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J. R. CROOK, C.Eng, M.I.E.R.E.

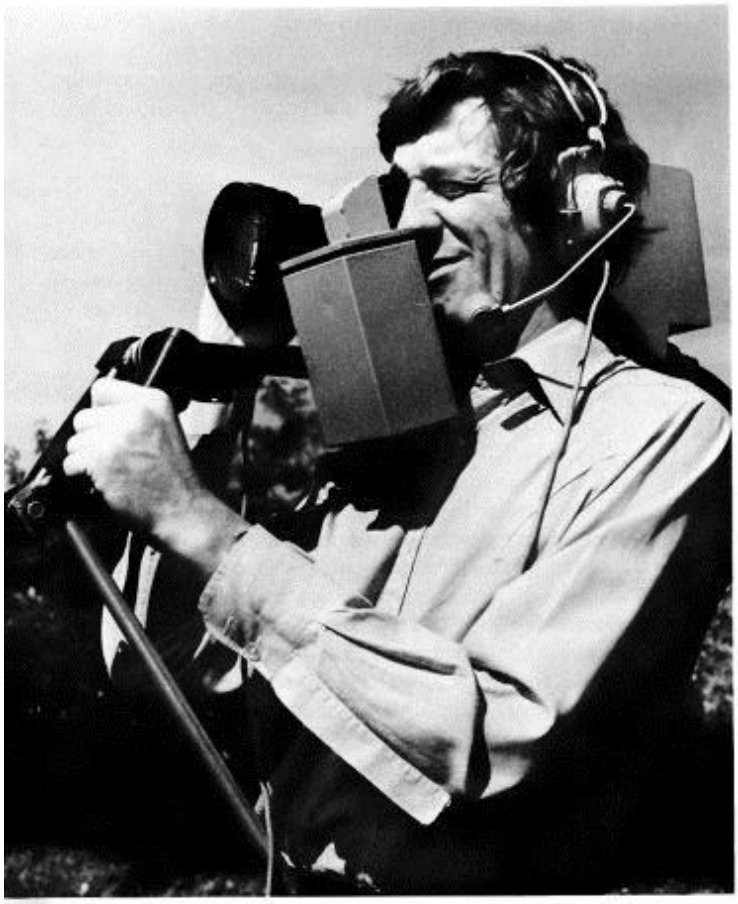
A portable camera head for the Mark VIII colour camera channel

Lightweight portable or 'hand-held' colour cameras are being increasingly used to extend television coverage to areas not readily accessible to standard studio or OB cameras. They are also beginning to displace film cameras in news coverage and for drama inserts.

Providing superior picture quality and more comprehensive facilities, a new portable colour camera head system has been designed to operate with the Mark VIII camera control unit and power supply. It may therefore be used with Mark VIII equipment already in use throughout the world.

The portable camera system comprises a camera head and an auxiliary pack, joined by up to 50m of standard camera cable. The camera head may be carried by the cameraman or be mounted on a lightweight tripod. The auxiliary pack may be carried by the cameraman or an assistant, or may be mounted on a small two-wheeled trolley, and is connected to the CCU by up to 900m of camera cable.

The camera uses three 1in lead-oxide photoconductive tubes. Its viewfinder has a high-resolution 1in c.r.t with a magnifier lens.



Introduction

For some time broadcasting organizations have been making use of lightweight portable, or 'hand-held' television cameras for greater mobility and to extend coverage of events to areas not readily accessible to standard studio or outside broadcast cameras. Apart from its obvious application to sports and similar events, the portable camera is beginning to displace the film camera in areas of operation which have hitherto made use of film exclusively. In news coverage, for example, the delay incurred in the processing of film is eliminated, and furthermore, the portable television camera is often capable of operating in poorer light.

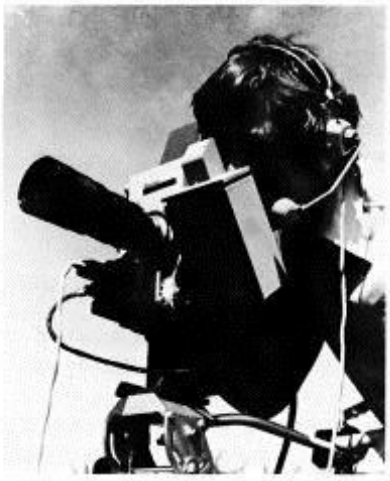
Another area in which the portable camera is being increasingly used is in the recording of inserts for television drama productions at locations outside the studio. This has the advantage over the use of the film camera that a good colour match to the studio camera pictures can be more easily obtained, and in addition, the director is immediately able to see the results of each shot.

More general use of the portable camera has been limited, amongst other factors, by the relatively poor picture quality of some of the early models, which could, however, be justified by the immediacy of the pictures. Other limitations are imposed by the lack of normal operational facilities.

The new Mark VIII portable camera head described in this article has been designed to satisfy the various operational requirements demanded of the lightweight camera, including the provision of broadcast quality colour pictures and comprehensive facilities. In addition, a notable feature is that it employs the same type of camera control unit and channel power supply as the Mark VIII studio and OB colour camera[1]. Thus it can be used with the many existing Mark VIII equipments already in use throughout the world.

General features

The camera head system consists of two parts, the camera head itself and an auxiliary pack. In this way the camera weight has been minimized so that it can be



carried comfortably on the cameraman's shoulder, or alternatively, can be mounted on a lightweight tripod.

The two units are connected by a lightweight camera cable which can be up to 50m (160ft) long, so that for many situations it will not be necessary to move the auxiliary pack during a transmission. The length has been chosen as a compromise between on the one hand, the need for the greatest mobility and on the other the penalties in terms of equipment performance, cost and weight that result from the voltage drop in the conductors feeding power to the camera. The camera head cable is fitted with connectors at each end. The use of a connector at the camera is felt to be justified despite its weight because it is essential to be able to replace a damaged cable quickly, and the repair of a wired-in cable could take some hours to complete.

The auxiliary pack can be located up to 900m from the camera control unit (CCU) connected by a standard Mark VIII camera cable. It can be mounted on a small two-wheeled trolley or fitted to a shoulder harness carried by the cameraman or an assistant.

The complete portable camera channel thus comprises the camera head and the auxiliary pack together with standard Mark VIII CCU and channel power supply units.

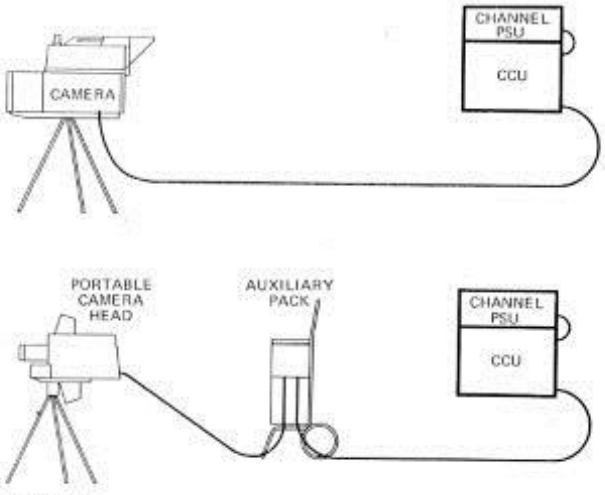


Figure 1

Operational facilities

The need to keep size and weight to a minimum necessarily imposes a limitation on what can be provided in a portable camera. Nevertheless, through careful design, the facilities of the standard Mark VIII studio and OB camera that are useful in the portable role have been incorporated. These include: automatic registration, automatic colour balance, the standard talk-back system, iris servo-controlled from the CCU, selection of the viewfinder picture source and the option of a power-driven zoom[2,3,4]. In addition, two-way communication has been provided between the camera head and the auxiliary pack.

Camera

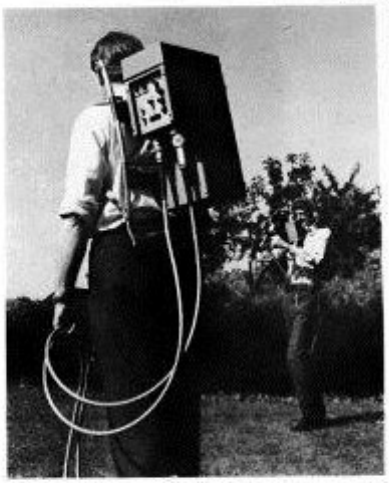
CONSTRUCTION AND MOUNTING

The optical block housing, the camera base and most parts of the shoulder mount are made from magnesium castings, magnesium having about half the density of aluminium. This, and a close attention to weight throughout the design has resulted in a camera providing excellent portability and ease of handling consistent with robust construction.

To give the greatest flexibility in use, a number of arrangements have been designed to facilitate operation of the camera in various situations. In the shoulder-mounted arrangement the camera body may be mounted forward of the shoulder with the front supported by a 'chest pad', and this will generally be the best position when using a light 6:1 zoom lens. When a larger lens such as a 10:1 zoom is used the camera can be mounted further to the rear so that it is near to balance on the shoulder. This provides a very comfortable carrying position for the heavier lens. Adjustments of the shoulder mount and the viewfinder position have been arranged so that the camera can be readily adapted to suit cameramen of different builds.

The shoulder mount may be easily removed from the body, enabling the camera to be mounted with an





adaptor to a lightweight pan-and-tilt head and tripod. In this situation the viewfinder is mounted on a swinging arm so that when the camera is mounted on a very short tripod the viewfinder picture can be viewed from above.

OPTICS

The camera uses three tubes in a G, R, B arrangement, with a conventional type of colour splitter block. The three focus and deflection yokes are mounted in a vertical plane on the optical block housing. On the front of the housing a quick-release coupling enables a variety of different zoom lenses to be fitted. A three-position optical filter turret is included, and a manually-operated capping shutter is located between the zoom lens and the splitter block.

Whereas in the Mark VIII studio camera, an internal diascope is provided for the automatic registration system, for the portable camera a convenient external arrangement is employed. This gives a valuable reduction in camera weight, both in respect of the diascope itself, and in enabling otherwise excellent lightweight zoom lenses to be used, which have too short a rear focus distance to permit a diascope to be inserted.

One-inch lead oxide camera tubes are used which can include light bias to reduce lag. The yoke design is based on the Mark VIII type, having etched deflection coils on a borosilicate glass substrate, but it is shorter and lighter. The focus coil is wound with aluminium wire to reduce weight further.

ELECTRONICS

So as to achieve the valuable advantage of being able to use up to 50m of camera cable between the camera head and the auxiliary pack, slightly more electronic circuitry has to be packaged in the camera than would be the case if the distance was limited to, say, 2m. The camera head, therefore, contains the head amplifier front end, the line scan output stages, the beam focus stabilizers, talkback amplifiers, target blanking generator and scan failure protection circuits.

The three head amplifiers, which are on a single printed-circuit board mounted on the optical splitter block housing, each use a field effect transistor input stage, with the f.e.t forming the lower half of a cascode pair, and is included in a negative feedback loop. The green head amplifier, from which the high frequency signals for the green, red and blue CCU outputs are derived, is fitted with a Percival circuit to reduce noise to a minimum. Each head amplifier is followed by a 75-ohm output stage to drive approximately 0.3V p-p into the cable connecting the camera head to the auxiliary pack.

The line scan output stages are operated as linear amplifiers using current feedback, with the output transistors operating in a complementary class AB mode. Since these amplifiers are d.c coupled and possess a very high order of d.c stability, the centring d.c can be applied to the input. A single wire in the cable is used for each amplifier input signal, each carrying the combined line sawtooth, skew waveform and centring voltage.

To allow control of beam focus using a low voltage at the CCU, amplifiers are used in the camera head to control the high voltage applied to the camera tubes. The beam bias controls also use the same principle. A further advantage of using low voltage control lines is that some signals, talkback for example, can readily make use of the same lines, since low voltage coupling and decoupling components can be used. This enables the total number of ways required in the cable between the camera head and auxiliary pack to be kept within the number available in the standard camera cable.

It would have been possible to have mounted the field scan output stages in the camera head and thus make available some wires in the camera cable for other purposes. This presents problems in a unit which is very remote from its power supply, since adequate decoupling to avoid low frequency earth currents becomes impractical because of the size and weight of the necessary components. Due to the resistance of the conductors in the cables, low frequency earth currents result in spurious signals being added to the video signals from the camera head amplifier. It was, therefore, decided to mount the complete field scan in the auxiliary pack in spite of the six conductors required in the cable.

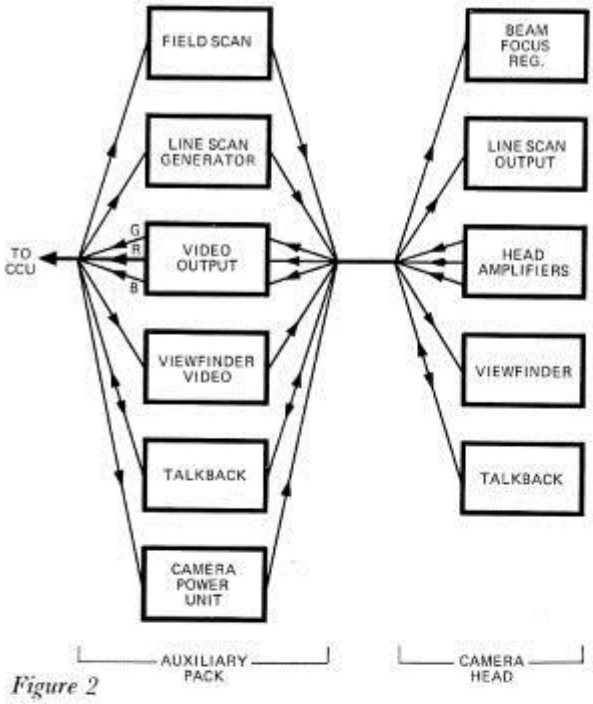


Figure 2

Auxiliary pack

This unit contains several printed circuit boards and the camera power supply unit, which is a high-frequency d.c-to-d.c converter. A number of these boards and the camera power unit are identical to those used in the Mark VIII camera head and are directly interchangeable. A new board in the auxiliary pack is the line scan generator which provides the line sawtooth drive for each output stage in the camera head and adds the skew waveforms and centring voltages. Also new is the output section for the camera head amplifiers, which provides the gain switching facility, clamping, clamp noise-reduction circuits, highlight clipping, and 75-ohm output amplifiers providing 0.7V of video to the camera cable. The distribution of the circuit functions between the camera and the auxiliary pack is shown in figure 2.

Viewfinder

A new viewfinder has been designed for the portable camera which uses a 1in c.r.t first developed for a high resolution electronic gun sight. The tube, which is complete with integral scanning coils and mumetal shield, is mounted with a prism and magnifying eyepiece in a small detachable unit together with the scanning generators, video amplifier and e.h.t generator. The eyepiece has been designed to provide the same apparent image size as that seen by cameramen viewing a 7in viewfinder from an average operating distance. In an eyepiece viewfinder the distance between the image and the operator's eye is fixed, so that the magnification provided involves a compromise between the ability to see fine detail in the picture and the whole picture being within the operator's field of view, in order that the picture may be easily framed. A glass prism is used to deflect the image through a right-angle and has been used in preference to a mirror mounted at 45° because the optical path between the tube face and the lens is lengthened, which in this instance was mechanically convenient.

DEFLECTION

A magnetically-deflected tube was chosen because in general the brightness available for a given resolution is superior to that obtained from tubes using electrostatic deflection. The penalty paid, however, is that deflection coils are more difficult to drive than deflection plates. Since the field coil resistance is relatively low it is necessary to use a transformer in order to obtain good efficiency when using the positive and negative 15V power supplies available at the camera head. The line scan coils are also driven via a transformer, using an energy recovery circuit which offers the best possible efficiency. Linearity correction is applied using a saturable reactor with a permanent magnet to provide the control field. An additional winding on the line scan transformer drives a further energy-recovery circuit which provides the 5kV e.h.t required by the tube final anode. A voltage-multiplier rectifier is used in order that the transformer voltage can be reduced to 1·5kV and hence makes the transformer more reliable. The cathode ray tube requires 800V for its focusing anode and this is derived via a regulator from the 950V supply available in the camera head.

VIDEO

The green, red and blue camera output signals occupy the three coaxial cables of the standard Mark VIII camera cable. Thus, some form of carrier system has to

be used to convey the video signal for the viewfinder from the auxiliary pack to the camera head. In the standard Mark VIII camera channel the viewfinder signal frequency modulates a 15MHz carrier and is transmitted up the coaxial cable allocated to the blue head amplifier output signal to the camera head where it is demodulated.

The same signal could have been used for feeding the portable camera viewfinder, but space was not available in the camera head nor in the viewfinder for the fairly complex filters (which are necessary, due to the relatively close spacing of the video signal and the lowest frequency sidebands of the f.m signal), nor the electronic circuitry associated with the limiters and discriminator. It was decided, therefore, to demodulate the f.m signal in the auxiliary pack and to use the resulting video signal to amplitude-modulate a 35MHz carrier. This also makes available a video signal at the auxiliary pack for monitoring purposes.

The 35MHz signal is fed to the camera head on the coaxial cable carrying the blue camera video signal. At the camera the two signals are separated by simple filters. In the viewfinder the 35MHz signal is demodulated by a low-level integrated-circuit synchronous demodulator.

Conclusion

By splitting the camera components into two packages, the camera head itself and the auxiliary pack, it has been possible to design a portable camera system that combines excellent mobility with, at the same time, broadcast picture quality and full operational facilities, including the essential automatic features of the Mark VIII camera. The use of the same type of CCU and power supply as used for the Mark VIII is a further significant advantage.

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