Colour Television Camera Channel for B.B.C.

Colour television camera equipment made by Marconi's Wireless Telegraph Company, Ltd., has recently been supplied to the B.B.C. for experimental work. The equipment is a compatible system (that is to say the colour transmission would be capable of being received in monochrome on existing receivers). It is based on specifications adopted by the N.T.S.C. of America.*

A COMPLETE colour television camera chain has been supplied to the B.B.C. for experimental purposes by Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex. The equipment consists of a three-tube colour camera, a camera channel amplifier, and complete signal coding equipment for providing the equivalent of N.T.S.C. signals on British 405-line standards, with accessories to make a complete colour-camera channel. The auxiliary apparatus supplied includes black-and-white and tricolour monitors and colour test equipment.

The colour camera (Fig. 1) consists of an assembly of three 3in "Image Orthicon" tubes of special design. Each of these tubes handles a primary colour component fed into it by a system of dichroic mirrors and lenses which serves to split into three primary colours the light received from the televised scene, as described more fully below.

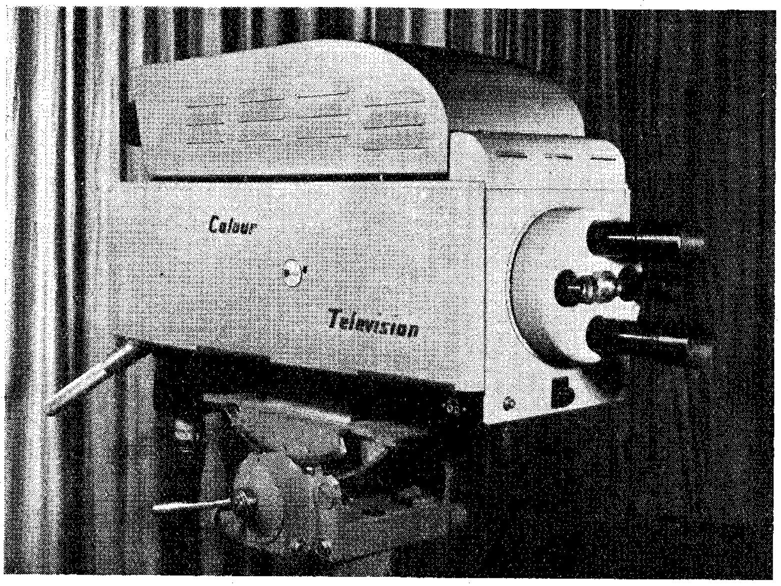
TRANSMISSION SYSTEM

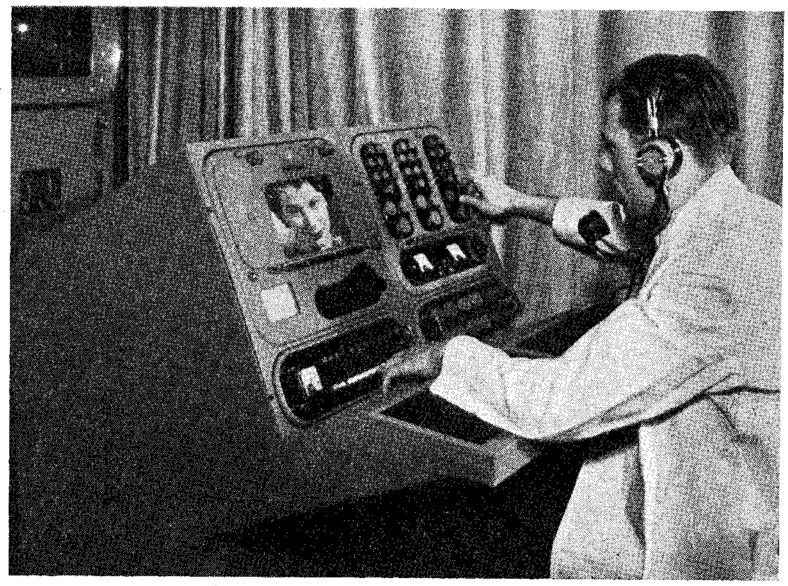
The system adopted for the transmission of the colour information is based on the fully compatible system now in use in America. The composite vision signal, as supplied to the transmitter, is composed of two parts—luminance (brightness) and chrominance (colour). The first component, luminance, is transmitted as amplitude modulation of the picture carrier and is identical to the black and white transmission used in this country: it is this fact which enables the composite colour transmission to be received on standard black-and-white receivers. The second part of the composite vision signal is a sub-carrier which is modulated by the chrominance information. The frequency adopted for the colour sub-carrier on the 405-line system is approximately 2·66 Mc/s.

This choice results from a consideration of two factors—the interference level produced on standard black and white receivers and the bandwidth available for the chrominance signal, the latter being limited in the one direction by the sound carrier. A sub-carrier at 2·66 Mc/s is barely noticeable on a black and white receiver for four reasons. First, the average receiver characteristic has fallen off appreciably at this frequency. Secondly, the exact frequency is chosen so that the dots produced tend to cancel on alternate fields. Thirdly, the carrier is locked to the synchronising pulses, thus preventing a moving pattern. Finally, the system is designed so that the amplitude of the carrier is zero in the absence of any colour information, that is for whites and greys, and is at full amplitude only in areas of highly saturated colour such as are rarely produced in an average scene. With regard to the bandwidth limitation imposed on the chrominance signal, advantage is taken of the well-known fact that the eye is insensitive to colour in fine detail, and, furthermore, that this effect is most marked along the purple-greenish yellow axis of the colour triangle and least so along the orange-cyan axis.

The complete information defining the coloured scene initially exists as three independent vision signals defining the red, green and blue contents of the picture. From these signals are derived three further quantities, one being the luminance and the other two together forming the chrominance. By arranging the two latter so that the one contains information relating only to colours on the purple-greenish yellow axis and the other to those on the orange-cyan axis, full advantage may be taken of the permissible restrictions in bandwidth mentioned above. These two chrominance signals, known as the Quadrature or "Q" and the In-phase or "I" components, respectively, are carried on the colour sub-carrier as a combination of phase and amplitude modulation. Two balanced modulators, the use of which ensures a zero output in the absence of chrominance information, are each fed with colour sub-carrier, the phase of that to the "Q" modulator being in quadrature with that fed to the "I" modulator. The outputs of the two modulators are added to form the complete chrominance signal, which is in turn added to the luminance and synchronising signals to form the complete colour signal.

The fact that a synchronous demodulator is required to separate the two components of the chrominance signal at the receiver necessitates the transmission of a colour synchronising signal. This takes the form of a short burst of the sub-carrier frequency which is in fixed phase relationship to the "I" and "Q" vectors and to which an oscillator regenerating the carrier in the receiver may be locked. In the colour receiver, therefore, the luminance and chrominance may





Figs. 1 and 2—(Left) Marconi three-tube colour television camera and view finder. It has a four-lens turret and remotely operated iris. The panning and tilting axes pass through the centre of gravity of the camera to give ease of control. (Right) The camera control position shown here incorporates a picture and waveform monitor

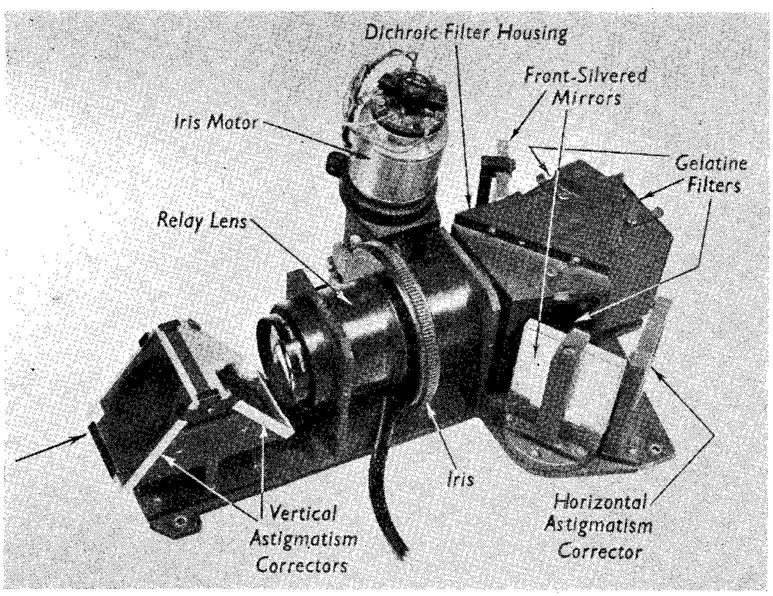


Fig. 3—Optical assembly of the Marconi three-tube colour camera. This view shows the astigmatism correctors, the relay lens unit and the dichroic and colour absorption filters, all of which help to split the light from the televised scene into three primary colours. The iris is remotely controlled by motor

* The National Television Standards Committee (N.T.S.C.) of America, in July, 1953, produced colour transmission standards and published a specification for apparatus which would compress all the necessary "information" for colour transmission into the same bandwidth as is now used for monochrome transmission. An adaptation of these standards is used in the Marconi equipment.

be separated by means of filters and the chrominance be split into its "I" and "Q" components in synchronous demodulators: proper mixing of these three quantities then enables the original red, blue and green signals to be recovered.

The Camera

The initial separation of the colours from the televised scene into the selected primaries—red, green and blue—is performed in the optical system (Fig. 3) of the camera. Light enters through one of the four taking lenses to form an image at a field lens mounted inside the turret. A one-to-one relay system follows and the final image is formed at a distance which allows a light-splitting system of filters and mirrors to be interposed. The division is by two dichroic filters mounted as a vee, green light passing straight through while blue and red are deflected to opposite sides, the light paths then being brought back into parallel paths by front-silvered mirrors. Further trimming is performed by gelatine filters. Astigmatism correctors are employed to overcome the distortion introduced by the dichroic filters.

Three "Image Orthicon" camera tubes are used, one for each colour. Neutral density filters are employed in the individual channels to enable the three tubes to be used over similar parts of their characteristics, the working range being restricted to the linear portion, to avoid colour unbalance with change of light level. Overall gain control is provided by a motor-operated iris, remotely controlled by the operator at the desk.

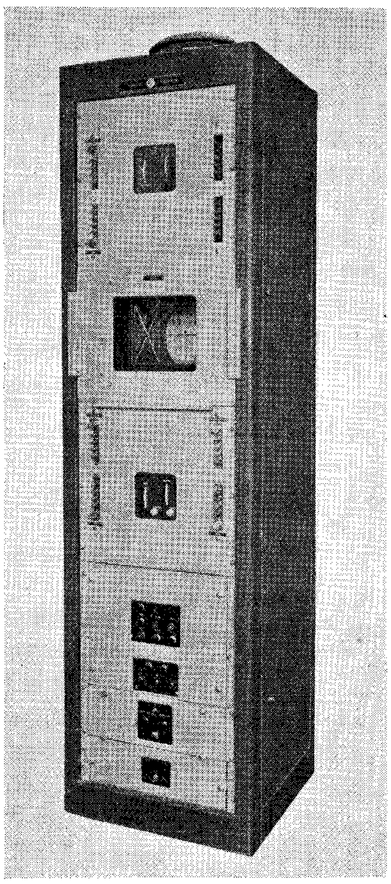


Fig. 4—Cabinet containing three-tube colour monitor

The focusing and deflection yokes are ventilated to eliminate any appreciable difference in operating temperatures between the tubes. The yokes are made to close tolerances and the provision of individual as well as common controls for height, width, centring, &c., enables a very high degree of registration to be obtained. Switching facilities on the view-finder and control desk monitor (Fig. 2), both of which provide high quality monochrome displays on 7in and 10in tubes, respectively, enable the three pictures to be superimposed for the purpose of registration. Under normal working conditions a degree of registration equivalent to 500-line definition in the centre and 400 lines in the corners may be achieved. Individual shading controls are provided to compensate for shading effects in the Image Orthicons." The red, green and blue outputs from the camera are fed to the "colourplexer" via an aperture compensator and a gamma corrector, both of which are triple-channel units. In the "colourplexer," the three signals are encoded to form the composite output described above.

The colour sub-carrier generator employs a temperature-controlled crystal, the frequency stability being better than three parts in a million. The sub-carrier is fed to each "colourplexer" via a phase-shifter which allows individual channels to be aligned. It also feeds a counter unit which provides a locked output at twice line frequency, this in turn being used to lock the synchronising pulse generator. The "colourplexers" are also supplied with a gating pulse timed so that the burst of sub-carrier, included for synchronising purposes, can be gated out so to make it appear in the post-synchronising pulse suppression period.

Two kinds of colour monitors are provided. One is a three-tube monitor which is incorporated in a 7ft cabinet (Fig. 4) and reconstitutes the picture by means of dichroic filters, registration being achieved in a similar way to that described above for the camera. The second is a single-tube monitor which is designed for mounting on a table or mobile stand and embodies a three-gun shadow-mask tricolour picture tube. In this tube the decoded signals are fed to the three guns, each of which is constrained to excite only one set of phosphor dots on a compound screen.

The equipment directly associated with the studio colour camera is housed in a twin-bay control desk (Fig. 2) and in four 7ft-high cabinets. The synchronising equipment which may be common to any number of studio or film camera channels, is contained in two 7ft cabinets.

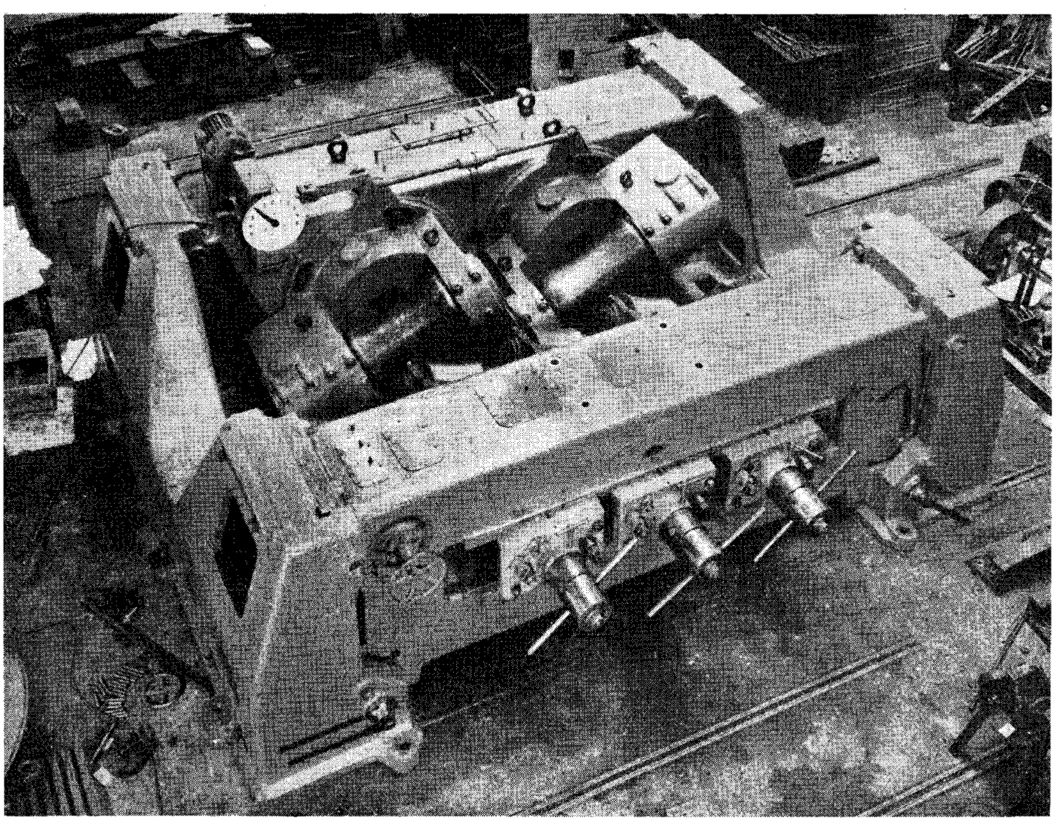
High-Speed Straightener for Large-Diameter Tubes

A TUBE straightening machine recently completed at the works of Joshua Bigwood and Son, Ltd., Wolverhampton, is stated to be the largest machine of its kind yet built in this country. It is for use in the production of high-grade, hot-finished steel tubes for oil pipelines, and is capable of handling tubes from 3in to 15in diameter. Normally, however, the machine will be used for straightening special alloy steel tubes, 9⅝in diameter with ⅝in thick walls. With this machine and its equipment, tubes are handled mechanically from the start to the finish of a straightening operation. Its controls are arranged at a central point from which the operator has an unobstructed view of the work but is a sufficient distance away to avoid risk of injury.

The machine works on the multiple inclined roll principle, where a number of idle and driving rolls disposed along the tube apply sufficient pressure to opposite sides to stress the material of the tube walls by flexure beyond its elastic limit. The driving rolls, by reason of their helical contact, rotate the tube and pass it through the machine, from which it emerges in the straightened condition. Straightening of the very wide diameter range in tubing, for which the machine is designed, makes it essential to employ rolls that can be adjusted angularly so that they may bear against a tube over their full length for all tube diameters, to eliminate any possibility of marking or crushing the tube.

The machine can be seen in the photographs we reproduce herewith. It has driving rolls of chilled iron running in heavy-duty roller bearings carried in swinging brackets located in circular machined recesses on the drive side housing. The three idle rolls are carried in steel forks, which are angularly adjustable in their chocks. Angular adjustment of the idle roll forks is effected by hand, and they are locked by bolts operated from the front of the machine. The weight of the driving roll swinging brackets makes it necessary to use an electric motor for their adjustment, and protection against over-adjustment is provided by limit switches. A dial is fitted to indicate the setting of the rolls to the operator who controls the adjustment from a remote push-button station.

As the straightening of tubes imposes relatively heavy loads on the idle rolls they are fitted with heavy duty roller bearings to ensure free rotation. The idle roll chocks are mounted in machined



Idle roll adjustment side of machine. The angularly adjustable driving rolls with their setting motor and dial can be seen on the opposite side of the machine