TECH NEWS

by Rodger J. Ross

COLOR TEMPERATURE AND ITS MEASUREMENT

When a tungsten filament lamp is turned on, it gives off light that appears to the eye to be white. But if the light is passed through a prism and spread out into the spectrum, it will be seen that the light is actually made up of a mixture of many different colors, from blue at one end of the display to red at the other. A sensitive instrument can be used to measure the energy in the different parts of the spectrum. Plotting these measurements on graph paper produces a continuous curve, rising steeply from blue to red. This indicates that the light from a tungsten lamp has much more energy in the red region than at the blue end.

The term "color temperature" is related to the actual temperature of a material when it is heated to the point where it gives off light. The standard reference material is known as a "black body" and the color temperature scale starts at absolute zero Celsius – 273 deg. below freezing. For practical purposes in the exposure of color film the color temperature in degrees Kelvin can be said to be approximately the same as the actual temperature of the incandescent filament in a lamp. As the current in the lamp is increased, by raising the voltage from, say, 100 to 130 volts, the filament becomes hotter, and this raises the amount of blue energy in the light, relative to red.

Daylight is made up also of a continuous band of colors, but a curve drawn on graph paper representing the energy in the light shows the blue end to be tilted up considerably, indicating that the amount of blue in daylight is much greater than in tungsten light. To the eye, both daylight and tungsten light usually appear to be white, due to the peculiar characteristic of the eye known as visual adaptation. It is only when these two sources of light are compared side by side that tungsten light can be seen as strongly orange-yellow in color, while daylight has a decidedly blue cast.

Color film is made with three separate light-sensitive layers. One layer is sensitive to blue, another to green (in the central part of the spectrum) and the third to red. During manufacture, films for use in cameras are "balanced" by adjusting the sensitivities of the three layers in relation to the amounts of red, green and blue light in either tungsten light or average daylight. If a film balanced for tungsten light is exposed with daylight, the pictures will have a strong blue cast – this can be avoided by placing a filter over the camera lens that absorbs the excessive amount of blue in daylight. Similarly, a daylight-balanced film can be exposed indoors with tungsten light when a filter is used that absorbs a sufficient amount of red light to match the film's sensitivity.

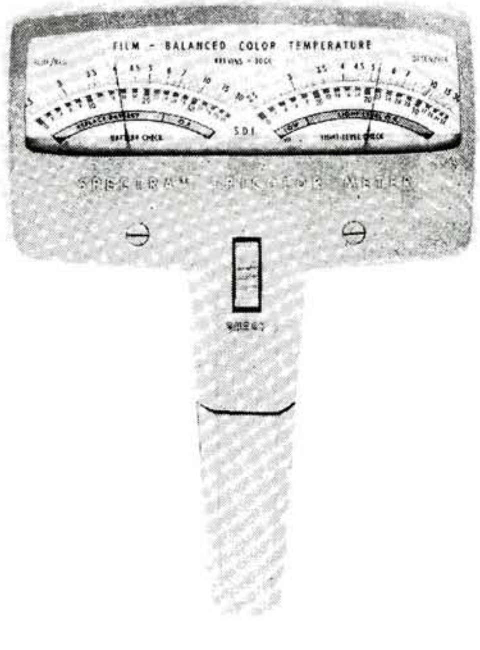
In practice, the amount of energy in light from tungsten lamps varies to an appreciable extent due to voltage variations and other factors. The earliest method for detecting these variations was to measure the ratio of blue to red. With this method the lamp voltage could be adjusted to maintain a particular predetermined ratio, known to give acceptable color pictures, or correction filters could be placed over the camera lens to compensate for color temperature variations.

This method worked so long as the light sources being measured had spectral energy distributions similar to tungsten lamps. Many light sources used in the exposure of color films do not have the near-ideal light-emitting characteristics of tungsten lamps, however. The spectral energy distribution of daylight does not conform with the tungsten light pattern, and its color varies considerably at different times of the day, and from one day to the next. Average daylight, which is a mixture of sunlight and skylight, gives a blue-red ratio quite different than that which would be expected from an ideal radiator emitting light at the same color temperature.

Color Temperature Meters

In the early 1950s there was a great surge of interest in the measurement of color temperature and in the interpretation of these measurements, since at that time color motion picture films were coming into more extensive use. In a paper published in the April 1950 issue of *SMPTE Journal* O. E. Miller of the Eastman Kodak Co. said that a meter was needed that could measure the amounts of red, green and blue energy in light sources, corresponding to the color sensitivity peaks in the three layers of the color film.

Karl Freund, well-known Hollywood personality and director of photography for several years on *The Lucy Show*, proposed a method of measuring the blue-red and green-red ratios in light sources. This principle was incorporated in the Spectra color temperature meter, put on the market in 1951 by Photo Research Corp. The meter was supplied with a circular calculator with which readings could be converted into required filter numbers.



Long time Supervisor of Technical Film Operations at the programming centre of the CBC, Mr. Ross is the author of two books, **Television Film Engineering** *and* **Color Film for Color Television** *and has just won the Agfa-Gevaert Gold Medal, awarded by the Society of Motion Picture and Television Engineers.*

The problems of matching light sources with the sensitivities of color film layers have become more acute with the more extensive use of light sources such as metal arcs and fluorescent lamps. These sources have spectral energy distributions that are not uniform across the spectrum. The peaks and dips in the energy curves may in some cases coincide with the peaks of film sensitivity, and in other cases fall between them. Either way, the resulting color pictures may turn out to be severely unbalanced in one direction or another.

In 1970 the Motion Picture and Television Research Centre in Hollywood collaborated with Photo Research Corp. to produce a new meter that would give more accurate indications of light source variations. This instrument, the Spectra film-balanced three-color meter, was designed so that its spectral sensitivity matched the sensitivity of commonly used camera films. A paper describing the meter and its development appeared in the Feb. 1971 issue of *SMPTE Journal.*

At the Society's 117th technical conference in Los Angeles, in October 1975, Richard Walker and james Branch described "a new direct-reading three-color meter" that had been developed by the Photo Research Div. of Kollmorgen Corp. In this paper, which was published in the Feb. 1976 issue of the *Journal,* the authors point out that the former film-balanced meter had some practical disadvantages; mainly because the user had to carry out several operations while holding the meter in a fixed position. The new meter includes two separate meter mechanisms for the readout, greatly simplifying the making of measurements. One meter gives a reading of the blue-red ratio, while the other shows the green-red balance of the light source. A separate photo-detector and filter combination is used for each of the three colors – red, green and blue – and the color temperature is computed electronically from the measured ratios. The ratios are determined simultaneously in a direct-reading mode, independent of light levels.

The color filters used in the meter were selected to match as closely as possible the photographic aim system. The system chosen as the aim was Eastman Ektachrome film, exposed through typical coated multi-element lenses. The spectral sensitivity of this combination is said to be similar to that of most other camera color films. Since the meter has almost the same response in any part of the color spectrum as the film will have, it will give reliable indications of the film's response to a particular source of light, the authors of this paper claim.

Calculators are provided with the meter to convert meter readings into the color correction filters needed to balance the light source color to the color film. These can be light balancing (color temperature shifting) filters, or cyan, magenta and yellow color compensating filters. From the calculator scales the filter needed to obtain the best possible match can be selected and placed over the camera lens.

While these papers deal mainly with the development of the meters, there is a great deal of valuable information in them for the practicing cinematographer, confronted every day with a bewildering variety of light sources and exposure conditions.

EQUIPMENT NEWS

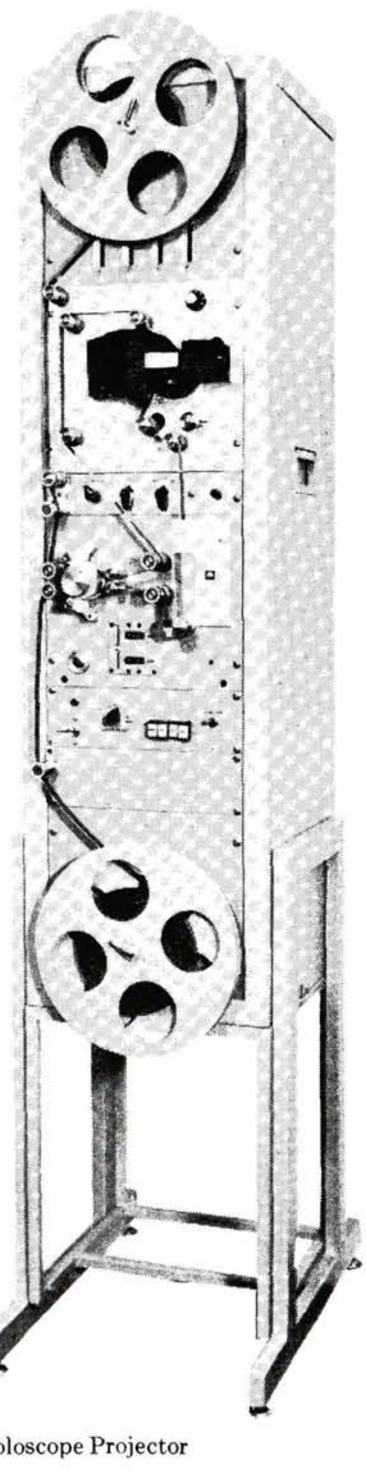
Note to Canadian distributors: We would like to include the names and addresses of Canadian distributors of equipment and services mentioned in this section. Please ask your suppliers to give Canadian sources in their publicity releases. Ed.

MultiTrack Magnetics Holoscope Projectors

MultiTrack Magnetics Inc., suppliers through Braun Electric Canada Ltd. of equipment for post-production and reproduction to Canada's film industry, has developed and produced "the newest tool in concept and operation" – the Holoscope Projector.

Everyone involved in post-production work has the problem of preserving the originals and still being able to view them with a projector, often with temporary splices. MTM's PH-16 High-Speed Holoscope Projector has effectively eliminated these problems, using a 24-sided prism and continuous film motion to give a totally flickerless picture. The film motion mechanism is the basic "building block" concept developed by MultiTrack Magnetics and provides steady, silent projection even up to 12 times normal speed, either forward or reverse. Frame lines are completely eliminated and the projected pictures remain in focus and frame synchronization during all modes of operation.

This unit is well-suited for telecine use. The projector can be fed into a telecine simultaneously with screen projection. The standard 400-W. tungsten-halogen lamp gives a picture size of about 40 inches, and the optional 500-W. xenon lamp a picture size of 59 inches. Prices and catalogues available from Braun Electric Canada Ltd., 3269 American Drive, Mississauga, Ont. L4V 1B9.



PH-16 Holoscope Projector