

# The Start of the Rainbow: Possibilities of Color Motion Photography for the Amateur <sup>[1]</sup>

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## **ABSTRACT**

This paper provides a chronology and summary of amateur cinematography's early color history. Drawing primarily on articles and advertisements in amateur movie makers' publications and the popular press in the United States and Europe, it summarizes the additive color motion picture processes, effects, and equipment available to amateur cinematographers in the 1920s and '30s. The paper concludes that while these additive processes might appear primitive and flawed in comparison to later processes and technologies, they are worthy of celebration and appreciation for their ingenuity and unique characteristics.

**KEYWORDS** Color motion picture film, Amateur motion picture film, Additive color processes, Historical color processes

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## 1. Introduction

The earliest era of amateur movie making offered an inventive array of color possibilities for the film enthusiast. From the simple addition of colored filters on a projector to the delicate hues of lenticular Kodacolor, and later the accessory-free magic of Dufaycolor's réseau [2]. The market for amateur movie-making quickly flourished after the introduction of 9.5mm and 16mm gauges in 1922 and 1923, respectively. New publications emerged dedicated to the amateur filmmaker, and industry and professional journals introduced amateur sections, providing advice to the more serious amateur, keeping them informed of the latest and forthcoming technological developments. The quest for color - particularly "natural color" [3] - was eagerly anticipated by most writers in these publications, stoking readers' excitement with articles about what to expect: "Do you want natural color motion-pictures? Yes, you do! Color, good color, is obtainable!" (s.n., Photo Era, 1929) Some even recognized the role that the rapidly-growing amateur market had played in the development of the new color technologies: "... industry has found amateur markets a sufficient spur to evoke invention and evolution designed for amateurs alone." (Maxim, 1928) In contrast, there were detractors and doubters too, for reasons of both practicality and cost, but also aesthetics. Some writers just did not consider color necessary for the amateur. For example, in Photo Era's amateur column, Herbert McKay, asserted that the amateur cinematographer did not need color, concluding, "let us be content to accept the monochromatic film [...] as our standard." (McKay, 1926) Others asserted that amateur filmmakers were very much the pioneers and that they had the power to drive the market and even influence the professional industry. For example, Carl Oswald was confident that, "... the efforts of the amateur [...] lead to advances which the commercial organizations cannot afford to anticipate by the establishment of experimental laboratories." (Oswald, 1928)

## 2. A Chronology of Color in Early Amateur Moviemaking

The earliest (pre-1935) methods for producing color in amateur motion picture film were all additive processes, wherein colors in the image are created by the addition of colored light sources, such as filters or dyes, located either on the film stock itself or attached to the camera and/or projector. These early amateur motion picture color processes can be categorized into four broad groups (Fig. 1): 1. the application of color to the film or projected image (either applied directly to the film or through filters on the projector), 2. lenticular processes, 3. rotating, alternating filter mechanisms used to produce natural color, and 4.

Dufaycolor's unique réseau. The dates in the table indicate the introduction of a process and its approximate obsolescence.

Date	Process	Type
1 1920s	Hand-coloring	Manually applied directly to film
1 1920s - 1930s	Tinting / toning	Processed by filmmaker or sent to vendor
1 1927 - 1929	Filter projector attachments	Projector attachment
2 1928 - 1935	Kodacolor	Lenticular
3 1928 - 1932	DuPont Vitacolor	Rotating filter on camera and projector
3 1931	Mroz-farbenfilm	Rotating filter on camera; color applied to film base
3 1931 - 1933	Morgana Color	Rotating filter on camera and projector
2 1932?	Agfacolor	Lenticular
4 1934 - 1951	Dufaycolor	Three-color réseau inherent in film base

Fig. 1. A chronology of motion picture color processes available to the amateur filmmaker, pre-1935

### 2.1. Direct Application of Color to the Film or Projected Image



Fig. 2. Advertisements and an article in amateur movie publications. *Special Cinema Coloring Outfit* ad, *Movie Makers*, 1928, p. 476; *Tinting and Toning 16mm Films*, *William Stull, American Cinematographer*, 1933, p. 18; *Automatic Colorator* ad, *Movie Makers*, 1927, p. 65

Several techniques were available to the amateur who wanted to introduce color to the image, either directly to the film or to the projected image through colored filters attached to the projector. These techniques allowed the amateur to use color to interpret a subject or evoke a mood. For example, red for fire or danger, blue for a seascape or night scene.

To apply color directly to the film, filmmakers could hand-paint dyes onto the film, either covering the whole frame with one color or by intricately coloring specific parts of the image on each individual frame in an attempt to replicate natural color. Advertisements in the press (Fig. 2) show that hand-coloring equipment was available to the amateur filmmaker. Many amateurs would have been aware of hand-coloring techniques from seeing films such as those from the Edison and Pathé studios. The technique of hand-coloring individual frames was painstaking, immensely

time-consuming, and the results did not live up to the ultimate quest for “natural color”. Nevertheless, professional hand-colorist, Gustav Brock, strongly advocated for – and practiced - the use of hand-coloring in theatrical prints into the 1930s. (Brock, 1930) He regarded it as an aesthetic choice, even when “natural color” was a possibility, Brock enthused about hand-coloring’s appeal and how aesthetically effective it could be.

While hand-coloring was an intricate and time-consuming process, tinting and toning was more easily achievable for the keen amateur. Tinting was a technique used to color the highlights of the image by immersing the film in a dye bath, and provided an overall color to the whole, or sections, of the film. Toning converted the black and white silver parts of the image to another metal, resulting in a different color depending on the metal. Tinting and toning techniques were advertised in the early amateur movie makers press – both for home processing and as a lab service. The amateur press ran several articles detailing methods and techniques for the keen amateur movie maker to try at home. [4] As early as 1925, Herbert McKay’s series on practical cinematography in *Photo Era* magazine (McKay, 1925) recognized the value of tinting and toning for amateur movie makers but he advised that it should be left for the labs to do. In contrast, later articles in the *British Amateur Cine World* and the *American Movie Makers* encouraged the more experienced amateur to experiment with tinting and toning techniques at home. (Abbott, 1934; Kerst, 1927)



Fig. 3. Advertisement for color filter attachment for Bell & Howell Filmo projectors (*Movie Makers*, January 1928, p41)

Color filter attachments which could be fixed in front of the film projector’s lens were a non-intrusive method of introducing color to the *projected* image. Some projector models (for example, within the Pathé 9.5mm and

Keystone 16mm series) had color filter attachments fitted as standard. Filter attachments were advertised regularly in the amateur press throughout 1927-29. Manufacturers included American Cine Products who made the Automatic Colorator, Beckley and Church, Inc., makers of the Koloray, and Bell & Howell’s Filmo projector attachment with four color filter discs [5]. The Automatic Colorator attachment provided “15 different colors at your fingertips” which could be “individually or collectively interchanged simultaneously at the touch of a button”. (s.n., *Amateur Movie Makers*, 1927) The Koloray was a circular attachment that could be rotated to select a variety of colored filters, and also allowed for two-color combinations by aligning two of the filters in front of the projector lens simultaneously. This might be used, for example, in a landscape scene to achieve blue for the sky and green for the land. One Koloray advertisement (s.n., *Movie Makers*, September 1928) carried a letter of recommendation from Herbert McKay, who apparently embraced the use of color filters (and tinting/toning, see above) but also cautioned the amateur about the burgeoning natural color processes available to professionals, “Color is a source of infinite pleasure—but only when presented properly” (McKay, 1926). Manufacturers emphasized the devices’ ease of use and their ability to add color “without the necessity of tinting or toning” (s.n., *Movie Makers*, April 1928), as well as the benefit of “toning down the glaring white of the screen to save the over-exposed scenes which otherwise would be worthless.” (s.n., *Movie Makers*, April 1928) As with tinting and toning, the color filters provided emphasis to a scene or created a mood. The projectionist’s interaction and interpretation of the scenes also introduced an air of performance to the home movie experience.[6]

## 2.2. Lenticular Processes



Fig. 4. Kodacolor box and Kodacolor filter (*Chicago Film Archives*); Agfacolor filters (*Leitz Photographica Auction*)

The launch of Kodacolor 16mm film in the United States in September 1928 was met with palpable joy by Amateur Cine League president Hiram Percy Maxim, declaring that “Kodacolor has made a dream come true” (Maxim, 1928). In a lengthy and enthusiastic article recounting the

inaugural demonstration of Kodacolor at George Eastman House, Maxim recounted an explanation of the lenticular technology employed in the Kodacolor process, and reveled in the visual pleasure of the natural color that it produced, in particular, “the startling effect of seeing living, breathing flesh and blood”. Maxim professed that he found the experience “very stirring”. (Maxim, 1928)

Kodacolor’s technology was based on a process originally proposed by Frenchman R. Berthon in 1909, and further developed by A. Keller-Dorian. It required a special red, green, and blue striped filter (Fig. 4) to be attached to the camera lens when shooting, and to the projector lens when projecting the film. The lenticular process utilized black and white reversal film, which had been embossed with miniscule lenses (lenses) running lengthwise, covering the surface of the film’s base. Maxim’s article quotes a fuller explanation given by Dr C.E.K. Mees, head of Research Department at Eastman Kodak, “The function of the lenses embossed on the film is to guide the rays of light falling upon each tiny area and lay them on the sensitive emulsion as three distinct impressions corresponding to the three filter areas, so that the three colors covering the lens are imaged behind each tiny cylindrical lens as three parallel vertical strips, because the tiny cylindrical lenses are parallel to the stripes of color on the filter.” (Maxim, 1928)

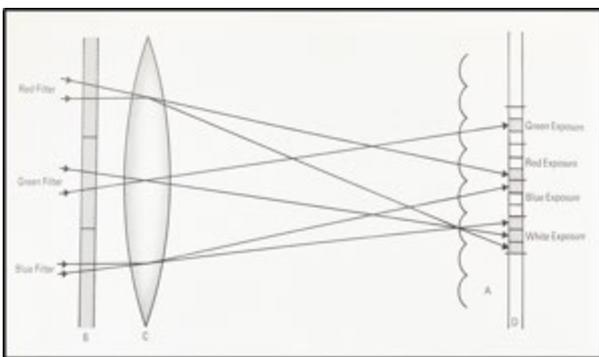


Fig. 5 – Diagram illustrating the lenticular process (Coe, 1981)

When the film was projected through the same three-color filter, a natural color image was achieved. This was “a novel and exciting capacity for the amateur cinematographer, one that put his or her craft ahead of even theatrical motion pictures, which still had limited color processes with which to work.” (Gordon, 2013) In concluding his report of the inaugural demonstration, Maxim fired up his readers with the promise of the new technology for amateurs: “... what is nothing short of epoch making, we amateurs are given the means by which

we may render immortal our loved ones, for portraits made with Kodacolor bring the living person directly before us.” (Maxim, 1928)

Although the technology had its drawbacks, in particular, the need for additional accessories and the necessity for brighter lighting conditions, its ease of use and pleasing, natural colors meant that it was embraced by the keen amateurs who could afford it (the multipage Kodacolor ad provides a detailed breakdown of costs, *Movie Makers*, August 1928), making it a relative commercial success. With this burgeoning success, Kodak introduced additional accessories such as special projection screens to increase reflection and boost the loss of luminance due to the colored filter, and by the following year, rival manufacturer Bell & Howell was producing camera lenses and projectors equipped to shoot and project Kodacolor (s.n., *Movie Makers*, May 1929). Due to its relatively widespread commercial success, several film archives in the USA have preserved examples of Kodacolor.

While there were reports of lenticular Agfacolor 16mm film being demonstrated in Germany and Britain in 1931 and 1932 respectively (s.n., *The International Photographer*, November 1931; s.n., *The Amateur Photographer and Cinematographer*, 1932), and an extensive description of the principles behind the process in the *Journal of the Society of Motion Picture Engineers* (Weil, 1933), it is not known if lenticular Agfacolor for amateur movie makers was ever manufactured for commercial sale [7]. The filter in Fig. 4 was likely for a stills camera using lenticular film.

### 2.3. Rotating, Alternating Color Filters – Natural Color

Based on processes available to professional filmmakers such as Kinemacolor and Biocolour in the 1900s and 1910s, a number of attempts were made to replicate the principle of an alternating color filter for the amateur market. Vitacolor was the most commercially successful of these.

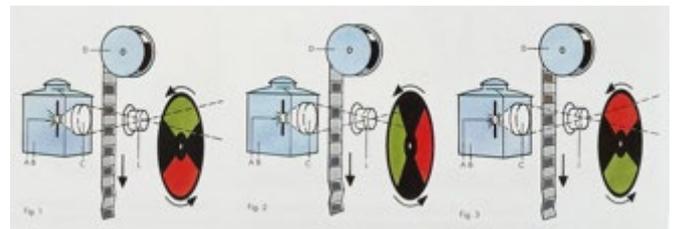


Fig. 6 – Vitacolor used the same principle as the earlier Kinemacolor process, illustrated here (Coote, 1993)

Invented by cinematographer, Max B. Du Pont (not related to the family of chemical and film stock manufacturers), a

Frenchman who emigrated to the USA in the early 1900s to work in the motion picture industry, and whose “desire to improve motion pictures with natural color came to him one day while examining some Pathé hand-colored film” (Anthony, 1928).

The process, which he developed over 10 years, used 16mm [8] black and white negative stock, which was exposed in the camera through a rotating filter, alternating between red and green so that alternate frames were exposed through either the red or green filter. After processing, a positive print was made, which was then projected through a rotating, alternating red and green filter attached to the projector, producing a natural color image. (Fig. 6).



Fig. 7. Vitacolor advertisement (Movie Makers, May 1929, pp. 282-283)

Throughout the latter part of 1928, numerous demonstrations were presented across the USA, and Vitacolor was launched onto the market the following year. Articles in the amateur cine press described and praised the new technology. Full page advertisements (Fig. 7) - sometimes double-page spread and illustrated - appeared in the amateur press. As was common at the time, a woman modelled the camera in order to emphasize the technology's ease of use. The 'Vitacolor Girl' – Mary Mabery - featured heavily in its promotion. Formerly “... a Sennett Girl [...] from the University of California, where she was specializing in a course of athletics for a career of athletic instruction in high schools and universities” (s.n., 1927), she became the face of Vitacolor's print advertisements and featured in some of the demonstration films.

As with the lenticular process, Vitacolor's colored filters reduced the amount of light reaching the film's emulsion, so brighter lighting conditions were necessary. There was

also an issue with “fringing” – the separation of the red and green projected images – particularly when the filmed subject was in motion. Despite this, the process was well-received by those who attended the demonstration screenings, even by those who had previously been skeptical about color. Natural color skeptic, Herbert McKay heralded Vitacolor to be superior to “old” Kinemacolor, and declared, “Every amateur owes it to himself to make films in natural color” (McKay, 1929) While there are no exact figures available, some amateurs--albeit *wealthy* amateurs who could afford the initial cost of the hardware - over \$2,500 in 2022's money—did invest in the technology. The Yale Film Archive holds some examples of Vitacolor in its S.W. Childs collection.

In Austria, several years after Vitacolor was launched in the USA, Ukrainian-born Josef Mroz, experimented with a similar process for 9.5mm film. Comparable to Friese-Greene's Biocolour, the process exposed panchromatic black and white stock through a rotating, alternating green and red filter, then after processing, the film's alternate frames were colored red and green by the application of dyes directly onto the film. Mroz probably used a machine to apply the color to the film but the coverage was inconsistent, resulting in dense patches of color in some areas of the frame and thinner in other areas. Because the color was applied directly to the film, there was no need for a rotating filter on the projector. The process was never made commercially available (Zingl, 2018).

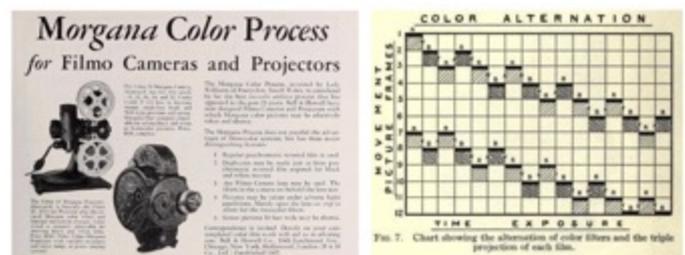


Fig. 8. Morgana Color/Bell & Howell advertisement (Movie Makers, July 1932, p. 285); Color alternation chart (SMPE Journal, 1933, pp. 403-412)

The Morgana Color [9] process refined the alternating red and green filter technique by attempting to eliminate excessive flicker and fringing during projection. This was achieved by a complex projection mechanism devised by Lady Juliet Williams of Pontyclun, south Wales [10] - a politician and advocate for social reform, with a strong interest in motion pictures. She was inspired to develop a practical color process after spending time on a film set in 1924 with her mother, the author, screenwriter, director/producer Elinor Glyn. Over several years, Lady

Williams worked with co-inventor George Short to create a mechanism that advanced the film two successive frames forward and one backward and thus (reportedly) eliminated flicker. According to Bell & Howell employee Joseph Dubray's detailed article in the *Journal of the Society of Motion Picture Engineers*, this was achieved by a quasi-increased film speed: "... although the film is running at a linear speed of 24 frames per second, 72 frames are alternating at the aperture during the same length of time, each picture frame being projected three times on the screen." (Dubray, 1932, p. 410) The diagram in Fig. 8 illustrates this.

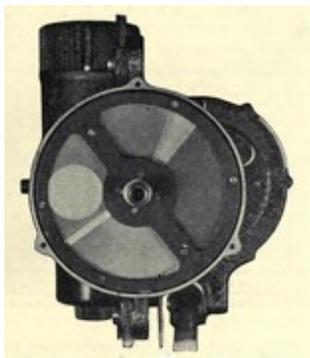


Fig. 9. Morgana color filter wheel on the projector (Dubray, 1933)

In December 1931, the Morgana Color process was backed by Bell & Howell, and in 1932 they began promoting it for use with their 16mm Filmo cameras and projectors. In the March 1933 issue of *The International Photographer* a short article describes a 350ft film made by a Bell & Howell employee (Dubray) of the 1933 Tournament of Roses, Pasadena, USA (s.n., 1933). It is reported that the film was shown to an audience of 300 as well as at a private screening for the parade's grand marshal, Mary Pickford, and Douglas Fairbanks. Later that year, the amateur section of *American Cinematographer* reported that Comte de Janze of Paris would be experimenting with Morgana Color on his forthcoming game-shooting trip to Africa. (s.n., *American Cinematographer*, 1933). Despite these references to Morgana Color films being made, and Bell & Howell's promotion of the process, no extant films or equipment are known to exist (with the exception of a few sample frames in the Theisen Film Frame Collection at the Seaver Center for Western History, Los Angeles). With the onset of the Great Depression in the USA and other, more practical and affordable color processes on the horizon, there is little evidence that the equipment was ever sold commercially. Simon Brown notes that, "The registrar was informed to dissolve the [Morgana Color] company in

February 1937 and it was noted at this point that the Morgana patents had been allowed to lapse and that the agreement with Bell and Howell was therefore valueless." (Brown, 2012, p.277)

## 2.4. Dufaycolor Réseau

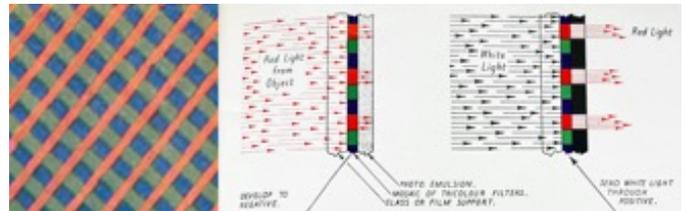


Fig. 10. Dufaycolor réseau (The Dufaycolor Process, 1935); Dufaycolor schematic (Spencer, 1948)

Launched in the United Kingdom in September 1934, Dufaycolor 16mm was the first motion picture color process available to amateurs that did not require additional accessories to produce a color image. Based on the 'screen plate' principle, and drastically refined from Louis Dufay's original process for stills photography in the early 1900s, the complex mechanical manufacturing process added a minute regular pattern of red, green, and blue dyes - the réseau - to the base of a black and white reversal film. The film was exposed in the camera with the its base facing the subject so that light passed through the réseau's colored dyes before exposing the black and white emulsion. After processing, the film was projected with the emulsion facing the projection screen, so that light from the projector lamp passed through the colored base first and created a natural color image on the screen. When viewed at an optimal distance, the pattern of the réseau was barely discernible.



Fig. 11 – Advertisements for Dufaycolor movie film (*Amateur Cine World*, Sept 1934, p. 156; *Movie Makers*, June 1935, p. 232)

Karl A. Barleben's article in *The International Photographer* in April 1935 excitedly pronounced that, "DuFayColor [sic] Is Here With a Bang!" (Barleben, 1935)

He observed that the numerous attempts to achieve natural color over the last few years had “not been a particularly successful venture, technically or financially. [...] At the present time, there exists a most practical and worthy natural process – The DuFay Color [sic] process.” Its benefits he noted, were that, “It has speed galore, requires no special adjustments or accessories, and reproduces color in a manner which is nothing short of amazing, considering that it is a one-film process.” (Barleben, 1935) Because of its ease of use and, contrary to Barleben’s claim of “speed galore”, the brighter lighting conditions needed for optimum exposure, Dufaycolor enjoyed reasonable commercial success up to the 1950s (in stills photography, too).

Dufaycolor’s USA launch in spring/summer 1935, however, coincided with the introduction of Kodachrome 16mm film, which offered the amateur even greater ease of use (although not accurate natural color for the first three years). Nevertheless, Dufaycolor introduced 9.5mm reels and cartridges in 1937, and the process remained on the amateur market until around 1950. The possibility of producing 8mm Dufaycolor was considered by its manufacturers (Hercok, 1979), but apparently never realized, possibly because the réseau would be too visible and intrusive. There is mention of 8mm Dufaycolor in some amateur movie magazines, and a few sample frames exist at the Theisen Film Frame Collection at the Seaver Center for Western History, Los Angeles, but otherwise it was not known to have been commercially produced. However, a reel of poorly-slit 8mm Dufaycolor was discovered a few years ago by the author of this paper, and has been donated to the University of Southern California’s Hugh M. Hefner Moving Image Archive. The history and provenance of this reel is yet to be determined. Examples of 16mm and 9.5mm Dufaycolor can be found in many regional film archives, particularly in the UK.

### 3. Conclusion

In 1933, writing in the *Journal of the Society of Motion Picture Engineers*, F. Weil (Weil, 1933) outlined what he believed to be the principal requirements to make motion pictures in natural colors practically and technically successful:

1. The photographic manipulation and apparatus must be simple
2. The process must provide sufficient color saturation and resolution; that is, the color elements must be small enough to be unobjectionable
3. It must be possible to make prints from an original exposure

4. The process must make efficient use of the available light, both in making camera exposures and in projecting the pictures on the screen

These requirements echoed the predominant prescriptive approach of the majority of those writing about and making photographs and movies at the time. With the arrival of Kodachrome in 1935 - and its ability to fulfill the above criteria (at least post-1938) - the path was set for subtractive processes to dominate the markets, both amateur and professional. But while the impracticalities of accessories and slow film speed, as well as poor cost-effectiveness, meant that early additive color processes were short-lived and achieved relatively low commercial success, they should not be dismissed because of their inherent ‘flaws’ and relative lack of success. Instead, their inventors’ ingenuity and each process’s unique characteristics and aesthetic qualities should be considered worthy of our appreciation and duly celebrated.

### 4. Conflict of interest declaration

The author declares that no actual or potential conflict of interest exists including financial, personal, or other relationships with other people or organizations within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, their work or objectivity.

### 5. Funding source declaration

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### 6. Short biography of the author(s)

**Louisa Trott** has worked with amateur film collections at regional and national film archives in the UK and USA. She holds an MA in film archiving from the University of East Anglia, and is co-founder of the Tennessee Archive of Moving Image and Sound. She is currently Liaison Librarian for Cinema Studies and Theatre at the University of Tennessee, Knoxville.

### Notes

[1] The title of this paper is adapted from Carl Oswald’s article, “The End of the Rainbow – Possibilities of Color Motion Photography for the Amateur” (Oswald, 1928) in which he considers the feasibility of color motion pictures for the amateur. Published in January 1928, marginally pre-dating the introduction of lenticular Kodacolor, the article weighs the eager anticipation of color for the amateur filmmaker against the practical considerations of cost and the limitations of technology. Oswald was an authority on photographic processes and was a regular contributor to

Movie Makers magazine. For a brief biography of Oswald, see *Movie Makers*, June 1928, page 422.

[2] Réseau is the French word for “grid” or “network”, and refers to the “screen” formed by the three colored dyes applied to the film’s base.

[3] “Natural color” referred to a photographic image whose colors closely replicated the original scene, in contrast to the color-block effects of tinting or hand-coloring.

[4] A few examples of this technique can be found in the Amateur Movie Database ([www.amateurcinema.org/](http://www.amateurcinema.org/)), but generally, examples of hand-coloring and tinting/toning in amateur films seem to be fairly rare.

[5] The author has yet to locate any extant examples of the Automatic Colorator, the Koloray, or the Bell & Howell filter attachments.

[6] The author has been unable to locate any examples of these filter attachments in museums, archives, or private collections, but at the Northeast Historic Film symposium in 2019, the effect was replicated in a presentation, and proved to be quite satisfying - producing an audible gasp from the audience in spite of the primitive, low-tech process.

[7] The name Agfacolor was later used for other color processes made by Agfa. The Timeline of Historical Film Colors has some sample frames of lenticular Agfacolor.

[8] In addition to 16mm, Vitacolor was originally trialed in 35mm for the professional market, but Du Pont decided to focus on the amateur market alone.

[9] The author has not yet found an explanation for why the name Morgana Color was chosen. An informed guess might be that the name is a reference to the county of Glamorgan, where Lady Williams lived, and/or possibly a reference to the character of Arthurian legend, Morgan le Fay (aka Morgana), whose origins lie in Welsh/Celtic mythology.

[10] Pontyclun, south Wales (pronounced Pont-uh-clean) – in recent literature about Morgana Color, the name of this town has sometimes been misspelled as Pontyclud, probably originating from a typographical error in Brian Coe’s *History of Movie Photography* (1981). Also originating from south Wales, the author of this paper has a personal interest in the history of Morgana Color and its inventor, and is currently working on a more detailed biographical piece about Lady Williams.

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