

# Camera Remote Control

USED IN B.B.C. REPORTING STUDIOS

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**I**N recent years the stability of vidicon cameras has improved to the degree that it is now possible to use them without the attention of technical operators. The first example of the use of an unattended camera in this fashion was, in fact, in the B.B.C.'s Parliamentary Reporting Studio at Westminster which was put into service about a year ago.

This studio is as simple as it is possible to conceive a television studio to be, consisting of a small room furnished with a table and chair, lights, microphone and a single television camera in a fixed position. The studio is brought into action by remote control from the Television News Studio at Alexandra Palace where the received signal is "mixed" into the programme. The operational success of this facility, simple as it is, stimulated a demand to be able to control the main positional functions of the remote camera in order to give variety to the presentation. In turn, the development of the apparatus for this positional control has led to the provision of a facility whereby the camera can be made to take up any one of a number of pre-set "shots" by the operation of a push-button switch, which may, if desired, be operated by the "subject" himself.

The camera functions which require to be controlled are horizontal angle (pan), vertical angle (tilt), angle of view (focal length of lens), camera focus and lens aperture. In order to avoid a hiatus in the picture while changing the focal length of the lens, advantage can be taken of a zoom lens.

As a field experiment, a vidicon camera has been fitted with a zoom lens and is installed in the B.B.C.'s studio in All Souls Hall, near Broadcasting House, and the camera can be controlled in all its main functions, either from the local control room or from the control room at Alexandra Palace, some seven miles away.

The camera is a standard vidicon, of a type in general use in interview studios where it is normally fitted with a four-lens turret. For the purpose of this experiment, the turret was removed and replaced by a cast plate on which is mounted the zoom lens together with the motor mechanisms for the zoom, focus and iris movements.

The servo system employed is shown in Fig. 1. The two potentiometers, A and B, form a bridge circuit of which the potential difference, at d.c.,

between points A and B, is fed to a modulator, which detects the potential difference between these two points and provides a correcting signal which, in turn, operates a motor so that the two points are brought as nearly as possible to the same potential. The modulator circuit employed is the well-known "ring" connection of four diodes to which, in addition to the d.c. control voltage, a constant 50 c/s e.m.f. is also connected. In order to keep harmonics in the output voltage to a reasonably low level the amplitude of the 50 c/s applied to the modulator is relatively low. It can be seen from the symmetry of the circuit that at balance, i.e., when A and B are at the same potential, there will be no 50 c/s output from the bridge into the control amplifier. On the other hand, when potentiometer A is moved, say to give a current flowing in the direction from B to A, diodes M1 and M3 conduct, causing the 50 c/s e.m.f. in transformer T1 to send a current through the centre-tapped winding of the transformer T2, producing an output in a particular phase. Movement of potentiometer A in the other direction, so as to cause a current to flow from A to B, makes diodes M2 and M4 conduct and, as compared with the previous condition, reverses the connection of the e.m.f. in transformer T1 to the terminals of transformer T2. Thus the phase of the output of the voltage from T2 changes by 180° as the direction of current between A and B reverses. Accordingly, the motor can run in either direction, depending upon the position of potentiometer B relative to potentiometer A. The a.c. output from the bridge is amplified and drives the servo control motor, which will always attempt to keep the bridge

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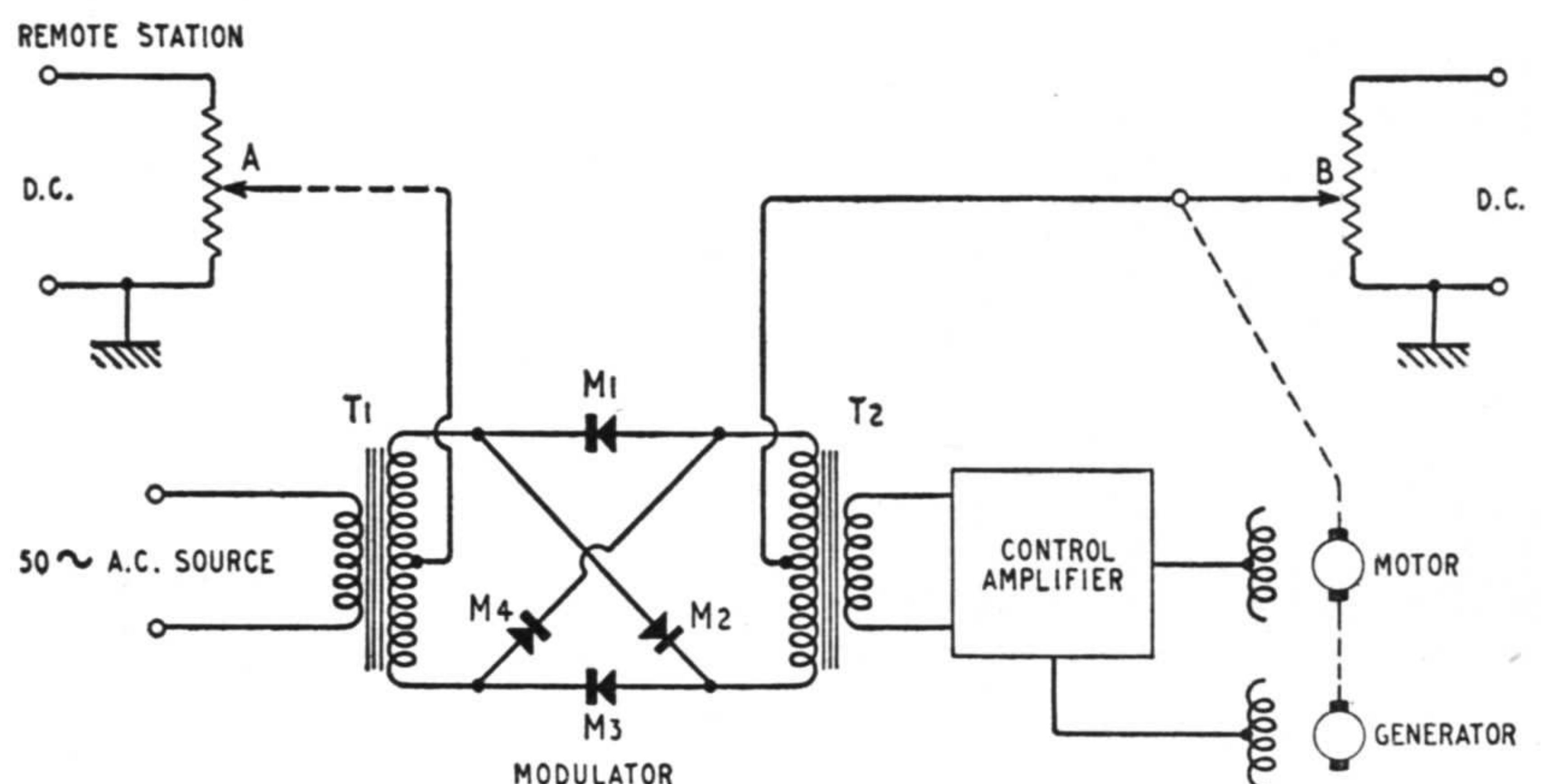


Fig. 1. Servo system schematic used for the remote control of a television camera.



Fig. 2. Servo motors, zoom lens, etc., mounted in place of the normal four-lens turret. These are enclosed in a cover which also forms a lens hood.

in balance. Thus, any movement of the control knob results in an equal movement of the controlled potentiometers as the motor drives the bridge into balance. Coupled to the motor shaft is a generator which produces an output of voltage proportional

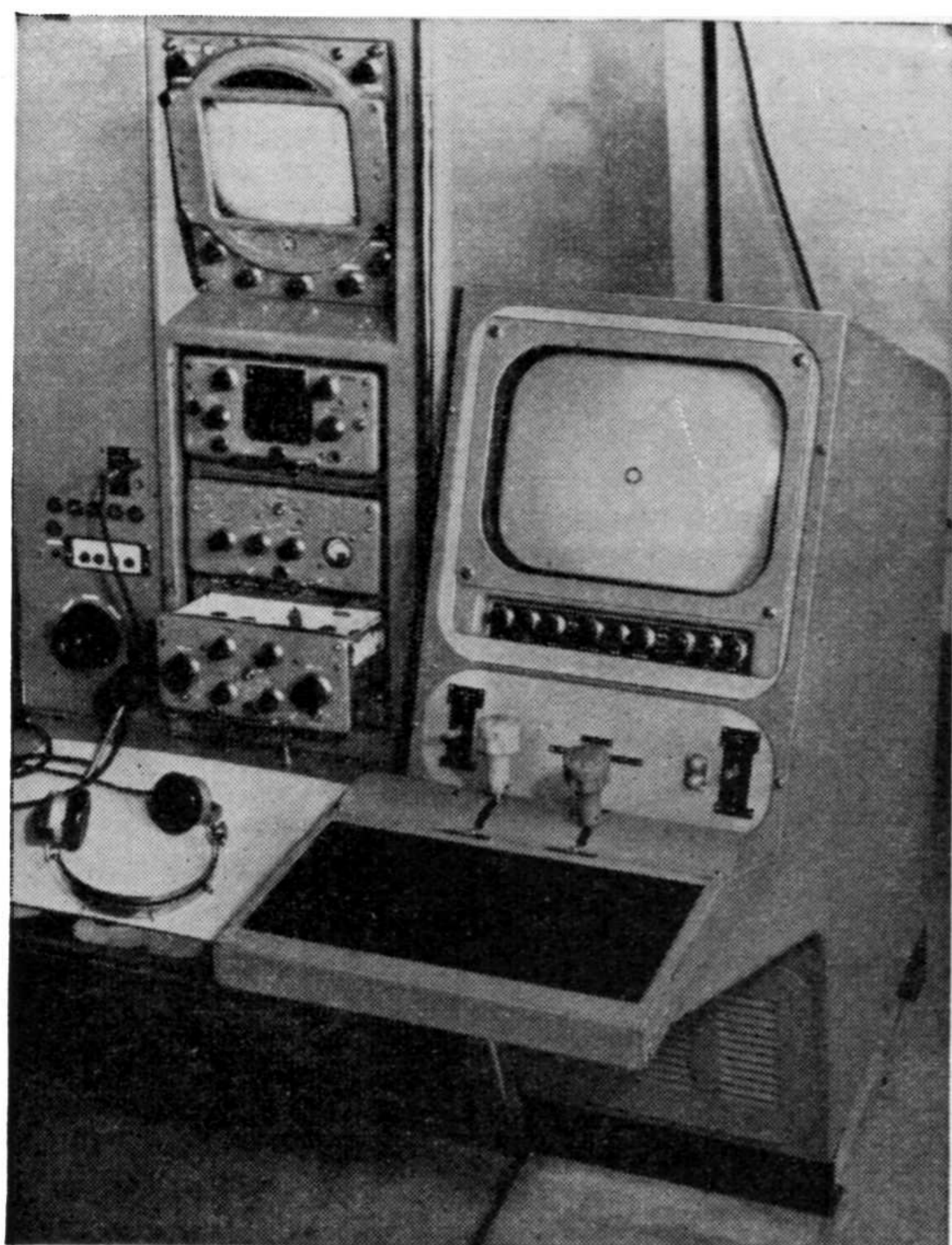


Fig. 3. Remote control console. The two large knobs control focus and zoom (left) and tilt and pan (right).

to the speed which is fed into the servo amplifier and so adjusted as to make the whole system critically damped. The action is very nearly dead beat giving the operator the impression that the knob is directly coupled to the mechanism which it operates and he has little or no feeling that it may well be many miles away.

The use of d.c. for the control current has the advantage that for short distances, say of the order of 10 miles, low quality circuits may be used. The system as installed between Alexandra Palace and All Souls Studio makes use of phantom circuits superimposed on existing speech and music circuits. For longer distances on which a d.c. loop is not available, it would be necessary to translate the control signals to audio frequencies, at which they can be conveniently transmitted.

The control amplifiers are four identical transistorized units capable of giving a continuous output of 20 watts each. They are driven from a stabilized 24-volt power supply. The amplifiers are straightforward audio amplifiers with emitter follower driven Class B output stages, the transistors being OC71, OC71, OC72 + OC72 driving 2N268 + 2N268. There are two controls, i.e., gain and velocity feedback, thus allowing the performance of any function to be varied at will.

The lens fitted has a minimum focus of 4 feet with a maximum aperture of  $f/2.8$ . The movement of the knurled operating rings required to go from minimum to maximum of all three functions of the lens is approximately  $180^\circ$ , and the preliminary design called for an operational time of 5 seconds end to end. This sets the reduction gear ratio for the servo motor, the stalled torque necessary at motor shaft being sufficient to overcome the friction of the mechanism. In view of the experimental nature of this camera only two positional servos were used on the lens, i.e., focus and zoom. The iris is controlled by a non-servo type of small reversible motor of low torque, end stops being used to limit travel. The servo balance potentiometers are mounted on the penultimate drive shaft; the final drive to the lens is by neoprene toothed timing belts. These belts have built-in flexible steel wires which prevent stretch, the teeth giving positive drive so that a minimum of side loading is required and they are silent in operation.

All the connections to the motors, etc., are brought out to a multi-way plug on the side of the plate. A cover with acoustic damping fits over the whole assembly and also operates as a lens hood.

The camera and lens assembly is mounted on a panning tilt head which has a tilting centre above the camera mounting platform so that the centre of gravity of the camera can be placed at this point, thereby making the whole assembly inherently balanced. The camera tilt mechanism consists of a sector of a circle whose centre is above the camera mounting surface. Gear teeth are cut in the curved underside of this sector and mesh with a transverse driving shaft. This mechanism can be seen in Fig. 2.

A servo motor is fitted to both pan and tilt mechanisms. The error detector in the tilt servo is a carbon track potentiometer geared to the transverse shaft, but that in the pan is a three-turn potentiometer to give adequate resolution. Velocity feedback is achieved by using a generator on the same shaft as the motor, as in the focus and zoom unit.

The pan motion uses an 8mm roller chain with a spring-loaded jockey pulley. In this case the driven chain wheel is fixed to the tripod head and the motor and driving pulley drive themselves round the head carrying the camera with them. The use of this method permits a change of gear ratio to be used without the use of large, expensive, special gears.

For continuous operation of the camera controls at the remote point, the operator sits at a console on the front of which are two knobs; each of these is moved in two modes: (a) rotation, (b) fore and aft like a lever. On the right-hand knob the rotation corresponds to pan and the fore and aft motion to tilt; on the left-hand knob the rotation corresponds to focus and the fore and aft to zoom (see Fig. 3). With a little practice, by the use of both hands the operator can control all four functions of the camera smoothly and comfortably.

It was soon apparent that to give smooth control, some form of damping on the motion is required, and this is provided by discs immersed in a silicone fluid rotating in a close-fitting chamber. The physical operation of each of these controls turns a potentiometer which forms part of the bridge of the appropriate servo mechanism.

Because the setting of any of the camera functions can be represented by the position of a potentiometer, by arranging to switch to groups of potentiometers, it is possible to give the camera a number of pre-set "shots." For example, Shot No. 1 might consist of a general view showing two people in conversation, Shot No. 2 would then be a close-up of the interviewer and Shot No. 3, perhaps, a close-up of the person being interviewed. On the operation of a push button, the camera can

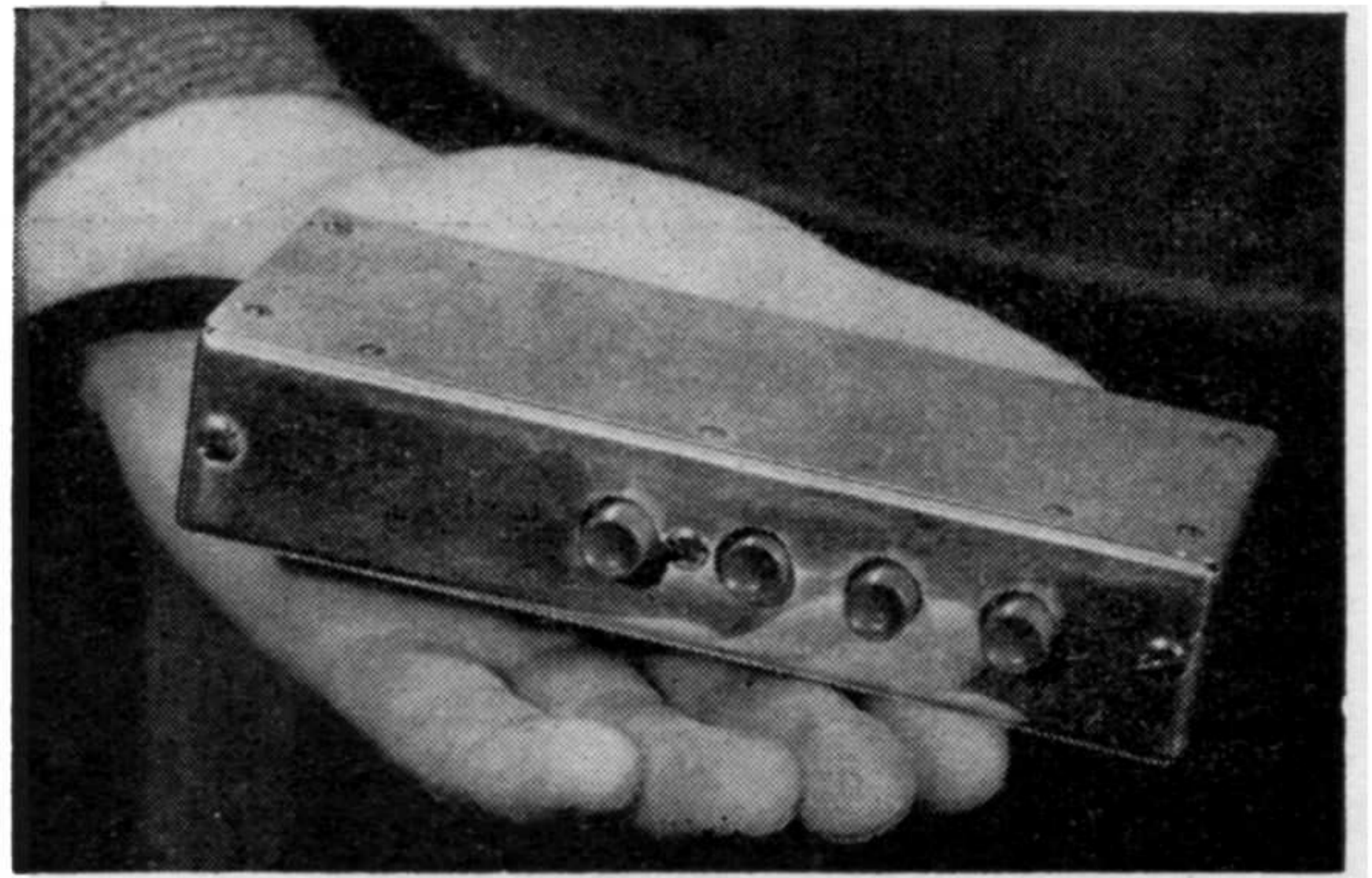


Fig. 4. "Shot-box" for the control of a camera by an interviewer.

be made to take up any of these shots at will. This leads to the possibility in studios where the programme is of a pre-set nature of using say, two remotely controlled cameras which look in turn at the appropriate "shots" under the control of the vision operators in the control room without having to have studio cameramen at all.

To pre-set any particular shot, it is only necessary to adjust the corresponding potentiometers for pan, tilt, focus and zoom, there being a group of four such potentiometers for each shot required. On the experimental camera the four positions on the "shot-box" control have proved adequate and useful. Visitors to one of the B.B.C. stands at the Earls Court Radio Show had the opportunity of manipulating a camera in this manner.