10. The Extraordinarily Stable Technicolor Dye-Imbibition Motion Picture Color Print Process (1932–1978)

Except for archival showings, *Gone With the Wind* hasn't looked good theatrically since the last Technicolor prints were struck in 1954; the 1961 reissue was in crummy Eastman Color (the prints faded), and 1967's washed-out "widescreen" version was an abomination.[1]

Mike Clark
"Movies Pretty as a Picture"
USA Today – October 15, 1987

In 1939, it was the most technically sophisticated color film ever made, but by 1987 *Gone With the Wind* looked more like *Confederates from Mars.* Scarlett and Rhett had grown green and blue, a result of unstable film stocks and generations of badly duplicated prints. Hair styles and costumes, once marvels of spectral subtlety, looked as though captured in Crayola, not Technicolor.

Not anymore. Turner Broadcasting System, owner of the film, spent two years and $250,000 restoring David O. Selznick's four-hour classic, in time for the film's 50th anniversary this year.

For the restoration of *Gone With the Wind*, Richard May, director of film services at Turner, returned to the original — and highly flammable — nitrate negatives, stored specially at Eastman House in Rochester.

Using as a guide a 1954 Technicolor print approved by the late Mr. Selznick, work began on rephotographing the negatives in early 1987 at YCM Laboratories in Burbank, California.[2]

Max Alexander
"Once More, the Old South
in All Its Glory"
The New York Times – January 29, 1989

While three Hollywood companies rush to produce a new Robin Hood film in head-to-head competition, Turner Entertainment Company stands ready to bring back the definitive film of the saga, Warner Bros.' 1938 Technicolor hit *The Adventures Of Robin Hood.*

Dick May, v.p. of entertainment and film services at Turner Entertainment, says "Give me 10 or 12 substantial bookings and we'll go ahead striking new prints and reissuing the film."

See page 347 for Recommendations

He notes that the negative used to make existing prints in circulation had worn out [faded].

"That negative dates back to the early '50s when United Artists acquired the film's distribution rights from Warner Bros. in the purchase of the old WB library. Four years ago we at MGM/UA went back to the three-strip Technicolor materials to make a new internegative and now have excellent printing materials. All it takes is a phone call to our lab to make new prints," he says.[3]

Lawrence Cohn
"Turner Eyes '38 *Robin Hood* Redux"
Variety – July 25, 1990

The 45-Year Era of "Permanent" Technicolor Motion Pictures

With the introduction in 1932 of the Technicolor Motion Picture Corporation three-strip beam-splitter camera, which simultaneously filmed separation negatives in register through red, green, and blue filters on three separate reels of black-and-white film, and the companion Technicolor dye-imbibition printer to make full-color prints from the separation negatives, the entertainment film industry in the United States began a 45-year era of color motion pictures with essentially permanent images. Under normal room-temperature storage conditions, the images of Technicolor dye-imbibition motion pictures will probably last for hundreds of years without perceptible changes in color balance, density, or stain level.

According to accelerated dark fading tests conducted by this author, the image stability of triacetate-base Technicolor imbibition prints is *vastly* superior to that of the improved Eastman Color Print Film 5384 and similar "low-fade" Fuji and Agfa-Gevaert color print films which entered the market in 1982–1985. Previous films, such as Eastman Color Print Film 5381 and 5383, and Fujicolor Positive Film HP 8814, had extremely poor image stability — a fact that becomes painfully clear with a visit to any film archive.

Historically, dye-imbibition color images of all types have had extremely good stability when stored in the dark under normal room-temperature and humidity conditions. Light fading is not usually an important factor in the deterioration of motion picture images since the accumulated light exposure on each frame of film — even after hundreds of projections — is not enough to cause significant fading with most types of color films.

The life of a Technicolor dye-imbibition motion picture is limited by the cellulose nitrate or cellulose triacetate base upon which it is made — the color image is far more permanent than is either type of film-base material!

Technicolor three-strip cameras on location in Eureka, California filming the Warner Bros. 1938 feature **Valley of the Giants**. The wide film magazines on the cameras carried three rolls of black-and-white separation negative film. Brilliant color prints were made from the negatives by the dye-imbibition (dye transfer) process in Technicolor's laboratories.

Mac Julian – 1938 (Courtesy of Warner Bros.)

The dye-imbibition color images of both early and more recent Technicolor films are so stable, in fact, that, had they been printed on modern polyester-base film stock instead of the cellulose nitrate or cellulose triacetate film bases available at the time, Technicolor movies would have joined UltraStable Permanent Color Prints, Ilford Ilfochrome (called Cibachrome, 1963–91), Kodak Dye Transfer, Fuji Dyecolor, polyester-base black-and-white films and fiber-base prints that have been treated with a protective toner, and the few other modern photographic materials that are essentially permanent when stored in the dark under normal temperature and humidity conditions.

If cellulose nitrate Technicolor films are properly cared for and not physically scratched and abraded by repeated projection, the useful life of these early films is limited only by the instability of the nitrate film upon which they were printed (nitrate film was used throughout the film industry for both black-and-white and color movies until 1950–52). The useful life of both cellulose nitrate film and modern cellulose triacetate film is influenced by the temperature and relative humidity of storage, and, to a lesser extent, by how the film is packaged. The lower the temperature and relative humidity, the longer the film will last.

At any given storage temperature, the color images of early Technicolor films are much more stable than the film base itself. Under adverse storage conditions, some nitrate films became unusable after only 20 or 25 years; others remain in very good condition today, more than 50 years after they were made.

Cellulose nitrate motion picture films still in good condition can easily be preserved almost indefinitely in low-cost explosion-proof freezers (a subject discussed in Appendix 19.1 at the end of Chapter 19), or in larger, specially designed humidity-controlled 0°F (–18°C) storage vaults.

In 1950–52, the motion picture industry converted from highly flammable cellulose nitrate-base film stock to less

Recommendations

Preservation of Technicolor Dye-Imbibition Motion Picture Prints and Separation Negatives

- Surviving Technicolor imbibition prints, made on either nitrate or cellulose triacetate safety film, are irreplaceable historical artifacts and must be treated as such.
- Technicolor imbibition prints should never be projected or routinely viewed on Steenbecks or similar equipment.
- For viewing and study purposes, a videotape master and duplicate user tapes should be made from Technicolor imbibition prints. Duplicate motion picture prints should be prepared from a color internegative made from the imbibition prints; Eastman Color Internegative Film 5272 (special order in 35mm) is suitable for this purpose. The internegative can also be used to make videotapes.
- Cellulose triacetate-base imbibition prints, separation negatives, and other preprint materials should be stored in the dark with low relative humidity (20–30% RH) and a temperature of 40°F (4.4°C) or lower. Ideally, triacetate-base materials should be stored at 0°F (–18°C) or lower. Film in tin-plated or painted steel cans should be transferred to plastic or aluminum cans.
- Nitrate-base Technicolor imbibition prints should be wound on cores and stored in untaped film cans in vaults specially designed for nitrate film storage, at a temperature of 0°F (–18°C) or lower and with a relative humidity of about 30%. Nitrate camera separation negatives, master positives, soundtracks, and other preprint materials should be preserved in the same manner. Film in steel cans should be transferred to plastic or aluminum cans.
- If humidity-controlled, low-temperature (i.e., 0°F [–18°C]) storage cannot be provided, nitrate-base imbibition prints should be wound on cores, conditioned to a relative humidity of about 40%, placed in taped plastic or aluminum cans, double-sealed in vapor-proof paper/polyethylene/aluminum-foil bags, and stored in explosion-proof freezers at a temperature of 0°F (–18°C) or lower (for further information on nitrate film preservation, see **Appendix 19.1** at the end of Chapter 19). Nitrate camera separation negatives, master positives, soundtracks, and other preprint materials should be preserved in the same manner.
- With proper handling and storage, original nitrate and cellulose triacetate Technicolor imbibition prints still in good condition can be preserved for hundreds and possibly thousands of years. Technicolor imbibition prints are not expendable films to be viewed and abused for the pleasure of filmgoing audiences who would like to see the "real thing." These films must be preserved in their original form — saved so that they can serve as printing masters for whatever film and electronic reproduction media emerge in the future. The current practice of some of the major film archives and other collecting institutions around the world of screening original Technicolor imbibition prints must stop.
- The American Film Institute, in conjunction with the Library of Congress, should administer carefully designed, low-temperature, humidity-controlled storage facilities at two separate geographic locations for the long-term preservation of color and black-and-white motion pictures and videotapes. Original materials should be stored at one location, with back-up duplicates kept at the other. Separate areas, isolated from other storage buildings, should be provided for Technicolor nitrate prints and negatives and other nitrate films. The high-security facilities should offer low-cost storage services for commercial studios, motion picture and videotape libraries, museums, archives, and individuals (for further discussion of motion picture preservation, see Chapter 9 and Chapter 20).

hazardous cellulose triacetate "safety-base" film. Triacetate film was long believed to be much more stable in storage than cellulose nitrate film, but recent research at the Image Permanence Institute[4] and elsewhere has indicated that cellulose nitrate and cellulose triacetate films have generally similar aging characteristics: triacetate film has a shorter life than once supposed, and cellulose nitrate film can last longer than commonly believed. Low-temperature and low-humidity storage will *vastly* extend the life of both types of film (see Chapter 9).

Color Image Formation with the Technicolor Dye-Imbibition Process

The Technicolor dye-imbibition process produced color images with preformed acidic cyan, magenta, and yellow dyes in a manner very similar to today's Kodak Dye Transfer (introduced in 1946) and Fuji Dyecolor (introduced in Japan in 1947) print processes for still photography. However, the Technicolor process required complex machinery to print in register all three dye images on complete reels of motion picture film. Technicolor dye-imbibition motion picture prints have sometimes been called dye transfer prints, or IB prints (IB stands for the I.B. Corporation of Cambridge, Massachusetts, which constructed the electrically controlled transfer machines designed by Malcolm H. "Mack" Ames of Technicolor).

The term "imbibition" refers to the absorption and transfer of image dyes from three gelatin relief "matrix" films to a print film. Matrix films printed from the three Technicolor camera separation negatives were developed with a "tanning" developer which selectively hardened gelatin adjacent to the developing silver grains within the emulsion. Following development and chemical bleaching of the silver image, a hot water "wash-off" (at about 130°F [54.5°C]) removed unhardened gelatin, forming gelatin relief images which varied in thickness according to the densities of the different areas of the image. Fixing and drying completed the process. When immersed in a dye bath, the amount of dye absorbed by the matrix film is a function of the gelatin thickness at any given point in the image. Imbibition printing is not a light-sensitive process; the printing procedures are normally carried out in brightly lighted rooms.

Matrices can also be printed directly from Eastman Color and similar chromogenic negatives, as well as from separation negatives printed from Kodachrome and other reversal motion picture color films; this in turn allows production of imbibition prints. Beginning in the early 1950's, Technicolor imbibition release prints were made for many hundreds of motion pictures shot on color negative film.

To make a print, the cyan, magenta, and yellow dyed matrix films were successively placed in brief contact (in exact register) with the emulsion of an unsensitized print film (called a "blank" film), and the gelatin coating on the film absorbed (imbibed, or "drank-up") dyes from each of the matrix films. After the introduction of sound films, the "blank" film used by Technicolor was an inexpensive, contact-speed black-and-white film printed with the sound track and developed and fixed in conventional chemicals prior to imbibition printing. The completed full-color motion picture contained both a silver sound track and a dye color image (most early Technicolor prints also contained a low-density silver "key" image to add depth to the shadows).

Kodak had been closely involved with Technicolor almost from the beginning and produced the separation negative films and matrix films needed in the imbibition process. Prior to about 1940, Kodak Super-XX negative film was used in the camera to film the separation negatives; after that year, Kodak produced a number of special films for Technicolor, and until 1976 Kodak Ltd. of England produced the matrix films for the Technicolor plants in England and Italy. Most of the Technicolor print film was supplied by Eastman Kodak Company.

The 45-Year Era of "Permanent" Color Motion Pictures Comes to an End

In February 1975, the Technicolor imbibition plant in Hollywood, California was closed and the printing equipment dismantled. Technicolor's overseas imbibition plant in Rome was shut down on June 1, 1978, and the London facility — the last Technicolor imbibition plant — ceased operation on June 14, 1978. "Color by Technicolor" lives on, however. With laboratories in Hollywood, New York City, London, and Rome,[5] the company is now owned by Carlton Communications P.L.C., a British firm that in 1988 purchased Technicolor from its previous owner, MacAndrews & Forbes Group, for $780 million (MacAndrews & Forbes acquired Technicolor in 1983 for $100 million). At the time it was purchased by Carlton Communications, Technicolor was not only the largest motion picture processor in the world but was also the world's largest duplicator of video cassettes for the home video market.[6]

With the its dye-imbibition laboratories closed, Technicolor now processes Eastman, Fuji, and Agfa-Gevaert chromogenic color negative and print films for television and theatrical film producers. The slogan "Color by Technicolor," which for many years has appeared in the title frames of most of the theatrical and television release prints produced by the Technicolor Corporation, simply means that Technicolor laboratories made the prints (and in most cases, also processed the negatives). "Color by Technicolor" no longer refers to any particular motion picture film stock or process; the "Technicolor" name is protected by trademark registration in 84 countries.

At the time of the Technicolor imbibition plant closings, few people in the film industry were aware of the extraordinary image stability of Technicolor dye-imbibition prints. For that matter, not many knew very much about the comparatively poor image stability of Eastman Color prints until 1979, when a series of articles on color stability began appearing in motion picture publications. By then the Technicolor imbibition plants had been dismantled and Technicolor had no interest in reviving the process. This abruptly ended the era of permanent color motion pictures in the United States and Europe.

Technicolor Builds a New Imbibition Printing Plant in China

Ironically, almost simultaneously with the loss of permanent color motion picture production in the Western world, the People's Republic of China gained the capability. In 1974 the Chinese government contracted with Tech-

nicolor Ltd. in England to have a complete motion picture imbibition printing plant constructed in China. Operation of the plant began in late 1978. The original three-strip Technicolor cameras (discussed later in this chapter) have been abandoned; Chinese films are shot with Eastman Color and other color negative films, and imbibition matrices are prepared from the color negatives.

A delegation of members of the U.S. Society of Motion Picture and Television Engineers (SMPTE) visiting China in 1979 commented on the new imbibition plant:

> The group was impressed by the extreme cleanliness of this facility. . . . A number of reels of the prints were projected for us and we were greatly impressed with the screen color quality. Here was a very new plant, a complicated process, operating correctly and efficiently, and producing a quality product.
>
> . . . Some may wonder why the imbibition or Technicolor process is important in China. It is not used in the United States today, having gradually declined as the use of colorpositive materials increased; so why would the PRC adopt the imbibition system which is virtually obsolete in the United States? We asked this question of our Chinese hosts and the answer makes sense. With the Beijing and Shanghai laboratories now making release prints to be shown throughout all of China, large numbers of prints are made of each subject. Our Chinese friends told us that the print costs on a dye imbibition process in the single subject quantities in which they are made are considerably less than for conventional color positive materials and that the color quality is comparable for both systems.[7]

Most of the equipment supplied to China was new and specially constructed by Technicolor Ltd. to meet Chinese requirements. It has been reported that the equipment is an advanced modification of previous Technicolor printing equipment.[8] The imbibition motion picture process is at its best economic advantage when large numbers of release prints are required and when skilled labor is available at low cost; both of these conditions now exist in China. The normal print run for the Beijing imbibition plant is said to be about 250 35mm copies, with up to 500 copies being made for very popular films; in addition, the lab makes about 1,000–2,000 16mm prints and about the same number of 8.75mm (35mm blank stock slit into four strips) copies for showing in rural areas.[9] China, with an estimated population in excess of one billion people, is a huge market for movies and video productions.

The Chinese now manufacture their own blank stock and matrix film for making release prints in their imbibition plants. Kodak supplies considerable quantities of color negative and intermediate print stocks to China[10] and is said to have supplied matrix stocks before the Chinese started producing their own.

Another large imbibition film laboratory located in Shanghai is equipped with two rotary imbibition transfer machines installed in 1968.[11] These machines, which were designed and built in Russia, have a large dye-transfer wheel about 40 inches (1 meter) in diameter instead of the stainless steel belt found in the Technicolor equipment. The Russian machines require three passes of each film to transfer the cyan, magenta, and yellow dye images.[12] The Soviet Union for many years printed some of its color motion pictures with imbibition transfer machines of this basic design.

The Beginnings of Technicolor

The Technicolor Motion Picture Corporation was founded in 1915 in Boston, Massachusetts by Dr. Herbert T. Kalmus, Dr. Daniel F. Comstock, and W. Burton Westcott, with financial backing from Boston attorney William Coolidge and his partner C. A. Hight. Kalmus and Comstock were classmates at the Massachusetts Institute of Technology (M.I.T.) and in 1912 formed the engineering company of Kalmus, Comstock & Westcott, Inc. The "Tech" in the Technicolor name was chosen as a tribute to M.I.T.

The first Technicolor processing plants, research laboratories, and equipment shop were built in Boston, but in 1924 Technicolor opened a processing and imbibition printing plant in Hollywood, California. This was followed by the Technicolor Ltd. plant in England in 1937 and the Technicolor Italiana S.p.A. facility in Rome in 1955. Technicolor also operated a plant in Joinville, France (near Paris) for a few years beginning in 1955; the French division was known as Societe Technicolor.

The company's first film, *The Gulf Between*, was produced in 1917 in Florida using a two-color additive process; this was the only film Technicolor made with the additive process. To make the film, Technicolor outfitted a railroad car with a complete processing laboratory and took the car from Boston to Jacksonville, Florida for the production. A single-lens beam-splitter camera was used to shoot the film. The projector for this film had two apertures with red and green filters in front. The two image components on the single piece of nitrate film had to be kept in precise register by the theater projectionist, and difficulties with registration soon caused the process to be abandoned by Technicolor. Kalmus has described the problems that occurred at one of the first public demonstrations of the two-color additive process:

> I was invited by the American Institute of Mining Engineers to give an exhibition of the "revolutionary" Technicolor process at Aeolian Hall in New York City. We were photographing a picture called *The Gulf Between* in Florida. The audience included Mr. Coolidge, Mr. Hight and about 150 others, many of whom were interested in financing the growth of Technicolor. After my enthusiastic preliminary remarks the picture began to appear, and behold there were the most glaring color fringes anyone had ever seen on the screen. The projectionist had failed to register the picture at the outset. This and some further experiences in the theatre with the difficulties of registration in the projection brought about the first deep depression for the then very young company.[13]

The Cemented-Film Two-Color Process

Developed in 1919, a new method of making color prints consisted of two cellulose nitrate gelatin relief films (similar to the later "matrix" films for transferring dyes to a blank film) cemented together, back-to-back. The relief films were individually dyed with subtractive colors by floating the film on dye baths. This was still a two-color process and as such was quite deficient in color reproduction. The first two-color subtractive motion picture was a Metro Pictures release, *The Toll of the Sea*; the film starred Anna May Wong and was filmed by Technicolor in Hollywood. The first showing of the film was at the Rialto Theater in New York City in November 1922. Public demand for the film quickly exceeded the limited capacity of Technicolor's small laboratory, and the film was not widely distributed until the following year.

Prints of *Toll of the Sea* were manufactured at the original Technicolor pilot plant on Brookline Avenue in Boston; prints cost about $0.27 per foot, which was substantially more than black-and-white prints in those days. The film was quite successful and grossed more than $250,000, of which Technicolor received about $165,000. Even though Metro Pictures distributed the film, Technicolor had acted as producer. In 1923 Technicolor built a second Boston plant with a capacity of about one million feet of release prints per month. In 1924 Metro Pictures became Metro Goldwyn Mayer — better known as MGM — and with the acquisition of United Artists in 1981, the firm became the MGM/UA Entertainment Company.

In 1986 MGM/UA was purchased for about $1.5 billion by Ted Turner's Atlanta, Georgia based Turner Broadcasting System, Inc. As the operator of CNN (the worldwide Cable News Network) and WTBS television, a "superstation" that broadcasts nationwide by satellite and cable systems, Turner was primarily interested in acquiring the more than 2,200 movies in the MGM Film Library (which, by a previous purchase, included most pre-1950 Warner Bros. films). By purchasing MGM, such film classics as *Gone With the Wind, Casablanca, The Wizard of Oz, 2001: A Space Odyssey,* and *Ben Hur* became available to Turner for broadcast, sale on videocassette and videodisc, and worldwide syndication to other television broadcasters. Once MGM/UA was in hand, Turner promptly broke up the company and sold off the MGM movie production unit, the United Artists division (which kept the UA Film Library), the MGM Metrocolor film lab (which was eventually acquired by Technicolor, Inc.), the 44-acre MGM studio lot in Culver City, California, and a number of other MGM/UA assets in order to reduce the massive debt resulting from the purchase.

In the end, Turner Broadcasting, through its Turner Entertainment Co. division, retained only the MGM Film Library, now known as the Turner Entertainment Co. Film Library, at a cost of almost *$1.3 billion!* (The library has since been enlarged and now includes the RKO domestic market film library. In all, Turner now owns more than 3,300 feature films.)[14]

Almost immediately after acquiring the MGM Film Library, Turner became involved in a heated controversy with film directors over Turner's plans to artificially "colorize" over 200 black-and-white film classics, including *Casablanca, The Maltese Falcon, Yankee Doodle Dandy,* and *The Postman Always Rings Twice.* "Colorization" is a computerized video process whereby artists add color on a frame-by-frame basis to a videotape transfer of a black-and-white film. Based on intuition, and perhaps a bit of historical research, the artists decide what colors are appropriate for the background, props, actors' and actresses' clothes, hair, eyes, skin, etc.[15] The resulting "color" videotape is used for television and videocassette release, with the original black-and-white film sent unharmed back to the film vault. It is likely that except for a few of the classics such as *Casablanca,* black-and-white video versions of colorized films generally will cease to be available.

No Original Print of *Toll of the Sea* Is Known to Exist Today

Incredibly, it appears that not a single complete print of *Toll of the Sea* has been retained anywhere in the world. In late 1985 the UCLA Film, Television and Radio Archives at the University of California at Los Angeles (UCLA), working with YCM Laboratories in Burbank, California, completed a major project to make a new print of *Toll of the Sea* on Eastman Color Print Film 5384. Fortunately, the original camera negatives for most of the film had survived. The missing section — the final 300 feet of the film — was "re-created," using as a guide a written scenario for the film which had been located in the Library of Congress. According to Peter Comandini of YCM Laboratories:

> . . . the scenario told us what the last three or four title cards were supposed to have said and we had an artist, working from a blow-up frame of an original title card, reproduce the backgrounds and the lettering. We shot the title cards on film and we got some shots of some rocks at Malibu that matched frame enlargements of the rocks and the surf in the show. We shot some footage of that two ways. For expediency's sake, we initially shot it on Eastman Color, but it was shot on a second shoot with an original Technicolor two-color camera. We effectively re-created the Technicolor two-color ending with actual two-color Technicolor footage of the waves breaking on the rocks.[16]

Technicolor Opens Its First Lab In Hollywood

In 1924 the first Technicolor laboratory and camera unit were established on North Cole Avenue in Hollywood. It was necessary to set up this processing operation to supply rush prints to Hollywood filmmakers. Hollywood had become the center of the motion picture industry in the U.S. because the mild climate permitted year-round location filming and because of the tremendous variety of natural scenery (mountains, deserts, forests, an ocean, urban locations, etc.) within a relatively short distance of Hollywood. Another major factor in the early migration of the filmmaking companies to Hollywood was that being in California — far away from the East Coast — made it much easier to evade the Motion Picture Patents Company; this organization, founded in the late 1800's by Thomas Edison, attempted to control all filmmaking companies on the basis of patent rights claimed by Edison's companies.

Toll of the Sea was followed in 1924 by the Famous Players-Lasky Corporation production of *The Wanderer of the Wasteland* and by *Ben Hur,* released in 1925 by MGM. One of the most famous two-color films made with the relief films cemented back-to-back was *The Black Pirate,* with Douglas Fairbanks, released by United Artists in 1925. Kalmus has written that at the time this film was made there was considerable skepticism about the desirability of color in motion pictures but that Douglas Fairbanks felt that color would be a great asset in *The Black Pirate:*

> The argument has been that it would tire and distract the eye, take attention from acting, and facial expression, blur and confuse the action. In short it has been felt that it would militate against the simplicity and directness which motion pictures derived from the unobtrusive black and white. These conventional doubts have been entertained, I think, because no one has taken the trouble to dissipate them . . . . Personally I could not imagine piracy without color.[17]

In deciding the type of color reproduction to be used in the picture, Technicolor made test prints for Fairbanks at six different color levels, from slightly more color than black-and-white to "the most garish rendering of which the Technicolor process was then capable." The level of color saturation could be reduced at will by changing the filters on the beam-splitter prisms in the two-color cameras. Color saturation and contrast could also be adjusted by altering the development of the separations, or by changing the composition of the printing dye baths. Controls of this type are possible with any imbibition process, including the Kodak Dye Transfer process for still photography.

The Black Pirate cost over one million dollars to make, a considerable sum for a motion picture in 1925, but it was an immediate critical and financial success.

The cemented-film two-color subtractive process eliminated the projection registration problems that plagued the previous two-color additive process; however, the new process had difficulties of its own. The cemented films were easily scratched during projection, and Kalmus described another serious problem:

> As you know, motion picture film, as a result of passing through the heat of the projector and cooling off again, curls or buckles because it has gelatin emulsion on one side and plain celluloid on the other. But with double coated film, with gelatin emulsion on both sides, the direction of this buckling changes from time to time and with each change the picture jumps out of focus during projection in the theatre. And so it became necessary to have men travelling about the country replacing these prints and returning them to our laboratory in Boston where they were put through a debuckling process and reshipped. While we, with special attention, could operate in this manner for a picture or two obviously it was not a commercial process and Technicolor entered into the depths of its second depression.[18]

The Technicolor Two-Color Dye-Imbibition Process

In late 1927 the cemented film system was replaced by a two-color imbibition process in which separate printing *matrices* were made from the original camera negatives. These relief matrices were soaked in acid dyes, rinsed, and the dyes transferred to a single gelatin-coated "blank" film which had been treated with a dye mordant.

Technicolor developed rapid-transfer dye and mordant systems that permitted relatively high-speed printing and minimized losses in image resolution caused by lateral diffusion of dyes in the gelatin coating of the print stock. In later years Technicolor achieved a dye transfer time of about 18–20 seconds per dye; the transfers were quickened by heating the print film while it was in contact with the matrix films. Several methods of heating the print film and matrix film to speed dye transfer were tried by Technicolor, including radiant heating, hot-air circulation, steam, and electrical induction. By comparison, the transfer time at room temperature is from 2 to 5 minutes for each dye with the current Kodak Dye Transfer process for still prints.

Equipment was designed to hold the Technicolor matrix films in exact register with the positive print film during the dye transfer steps. The print film and dyed matrices were brought together in a warm water bath to eliminate air bubbles between the two films; the films remained under water for about 1 second at the beginning of each of the transfers. The matrix films were held on 35mm-wide stainless steel belts which were just over 205 feet (about 63 meters) long; the belts had coin-silver pins to engage each sprocket hole.

During the transfer steps, the film was placed over the pins in contact with the dyed matrix films; this system enabled exact registration during each of the three transfers and also prevented the matrix film from stretching in the course of repeated printings. One set of matrices could produce many hundreds of release prints before wearing out. A single set of matrices made on the polyester-base matrix film that became available in the late 1960's was capable of producing more than 1,000 release prints. After a dye transfer was completed, the matrix film was washed and dried prior to dyeing for a transfer to another print film; the process was repeated over and over. Technicolor's first transfer machine operated at about 15 feet per minute; by 1975, when the Hollywood laboratory was shut down, improved machines were operating at 330 feet per minute.

Orange-red and blue-green dyes were used in the two-color processes; these subtractive colors produced fairly pleasing reproduction of flesh tones and gave reasonable results with indoor studio filming where costume and set decoration colors could be carefully selected. However, many colors found in natural scenes were not well reproduced, and the deficiencies were obvious in most scenes filmed outdoors. Reds were reproduced as too pinkish and blues were too greenish. Kalmus once said that only "girls and music" in the films helped make the lack of good color reproduction unobtrusive.

It was known from the beginning, of course, that three subtractive colors — cyan, magenta, and yellow — were necessary for proper color reproduction, but the construction of a three-strip camera was far more complicated than

the two-color camera in which a beam splitter exposed two successive frames simultaneously on a single strip of film. Because the camera mechanism pulled down two frames at a time, this two-color camera has sometimes been incorrectly called a two-strip camera. Two printing matrices were prepared from alternate frames of the original camera negative, and because of this the two-color imbibition process is often called the two-strip process. It was not too difficult to adapt the two-color imbibition printing process to a three-color process once the three-strip (three-color) camera was perfected.

Other Early Color Motion Picture Processes That Competed with Technicolor

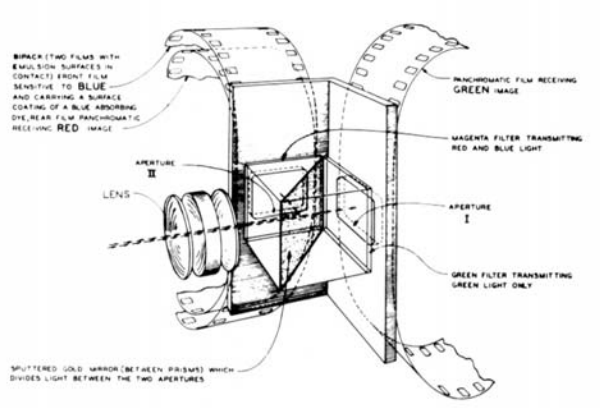
During the 1930's and 1940's a number of other color motion picture processes were introduced by a variety of companies in the U.S. and Europe. Most of these were two-color systems and several, including Magnacolor, Trucolor, and Cinecolor, enjoyed significant popularity during the 1940's and even into the early 1950's. Trucolor was a two-color process when it was introduced in 1948; prints were made from bipack or successive frame separations on Eastman Two-Color Print Safety Film, Type 5380, an unusual color-blind incorporated-coupler chromogenic film with an emulsion containing magenta and yellow couplers coated on one side of the film and an emulsion containing cyan couplers coated on the other side. About 3 years later, Trucolor was changed to a three-color process employing DuPont Color Positive Film, Type 275. A few years after that, Trucolor was changed again, and this time used Eastman Color Print Film, Type 5382.

All three versions of Trucolor were processed by Consolidated Film Industries in Hollywood; the process was discontinued about 1958. Consolidated is still a major Hollywood lab and at present processes Eastman, Fuji, and Agfa-Gevaert motion picture films. Many of the Roy Rogers western features released by Republic Pictures (the parent company of Consolidated) were made with the Trucolor process.

Cinecolor was a two-color process used by the Cinecolor Corporation to make release prints for a great number of features and cartoons released by MGM, Paramount, Columbia, United Artists, Universal, and others. In the early 1950's Cinecolor became a three-color process known as Supercinecolor (shot on standard Eastman Color Negative Film), and the Cinecolor Corporation changed its name to the Color Corporation of America; Supercinecolor was abandoned about 1954.

These processes were serious competition for the Technicolor Corporation during the late 1940's. This author is not aware of any stability data on any of these non-Technicolor processes. As with Technicolor, all 35mm movies shot with Cinecolor, Trucolor, and other motion picture processes before about 1951 were made on unstable cellulose nitrate-base film.

It is interesting to note that Technicolor was also involved in research with various other color photography systems, including integral tripack films. Certain elements of U.S. Patent 1,808,584 (applied for in 1921 and issued in 1931), granted to Dr. L. T. Troland of Technicolor, were incorporated in Kodachrome film introduced by Kodak in 1935. Kodak paid Technicolor royalties, which ultimately amounted to millions of dollars, for rights to certain parts of the Troland patent. Technicolor itself never produced an integral tripack film, although for some productions the company made dye-imbibition prints from a low-contrast version of Kodachrome film, called Monopack film, discussed later in this chapter.



The Technicolor three-strip camera employed a glass prism beam-splitter to expose a green-sensitive negative at one aperture and a bipack consisting of a red-sensitive and blue-sensitive film placed emulsion-to-emulsion. This complex arrangement allowed the simultaneous filming through a single lens of three separation negatives in exact register.

Technicolor Sound Films Appear

After the introduction of the two-color imbibition process, Technicolor began to produce sound films in which a silver sound track was developed on ordinary black-and-white motion picture print film. The film was then fixed, washed, and treated with a basic 5% chrome-alum solution prior to transferring the three image dyes by imbibition. Silver sound tracks give better sound reproduction than dye sound tracks because silver has a uniform absorption of the wavelengths of light and infrared radiation to which the photocells in traditional projectors are sensitive.

The Viking, released in 1928, was the first Technicolor motion picture with music and sound effects. The first "all talking" picture with "live" sound throughout, in addition to music, was *On With the Show,* released by Warner Bros. in 1929; the film featured an all-star cast and sparked tremendous public interest in color films.

Between the years 1929 and 1935, more than 50 films were produced by the two-color imbibition process; these included *The Mystery of the Wax Museum,* a 1933 Warner Bros. release starring Lionel Atwill, and the Samuel Goldwyn-Florenz Ziegfield production *Whoopee,* starring Eddie Cantor. Kalmus has said that these two films may have reached the ultimate color quality possible with the inherently limited two-color process.

Despite the early successes with the two-color imbibition process, Technicolor soon found itself with declining business and renewed financial problems. In 1955, looking back on the two-color period, Kalmus wrote:

1980

Storage vaults for nitrate separation negatives and other preprint film elements on the Walt Disney lot in Burbank, California next to Hollywood.

But after all this was only a two component process which was an attempt to create all shades of colors from two component colors. As everyone knows, to do a good job of this kind three components are necessary. But with sufficient care in the choice of materials, in the choice of colors placed before the cameras, with the make-up, with the amount of sky showing in the scene, etc., etc., it was possible to make wonderful pictures even with this two component method. But when the rush was on and every producer was clamoring to turn his black and white pictures into Technicolor no such care was employed. Some producers spoiled what opportunity they had by insisting upon more and more garish colors in however bad taste. They were out for more color and they wanted plenty of it. And in the rush to meet the demand other defects crept in such as excessive graininess. And so after awhile Technicolor was in its third deep depression. Once the tide set against us we constantly heard producers say "the public doesn't want color," "it detracts from the story," "it hurts the eyes," "it is too expensive," etc. Something had to be done and again Technicolor research and development must come to the rescue. This premature rush to color was doomed to failure simply because Technicolor was then a two color process.[19]

1980

The Disney storage vaults, which are not refrigerated, house the original Technicolor three-strip camera separation negatives from Disney's live-action films, and sequential-frame separation negatives for the studio's cartoons and animated features. All of the nitrate separations have been duplicated on cellulose triacetate black-and-white film and are stored at a separate location.

Original nitrate successive-frame separation negatives from **Snow White and the Seven Dwarfs**, the classic Disney animated feature released in 1937. The film has been released many times since and earned millions of dollars more for Disney in the 1987 re-release, the film's 50th anniversary.

The Complex Three-Strip (Three-Color) Technicolor Motion Picture Camera

In May 1932, construction of a complex three-strip camera was completed under the direction of J. A. Ball. Costing about $25,000, the camera simultaneously filmed three black-and-white separation negatives through a single lens using a beam splitter in combination with a separable bipack and a single film;[20] the cellulose nitrate-base separation negative films were made for Technicolor by Eastman Kodak. Technicolor rented the cameras to film studios for specific productions; in 1935 the rental fee was about $90 per week. Technicolor also supplied crews trained in the operation of the cameras to help with the filming.

With the development of the three-strip camera, the two-color imbibition printers were modified for three-color printing with newly developed cyan, magenta, and yellow dyes. A fourth neutral-gray "key" developed-silver image made from the green record (magenta) separation negative was included with most of the three-color imbibition prints until the early 1940's. This silver "key" image, known as the "gray" image in Europe, added density and contrast to the shadow areas of the film and increased apparent image resolution (in a manner similar to the "black printer" in book and magazine color printing), and formed frame lines around each frame.

This silver image was discontinued about 1946 because improvements in the matrix film, blank stock, and the magenta, cyan, and yellow dyes made additional shadow density unnecessary. Concurrent with the elimination of the silver image, Bell & Howell (BH) film perforations were changed to Kodak Standard (KS) perforations, which increased projection life of the release prints. In early film clips examined recently by this author, the silver "key" image still appeared to be in very good condition, with no visual indications of sulfiding or other deterioration.

The three-color process gave excellent color and tone reproduction, and was met with immediate enthusiasm. During the years that followed, the image resolution and color reproduction of the process were continually improved. The dyes in the Technicolor imbibition process have better spectral characteristics than dyes available for current negative-positive processes. This gave the prints somewhat better color saturation with lower image contrast.

Technicolor developed a method of controlling the density and color balance of the color image while a film was being printed by means of what the firm called the *wash-back* system. Initially, the degree of dye removal was controlled by variation of the time or temperature of the water bath; beginning in the late 1940's, an improved water-spray method was perfected. After dyeing, the matrix films were rinsed with water from spray-jets; the amount of dye removed from the film prior to transfer could be precisely controlled by adjusting the number of spray-jets activated.

When a completed section of film came out of the dryer following the final dye transfer, it was fed directly into a special projector before being wound on a reel. An operator carefully monitored the projected picture (often with a reference print projected on an adjacent screen) and, over direct-wired telephones, notified machine operators working along individual sections of the processing machines if slight dye density corrections were needed. This allowed accurate control of the color balance of the film and was said to minimize the number of rejected prints.

The First Full-Color Technicolor Films

The first motion picture produced with the Technicolor three-color process was a Walt Disney cartoon short called *Flowers and Trees;* this film was released in 1932 as part of the Disney *Silly Symphonies* series. Disney had completed nearly half of *Flowers and Trees* in black-and-white when Technicolor showed him samples of the new three-color process. Disney became so enthusiastic about the idea of a full-color cartoon that he abandoned the black-and-white version and had his animation artists start all over in color.

Technicolor made the prints of *Flowers and Trees* in Hollywood, using two-color imbibition equipment modified for three-color printing which had been brought to Hollywood from its Boston laboratories in 1931. The cartoon was a great success and was followed in September 1932 by *King Neptune* and in December 1932 by the Disney cartoon *Santa's Workshop*. These were followed in 1933 by, among others, *Three Little Pigs* and in 1934 by *Funny Little Bunnies* and *Big Bad Wolf*. Disney was so pleased with the color cartoons that the process was used for all the new *Silly Symphonies* and — after *The Band Concert* in 1935 — for the ever-popular *Mickey Mouse* series.[21]

At first, the three-strip camera was used to film cartoons directly from the original art. However, beginning in 1934, Disney Studios started filming cartoons with a specially designed *successive-frame* camera which exposed three film frames in a row through red, green, and blue filters, respectively. A successive-frame camera is simpler to operate and much less expensive than the Technicolor three-strip camera; an ordinary single-strip camera is suitable for this type of filming. The matrix films are prepared by exposing them to each third frame; for example, the magenta dye matrix is exposed only with the green-filter frames. Most black-and-white negative films will not produce the same contrast with the three color records when all three color record films are given the same development; however, the contrast mismatch of the original successive frame negative can be compensated for by adjusting the exposure and development of the individual matrix films.

At the time of this writing, Disney Studios still had single-strip cameras for shooting successive-frame black-and-white negatives of cartoons; however, instead of making imbibition prints, the successive-frame negatives are now used to make color negatives for printing on conventional motion picture print film. The single-strip successive-frame technique is suitable only for static scenes (cartoons are made by photographing large numbers of still drawings, or "cels"). To avoid color fringing when filming moving scenes, all three color records must be exposed at exactly the same time, and it was for this reason that the complex three-strip camera was necessary for general filming.

The first motion picture to include live action filmed by a three-strip camera was the 1934 film *The House of Rothschild,* a black-and-white feature produced by Twentieth Century Pictures, which used three-strip Technicolor for the closing sequence. Also released in 1934, and shot entirely in three-strip Technicolor, was *La Cucaracha,* a famous short film produced by Pioneer Pictures.

The 1935 Production of *Becky Sharp*

The first full-length three-strip color film was the 1935 Pioneer Pictures production *Becky Sharp,* based on William Makepeace Thackeray's 1848 novel *Vanity Fair* and starring Alan Mowbray and Miriam Hopkins. Released by RKO, the film cost almost one million dollars to make. Rouben Mamoulian, who directed *Becky Sharp,* said this about the use of color in motion pictures:

> For more than 20 years cinematographers have varied their key lighting in photographing black-and-white pictures to make the visual impression enhance the emotional mood of the action. We have become accustomed to a definite language of lighting: low-key effects, with sombre, heavy shadows, express a somberly dramatic mood; high-key effects, with brilliant lighting and sparkling definition, suggest a lighter mood; harsh contrasts, with velvety shadows and strong lights, strike a melodramatic note. [Now] we have color — a new medium, basically different in many ways from any dramatic medium previously known, whether the stage or previous black-and-white pictures. And in color we have not only a new dimension of realism but also a tremendously powerful means of expressing dramatic emotion.[22]

Reflecting the excitement of the advent of full-color movies, a reviewer in the June 14, 1935 *New York Times* commented:

> Science and art, the handmaidens of the cinema, have joined hands to endow the screen with a miraculous new element in *Becky Sharp.* . . . Although its faults are too numerous to earn it distinction as a screen drama, it produces in the spectator all the excitement of standing on a peak in Darien and glimpsing a strange, beautiful and unexpected new world. As an experiment, it is a momentous event, and it may be that in a few years it will be regarded as the equal in historical importance of the first crude and wretched talking pictures. Although it is dramatically tedious, it is a gallant and distinguished outpost in an almost uncharted domain.[23]

Courtesy of UCLA Film, Television and Radio Archives

A production scene from **Becky Sharp.** The RKO feature, released in 1935, was the first feature film shot with the Technicolor three-strip cameras. Despite the artistic and historical significance of the film, not a single complete Technicolor imbibition print has survived from the 448 prints made in 1935. In 1984 the UCLA Film, Television and Radio Archives, working with YCM Laboratories in California, reconstructed the film with various negative and print elements gathered from all over the world. New separations were made, and prints were produced on Eastman Color Print Film 5384 via a color master positive.

The Resurrection of *Becky Sharp* in 1984

Throughout its history, much of the film industry has been astonishingly lax about the care of its films after production and release. There have been some exceptions, of course, and some producers have devoted considerable effort to assure the survival of their movies — Walt Disney Studios being the most obvious example — but as a whole, the industry has concentrated its attention on current and future productions, adopting a policy of "benign neglect" for everything else. In many instances, the lack of care went beyond simply not providing storage with reasonable temperature and humidity conditions. Almost unbelievably, for many films not a single print or intact negative (or other preprint materials) can be found today. Neither the producers nor collecting archives have managed to retain even one copy!

Becky Sharp, which for the second time in 50 years is being called one of the most important films in the history of American cinema, is a case in point. It was left to Robert Gitt of the UCLA Film, Television and Radio Archives and Richard Dayton of YCM Laboratories to resurrect *Becky Sharp* in 1984 by recombining various negative and print elements of the film collected from all over the world. They discussed the fate of the original prints:

> In May of 1935, Technicolor manufactured a total of 448 release prints of the film, 259 for domestic use and 189 for foreign release. As far as can be ascertained, not one of those original nitrate prints has survived. The Technicolor Company, itself, retained a print of only the first ten minute reel for color timing purposes. In 1943, the Whitneys and their company, Pioneer Pictures, sold all rights in *Becky Sharp* to Film Classics, Inc., and at the same time turned over all printing materials on the film. Probably for budgetary reasons, Film Classics decided to reissue the film, not in Technicolor, but in the cheaper to manufacture, two-color, Cinecolor process. Thus, 16mm prints, for non-theatrical purposes, were released of the full-length 84-minute version, while 35mm prints were cut to 66 minutes. In shortening the film, Film Classics removed and junked sections from the magenta and cyan negatives and from the soundtrack negatives. When Film Classics went out of existence in the early Fifties, the film changed hands several times, and by 1958, when television prints were first made, *Becky Sharp* was only available in a black-and-white, 16mm cut version. Since then, miscellaneous reels of the surviving 35mm negative have been lost.[24]

Becky Sharp is once again getting rave reviews. Tom Collins, writing in March 1985 in *The Wall Street Journal,* said: "UCLA unveiled a dazzling new version of 'Becky Sharp,' Rouben Mamoulian's witty rendition of 'Vanity Fair.' . . . Over the years, the original sparkle had been lost, not because of the fading that plagues all color pictures today, but by a ghastly transformation into a pallid, washed-out process called Cinecolor. This reduction gave little hint of the glories of the original until the three-year restoration effort by Mr. Gitt and Richard Dayton was put on view."[25]

A fascinating article by Gitt and Dayton describing the reconstruction of *Becky Sharp* was published in *American Cinematographer* in November 1984. Since publication of the article, additional footage from an incomplete, frequently spliced, and badly scratched imbibition print was obtained from the Cineteca Nazionale in Rome, Italy, and this has subsequently been used to improve parts of the UCLA reconstruction of *Becky Sharp:*

> . . . a representative from the UCLA Archives flew to Rome to examine the print, carrying along a letter from Rouben Mamoulian, the film's director. As a result, Dr. Guido Cincotti, head of the Cineteca archives, lent UCLA the Italian copy of *Becky Sharp*. With the assistance of the Library of Congress, arrangements were made to ship the nitrate print by military transport from Rome to the United States.
>
> The fragile and badly worn film was a dubbed version, a real advantage because the images were free of subtitles and could be used to supplement the restoration. UCLA has now integrated the usable sections of the previously missing Technicolor footage into its version. This has allowed fine-tuning of the film's color balance and significant improvement of the color quality of the last reel.
>
> The best news is that this updated version of *Becky Sharp* is expected to be released both theatrically and on videotape during the upcoming months. After decades of being available only on truncated 16mm black-and-white television prints, or much inferior two-color prints, we will finally have opportunity to once again appreciate the film's rich Technicolor look.[26]

More recently, one reel of an original print was found in New Jersey, and parts of this were utilized to improve sections of the soundtrack of the reconstructed film.

In a 1984 interview with Mamoulian about the restoration of *Becky Sharp,* the 85-year-old director commented:

> As Miriam Hopkins and Sir Cedric Hardwicke glide around the ballroom, among the 400 bit players are two young women looking on. One was a sophomore putting herself through the University of Southern California. Her name was Thelma Ryan — but she became better known as Patricia Nixon [the wife of former U.S. President Richard Nixon].[27]

Between 1935 and 1938, a number of well-known films were shot with the three-strip cameras. These included: *A Star is Born,* Janet Gaynor and Fredric March (Selznick International Pictures); *Adventures of Robin Hood,* Errol Flynn, Olivia de Havilland (Warner Bros.); and *Garden of Allah,* Marlene Dietrich, Charles Boyer, Basil Rathbone, Joseph Schildkraut (Selznick International/United Artists). By 1936 Technicolor was producing about 2,750,000 feet (838,000 meters) of three-color release prints per month.

1987

Separation negative masters for **Gone With the Wind** and other color films in the Turner Entertainment Film Library (operated by Turner Entertainment Company, a unit of Turner Broadcasting System, Inc.) are stored in the high-security underground facility operated by the Records Center of Kansas City, near Kansas City, Missouri. Film storage areas are maintained at 38°F (3.3°C) and 40% RH. Only safety base film is accepted for storage at the underground facility.

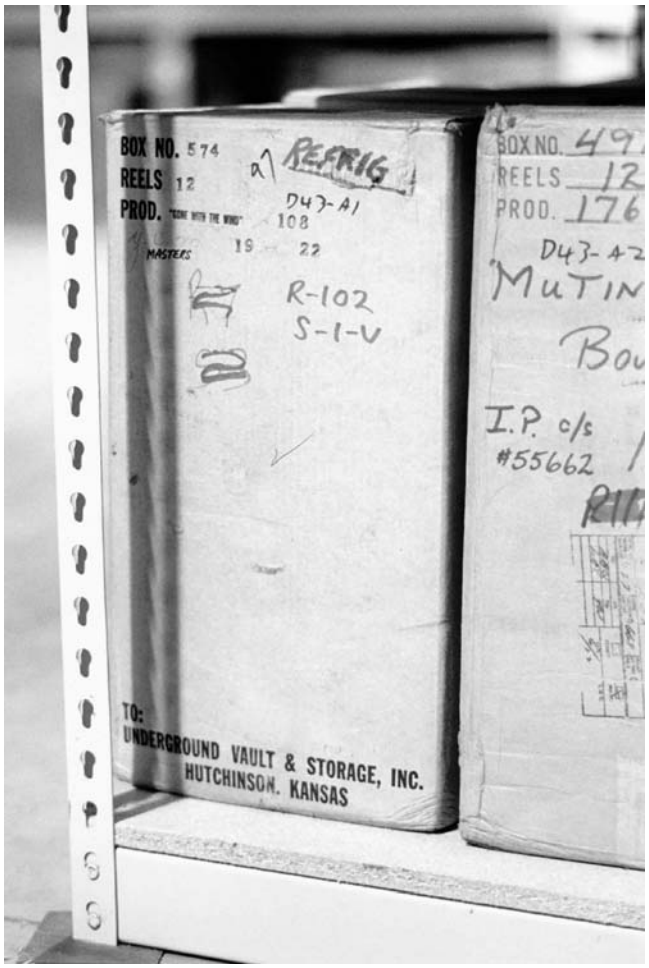
Snow White and the Seven Dwarfs Released for the Eighth Time in 1987, 50 Years After the Film Premiered in 1937

Walt Disney's classic animated Technicolor feature *Snow White and the Seven Dwarfs,* was released for the eighth time on July 17, 1987, simultaneously opening in 60 countries including the U.S., China, and the U.S.S.R. The Walt Disney Company believes that by the end of 1987 the film had been seen by more than 500 million moviegoers since its premiere in 1939; this, according to Disney, makes *Snow White* "the most popular American film of all time." To enhance this latest re-release, Disney reworked the soundtrack for Dolby Stereo.

Based on a Brothers Grimm fairy tale, *Snow White* was filmed with the successive-frame Technicolor camera and contains images of more than 250,000 drawings, selected from the more than one million drawings that were made for the project. *Snow White* originally cost $1.5 million to make, which was far over budget and at the time a huge sum for making a movie. Writing in *The New York Times* about the movie on the occasion of its 50th anniversary re-release in 1987, film critic John Culhane recounted the film's early history:

In 1934, when Disney announced his intention of making the first feature-length animated cartoon — perhaps costing as much as $250,000 — his sincerest well-wishers told him he was crazy. In the first place, there was a Hollywood truism that fantasies were failures at the box office. In the second place, the public wouldn't sit through so long a cartoon. In the third place, an adult audience wouldn't ever go to see a fairy tale. And in the fourth place, the juvenile audience wasn't large enough to pay for the cost of production.

Disney, who always said that self-confidence was the most important element of success, listened politely and made the feature anyway — at a final cost of $1.5 million in mostly borrowed dollars. *Snow White and the Seven Dwarfs* had its premiere in Hollywood on Dec. 21, 1937, and promptly grossed $8 million in its first release — at the time the most money a film had ever made. It played in 41 countries and soon had soundtracks in 10 different languages.[28]



1987

A box of cellulose triacetate separation negative masters from **Gone With the Wind**; the negatives which are duplicates of the original nitrate negatives shot with Technicolor 3-strip cameras, are stored in the refrigerated high-security underground vault at the Records Center of Kansas City. The originals are now part of the collection of the International Museum of Photography at George Eastman House in Rochester, New York, having been donated by MGM to Eastman House some years ago. The storage conditions provided by the museum for the original camera separations are less than adequate. On the occasion of the film's 50th anniversary in 1989, Turner made new prints from a newly reconstructed internegative printed from the original nitrate camera separations which were made available to Turner by George Eastman House.

To preserve *Snow White,* the original sequential-frame black-and-white cellulose nitrate camera negatives have been duplicated with cellulose triacetate film; for safekeeping, a set of duplicate separation negatives from *Snow White,* together with back-ups of most of Disney's other films, are in the high-security, atomic bomb-proof Underground Vaults & Storage, Inc. facility located more than 600 feet underground in an abandoned section of a salt mine in Hutchinson, Kansas.

Originally imbibition printed by Technicolor, theatrical prints for the latest re-release of *Snow White* were made with conventional chromogenic motion picture print film, printed from duplicate color negatives produced from the black-and-white successive-frame separations.

Disney has traditionally re-released *Snow White* and its other classic animated films every 5 to 7 years — counting on a huge new worldwide audience with every successive generation of children. In only 2 months after the 1987 re-release, the film grossed another $45 million — giving it a total gross to date of about $375 million! The next re-release of *Snow White* is expected to take place around 1993. Disney expects revenues in the coming centuries to be enormous.

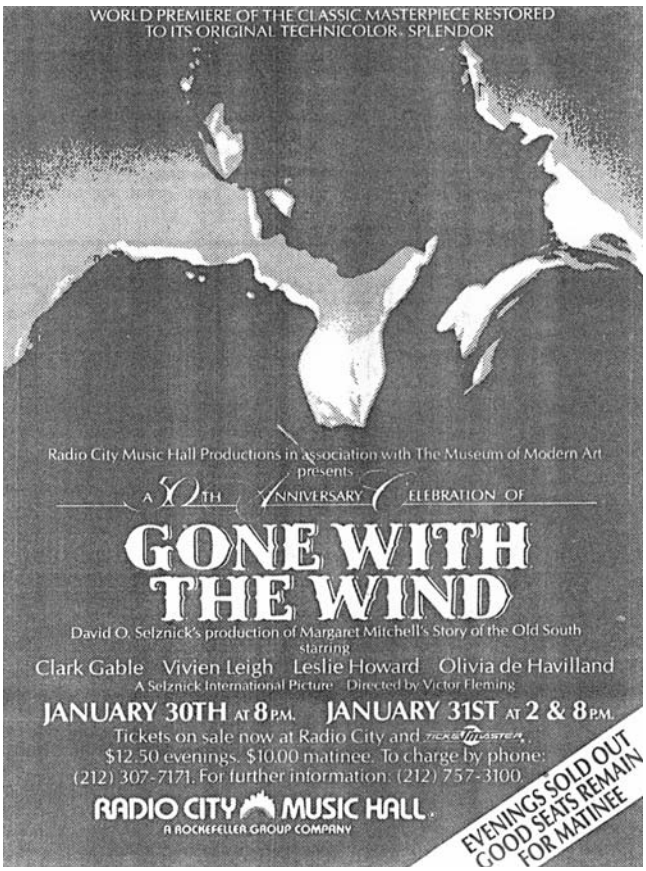
The Preservation of *Gone With the Wind*

Probably the most famous of all the films made with the Technicolor three-strip cameras is the 1939 David O. Selznick production of *Gone With the Wind,* starring Vivien Leigh and Clark Gable. Winner of the first Academy Award for Color Cinematography, the film cost more than $4 million to make — far more than any previous motion picture. At the completion of filming with the Technicolor three-strip cameras, more than one-half million feet of black-and-white separation negative film had been shot. This was edited to a running time of over 3½ hours, quite long by Hollywood standards. *Gone With the Wind* is still the inflation-adjusted top money-making movie of all time, and even in non-inflation-adjusted dollars, the film was the top-grossing movie in history until the 1977 release of George Lucas's *Star Wars.*

In the years since 1939, *Gone With the Wind* has been re-released many times, earning MGM untold millions of dollars (Turner Broadcasting System, Inc., as mentioned previously, purchased the MGM/UA Entertainment Company in 1986, and became the owner of theatrical rights to *Gone With the Wind* along with theatrical and television rights to the more than 2,200 other films in the MGM Film Library). Initially shown on television on the NBC network, the film earned NBC the highest viewer rating ever for a theatrical release when it was aired in 1976. Later, *Gone With the Wind* was licensed to CBS television for 10 years for $37 million. In 1987 Turner Broadcasting acquired television rights to the film from CBS in exchange for an undisclosed amount of cash and a license for some future airings of *The Wizard of Oz.* In 1985 MGM released *Gone With the Wind* on videocassette and videodisc, with the sound track "digitally enhanced" to create a simulated stereo track.

Beginning in 1966, MGM stopped having Technicolor produce imbibition prints of *Gone With the Wind;* instead, MGM made release prints on Eastman Color Print Film from a new color internegative. This was somewhat less expensive than making prints with the Technicolor imbibition process and also allowed the production of a 65mm internegative which was used to print the special 70mm prints for one of the re-releases of *Gone With the Wind.*

MGM made the Eastman color internegatives for *Gone With the Wind* from an Eastman color interpositive which had been printed by separate exposures from the original nitrate camera separation negatives. (MGM Labs, Inc., also known as Metrocolor Film Laboratories, was sold when Turner Broadcasting System, Inc. broke up the MGM/UA Entertainment Company in 1986.)



An advertisement for the newly restored **Gone With the Wind**, which appeared in **The New York Times**, Sunday, January 22, 1989.

At the same time MGM made the new color internegatives, MGM made master positives and duplicate separations from the original nitrate separations with Eastman cellulose triacetate black-and-white film in order to have stable copies of the original black-and-white camera separations for use in future years. The duplicate separations also provided a protection copy in the event of damage to the original separations during subsequent printing operations when the color internegative was made.

The 1988 Reprinting of *Gone With the Wind* from the Original Nitrate Camera Separations

For the 50th anniversary re-release of *Gone With the Wind,* Turner planned to make new prints from the duplicate separations made by MGM in 1966 from the original nitrate camera separations. But the print quality obtained was often unsatisfactory, so Turner borrowed the original nitrate camera separations from the International Museum of Photography at George Eastman House in Rochester, New York and used these to make a new color interpositive positive which in turn was used to make new duplicate color negatives for release printing. In addition, a new set of duplicate black-and-white separations was made. MGM had donated the original nitrate separations to Eastman House after they were duplicated in 1966.

In an article about the 1988 restoration in *The New York Times,* Max Alexander reported:

> [Turner Entertainment Company] initially planned to restore only the original title sequence in which the words *Gone With the Wind* sweep across the screen. (Later prints used a simpler block title.) Seeing the quality of the restored title "made us hungry for the rest of it," says Mr. Richard May [director of film services at Turner]. "We decided to go with the whole picture."
>
> Using as a guide a 1954 Technicolor print approved by the late Mr. Selznick, work began on rephotographing the negatives in early 1987 at YCM Laboratories in Burbank, Calif.
>
> According to Mr. May, "It had long been thought that the original negatives had shrunk at different rates; in fact the problem was not shrinkage but maladjustment of the prism in the Technicolor camera when it was photographed."
>
> The worst problem came during the Twelve Oaks smoking-room scene early in the film, where the men discuss the impending Civil War. "Rhett has on a tie that's supposed to be a black-and-white check, but it appears as a yellow-cyan and magenta check," says Mr. May, cringing at the thought.
>
> In another scene, he says, "Ashley [Leslie Howard] and Scarlett were silhouetted in front of a window, and he had three noses — different colors."
>
> Correcting the problems was "largely trial and error," sighs Mr. May: "Rephotographing the original at a slightly different relationship to the sprocket holes, hoping that it comes out the same as the other two strips. You're dealing with ten-thousandths of an inch."[29]

The once-again reprinted *Gone With the Wind* opened January 30, 1989 at Radio City Music Hall in New York City at a gala celebration to honor the "World Premiere of the Classic Masterpiece Restored to Its Original Technicolor Splendor." The premiere was co-sponsored by the Museum of Modern Art. During the year, the film was shown in theaters in 41 American cities. Restoration and publicity costs for the 1989 re-release reportedly amounted to about $350,000; the film earned $2.5 million at the box office and sold 220,000 copies of a special 50th anniversary edition videocassette for a total profit of about $7 million.[30]

Turner Entertainment Company Keeps Back-Up Film Elements in a High-Security Underground Refrigerated Storage Vault in Kansas City

For safekeeping, Turner Entertainment Company stores duplicate three-strip camera separation negatives and color interpositives and internegatives made from the original *Gone With the Wind* in the high-security, refrigerated underground vault operated by the Records Center of Kansas City, Missouri (a division of Underground Vaults &

Storage, Inc.). Located in a leased area of an abandoned section of an underground limestone mine operated by Texas billionaire Lamar Hunt, the Kansas City vault is maintained at 38°F (3.3°C) and 40% RH. The Records Center of Kansas City rents space to a variety of private and governmental clients; the vaults are intended to provide security for valuable films, magnetic media, microfilms, and paper records in the event of tornadoes, floods, civil strife, and even nearby atomic attack.

The original nitrate camera separation negatives from *Gone With the Wind* are in the motion picture collection of the International Museum of Photography at George Eastman House in Rochester, New York. On a hot summer day in 1978 there was a disastrous fire, attributed to spontaneous combustion, in a nitrate film storage facility on the grounds of George Eastman House; 327 features and short films, plus a number of early cartoons, were destroyed. The films were being stored in a building that had no temperature or relative humidity control, no fire detection or fire control equipment, nor any of the other provisions which are generally accepted as necessary for even short-term storage of cellulose nitrate motion picture film.

Fortunately, the *Gone With the Wind* separations were not among the films destroyed in the fire. After the fire, the separations, along with a large number of other nitrate films, were moved to rented space in storage vaults at Wright-Patterson Air Force Base near Dayton, Ohio. The priceless *Gone With the Wind* separations were returned to George Eastman House in 1990 where, at the time this book went to press in October 1992, they were being stored under less than ideal temperature and humidity conditions.

Cellulose Nitrate Motion Picture Film

Unfortunately, the camera separation negative films, the master positives printed from the original negatives to allow duplicate separations to be made in case the original separations were damaged, and the matrix films produced prior to 1948–1950 were all made on cellulose nitrate base (nitrate films are sometimes called "celluloid" films). The imbibition color release films were also made on nitrate base film during this period. After 1951 all Technicolor camera negatives, master positives, matrices, and release prints were made on cellulose triacetate safety film.

Despite the stability problems associated with cellulose nitrate film and the poor storage conditions in which apparently all of the original Technicolor separation negatives and master positives have been kept, many of those that can still be found are usable for making new duplicate negatives and color prints.

Other than suffering from scratches and other physical abuse, many surviving nitrate imbibition prints are also still in good condition. Thomas Tarr, formerly of Technicolor, has said that it appears to him that the life of cellulose nitrate films with which the early Technicolor movies were made increased as a result of treatment with the acidic dye solutions and/or the mordants used in the process. Tarr reports that many nitrate imbibition prints dating back to the early 1930's remain in excellent condition today, while black-and-white films made during the same period on the same type of nitrate support have suffered more deterioration.[31] Peter Comandini of YCM Laboratories says that in his experience, nitrate films made by DuPont generally have deteriorated much more than Eastman nitrate films stored under similar conditions.[32]

Technicolor normally disposed of cellulose nitrate and later cellulose triacetate printing matrices within 5 or 6 years of the initial printing; new matrices were prepared from the original separation negatives or the original color negative in cases where additional release prints were required after the original matrices had been discarded. Beginning in the 1960's, Technicolor adopted polyester-support matrix films which substantially increased the number of release prints that could be made from a set of matrices; polyester matrix films should remain usable for a great many years to come because the material has excellent dimensional stability during long-term keeping.

The professional motion picture industry was the last branch of photography to abandon highly flammable cellulose nitrate films. Kodak did not even introduce cellulose triacetate "safety" films for the motion picture industry until 1948, and the new films did not come into common use until 1949. Kodak continued to produce 35mm nitrate motion picture film until 1951.

Kodak introduced cellulose acetate "safety" roll film for still cameras in 1908 and has produced cellulose acetate films for the amateur home movie field since 1923. From the very beginning, all Kodak 16mm and 8mm motion picture films have been made on a cellulose acetate safety base because Kodak considered cellulose nitrate film to be too hazardous for home movie use.

The Hollywood motion picture industry preferred working with cellulose nitrate films — and Kodak and other manufacturers continued to produce them — because, compared with early cellulose acetate film, nitrate film had high tensile strength, good flexibility, and good dimensional stability after immersion in processing solutions.

In film industry terminology, films made on cellulose diacetate, cellulose triacetate, cellulose acetate propionate, and polyester supports are often referred to simply as *safety* films. The term "safety" indicates that the films will not burn rapidly; the fire hazards of safety films are approximately the same as of ordinary paper of the same thickness and packaged in the same manner.

If ignited, cellulose nitrate films burn extremely rapidly. Under certain conditions, large quantities of cellulose nitrate film stored without ventilation can spontaneously ignite when sustained temperatures in the storage areas are as low as 120°F (49°C).

It is by no means impossible, however, to preserve cellulose nitrate films that are still in good condition. At a given relative humidity of storage, the rate of deterioration of cellulose nitrate film is approximately *halved* for each 10°F drop in temperature; if the film still is in good condition, it can be preserved almost indefinitely in storage at 0°F (–18°C) or lower. For information on the long-term preservation of cellulose nitrate films in low-cost explosion-proof freezers, see Appendix 19.1 at the end of Chapter 19.

To keep matters in perspective, it should be pointed out that under typical storage conditions cellulose nitrate film is considerably more stable than the color *images* of films such as Eastman Color Print Film 5381 and 5383 which were in use worldwide as late as 1983.

Identification of Technicolor Imbibition Prints

Technicolor dye-imbibition prints are generally referred to as IB prints or occasionally as *dye transfer* prints. Technicolor imbibition release prints are not marked to distinguish them from the company's prints on Eastman Color and other chromogenic materials; however, *all* Technicolor release prints made from 1928 to about 1955 were made with the imbibition process. All release prints made by Technicolor on nitrate-base films were printed by the imbibition process. By 1949 Technicolor was reportedly printing about one million feet of imbibition release prints per day. By 1954, the company had produced over *four billion* feet of imbibition release prints since its founding in 1915 (most of this footage is no longer in existence).

Beginning in the mid-1950's, Technicolor started producing some release prints on Eastman Color Print Film (by about 1952, dailies from Eastman Color negatives were printed on Eastman Color Print Film), and by mid-1975 all release prints by Technicolor in the U.S. were made on this or similar chromogenic films. In 1977 Technicolor was said to be the largest single commercial customer of Eastman Kodak color motion picture films in the world.

It is sometimes difficult to differentiate Technicolor imbibition prints from Eastman Color Print Films or from other chromogenic color print films such as those made by Ansco, Fuji, Agfa-Gevaert, and Ferrania. Technicolor imbibition prints may also occasionally be confused with prints made by some of the less common color print processes of the 1930–1950's era, such as Supercinecolor or Trucolor (which used DuPont Color Film, Type 275).

Both Eastman Color prints and Technicolor imbibition prints have a slight physical relief image on the surface of the emulsion which corresponds to the optical density. However, the relief image is more pronounced with Eastman Color prints. Older Eastman Color prints have faded and suffered significant red or magenta color shifts unless the prints have been stored at low temperatures. Even the oldest Technicolor three-color imbibition prints, dating as far back as the early 1930's, show little if any color deterioration.

Nearly all the three-color prints until about 1946 have a fourth developed-silver "key" image to add density and contrast to the shadow areas, and these films will exhibit a microscopic grain structure in the middle- and high-density areas. The films usually exhibit a silver neutral-gray area adjacent to the image area of each frame.

Most Technicolor imbibition prints were made on Kodak film stocks and have *Eastman Kodak Nitrate Film* edge-printed in silver on the film (the words "Eastman" and "Kodak" and "Nitrate Film" were normally spaced about 2½ inches [6.4 cm] apart). Safety film made by Eastman Kodak is silver edge-printed with *Eastman Safety Film* or *Kodak Safety Film*.

The 3M Company — and possibly other manufacturers — also made "blank" print stocks for Technicolor during the last years of the imbibition process. If a Technicolor 35mm imbibition print is edge-printed with the "Safety Film" designation, it is certain that it was produced after 1948.

All Technicolor imbibition prints with optical soundtracks have neutral developed-silver soundtracks which do not contain any image dyes. Technicolor never produced 70mm release prints by the imbibition process; these have always been printed on Eastman Color Print Film or similar chromogenic films. Technicolor printed large numbers of 16mm and 8mm release prints by the imbibition process; these prints were normally made on a safety-film stock, although 16mm prints slit from 35mm cellulose nitrate film stock were produced for the armed forces during 1943–44.

The Demise of the Technicolor Imbibition Motion Picture Process

When dimensionally stable cellulose triacetate films became available, the Technicolor three-strip direct separation system was nearly ideal for making an accurate color record that could be kept for extended periods without the need for cold storage. However, the three-strip camera was a very bulky device and the system was difficult and expensive to operate compared to filming with Eastman Color Negative films and other integral tripack color films in conventional motion picture cameras.

The introduction of Eastman Color Negative Film, Type 5247, a daylight-balanced colored-coupler masked integral tripack, in late 1950 (the film was announced in late 1949) led to a rapid decline in use of the three-strip cameras over the next few years. The last major film shot with Technicolor three-strip cameras was the Ealing Studios production *The Lady Killers,* filmed in 1954 and released in 1955. The separation negatives and printing matrices were processed by Technicolor Ltd. in England; duplicate matrices were shipped to Technicolor in Hollywood for making release prints for U.S. distribution. The last American feature filmed with the three-strip cameras was *Foxfire,* starring Jane Russell and Jeff Chandler, also released in 1955.

At the same time Kodak began producing its color negative film, the company also introduced Eastman Color Print Safety Film, Type 5281 for printing dailies and release prints from the color negatives. In terms of tone and color reproduction, the Eastman Color prints were somewhat inferior to imbibition prints made from camera separation negatives and also to imbibition prints made from Eastman Color Negative Film originals. However, release prints made on Eastman Color Print Film were less costly than Technicolor imbibition prints when relatively small numbers of prints were required.

In the mid-1950's, Eastman Color Print Film was capable of significantly higher image resolution than the then-available Technicolor imbibition prints. The better image resolution of the Eastman prints was a decided advantage when large magnifications were needed for wide-screen theater projection and proved to be crucial when laterally "squeezed" anamorphic wide-screen optical systems came into common use. The quality of color and tone reproduction of Eastman Color Prints was considered adequate by the movie-going public, and the Eastman Color negative-positive system rapidly led to the almost universal adoption of color photography in motion pictures.

Eastman Color Negative Film, Type 5247 (not to be confused with the current Eastman Color Negative Film 5247) and its associated duplicating and print films came into significant use in the general film industry beginning in late 1952. *The Royal Journey,* a 1951 film made by the National Film Board of Canada about the visit to Canada of

Princess Elizabeth, was the first full-length feature produced with the new Eastman Color negative-positive films.

During the late 1940's and early 1950's, Ansco Color gained popularity, particularly at MGM, and this process became serious competition for Technicolor. Ansco Color was a chromogenic reversal process with a low-contrast camera film and a print film of the proper gamma to produce the higher contrast needed for projection. In 1953 Ansco introduced a negative-positive motion picture process. Partially because the Ansco films did not have the colored-coupler masking system used in the Eastman color films to reduce color degradation during successive printing operations, the Ansco system was inferior in color reproduction, and the process failed in the market some years later.

Eastman Color Negative Film, Type 5248, a tungsten-balanced film introduced in 1953, had better image resolution and finer grain than Type 5247. This new negative film, soon joined by various color intermediate and separation films from Kodak and by the improved Eastman Color Print Film, Type 5382, resulted in a complete color motion picture system with higher image resolution and generally lower production costs than the Technicolor imbibition process. This led to further economic distress for the Technicolor Corporation. In 1955 Kalmus said:

> But about 1953 came another development which heralded the fourth serious depression which was to overtake the Technicolor business. I refer to the advent of a new method of photography employing negative of Eastman color negative type which largely superseded the use of Technicolor special 3-strip cameras. And I also refer to the advent of large screen theaters and increased area negatives. The fourth Technicolor process which took care of a very substantial part of the motion picture requirements from 1934 to 1953 was tailored to make prints in the laboratory from Technicolor special 3-strip negative and to be projected on screens not larger than 30 or 35 feet in width. Beginning about 1953 both of these conditions changed and again Technicolor research and development departments had to do something to meet the new demands. And hence we come, in 1955, to the announcement of a fifth Technicolor process, "The Improved New Technicolor Process."
>
> Making Technicolor imbibition prints from Eastman Kodak type negative involved new and special laboratory problems. Continuing to operate with Technicolor Process number 4 resulted in Technicolor imbibition prints with the usual fine characteristic tone scale and color rendering but which lacked something in definition, or visibility. This became increasingly apparent when the industry began generally to use larger area screens in the theatres.
>
> So beginning around 1952–3 the objective of the Research and Development Departments of Technicolor became to improve the definition of its imbibition prints without the loss of any of its other superior characteristics. This work progressed on an emergency basis through a period of about two years until early in May, 1955 I saw on a 50-foot screen in Hollywood a demonstration of AN IMPROVED NEW TECHNICOLOR PROCESS. The 35mm print used for this demonstration embodied all the changes in the imbibition process that Technicolor has been striving for since the advent of Eastman and Ansco color type negative and the advent of large screens in theatres. The result was the most wonderful picture in color made by any process that I have ever seen on the screen from all technical points of view, including sharpness or definition and especially color rendition.[33]

The image resolution of dye-imbibition prints is usually less than the resolution of the printing matrix image because of slight lateral diffusion of the image dyes during the transfer step prior to drying. This type of lateral dye diffusion also takes place with the Kodak Dye Transfer and Fuji Dyecolor processes for still photographs; however, it is not so serious with reflection prints because they are generally viewed without magnification. Close examination of a Kodak Dye Transfer print will reveal the loss of definition caused by dye diffusion; the losses will be obvious if the print is compared with an image of the same original printed on Ilfochrome (Cibachrome) or on Kodak Ektacolor Paper.

Technicolor continued successful marketing of the improved imbibition process until the late 1960's, when popularity of the process started to decline in favor of the generally lower-cost Eastman Color Print Film and similar chromogenic release-print films made by Fuji and Agfa-Gevaert. During this period there was little discussion in motion picture circles of the relative stability characteristics of the various types of print films; because Kodak was still keeping the stability characteristics of its films a secret, and Technicolor decided not to make public what little information it had on the stability of its imbibition prints, the subject did not become a matter of concern at the time.

Thomas Tarr, now retired from Technicolor, says that the introduction of Eastman Color Reversal Intermediate Film, Type 5249 in 1968 (the film was used on a test basis in some labs, including Technicolor, a year or two before 1968) was the crucial factor that led to the end of the imbibition process.[34] Eastman Color Reversal Intermediate Film (CRI film) is a colored-coupler masked reversal film which produces a high-quality duplicate color negative in one operation; before the introduction of this film, labs had to make a duplicate color negative by first producing a color interpositive and then printing the positive on another film to make a duplicate negative. This additional operation was an added expense and, at the time, often resulted in unacceptable losses in reproduction quality.

Major motion pictures are not printed directly from the original camera negative because the negative cannot be replaced if it is damaged by repeated printing operations. For this reason, and to allow for the inclusion of special effects at an intermediate stage, duplicate color negatives are almost always required. Major studios also often make

black-and-white separation positives from the original color negative of major features for protection in the event the original is damaged or fades during storage.

The introduction of the Eastman CRI film made it possible to produce low-cost release prints on improved Eastman Color Print Film that were nearly equal in color and tone reproduction to Technicolor imbibition prints — and that sealed the fate of the imbibition process in the U.S. and Europe. In 1969 Eastman Kodak Company won an Oscar from the Academy of Motion Picture Arts and Sciences for the new reversal intermediate film.

With the 1979 introduction of Eastman Color Intermediate II Film 5243, an improved version of Eastman Color Intermediate Film 5253, designed to make color interpositives and duplicate negatives, many studios are no longer using the CRI film for duplicate negatives from 35mm originals (5249 is still used extensively for 16mm productions). The interpositive duplication method with 5243 is said to give better results than with the CRI film. A further drawback with 5249 is that it fades much more rapidly than 5243 film. In fact, 5249, which has not been significantly improved in terms of stability since its introduction in 1968, is by far the least stable of all current Eastman Color motion picture films.

Technicolor Imbibition Prints from Color Reversal Films

Release printing by the imbibition method is not restricted to films originally photographed with the three-strip camera or color negative films; the printing method can also be used with color reversal originals by making black-and-white separation negatives.

In 1941 Eastman Kodak manufactured a special low-contrast Kodachrome process film as a camera original reversal film for Technicolor; Technicolor called this product Monopack film. Separation negatives were made from the Monopack original and these were printed by the imbibition process. Monopack could be shot at low cost with conventional cameras, but the color reproduction obtained from the film was inferior to the three-strip camera process. Monopack was first used for outdoor sequences of *Lassie Come Home* (1943), a United Artists release. The first full-length feature shot with Monopack film was *Thunderhead — Son of Flicka,* released by 20th Century Fox in 1945. It was also used for Walt Disney's *True Life Adventure* series. Monopack film was discontinued by Kodak about 1952.

From the late 1940's and continuing through the 1960's, conventional Kodachrome films often served as camera originals for the imbibition process. The 1953 full-length documentary *Conquest of Everest* and the 1958 film *Antarctic Crossing* were both photographed with 16mm Kodachrome. Ansco Color reversal films were also used as original camera films from about 1946 to 1950. Many other types of reversal and negative films were printed by the Technicolor imbibition process; these included Agfacolor, Ferraniacolor, Gevacolor, Ektachrome, etc. Technicolor in England made prints from Russian Sovcolor color negative film for the motion picture *Othello* (1956) and later from the negative of the Russian 70mm production *The Story of the Flaming Years* (1961).

Technicolor Imbibition Prints Made from Color Negatives

With the decline in popularity of the three-strip camera in the early 1950's, most full-length feature movies printed by the Technicolor imbibition process were filmed on Eastman Color Negative films. Initially, Technicolor made separation positives (YCM masters) from the original color negative; the separation positives were then contact-printed to make separation negatives, and it was from these that the matrix films were printed.

Beginning in 1953, however, printing matrices were prepared from the color negatives with panchromatic matrix film in a manner similar to the printing of still color negatives directly on Kodak Pan Matrix Film in the Kodak Dye Transfer process. Soon after the introduction of the Eastman color negative and print films, Technicolor installed facilities for processing these films. During the early 1950's, Eastman prints were produced only for color dailies that were supplied to the filmmakers; Technicolor continued to make release prints with the imbibition process.

Agfa in Germany had introduced a color negative and color print film for motion pictures in late 1939; the films were used for a number of German productions during the war years. The early Agfacolor negative films did not contain color-correcting masks — Agfa did not begin to produce films with integral masking until about 1953, and at that time it was only a single silver mask.

Kodak did not attempt to enter the professional motion picture field with a negative-positive system until the company perfected its now almost universally adopted colored-coupler masking system in the late 1940's. This masking system was first incorporated in Kodak Ektacolor color negative film introduced in 1947 for still cameras and shortly thereafter in Kodacolor film for amateur photographers; with modifications, Kodak's masking system is now used with nearly all the still and motion picture color negative films in the world today.

One reason Kodak delayed introduction of a chromogenic negative-positive motion picture process was that prior to the development of the colored-coupler masking system, it was not possible to produce release prints that could compete in terms of color and tone scale reproduction with the Technicolor imbibition process. And Kodak was also selling Technicolor most of the film stocks for its productions, so there was limited financial incentive to offer an inferior alternative product.

Following the appearance of Eastman Color Negative Film, Type 5247 in 1950, and Type 5248 in 1953, Technicolor began making large numbers of imbibition release prints from color negatives. The first full-length film printed from Eastman Color Negative Film was *The Lion and the Horse,* released by Warner Bros. in 1952. This process was also used with the first CinemaScope wide-screen film *The Robe,* released in 1953 by 20th Century Fox.

More recently, Technicolor printed such films as *West Side Story* (1961), *My Fair Lady* (1964), *Bonnie and Clyde* (1967), the James Bond film *You Only Live Twice* (1967), *The Godfather* (1972), and *The Godfather Part II* (1974) from color negatives with the imbibition process for 35mm release prints; when wide-screen 70mm prints were required, they were produced on Eastman Color Print Film.

More than 1,000 imbibition prints — amounting to over eight million feet of film — were made of the James Bond film *On Her Majesty's Secret Service,* released in 1969.

The Godfather Part II (1974) was the last film made in the U.S. to be imbibition-printed by Technicolor for its initial release. Tarr reports that the last film *reprinted* by the imbibition process in Hollywood before the plant was closed was the 1975 re-release of *Swiss Family Robinson* (Disney, 1960); the prints for the new release were produced from previously made matrix films. The Hollywood plant was closed and dismantled in February 1975; the London and Rome plants were both closed in June 1978.

Tarr reports that Francis Ford Coppola, who directed *The Godfather* and *The Godfather Part II,* had planned to have European 35mm release prints of his 1979 epic about the war in Vietnam, *Apocalypse Now,* imbibition-printed by Technicolor in Rome. However, due to production delays, the film was not completed until after the last of the Technicolor imbibition plants had closed. Coppola is said to have preferred the color and tone reproduction of Technicolor imbibition prints over Eastman Color prints.

When Technicolor closed its imbibition operation in England in 1978, it opened a large new plant to expand its capacity to process and print Eastman negative-positive films. At the end, Technicolor believed that its imbibition process was no longer economically competitive with release prints made on chromogenic films such as Eastman Color, Fujicolor, and Gevacolor (Agfacolor) print films; the superior stability of the imbibition prints was not considered to be a worthwhile market advantage.

The Outstanding Image Stability of Technicolor Imbibition Prints

In the 1960's and 1970's, it was not uncommon for release prints of a given motion picture to be made both by the Technicolor imbibition process and with Eastman Color Print Film. The instability of Eastman prints can be dramatically illustrated by comparing them with Technicolor imbibition prints of the same film. After 10 to 20 years of storage, the Eastman prints exhibit severe cyan dye loss and have a pronounced red or magenta appearance; the Technicolor imbibition prints appear as perfect in color fidelity as the day they were made.

In 1977, at the Technicolor Motion Picture Corporation office in Hollywood, this author examined original film clips from a large number of early Technicolor imbibition motion pictures made on nitrate film base dating back to the 1935 release *Becky Sharp*. Without exception, the nitrate-base films were in excellent condition and showed none of the yellowing and physical deformation characteristic of the early stages of decomposition in nitrate film. Although original densitometric data are not available for comparison purposes, the dye images of the films appeared to be in uniformly excellent condition, with no obvious color shift or loss of density. The film had been kept in metal cans under normal room-temperature and humidity conditions at the former Technicolor office at 6311 Romaine Street in Hollywood, California. In recent years this office has been air-conditioned to maintain a temperature of about 70°F (21°C).

A non-color-corrected reproduction of an original frame from a cellulose nitrate release print of *Becky Sharp* is reproduced in Chapter 1. The film was imbibition-printed in 1935; still in excellent condition when this book went to press in 1992, the nitrate film was more than half a century old. The film clip had been stored with a large number of other film clips, all about 5 inches long and loosely packed in a metal film can. Because nitric oxides and other decomposition products can more easily escape from loosely packed films, such films may be expected to last longer than films wound tightly on a large reel in a can. In recent years, reproductions of a number of original, unfaded frames from old Technicolor imbibition-printed motion pictures have been reproduced in film periodicals in the United States and abroad.[35,36,37]

Based on the many Technicolor imbibition prints he has examined in recent years, Robert Gitt of the UCLA film archives had this to say about the image stability of the process:

> If you took a Technicolor dye imbibition print and you projected it many times at a drive-in theater and put a lot of light through it, the dyes do fade a little bit — particularly the cyan — although not that badly. But if you are careful with Technicolor imbibition prints, and keep them in the dark and don't show them a lot, they don't seem to fade *at all.* I've never seen one that has faded if properly cared for. It is a remarkably good process. Technicolor imbibition on triacetate base is very, very good.[38]

This author has conducted accelerated dark fading tests with frames from Technicolor imbibition prints made on Eastman cellulose triacetate film; based on density loss and stain formation of other color motion picture films and still materials tested under the same conditions, it could be predicted that Technicolor imbibition images will probably survive hundreds of years with only negligible fading — and with essentially no staining — when stored in the dark. The stability of the imbibition images is far better than the "high-stability" chromogenic print films introduced since 1984, including Eastman Color Print Film 5384 and Fujicolor Positive Film LP 8816. The stability of the Technicolor imbibition images is also far superior to that of Agfa-Gevaert's Agfa Print CP1 and CP10 Colour Print Films.

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