N. N. PARKER-SMITH, B.Sc, M.I.E.E

OPERATING THE MARK VII

SOME HINTS FOR BETTER PICTURES

WITH THE DELAYS that have attended the introduction of colour television in many areas, a large number of people are only now acquiring their first colour cameras. Many have little or no experience in handling colour equipment and in using it to the best advantage. The Marconi Mark VII colour camera has now been in operational use for over eighteen months, however, and it is the intention of this short paper to summarize a few of the more important lessons that have been learned during that time. It is hoped this information may be of some help to those who are just now commencing operations.

It is an inescapable fact that colour television is a more complex art than black-and-white television. The equipment generally is more complicated and equipment maintenance and setting-up procedures take longer. In general it is more difficult to pinpoint troubles. On top of all this, there is little doubt that for equal subjective acceptability, colour pictures must be of a relatively higher standard than their black-and-white counterparts.

Given a reasonable scene, the key to good colour pictures lies in the setting-up of the camera. Once a camera is in regular service it is not of course necessary, or desirable, to carry out the full setting-up procedure before each operation. Whatever adjustments are necessary, however, must be made in the correct way and a few of the basic ideas underlying the recommended procedures may be found helpful. Consider registration first.

REGISTRATION

Before starting the actual registration process it is important to check that the individual channels have been adjusted for optimum picture quality. Any adjustments which are overlooked at this stage, and which have to be made subsequently, may affect registration.

Initial setting-up should always be done by registering the individual images in pairs on a black-and-white display. A grating pattern of fairly fine lines is ideal. The best subjective result will be obtained by first setting green to luminance and then, taking green as master, adjusting red and blue to conform as closely as possible. The reason is that a small error on Y is relatively indiscernible. Using Y as master does not therefore lead to the optimum result.

Wherever possible, a final check should be made on a colour monitor. In this case, however, a pattern of relatively thick lines must be used, otherwise the grid will be outside the chrominance bandwidth so that vertical lines will appear in luminance only giving the effect of a perfect result.

Before leaving the subject of registration, a brief word should be said about the camera tube. The accuracy with which it is possible to register a camera depends not only on the quality of the scanning system but also on that of the camera tubes. It occasionally happens that the normal setting-up drill fails to produce registration to the normal degree of accuracy. The reason probably lies in the tube. The tubes are located in the yokes with reference to the outer surfaces of the glass envelopes. It may be that the electrode assembly within is not quite co-axial or concentric with the envelope. In such a case exact symmetry of the individual scanning systems is lost and perfect registration may be unobtainable. A significant improvement often results if the difficult tube is rotated.

Fig. 1. Six Mark VII cameras were used in Central Park, New York, during the Barbra Streisand show.

COLOUR FIDELITY

One of the most important factors in obtaining good colour fidelity is that the gamma correctors are not only accurately matched but set to the correct value. Unless the transmission system is linear from the light entering the camera lens to the point where light leaves the picture tube, no tristimulus system can work properly. The most accurate method of setting the gamma characteristics is by feeding a linear sawtooth into the video amplifiers and matching the output waveform to a graticule calculated for a value of $1/\gamma = 0{\cdot}45$, the value necessary to match the figure of 2·2 normally assumed for the picture tube. It is useful to check the performance on a grey-scale chart, the spectral neutrality of which is beyond reproach, a precise indication of the accuracy with which the channels are matched being given by operating the bridging switch at the output of the channel. This connects the Y, G, R, B outputs in parallel and should cause no significant change of colour through the range of the grey scale. It is important to concentrate on the actual grey scale, as the background is not guaranteed neutral and may change.

SIGNAL CURRENTS

The nature of the colour-splitting system of either a four-tube or a three-tube camera normally results in unequal signal currents in the various tubes. The red and blue currents are usually similar, whereas the green current can be three or even four times as much. Three-tube cameras are sometimes operated in this way in the interests of obtaining a good noise-free luminance signal. Operation with widely differing signal currents in the green, red and blue channels has certain disadvantages, however, and in the case of a four-tube camera, where little benefit derives from a larger green signal current, it is much more beneficial to insert a neutral density filter in the green so as to limit this signal current to not more than twice the red or blue. The problems arising if this is not done are dynamic misregistration and colour lag.

Dynamic misregistration is sometimes termed 'beam-pulling'. If the green tube has a higher signal current, it follows that the magnitude of the charge pattern on the photo-cathode is greater. As the scanning beam approaches the more highly charged area it is deviated more in the green than in the other tubes. The result is a coloured edge. The effect may readily be seen on a chessboard pattern and is, of course, quite independent of the accuracy with which the camera may have been registered.

As to lag, the Plumbicon,® although greatly superior to the vidicon in this respect, is not perfect. Since lag also is a function of the charge pattern, the lag will be different in the green, blue and red tubes unless the green current is limited. The effect of unequal signal currents can be demonstrated by passing a white object across a dark background. The leading edge of the white object will show a green smear, and a magenta trail will be seen to follow the object. The green smear is due to the slower build-up time of the red and blue tubes as the white object advances. The magenta trail is due to the discharge

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lag of the red and blue tubes as the object moves on. If the test be repeated with the green current limited, neither green nor magenta smearing will be observed and, moreover, the amount of lag will be determined solely by the luminance tube. The separate luminance principle of the four-tube camera is well known. By making the lag on the three colouring tubes equal, any colour lag is eliminated. This is because non-colour, or luminance, information from the colouring tubes is not conveyed on the encoded signal and the lag in the final picture, being only luminance channel lag, is that of the Y tube and is therefore negligible.

SIGNAL-TO-NOISE RATIO

Although the noise performance of a photoconductive tube television camera is a built-in performance characteristic and the picture can only be improved in this respect by providing more light, the noise performance of a colour camera is a much more complex subject than in black and white, and a little difficulty is sometimes experienced in tracking down noise problems. Noise is usually greatest in areas of saturated colour. Consider a saturated blue area. The luminance tube will be at a signal level corresponding to the luminance value of blue, that is 11%, or near to black. The noise in the luminance channel will thus be subjected to nearly the maximum gain of the gamma corrector. This relatively greater noise in the Y signal, appearing on the cathode of the display tube, is displayed by the blue gun at peak output. In other words, the noise has been precorrected for display at near black and is, in fact, displayed at maximum level by the blue gun. Blue noise on the output is thus seen to have originated in the Y tube. By the same argument the green and red tubes also contribute blue noise, and the same effect occurs, of course, in the case of a three-tube camera.

Fig. 2. The author with the Mark VII colour camera.

Another factor in the amount of noise appearing in the final picture is that high-frequency noise in the luminance signal lies within the chrominance band of the receiver and hence appears as lower frequency colouring noise. The amount of noise arising in this way can be determined by switching a low-pass filter into the Y channel output and noting the effect on the colouring noise.

The design of a four-tube camera must take account of all these noise sources, and the relative signal-to-noise ratios of the four channels of the Mark VII camera are such as to produce the best subjective result in the final picture. The tolerances on the light-splitting ratios in the optical system and those on the individual camera tubes sometimes produce minor variations in the final result. Thus one camera may show most noise on a saturated red and another on blue or magenta. Similarly, since it is often customary to expose the camera to a given luminance signal current, a particularly sensitive luminance tube may cause the colouring tube noise to be greater than normal. Such a camera will, of course, appear to be abnormally sensitive and the cure is to set the camera to the standard exposure, 150 f.c at *f*/8 or its equivalent, and operate at the luminance current which then results.

HIGHLIGHTS

An important aspect of performance of Plumbicon cameras is their limited ability to handle highlights. The tube has no inherent protection in this respect, as is provided, for example, by the knee of the image orthicon tube. Highlights in a Plumbicon camera must be removed by limiters in the video amplifiers and it is important that the limiters are correctly set in order to prevent highlights being objectionably coloured. The real problem lies, however, inside the tube itself, since if the charge pattern resulting from the highlight exceeds the capacity of the scanning beam to discharge it in at most a few fields, then objectionable blooming results, particularly with movement when the highlight produces a comet-tail effect. When highlights are likely, and this is the usual case, it is important to set the scanning beams at a value somewhat higher than is required for the normal scene.

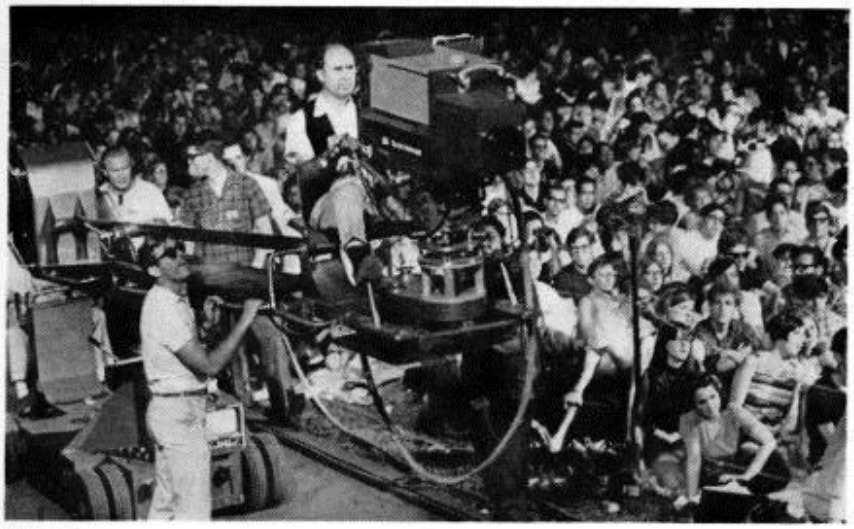
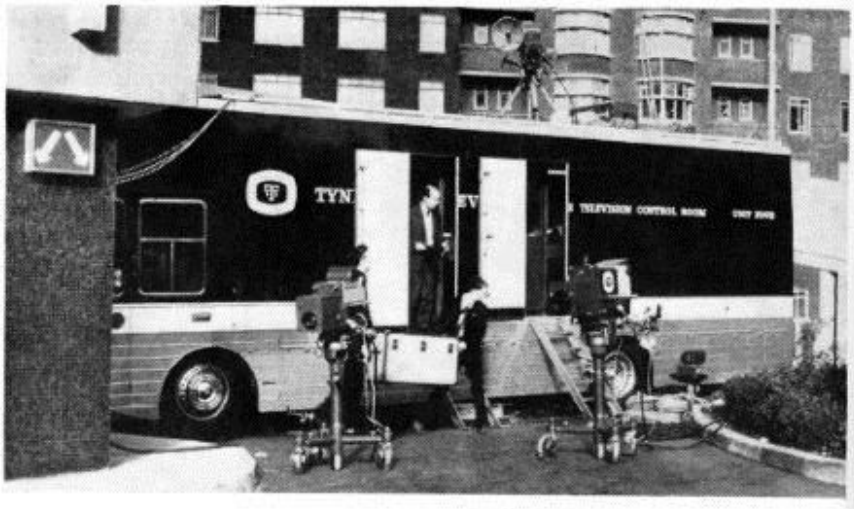


Fig. 3. The Mark VII colour camera in a typical O.B role.

With the present integral mesh tube a value of two or three times can normally be tolerated, the limit being set by a general loss of geometry which leads to unacceptable registration errors. Tests with separate mesh tubes indicate that a greater margin will be available with these tubes. The ability to use separate mesh tubes has been designed into the Mark VII from the start and the introduction of these tubes should therefore be a great benefit in this and other respects. Since Plumbicon lag is predominantly beam lag, increasing the beam current unfortunately tends to increase the lag, and this therefore is another factor in determining the best beam setting under severe highlight conditions.

Another method which has been proposed for overcoming the highlight effect is to operate the tubes with a reduced target voltage. The improvement results from the fact that the Plumbicon characteristic of signal output against target voltage has a knee, the output rising linearly up to about 20V and then levelling off. Reduction of the target voltage from a point well over the knee to a point just above it therefore causes little fall in output although a significant decrease in the charge pattern produced by the highlight results. The highlight effect is therefore relatively less severe. Good results are obtained by first setting the targets at the recommended value of 45V and then reducing this value to a point where the output has fallen by 5–10%. Doubts have been raised as to whether the practice of running the tube with low voltage is harmful, but experience indicates that there are no ill-effects provided the decrease is limited as above, rather than by setting the target down to a fixed value.

Tyne Tees mobile control room



The Tyne Tees Television mobile control room was first seen in action, and shown here, at the International Broadcasting Convention in London last year. Brief details were published in this journal, Vol. 8, No. 1, Spring 1967.