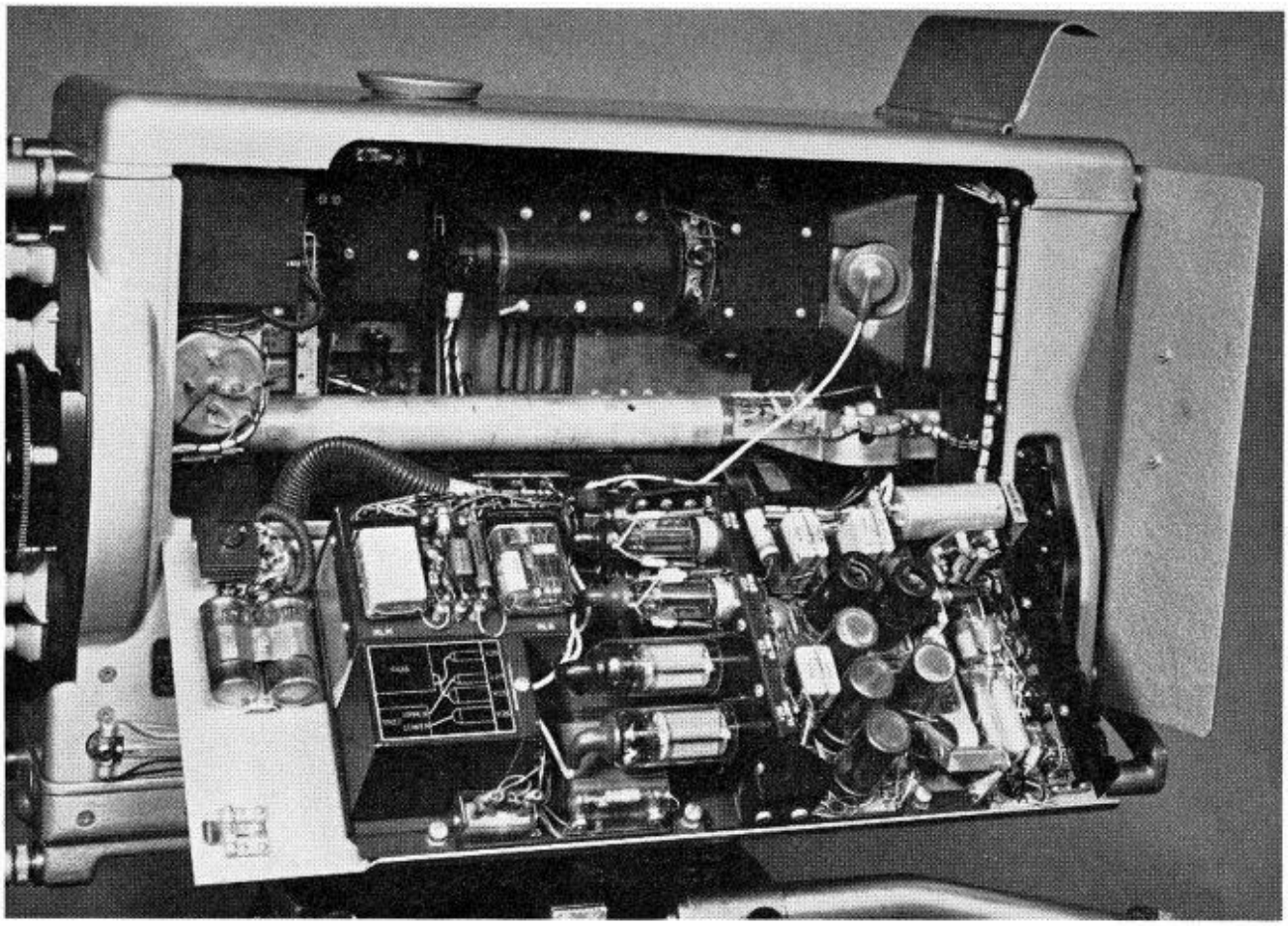

Fig. 6(a). The line scan and EHT modified for standards switching. The screening of the viewfinder tube can also be seen.

conditions similar to those in Studio 50 were simulated (Fig. 4).

A camera was modified and a fully screened yoke fitted into it and exhaustive tests carried out. This camera chain was then shipped to America for assessment by CBS. This was achieved in less than 5 weeks from the time the engineer first went to New York. That the whole venture was successful is clearly shown by the fact that Studio 50 is now fully operational, and has been equipped with fully screened Mark IV cameras for many months, providing pictures which meet the very high standards of technical quality which CBS expect from their studios, and for which they are known throughout America.

It can be stated without fear of contradiction that de-focusing due to panning a camera in the earth's field is a thing of the past with Edition J.

SOLID-STATE HEAD AMPLIFIER

The solid-state head amplifier is a direct mechanical replacement for its predecessor (Fig. 5). Its output is passed down the camera cable at standard level, and a simple attenuator in the camera control unit reduces this signal to the level of that provided by the valve head amplifier. The use of silicon transistors in the new unit makes it more reliable and gives it an improved frequency response both in normal use and in the test input condition. Accessibility and heat dissipation have been considerably improved by comparison with its predecessor.

STANDARDS SWITCHING

The earliest camera channels could only be changed from one line standard to another by changing soldered links on various printed boards and chassis. Full standards switching was introduced gradually to the whole range of Mark IV equipment. This range includes the Image Orthicon and Vidicon camera channels, Picture and Picture & Waveform Monitors and the Mark IV Communication unit. Full standards switchability implies the change from one standard to another of a whole series of units or equipments at the turn of a

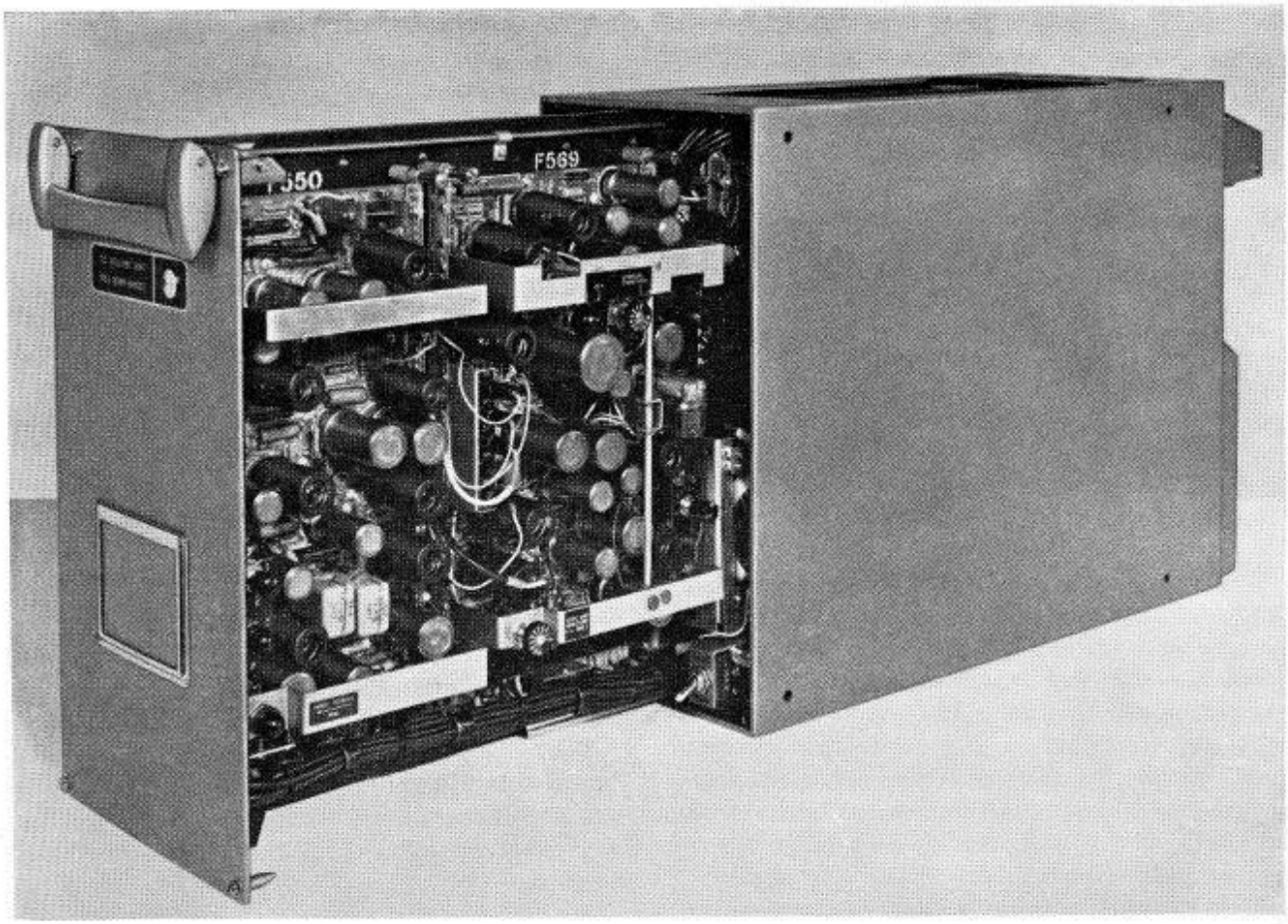

Fig. 6(b). The Camera Control Unit seen from the right-hand side. The relay for standards switching is at the top right.

single switch. This implies relays, and a number of units had to be designed to incorporate them. Some of the replacement units are not directly interchangeable with their earlier counterparts (Figs. 6(a) and 6(b)). However, simple modification instructions explaining the changes necessary to incorporate later units in older channels are available when called for. Change of standards can now also be achieved by changing certain systems determining plugs in the equipment, and a camera channel is despatched with only the appropriate set of these plugs when a single standard is required. By replacing these plugs with relays instant changeover from one system to another is possible.

A facility for common cueing — where a single cue impulse operates a series of equipments in sequence — was introduced at the same time as standards switching was introduced.

The whole history of the Mark IV Camera Channel has been one of continuous improvement. The various changes have been introduced in groups at various stages during the 4 years that it has been in production, and where possible, notice of changes has been sent to all users complete with details as to how they may introduce current improvements retrospectively into equipment that they hold. The organization inside the Company behind this, channels all comments and suggestions back to one group of engineers who devise the modifications and ensure that the significance of them is fed to the designers of new equipment, to ensure that future designs contain all the best ideas that are available. These criticisms and suggestions are welcome as it is only thus that the Mark IV Camera Channel and other products can continue to improve, and the receipt of regular reports of faults and copies of operational service logs are equally welcome.

REFERENCES

1 B. M. Poole: The Marconi Mark IV Camera; *Sound & Vision broadcasting*, Vol. 1, No. 1, p. 23, Spring 1960.
2 Dr H. Wehrlin: New O.B Units for Switzerland; *Ibid*, Vol. 2, No. 3, Winter 1961.