RARE-EARTH PHOSPHORS FOR COLOR-TV TUBES

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A new red phosphor which improves brightness by 43 percent is being used in color-TV picture tubes.

A BREAK-THROUGH in color-television picture tubes was announced by *Sylvania Electric Products Inc.* in June, 1964—a new red phosphor for use in making color-television screens. Since that time, the company has been using the new red rare-earth phosphor. With the utilization of the new phosphor, an improvement of 43% in brightness gain over the existing industry standard tubes was realized. The use of the new red allowed using the green phosphor to its fullest brightness capabilities instead of subduing it because of balance requirements with the previous red. To some extent this applies to the blue phosphor as well. Opening up the green along with the brighter red led to the new brighter color tube.

Although the brightness gain is important, still another equally important advantage is realized. The new red phosphor is a richer red; and unlike the color of the previous red phosphor, the new red color remains a rich red even when made considerably brighter by using higher gun-current density. The previous red phosphor shifted to orange under these same conditions.

Other manufacturers of color tubes are also obtaining the necessary rare-earth raw materials so that they too can make the new red phosphor. The whole industry has swung into the rare-earth camp and set manufacturers are employing the new rare-earth color-television picture tube types.

One of the four elements used in making the new red phosphor, europium, is of the rare-earth series and yttrium is similar to the rare-earth series of elements. The remaining two are oxygen and vanadium. The phosphor is actually yttrium vanadate activated by europium ($YVO_4:Eu$). See Fig. 1 for the spectral energy characteristics of the all-sulfide and rare-earth phosphors.

For true color rendition, it is important that each of the primary colors, *i.e.*, red, green, and blue, stay the same color throughout the various conditions of light mixing so that small amounts, or large, as needed, will result in truer representation. Since the new red phosphor color stays the same whether a low 100-μa. beam current or a high 2000-μa. beam current excites it (a ratio of 20 to 1), a truer color representation results over the various ranges of brightness called for in color-television pictures. (See Figs. 2 and 3 for details).

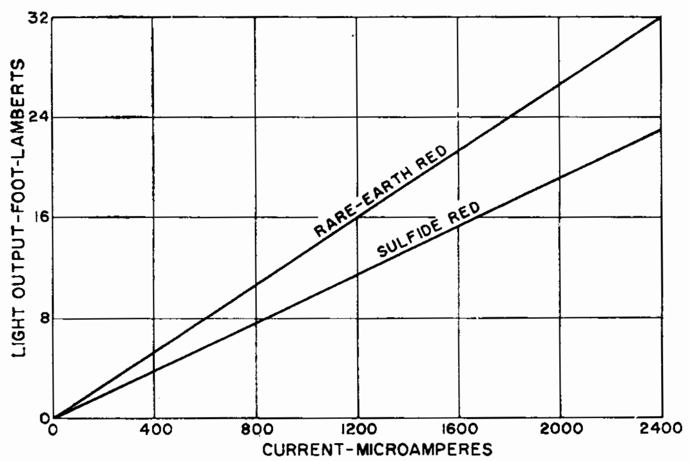


Fig. 2. Brightness comparison for various beam currents.

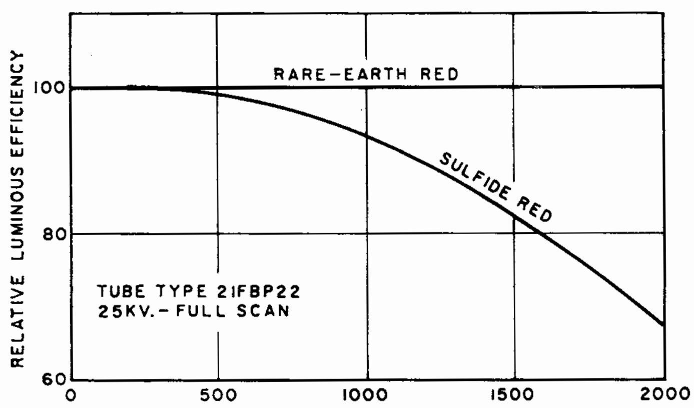
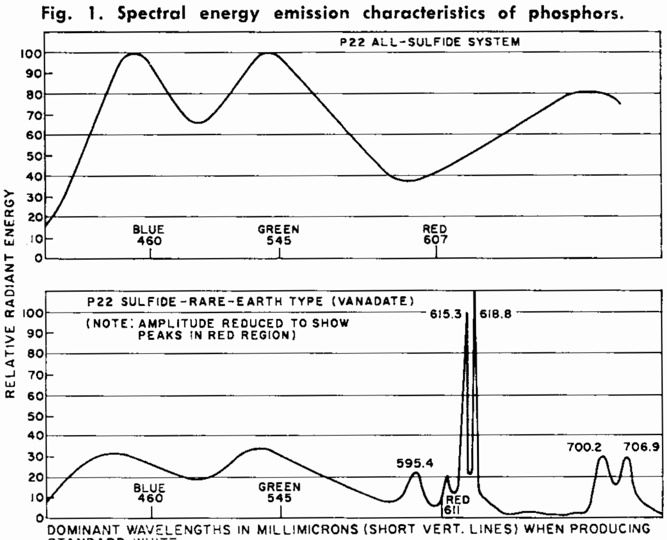


Fig. 3. Luminous efficiency for the red-emitting phosphors.

Fig. 1. Spectral energy emission characteristics of phosphors.



Viewing resolution, crispness of picture, and color fidelity in the high-brightness areas of a TV scene have all been improved by the rare-earth screen system. Specifically, the necessity for driving the red electron gun current to high levels compared to the green and blue to obtain white has been eliminated. Previously, the increased red gun electron beam size at the higher current (high brightness) condition degraded resolution and resulted in color fringing in dark areas surrounding high light areas.

An additional fact about the new rare-earth phosphor is that its unexcited appearance as a powder is white, like table salt. As a result, the new color-television screens do not have the yellowish look of the older types. Instead, they are much whiter in appearance with only the green sulfide phosphor having a very faint tint of color.

Color-tube manufacturers also find some processing improvements in making the new rare-earth red screen. Since it transmits ultraviolet light in the 3650 Å range instead of absorbing most of it, as did the sulfide red, this action of the new red in the photoresist exposure step is used in making the color phosphor dot patterns. ▲