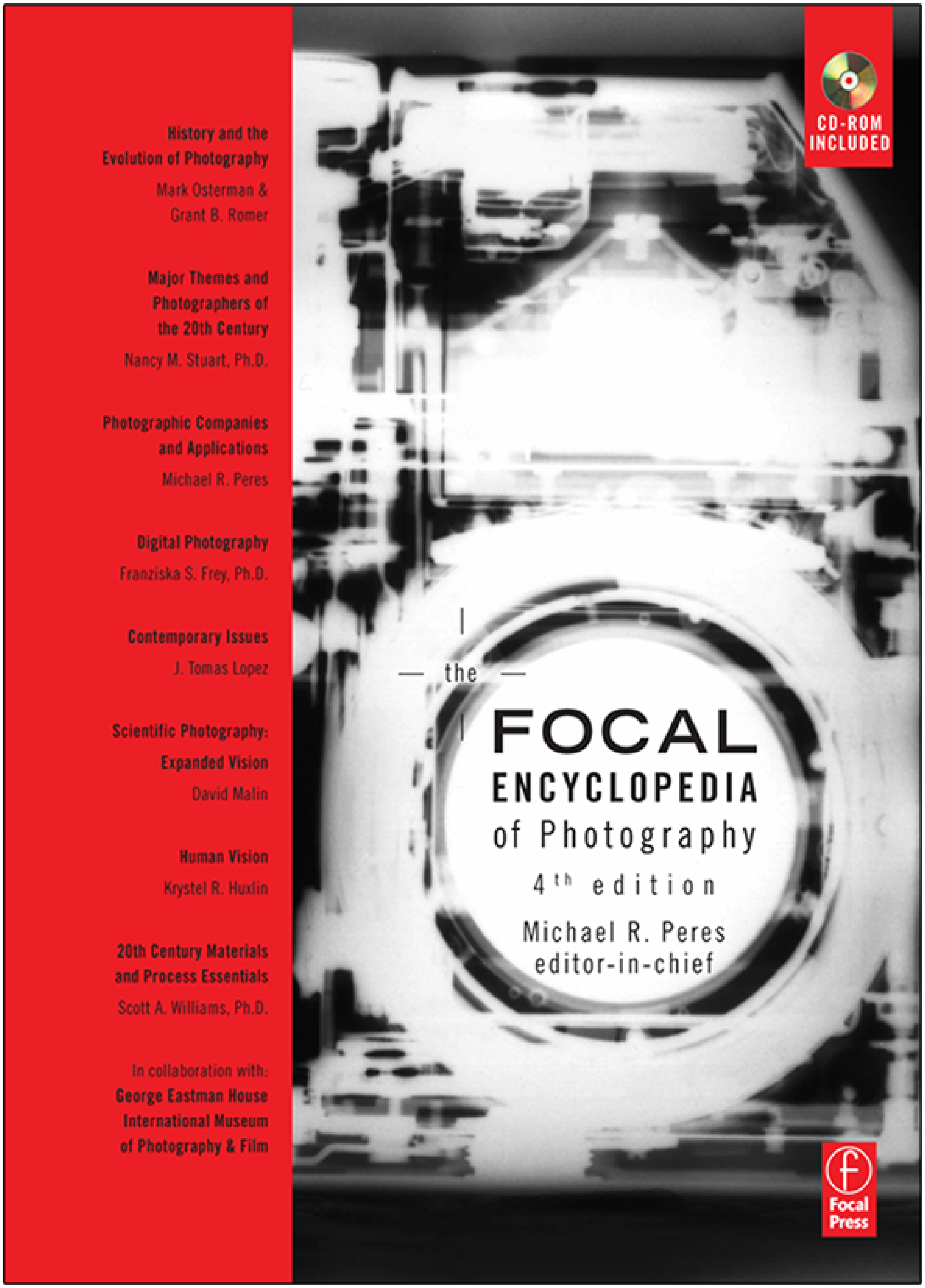
History and the Evolution of Photography
Mark Osterman & Grant B. Romer
Major Themes and Photographers of the 20th Century
Nancy M. Stuart, Ph.D.
Photographic Companies and Applications
Michael R. Peres
Digital Photography
Franziska S. Frey, Ph.D.
Contemporary Issues
J. Tomas Lopez
Scientific Photography: Expanded Vision
David Malin
Human Vision
Krystel R. Huxlin
20th Century Materials and Process Essentials
Scott A. Williams, Ph.D.
In collaboration with: George Eastman House International Museum of Photography & Film
CD-ROM INCLUDED
the
FOCAL
ENCYCLOPEDIA
of Photography
4th edition
Michael R. Peres
editor-in-chief
Focal Press

Buff
Used by daguerreotypists to apply the final polish to their silver plates. Buffs were usually made by initially applying layers of flannel cloth or cotton wadding to the flat surface of a long wooden paddle. A cover of cotton velvet, chamois leather, or buckskin was then stretched over the padding and tacked down along the edges of the paddle. The daguerreotypist polished the plate with two buffs. One buff was dusted with either rouge or carbon black just before passing it repeatedly over the plate. The second buff was used without these fine abrasives.

Bulb exposure
When lens shutters were introduced in the 1880s, one way of tripping the mechanism was by squeezing a rubber bulb that was connected, by a long rubber tube, to a small piston. One option for exposure was a duration, called instantaneous. The other exposure was keeping the shutter open as long as the bulb was compressed and was therefore known as a "bulb" exposure.

Burnisher
A finishing tool for applying a smooth, glossy finish to mounted prints. By the 1870s all *cartes de visite* and cabinet-card prints were burnished, as were many of the larger print sizes. When originally introduced, the burnisher featured a hand-cranked, textured roller that pulled the print over a smooth, heated bar. Eventually this design gave way to a rotary burnisher that featured two rollers: one smooth and heated and the other textured. In this configuration, the rollers rotated at different speeds, simultaneously compressing and rubbing the surface of the print. To get the best results, prints were rubbed with a lubricant before they were sent through the rollers. Burnished photographs remained popular until around the First World War.

Burnt-in photography
Also known as *ceramic photography,* this produced permanent vitrified images on enamel or ceramic supports. This practice was most commonly used for oval portrait vignettes on porcelain applied to tombstones. The process was also used for novelty jewelry and commemorative ceramic vases.

C

Cabinet photograph
Introduced in the early 1860s, the cabinet-card format featured a 4 × 5-1/2 inch print on a 4-1/4 × 6-1/2 inch mount. It was used primarily for studio portraiture, although views can occasionally be found. Prints mounted in this format were made on albumen paper, collodion-chloride printing-out paper, developed-out silver bromide gelatin paper, and gelatin chloride printing-out paper. Along with the *carte de visite,* cabinet cards were very popular until the end of the century, often sharing space in the family album.

Cadmium, Cd
A soft bluish metal, cadmium is extremely toxic, particularly in the compounds used for photography. It is found in zinc ores and in the mineral greenockite (CdS).

Cadmium iodide, CdI_2
Made by the action of hydriodic acid on cadmium oxide and crystallization. The colorless, flaky crystals are soluble in water, alcohol, and ether. This halide was a common iodizer for collodion formulas, particularly for negatives.

Cadmium bromide, $CdBr_2 4H_2O$
Made by heating cadmium to redness in bromine vapor. The yellowish crystalline powder is soluble in water and alcohol and is slightly soluble in ether. The crystals are deliquescent and must be kept in a well-stoppered bottle. Like its iodide counterpart, cadmium bromide was used in collodion in conjunction with an iodide of either ammonium or potassium.

Cadmium chloride, $CdCl_2 * \frac{5}{2} H_2O$
Made by the action of hydrochloric acid on cadmium and crystallization. The small white crystals are soluble in alcohol and water. Cadmium chloride was used to make collodion-chloride printing-out emulsions, also known as *leptographic* or *aristotype* papers.

Calcium bromide, $CaBr_2$
Made by the action of hydrobromic acid on calcium oxide and crystallization. The white granular crystals are soluble in water. Calcium bromide was used in making collodion emulsions, particularly for dye-sensitized plates.

Calcium carbonate, $CaCO_3$
Made by adding soluble carbonate to a calcium salt solution. The white powder or crystals are soluble in acid but not in water. Calcium carbonate was used to neutralize gold toning baths and as a fine abrasive added to water and alcohol for cleaning glass plates before they were coated with photographic binders.

Calcium chloride, $CaCl_2 * 6H_2O$
Obtained as a by-product in the manufacture of potassium chlorate. The white crystals, soluble in water and alcohol, are deliquescent and must be kept in a well-stoppered bottle. Calcium chloride was used in iodized collodion formulas and in collodion emulsions. It was also an important desiccating substance used in tin calcium tubes designed to store presensitized platinum papers.

Calotype
The first permanent negative process on paper, the calotype (also known as the *Talbotype*) was patented by William Henry Fox Talbot in 1841. The root of the word *calotype* comes from the Greek and means "beautiful." The calotype process was much faster than the photogenic drawing process that preceded it. It was a latent-image process based on the sensitivity of silver iodide. Paper was first coated with a solution of silver nitrate followed by a solution of potassium iodide. The potassium nitrate and excess iodides formed during the preceding step were washed from the paper. After drying, the iodized paper was coated again with silver nitrate, acetic acid, and gallic acid (called gallo-nitrate of silver) and then exposed in a camera while still damp.

The exposed paper was developed with a mixture of gallic acid, acetic acid, and drops of silver nitrate as needed to promote physical development. When development was complete, the paper was washed and fixed with sodium thiosulfate and then washed again to remove the residual fixer.

The calotype negative was permanent, displayed a pleasant range of tonality when made by skilled hands, and could be used to contact-print an unlimited number of salted paper prints. For this reason, the calotype process has often been regarded as the forerunner of modern negative/positive photography. Although the calotype was never to reach the popularity or commercial success of the daguerreotype, there is no doubt that the invention of glass negatives was a direct result of its influence. Glass negatives made by the wet collodion process quickly eclipsed both the daguerreotype and the calotype methods by the mid-1850s. *See also* Photogenic Drawing.

Camera

The viewing of an inverted image through a pinhole in a large room was recorded as far back as the 5th century in China. In the 16th century, Aristotle used this principle to view solar eclipses. However, it was not until the Renaissance that the concept really began to be worked on in earnest. Scientists and inventors such as Leonardo da Vinci and Girolamo Cardano began making references to the phenomenon of image projection in what then was known as the camera obscura. During the 16th century, great improvements over the original design were made, which not only improved the camera obscura but also extended its applications. A problem had existed concerning the dim image that the small hole projected. It was common knowledge that if the size of the hole was increased, the sharpness of the image would decrease. With this principle in mind, Cardano fitted a biconvex lens to the camera obscura in 1550, and Daniel Barbaro added a diaphragm that would improve the depth of the field in 1568. In 1676 Johann Strum inserted a 45 degree reflex mirror that allowed the image to be projected to the top of the box onto a sheet of oiled paper — and onto a ground glass in later versions. The significance was that the camera obscura could now be used from the outside, and thus it could be greatly reduced in size. The focusing lens became a complex arrangement of separate glass elements in a brass housing that corrected for various aberrations.

Cameras of the 19th century

All images on the following pages are courtesy of the Technology Collection, George Eastman House International Museum of Photography and Film, Rochester, New York. Comprising more than 16,000 objects, the George Eastman House technology collection is one of the world's largest collections of photographic and cinematographic equipment. It contains 19th- and 20th-century objects of photographic technology, including cameras, processing equipment, motion-picture devices, and a broad range of early historical accessories. Many of the objects are unique, representing distinguished historical ownership and significant scientific achievement.

This collection is the most comprehensive held by any institution in North America and is equaled in overall quality by only three other holdings worldwide. From devices that predate the formal invention of photography in 1839 to the most modern state-of-the-art instruments used by both amateurs and professionals, the collection offers visitors an unparalleled opportunity to examine and learn about photographic technology.

FIG. 3 Collapsible camera obscura, ca. 1800.

FIG. 4 Samuel Bemis daguerreotype outfit. Clockwise from lower left: camera, mercury chamber, iodizing box, plate box, ca. 1839.

FIG. 5 Giroux daguerreotype camera, ca. 1839.

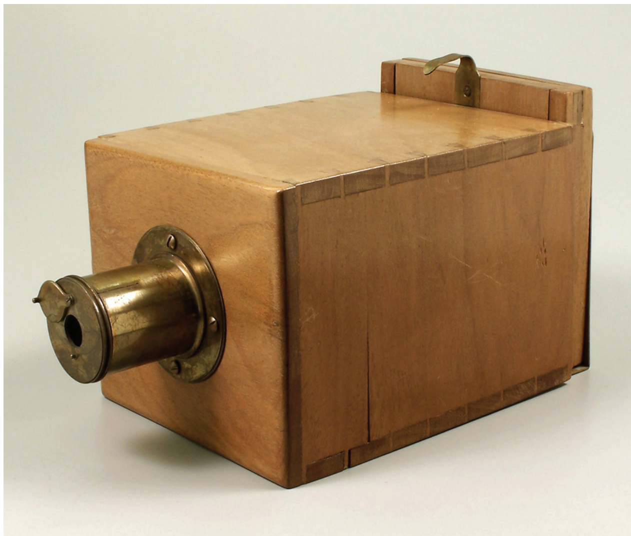

FIG. 6 Talbot design calotype camera of 1840 (replica).

FIG. 7 Talbot design mouse trap cameras (replicas).

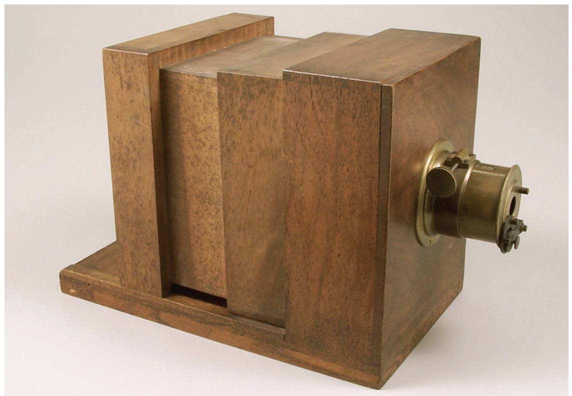

FIG. 8 Sliding box camera with single achromatic landscape lens, ca. 1841.

FIG. 9 W. & W.H. Lewis daguerreotype camera, ca. 1852.

FIG. 10 Albites patent laboratory camera, ca. 1860.

FIG. 11 Dubroni laboratory camera, ca. 1860.

FIG. 12 Dubroni outfit, ca. 1860.

FIG. 13 American chamford box daguerreotype camera, ca. 1864.

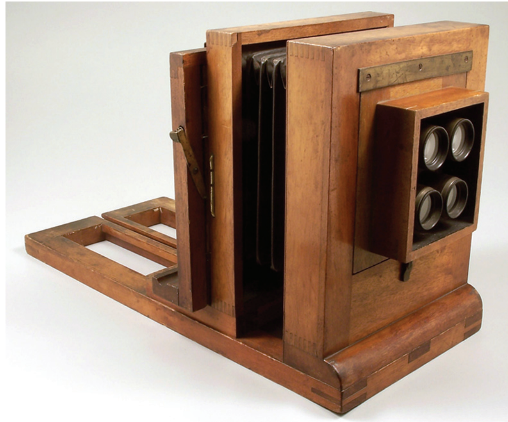

FIG. 14 John Stock bon ton ferrotype camera, ca. 1870.

FIG. 15 W. Rausch folding camera, ca. 1870.

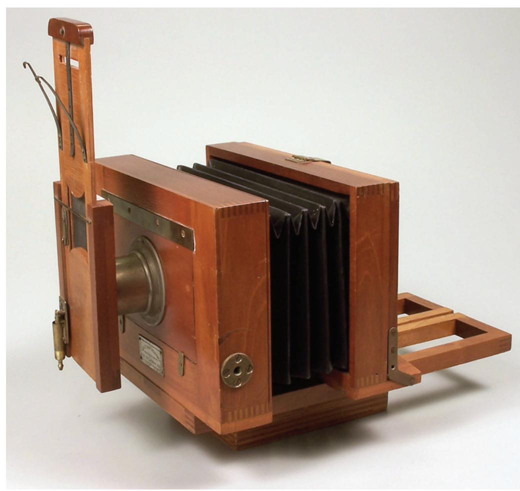

FIG. 16 Drop shutter, ca. 1880.

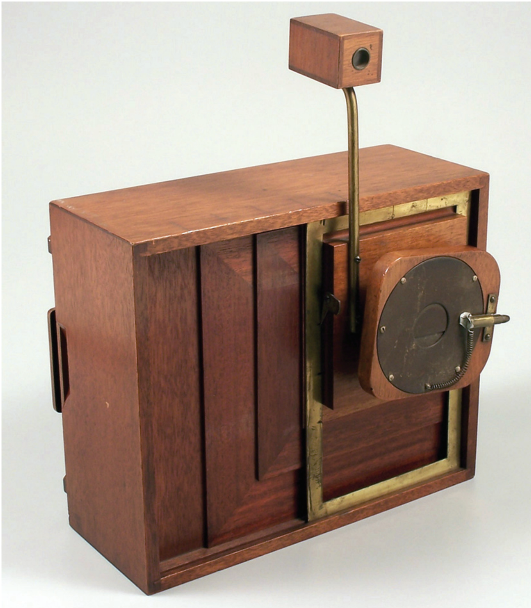

FIG. 17 Simon Wing “new gem” multiplying camera, ca. 1881.

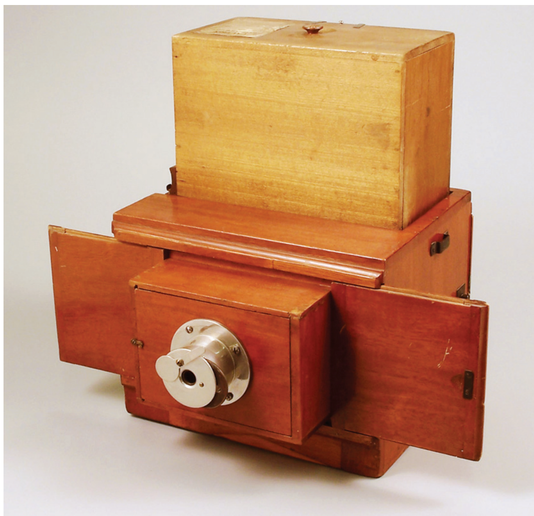

FIG. 18 Blair tourograph magazine camera, ca. 1882.

FIG. 19 PhotoRevolver Oe Proche, Paris, France, ca. 1882.

FIG. 20 Prosch duplex shutter, ca. 1844.

FIG. 21 Eastman-Walker roll holder, ca. 1885.

FIG. 22 Thornton-Pickard cloth shutter, ca. 1886.

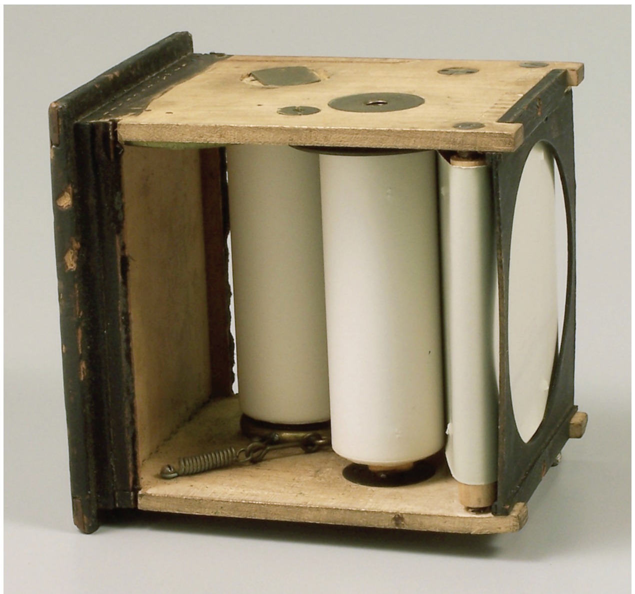

FIG. 23 Eastman American flim in Kodak roll holder, ca. 1888.

FIG. 24 Kodak camera, ca. 1888.

The portability of the new camera obscura greatly interested architectural and landscape artists, who carried the tool to various locations to do preliminary traced sketches for paintings. In 1807 William Hyde Wollaston added more portability to realistic sketching with the camera lucida, a prism-and-stand device that projected an image of a scene downward, where the image could be sketched more easily. A realistic perspective recording was a much-sought aesthetic—and a fundamental reason for photography's later popularity.

It is interesting to note that by the 17th century, the box, lens, reflex mirror, and ground glass had all been introduced. It would take another two centuries before the chemistry of the photographic process would become sophisticated enough to be applied to the camera apparatus.

Photographic Cameras

All photographic cameras were and continue to have the same basic elements: a box with an aperture on one end that may or may not be fitted with a lens and a focal point on the opposite end, where the projected image is visible. The very first cameras for photographic use were no different from the common camera obscura available for a hundred years before photography was invented. Very primitive results were produced when using these boxes fitted with simple biconvex lenses. The poor quality was due partly to the lengthy exposures required to print out a visible image but also to the fact that the materials were sensitive only to ultraviolet, violet, and blue light. Simple lenses did not focus parallel rays of light on the same plane—a defect called *spherical aberration,* which resulted in the loss of focus on the outer edges of the image. Nor did the lenses focus all the colors of the spectrum on the same plane—a defect called *chromatic aberration.* The most visible colors to the human eye are in the yellow range, so even if the image was focused properly, the final product would be out of focus on materials that were sensitive only to violet and blue light.

The First Cameras

Thomas Wedgwood, Nicéphore Niépce, William Henry Fox Talbot, and Louis Daguerre all made their very first images using simple uncorrected lenses, often taken from a solar microscope. The early experimenters quickly realized that lens design was critical for better results, and they looked to opticians for the achromatic lens used by telescope makers. While not always fully achromatic, these lenses were superior to the simple biconvex lens and were capable of remarkably good focus when stopped down.

The earliest photographic cameras known to exist are those used by Nicéphore Niépce, on display at the Muse Niépce in Chalon-sur-Sônne. The most notable example features a sliding box within a box for focusing (an innovation from camera obscuras that predates photography) and an unusual lens board that allowed the biconvex achromatic lens to be removed by sliding half of the board upward. Niépce gave one of his cameras to Daguerre when they became partners, but this was probably lost in the fire that destroyed Daguerre's studio in 1839.

Talbot's Early Cameras

Cameras used by Talbot before he introduced the more sensitive calotype process in 1841 were wooden boxes of various sizes fitted with a simple lens set in a brass tube. The lens tube was either fixed or sliding, allowing the focus to be adjusted by pushing or pulling the friction-fitted tube from the front of the box. Camera boxes with adjustable focus included a second peephole on the front of the camera so that the projected image could be seen on the sensitized photogenic paper for a moment to allow focusing. Once the image was focused, the peephole was plugged for the duration of the exposure. Many of these cameras still exist, the most endearing being those Talbot's wife called "mouse traps" because of their small size.

The first production camera

The first publication to feature both descriptions and illustrations of photographic equipment was Daguerre's 1839 manual. A masterwork whose comprehensiveness has never been equaled, Daguerre's manual included scale drawings of the camera, plate holder, focusing glass, and reflex viewing mirror. Although the equipment was available for purchase, the manual also featured all of the processing equipment in drawings detailed enough for a skilled cabinetmaker to produce any one of them to order.

Daguerre's camera was an adaptation of Niépce's, featuring the sliding-box system for focusing. The sensitive plate was brought to the camera in a holder with a hinged double door, which opened into the camera when the operator pushed curved brass levers from the outside. The 6-1/2 × 8-1/2 inch plates were temporarily tacked to a removable wood plate in the back of the holder. The camera featured a brass mounted single-achromatic lens (made by Charles Chevalier) that was fitted to the box (built by Alphonse Giroux [Figure 5]). The basic design — with the exception of the unusual system of exposing the plate to the interior of the camera — was used by camera makers well into the late 1850s for all of the processes common in that era, including daguerreotype, calotype (also called the waxed paper process), albumen, and collodion-on-glass methods.

Wolcott's mirror camera

The world's first studio system also included the most unusual camera. Alexander Wolcott patented a lensless camera on May 8, 1840, that was based on designs adopted by the scientific community for celestial telescopes. By replacing the lens with a highly polished concave mirror of speculum metal, Wolcott was able to create a faster camera suitable for portraiture. The mirror also solved the problem of chromatic aberration because light wasn't required to pass through glass. Wolcott's camera was used by Richard Beard in the world's first commercial portrait studio at the Royal Polytechnic Institution in London.

Despite its optical advantages, the Wolcott camera never realized commercial success. This was probably because of the small image-size limitations of the heavy mirror, which seemed grossly disproportionate in diameter and weight. The camera did not feature a separate plate holder, making it necessary to load the camera in the darkroom or under a covering in the studio.

Sliding-box cameras

The sliding-box camera was the most common instrument of the 1840s and 1850s. In that period, the box design was common to all photographic processes, and the portrait and landscape lenses were made to suit their respective purposes. It was the plate holder that differed from process to process. Holders, also called shields, were available for either plates or paper. Some holders designed for calotypy were hinged like a book, with a central septum to hold two pieces of sensitized paper. Other holders required the paper to be either affixed to or placed between two sheets of glass.

Sliding-box cameras were usually made with two boxes, but some featured multiple telescoping boxes (Figure 8). They were made in a variety of sizes for studio portraiture, with single or multiple lenses, but also for landscape and stereo work. The sliding-box design continued to be used for some purposes well into the dry plate era.

The addition of bellows

The use of an accordion-type bellows to lengthen photographic cameras was commercially introduced by the W. and W. H. Lewis Company of New York (Figure 9). The company initially sold chamfered box daguerreotype cameras with two different plate positions: one for portraits and views, the other for copy work. This design was abandoned for an inner sliding box. In 1851, the company introduced a camera cut in half, featuring leather bellows between the front and rear sections of the box. This innovation allowed almost unlimited flexibility of focusing on objects near and far. The Lewis design influenced camera makers in the United States and Europe, and bellows-type cameras would eventually replace the sliding-box style by the middle of the 1860s.

An important variation of the bellows-type camera was the introduction of the tapered bellows (Figure 15), by Scottish photographer C. G. H. Kinnear in 1857. The tapered design allowed the folds of the bellows to collapse upon themselves in a way that required a fraction of the space needed for the so-called square bellows. The Kinnear design was adopted by camera makers who produced equipment suited for landscape work. Weight limitations were always a consideration there because of the inherent difficulties of working in the field. Tapered and square bellows were used throughout the 19th century and are still in use today.

Early improvements

By the early 1850s, other improvements were made that evolved to become standard features on many cameras by the third quarter of the 19th century. The lens board was designed to be raised and lowered, making it possible to include more or less sky in the picture without tilting the camera box, which would cause distortion. The back of the camera was also made to tilt forward and backward to manipulate the focal plane and to correct for the keystone effect, where for example, a building looks narrower at the top than at the bottom. Plate holders for cameras of the 1850s through the 1870s were generally designed to hold one plate loaded from the back, with the dark slides being withdrawn from either the top or right side of the holder when the operator was standing at the back of the camera.

The earliest cameras were built on a rigid frame, called the bed. The bed extended beyond the rear of the camera far enough for the back holding the focusing glass to allow focusing the closest subject. This rear extension of the bed became know as a *tailboard*.

When photographers in the 1860s sought cameras specifically for landscape work, clever builders cut the tailboard so that the rear extension could be folded. By the 1870s most cameras were manufactured for the studio, with rigid tailboards or with folding (or even detachable) tailboards for landscape work.

Laboratory cameras

Less known were the laboratory cameras of the wet plate era. The first of such cameras to be manufactured and offered for sale was designed in 1853 by the inventor of the collodion process, Frederick Scott Archer. A glass plate was coated with iodized collodion in the daylight as usual, but then the collodionized plate was placed into the camera to be sensitized with silver nitrate solution and to be exposed. The exposed plate was then developed in the camera and washed with water, allowing it to be removed from the camera for subsequent fixing. Some of these cameras featured separate dipping tanks for the silver, developer, and water wash; the operator relied on a system of levers or pulleys to manipulate the plate from the outside (Figure 10).

The Dubroni

The first commercially successful and most common laboratory camera was the Dubroni, introduced by the inventor G. J. Bourdin in 1864 (Figures 11 and 12). Unlike other designs, Bourdin's camera was made with a ceramic or blown-glass chamber held between the front and rear sections of a wood camera. The chamber had a small opening in the top for introducing processing solutions, a hole in the front to allow the projected image to pass from the lens to the back, and a larger opening with a ground edge in the back, onto which the collodionized plate was placed.

Once the plate was in place, the back was closed and silver solution was poured into the camera using a small funnel. The camera was tilted back so that the silver solution came in contact with the collodion surface of the plate. The camera was then turned upright, and the silver solution was drawn out by a suction pipette. The exposure was made, and the subsequent development and water wash were performed by the same means as that used for the silver solution. Many Dubroni cameras in several sizes were sold in the wet plate era, although very few images made from them exist in collections.

Multiple-lens and Multiplying Cameras

Cameras bearing more than one lens were originally introduced for the purpose of stereo photography in the mid 1850s. John Dancer, an English optician, patented and sold the first successful double-lens sliding-box stereo camera in 1856. Before this, stereo images were made either with two cameras side by side or with a single camera carefully moved from one side to the other between exposures. A design variation of the single-lens stereo camera was the sliding or multiplying back, which was to become a very important camera movement for studio portraiture.

When the need for photographs in quantity was spawned by the introduction of the *carte de visite* in the late 1850s, camera makers increased efficiency by applying more lenses to the camera box. By attaching four lenses to the front of the camera and a sliding back to the rear, it was possible to make eight *carte*-size negatives on an 8 × 10 inch plate. More often than not, however, most *carte de visite* negatives were single plates made with smaller and less expensive single-lens studio cameras.

The four-lens design with or without the sliding back found its true calling with the ferrotype camera (Figure 14). Often confused with the much rarer four-lens *carte de visite* camera, ferrotype cameras were manufactured specifically for making ferrotypes, popularly known as tintypes. The most common format was four images made on a 5 × 7 inch plate. Called *bon tons* in the trade, the individual tintypes were cut from the plate and inserted into paper window mats. If the four-lens bon ton set was replaced with a standard portrait lens, several other sizes of images could be made, depending on various back masks that were available. Multiple-lens sets with nine or more tubes were manufactured throughout the last quarter of the 19th century, with popularity fading after the First World War.

By using different back masks, the tintypist could make either four or eight images on a 5 × 7 inch plate by using four lenses. If the camera was fitted with a sliding back, 8 to 16 images could be made on an 8 × 10 inch plate with one movement of the back. A variation of the sliding back for multiple exposures was the sliding front, patented by Simon Wing in 1862. Wing's multiplying camera allowed a single lens to be moved both up or down and side to side between exposures to make 15 exposures on a 5 × 7 inch plate (Figure 17). When made on tintype plates, these images became known as *gems*. Other variants of the Wing camera also had multiple lenses and sliding backs. *See also* Multiplying Camera.

Exposure control

Throughout the daguerreotype, calotype, and wet collodion eras, exposures were slow enough to forego the need for a lens shutter. Photographers made exposures simply by standing to the side of the camera and uncapping the lens. In the days before adequate lens hoods, the photographer often used the withdrawn dark slide to shield the lens from strong light. The earliest shutters were patterned after their namesake, a design featuring one or two doors that were opened by hand or pneumatic tube. Speed was not the issue for these shutters; they simply facilitated the uncapping of the lens.

In the 1860s some photographers boasted that they could make instantaneous exposures with wet plates. These were almost always made on plates with high bromide content using smaller cameras. A fast lens of a short focal length and a well-lit subject out-of-doors made these instantaneous exposures possible. But the term *instantaneous* was not very specific. The earliest-manufactured shutters for instantaneous exposures resembled a guillotine (Figure 16). Known as *drop shutters,* or simply *drops,* these were made by cutting a hole in a long, thin piece of wood and allowing it to drop into a second wooden track with a hole that was attached to the front of the lens. Gravity was the initial power for drop shutters; the introduction of more-sensitive gelatin plates in the mid-1880s allowed for faster exposures, and rubber bands were applied to the mechanism.

Mechanical shutter designs evolved as the sensitivity of gelatin plates increased throughout the last quarter of the 19th century. Most of these designs used a system of one or more thin blades of hard rubber that opened and closed by a lever, cord, or pneumatic bulb. Like the popular Prosch Duplex shutter (Figure 20), these early examples included both an instantaneous and a timed setting. The earliest Kodak camera, introduced in 1888, used a spring-loaded rotating barrel shutter that was cocked by pulling a string at the top of the camera and was released by depressing a button.

By the early 1890s, an iris-diaphragm shutter design had been adopted that was particularly suited for photography outside the studio. The iris-diaphragm shutter was based on a series of thin blades pivoting from an outer ring and converging on a central aperture. This design, which can be seen on one of Niépce's cameras in the Muse Niépce, continued to be used well into the 20th century.

The last improvement in exposure control in the 19th century was the slit shutter (Figure 22). This system used a long cloth panel fitted with an open slit and wound between rollers set in front or behind the lens. The focal-plane slit shutter was placed just in front of the sensitive plate or film. When the spring-loaded system was tripped, the length of cloth traveled from one roller to the other, moving the open slit past the film and making the exposure. Once again, this design had many variants and was used by camera makers throughout the next century.

Magazine and detective cameras

The wet collodion process made candid photography virtually impossible, although Skaife's pistolgraph came close to reaching the technology. The tiny brass camera was fitted onto its own small wooden storage box by means of a ball-and-socket joint. Relatively fast exposures were made possible by a small lever-action barn-door-type shutter.

When thoughts turned to producing dry plates, the collodion process was the first practical method. By the mid-1850s, amateurs were experimenting with wet collodion plates prepared as usual and then kept moist or allowed to dry completely by applying one of many treatments. By the late 1870s, collodion emulsions were being coated on glass. Dry collodion plates were generally 3 to 10 times slower than the wet plate process, but plates could be made weeks prior to shooting, doing away with the necessity of a darkroom in the field. These dry processes were particularly suited to a special magazine system for loading and retrieving plates. The plate magazine was usually a separate slotted box that attached to the camera. Plates were transferred from box to camera, and vice versa, by indexed knobs, buttons, or levers.

The magazine camera was not a commercial success until after the general adoption of gelatin plates (over the collodion process) in the late 1880s. In particular, the magazine system was used on many so-called detective cameras. These hand-held cameras were introduced when the general public had become accustomed to seeing larger cameras mounted on tripods.

Flexible film cameras

While the concept and application of flexible transparent films dates back to Archer in 1851, the first true roll-film holder was introduced by Leon Wernerke around 1875. His film was designed to be stripped from a temporary paper support, a technique later improved by George Eastman when he introduced American Film. Wernerke's product was not a commercial success. Professor E. Stebbing, a Parisian camera maker, produced his so-called Automatic Camera in 1884 to accommodate glass plates and flexible negatives on paper or gelatin-based film transported between rollers. Once again, this camera design met with limited success.

George Eastman and William Walker, a Rochester camera maker, produced the Eastman-Walker roll holder around the same time (Figure 21). This system used Eastman's American Film: a silver bromide gelatin emulsion layer on a soluble layer of plain gelatin that was applied to a flexible paper support. Although the holder could be made to fit existing view cameras, real success wasn't realized until the introduction of the hand-held Kodak detective camera in 1888 (Figures 23 and 24). The Kodak was arguably one of the most influential cameras for the next century, allowing amateurs to make photographs easily and spawning several generations of hand-held box cameras manufactured by a host of companies. By the end of the 19th century, flexible films were made by applying silver bromide gelatin emulsions to a transparent cellulose-nitrate base; however, the professional photographers and many advanced amateurs still shot on glass plates.

Camera stands

Large cameras used in commercial portrait studios required a stand that could be moved easily across the floor and adjusted without removing the camera. The camera stand was a substantial piece of studio equipment that was available with either three- or four-legged supports, which usually stood on roller casters. It was essential that the stand be designed to allow raising, lowering, and tilting the camera. Typically the camera rested on a flat wooden bed secured only by weight. There was no need to attach the camera to the bed.

Some four-legged stands, particularly for larger cameras, were fitted with counterweights and pulleys or springs to facilitate raising and lowering the camera. The tripod's adjustments were made by turning a crank, which raised or lowered the system. Another less popular design was the lever stand, where by the height of the camera was adjusted by using notched wooden levers. When silver bromide gelatin dry plates were adopted, manufacturers began to offer a wood rack attached to the side of the stand that held loaded plate holders at the ready.

Pinhole cameras

The pinhole camera uses a small hole (made by a needle) in a thin opaque material instead of using a lens to relay an image to the focal plane. The pinhole forms an image by allowing only a single narrow beam of light from each point on an object to reach the opposite surface. Light rays traveling through this pinhole continue in a straight line and form an inverted image on the opposite side of the box, where a piece of photosensitive emulsion is placed to record the image. The pinhole itself should be circular with clean edges, and the opaque material should be thin enough to prevent objectionable vignetting. Image size depends on the distance from the pinhole to the opposite side. The f-number of a pinhole is calculated by dividing the pinhole-to-film distance by the diameter of the pinhole; for example, 5 inches divided by 1/50 inch equals f/250. Pinhole images are not critically sharp, but the sharpness appears uniform from within a few inches of the camera to infinity. The relatively long exposure times required prevent the pinhole camera from recording moving objects without blur.

Canada balsam

See Balsam.

Carbon, C

Carbon can be found in three basic forms: charcoal, graphite, and diamond. All three forms were used in 19th-century photographic studios. Carbon black, made from the gleanings of lampblack, was used as a colorant for dichromated colloid printing processes such as gum printing and carbon transfer. Graphite powder and pencils were used for retouching paper and glass negatives. Graphite powder was also mixed with gums and used as a blocking-out medium. Diamonds were hand set into brass, then fitted onto wood handles and used to cut glass until the introduction of the steel-wheel-type cutters late in the century.

Carbon process

The fading of prints made by the processes available in the 1840s encouraged a search for a method of making permanent positive prints in pigment. In the 1850s, a variety of techniques were proposed by A. L. Poitevin, J. Pouncy, and A. Fargier. They relied on the hardening of potassium bichromate when it is exposed to light to make carbon pigment suspended in gelatin or gum insoluble in water after exposure. In the mid-1860s, Sir J. W. Swan introduced a process that used ready-made carbon tissue and transfer sheets manufactured by his firm, Mawson and Swan.

Swan's tissue consisted of finely powdered carbon in gelatin, spread on paper. The photographer sensitized the tissue with potassium bichromate, dried it, and made an exposure by contact. The degree of exposure determined the depth to which the gelatin hardened, with the gelatin closest to the exposing light becoming hardest. The tissue was then attached to a temporary paper support and soaked to remove the paper backing and the soluble parts of the gelatin — those that had not received a sensitizing exposure. This transfer was necessary to facilitate the removal of the gelatin from the area adjacent to the backing paper. A laterally reversed image was now left on the temporary paper support — unless the exposure had been made from a laterally reversed negative — and the image was transferred to a final support to produce a positive relief image in carbon pigment. Greater exposure through thin areas of the negative produced a greater thickness of carbon in the final print.

The Swan patents were purchased in 1868 by the Autotype Company of England, which introduced improvements to the original process and supplied 50 or more different tissues in 30 colors. Variations on the gum bichromate-based carbon process included Victor Artigue's artigueotype, shown in 1892; Walter Woodbury's woodburytype of 1864; the photomezzotint patented by Swan in 1865, which, like the Woodburytype, produced multiple carbon relief images from a master gelatin relief image; and Thomas Manly's ozotype of 1899 and ozobrome of 1905 (the latter was called *carbro* in an improved version by Autotype in 1919).

Carbon tissue

The paper prepared for printing in the carbon process. It consists of paper coated with a pigmented gelatin. The color of the pigment used determines the color of the print. Carbon tissue is prepared in two forms. In the first form, the potassium dichromate (which is the light sensitizer) is combined with the pigmented gelatin. In the second form, the tissue requires sensitizing by immersion in a bath of potassium dichromate before it can be used. There are photomechanical reproduction processes that also can use carbon tissue. An example of this is the photogravure process, which uses the carbon tissue as a photoresist that is transferred onto a copper plate and etched through the exposed gelatin relief image.

Carte de visite

A photographic visiting card, often a full-length portrait. The *carte de visite* was introduced in 1851 by Dodero, a photographer working in Marseilles. The *carte* was popularized by André-Adolphe-Eugéne Disdéri, of Paris, in 1854, after he patented a method of producing as many as 10 (but usually 8) images on a single wet-collodion plate. Most photographers, however, could not afford this multi-lens camera and made individual images on a single quarter plate. The image size was 3-1/2 × 2-1/2 mounted on a 4 × 3 inch visiting card. Disdéri produced thousands of *cartes de visite* each month. His studio was patronized by wealthy and powerful people, including Napoleon III. The popularity of the *carte* peaked in the 1870s, when *cartes* of celebrities were sold by the hundreds of thousands to the public. They were produced until the end of the 19th century.

Celluloid

Nitrated cellulose, when combined with a plasticizer such as camphor or butyl phthalate, can be coated on a smooth surface to form thin, tough, and transparent films suitable as a flexible base for photographic emulsions. Nitrocellulose was the first practical film base but is highly flammable, sometimes catching fire spontaneously. This film base had better dimensional stability and less water absorption than the less flammable cellulose triacetate safety films. Celluloid for flexible film stock was originally made by pouring a viscous solution of cellulose on the smooth surface of a glass casting table. Improvements in manufacturing replaced the table with a large rotating casting wheel. When the solvents evaporated during the wheel's rotation, the ribbon of celluloid was pulled through a series of rollers and wound on a core at the end of the factory.

Cellulose nitrate

The product of treating cellulose, usually clean cotton, in fuming nitric and sulfuric acids. Cellulose nitrate was introduced by German chemist Christian Fredrich Schonbien in 1846. Nitrated cotton is increasingly flammable, depending on the level of nitration based on the strength of the acids and duration of the treatment. The highest level of nitration, achieved in gun cotton, was used to make smokeless gun powders and to fill exploding projectiles. Cellulose nitrate treated to the 14 percent level of nitration was dissolved in equal parts of alcohol and ether to make collodion. This product was also called *cellulose nitrate solution* or *dope*. Cellulose nitrate was known by many names; among them were *nitrocellulose, soluble cotton, nitrated cotton, positive and negative cotton,* and *pyroxylin. See also* Collodion.

Ceramic process

A process by which photographs are permanently vitrified onto ceramic or enamel surfaces. The end product was used for jewelry, ceramic objects, commercial decorative novelties, and permanent portraits applied to tombstones. Several methods were invented in the mid-19th century by as many individuals. The substitution processes introduced by Du Motay involved making a collodion transparency on glass from a negative. The image was toned with gold, platinum, or another metal and then transferred onto the final ceramic or enamel support. When fired, the collodion binder burned off, leaving the metal image fused to the vitrified support.

The other methods were based on the bichromated colloid work of Poitevin. A carbon-transfer print made from a tissue bearing finely powdered glass could be applied to the final support and fired. A variation based on the dusting-on process relied on coating the final support with bichromated sugar. After exposure in contact with a negative, the sugar was selectively hardened where exposed to light, allowing fine powdered glass to stick preferentially.

Chilling table

When hot gelatin emulsions were hand applied to glass plates, a chilling table was required to set the gelatin to a stiff jelly before the plate was placed vertically in a drying box. The tables were usually long, leveled slabs of polished marble. They did not require chilling with ice as long as the ambient temperature was not very high. Chilling tables were used by both amateurs and commercial platemakers before the introduction of automated plate-coating machinery in the mid-1880s.

Chloride paper

The use of silver chloride paper dates back to the experiments of Thomas Wedgwood in 1802. H. Florence used chloride printing-out paper as did N. Niépce. William H. F. Talbot also used this paper for photogenic drawing. Silver chloride with an excess of silver was used with albumen, gelatin, and collodion binders. Gaslight papers were developing out a silver-chloride paper, but they were made with an excess of chloride rather than silver. These contact printing papers could be exposed using a common house-hold gaslight. The emulsion was not sensitive enough for enlarging.

Chlorophyll

The natural substance that gives plants green coloring. It is neutral and soluble in alcohol and ether but not in water. Although the concept was known by others, Frederic Ives introduced chlorophyll as a dye sensitizer for collodion bromide plates in 1879.

Chlorine, Cl

A greenish yellow, poisonous gas, chlorine is one of the halogens used in silver halide photography. In its elemental form, chlorine was used in the daguerreotype process as an accelerator. *See also the various chlorides listed under their compound names, such as* Ammonium Chloride.

Chromatype

A variant of photography on paper, using chromium salts. Robert Hunt, who coined the name, announced his process in 1843. The paper was prepared with a solution of sulfate of copper and potassium bichromate. It produced direct positive photogenic drawings but was not sensitive enough for use in the camera.

Chrysotype

Sir John Herschel sensitized a sheet of paper with ferric ammonium citrate, contact-printed it, and developed the image in a weak solution of gold chloride. The ferrous salts created by exposure to light in turn reduced the gold, which precipitated out as a purple deposit over the image in proportion to the original exposure. Also called *chripotype*.

Citric acid, $C_6H_8O_7$

An organic acid obtained from lemon or lime. The colorless crystals of this acid are soluble in water and alcohol but less so in ether. It was used as a chemical restrainer particularly in developers for the collodion process and in silver nitrate solutions used for sensitizing salted and albumen papers.

Cloud negative

It was very difficult to produce landscape negatives — with proper exposure of the ground and sky at the same time — when using blue-sensitive plates. A light-blue sky and white clouds would produce the same density on the negative, preventing the clouds from being recorded at all. Worse, a cloudless sky emphasize the indelicate handling of the plates and of applications of collodion, silver, and developer. More often than not, muddy skies were simply painted out with opaque on the negative, leaving a perfectly white sky in the finished print.

To produce clouds in the finished print, special sky negatives were made by underexposing plates of dramatic skies, particularly skies that were pink or red. These negatives were used to print-in the sky in prints made with negatives where the original sky had been painted out.

Cloud shutters and stops

Photographers understood that if the sky was exposed much less than the landscape when making a negative, there was a chance that clouds might be recorded, provided that the sky was tinged with pink. Special cloud shutters and stops were designed to allow less light to expose the lower area of the plate producing better exposure of the sky.

Coating machine

The first commercially successful coating machines were designed in the early 1880s for coating collodion and gelatin emulsions on rolls of paper support. These were soon followed by machines that coated glass plates with silver bromide gelatin emulsions and finally with gelatin emulsions, onto a flexible nitrate-based film support.

Collodion process

Plain collodion

A clear solution of cellulose nitrate in ether and alcohol. The discovery that nitrated cotton would dissolve into equal parts if these two solvents were present, was made by several experimenters around 1847. Louis Menard, of France, and John Parker Maynard, a medical student in Boston, are credited independently with the invention of collodion. The root of *collodion* is taken from the Greek word meaning "to stick." The liquid is not actually sticky to the touch; however, a thin, clear film of collodion adheres firmly to many materials once the solvents have evaporated. It was originally introduced as an adhesive to consolidate cloth medical dressings but was quickly identified as a perfect substance for bearing light-sensitive silver halides. When describing the assay of collodion, the percentage of cellulose nitrate is usually stated first, followed by the ether content by percentage. Since there is no other constituent besides alcohol and ether, the latter is seldom mentioned.

Wet collodion process

The first person to suggest the use of collodion for photography was probably Robert Bingham, in his 1850 book *Photogenic Manipulation*. Gustave Le Gray published the first formula for iodized collodion in his photographic method on paper and glass in 1850; however, his formula was only theoretical at best. Frederick Scott Archer introduced the process with tested and working formulas in the 1851 issue of *The Chemist*. Archer sought to improve the process for making paper negatives by attempting to coat paper with collodion-bearing silver iodide. When coating paper with the solution appeared to be problematic, Archer turned to sheets of glass as a temporary support for exposure and processing, subsequently transferring the thin film that bore the finished image onto the paper. The glass was then reused. Eventually, Archer decided that each image should remain on its own glass support.

The process as introduced was simple enough. A 2 percent solution of collodion, bearing a very small percentage of potassium iodide, was poured over a plate of glass, leaving a thin, clear film containing the halide. The plate was then placed in a solution of silver nitrate. When removed from the silver, the collodion film contained a translucent yellow compound of light-sensitive silver iodide. The plate was exposed still wet and then developed by inspection under red light, using acid-restrained pyrogallic acid. The developer was then washed off with water and brought into sunlight, where it was fixed in sodium thiosulfate to remove the unexposed silver iodide. Once the plate was washed and dried, it was coated with a protective varnish. The mechanics of this process remained essentially the same throughout the collodion era.

Improvements to and variations of the process

The early collodion negatives had a medium-brown image color. When underexposed plates were placed against a black ground, the brown-silver image appeared as a dull positive. Archer bleached these underexposed images with bichloride of mercury to lighten the color of the silver highlights and make the positive effect easier to view. He called these *alabasterine positives.* Bleaching was also the first step to intensifying underdeveloped negatives. Once bleached, the image could be toned with one of several chemicals to a darker or warmer color that was more suited to the printing-out papers used at that time.

Wet-collodion was primarily an iodide process, but the addition of lesser amounts of bromides contributed to greater sensitivity in the blue-green hues, giving the impression of a general gain in sensitivity. Halides of cadmium, potassium, and ammonium were all used throughout the collodion era.