RESEARCH DEPARTMENT

Colour errors in the telecine reproduction of Technicolor film

TECHNOLOGICAL REPORT No. T - 179

UDC 621.397.132:621.397.331.2 1966/63

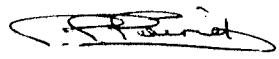
THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

RESEARCH DEPARTMENT

COLOUR ERRORS IN THE TELECINE REPRODUCTION OF TECHNICOLOR FILM

Technological Report No. T-179
UDC 621.397.132: 1966/63
621.397.331.2

C.B.B. Wood
E.W. Taylor, M.A.
F.A. Griffiths



Head of Research Department

This Report uses SI units in accordance with B.S. document PD 5686.

Technological Report No. T-179.

COLOUR ERRORS IN THE TELECINE REPRODUCTION OF TECHNICOLOR FILM

November 1966

Technological Report No. T-179
UDC 621.397.132: 621.397.331.2 1966/63

COLOUR ERRORS IN THE TELECINE REPRODUCTION OF TECHNICOLOR FILM

SUMMARY

Some colour films show incorrect colour in dark areas of the picture when reproduced by colour telecine. The cause of this error is discussed and a remedy, involving an alteration to the red colour-analysis characteristic, is described.

1. INTRODUCTION

It has been noticed that when colour films made by the Technicolor (dye imbibition) process are scanned in a colour telecine, the dark areas of the resulting pictures acquire a very pronounced red colour cast, but that when the same films are optically projected, this colour cast is not evident. The fact that only Technicolor prints give rise to this effect has led to an investigation into the effect of differences between the dye characteristics of these prints with those of other prints.

2. THEORY

Fig. 1*(a)* shows the spectrophotometric curves of a Technicolor print and an Eastman Colour positive print film Type 5385 when each has been exposed to give a neutral grey of density 2·0; the density of each film depends to a certain extent on wavelength, because it is the sum of the spectral densities of the yellow ('blue-controlling'), magenta ('green-controlling') and cyan ('red-controlling') dyes that are present on the film. Of particular significance is the fact that the density of Technicolor film to red light decreases to low values for wavelengths in excess of 660 nm while Eastman Colour print-film Type 5385 retains high density up to 690 nm; Fig. 1*(a)* shows that a density of 1·4 is reached at a wavelength of 675 nm for Technicolor print (point X) and at 711 nm for Eastman Colour print film (point Y).

The photopic response of the eye and the red colour-analysis characteristic of the film scanner are shown in Fig. 1*(b)*, plotted on the same wavelength scale as in Fig. 1*(a)* but using a linear ordinate scale. It can be seen that the response of the eye is very low at 'far-red' wavelengths; this is the region where the responses of the two film stocks differ from one another. The differences will not, therefore, be apparent when examples of each film stock are optically projected and the intended neutral grey will be reproduced satisfactorily to the eye. The red channel of the film scanner, however, has considerable sensitivity in this long-wavelength region, and the difference in the spectrophotometric responses of the two film stocks becomes important. If, for example, the wavelength at which a spectral density of 1·4 is reached is again considered, it can be seen that in the case of Technicolor prints, the red channel of the film scanner has a sensitivity of 53% of its peak value while in the case of Eastman Colour print-film, the corresponding value is only 5%.

Where the film is intended to represent a neutral density of 2·0, the signal in each channel of the film scanner should be 1% of its maximum value but calculations show that in the case of Technicolor print, the output of the red channel is 2·4% while for Eastman Colour print-film, the corresponding value is 0·93%. The enhanced output with Technicolor print gives rise to the red colour cast in the dark picture-areas; the slightly low output in the case of Eastman Colour print-film appears to have no noticeable effect.

3. MODIFICATION OF THE RED COLOUR-ANALYSIS CHARACTERISTIC.

It can be seen from the foregoing that an unwanted red colour cast in dark areas when reproducing Technicolor print may be avoided by restricting the far-red response of the red channel of the telecine. A difficulty arises, however, in that each of the three telecine output signals is influenced not only by the appropriate dye layer of the film but to a lesser extent by the two other dye layers also, because there is a pronounced overlap of the dye characteristics. When a saturated primary colour is reproduced, at peak luminance the appropriate dye will be absent in the scanned film and the

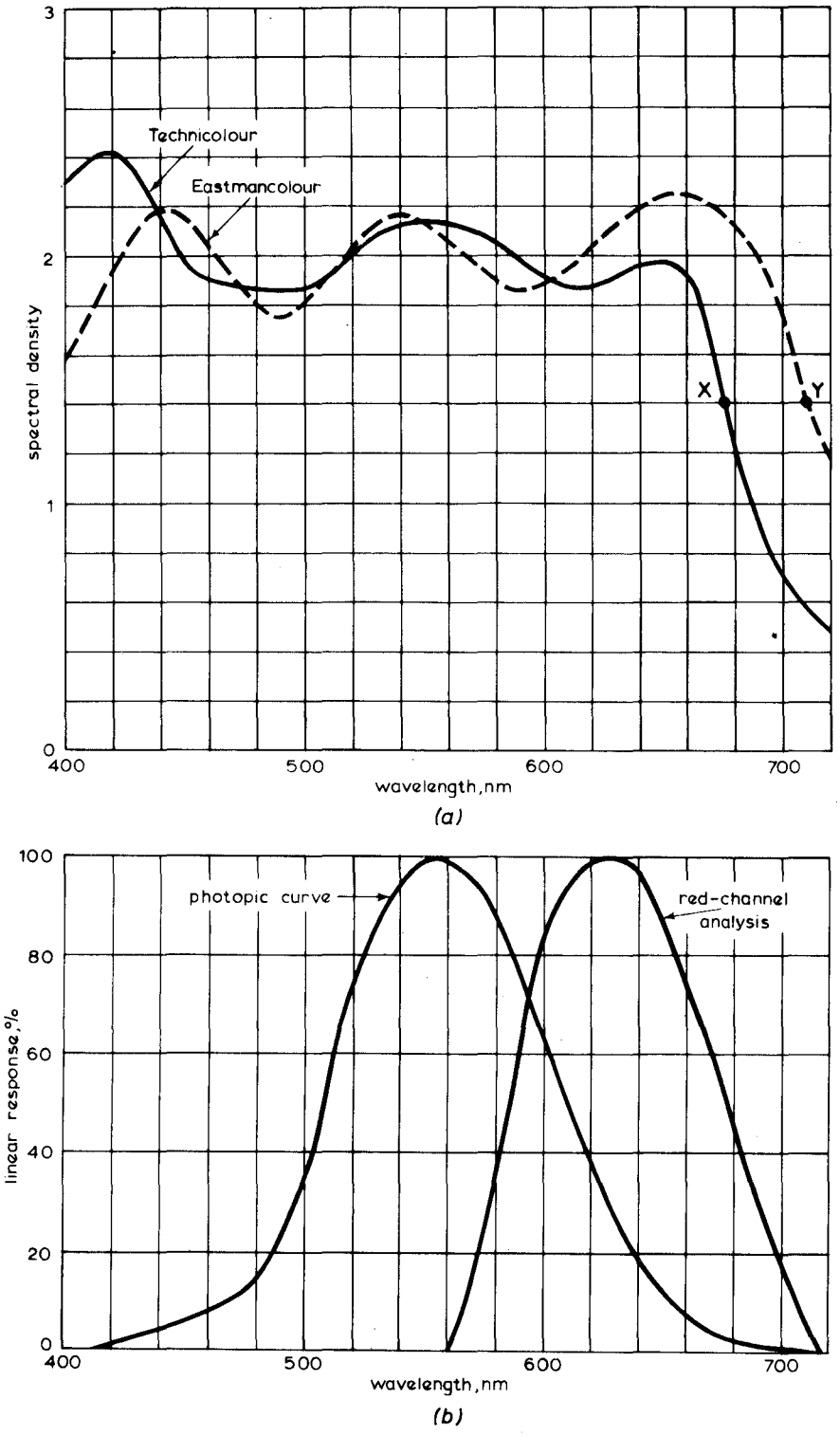


Fig. 1 - Comparison of Spectral densities of film stocks with eye response and telecine red-channel response.

(a) Film stocks *(b) Eye and telecine responses*

other two dyes will be present at maximum concentration. The output from the appropriate channel should then be at the peak value, which is determined in the complete absence of any of the dye materials; the output of the other two channels will be zero. Because of the overlap of the dye characteristics, however, the wanted channel output does not achieve the peak value even in the complete absence of the appropriate dye; some of the light is absorbed by the other two dyes. In the red analysis characteristic, this unwanted absorption occurs mainly at the shorter wavelength tests; any restriction in the long-wavelength region will therefore effectively increase the unwanted control exercised by the magenta dye. Where a saturated red is to be reproduced, the effect of the unwanted absorption by the magenta dye in a Technicolor print is to cause the output from the red channel to be too low although, as already shown, it is excessive when reproducing neutral greys.

Although the effects of the unwanted absorptions may be considerably reduced by electronic masking techniques, a compromise between the exaggeration of such effects on the one hand, and the reduction of colour errors in deep shadows on the other hand, must be made when choosing the characteristics of far-red restricting filters. A series of subjective tests was carried out to determine the characteristics of filters offering the best compromise; it was found that a very sharp cut-off is necessary, occurring at 665 nm, to discriminate between the wanted and unwanted transmissions of light by the film. This requirement is met by an interference-type filter, a practical case being shown in Fig. 2.* With this filter placed over the red receptor of the telecine, the relative sensitivity of the red channel becomes only 15% at 675 nm compared with 53% for the unmodified characteristic.

Having re-adjusted the channel-gains of the scanner to restore a neutral balance following the insertion of the new filter, it was found that with a Technicolor print of neutral density 2·0, the output of the red channel was reduced from 2·4% to 1·4%. as compared with the theoretically-required value of 1%. Subjective tests showed that an acceptable grey scale reproduction was then achieved. When reproducing a saturated red, the red channel output was hardly affected; it was reduced from 36% to 33% in the case of a Technicolor print and from 65% to 63% for an Eastman Colour print.

* This filter was designed by W.N. Sproson and M.K.E. Smith.

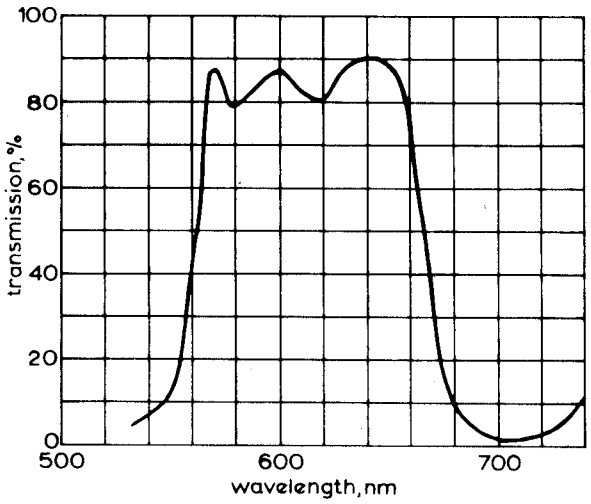


Fig. 2 Interference filter to amend red channel response of telecine.

The narrowing of the red analysis characteristic that has just been described does not significantly impair the signal-to-noise ratio of the red colour-separation signal.

4. CONCLUSIONS

The modification described results in a substantial improvement in the telecine reproduction of Technicolor imbibition process print, without significant loss of other aspects of performance on this or any other colour film stocks.

Printed by BBC Research Department, Kingswood Warren, Tadworth, Surrey