The X-ray Investigation of Postage Stamps

HERBERT C. POLLACK, M.D.
Radiologist
5435 Hyde Park Boulevard
Chicago 4, Illinois

CHARLES F. BRIDGMAN
Medical Division, Eastman Kodak Company
Rochester 4, New York

HARRY R. SPLETTSTOSSER
Research Laboratories
Eastman Kodak Company
Rochester

• As is well known, stamp collecting is a widespread hobby. It may also be regarded as an important business, since many individual postage stamps are valued by collectors at hundreds and even thousands of dollars. Some collections are worth several hundred thousand dollars.

Basically, a postage stamp is a design printed with ink on a thin piece of paper. In addition, there may be an overprint of letters or numerals and a cancellation. Generally, two types of ink are utilized to print stamps. These are inks in which the pigment contains a metallic compound, and inks made from organic dyes. Many types of papers are also employed for making postage stamps, including laid, woven, bâtonné, granite, handmade, and machine-made. Often a watermark design is impressed in the paper. The same stamp may be issued several times with various issues printed on paper having a different watermark.

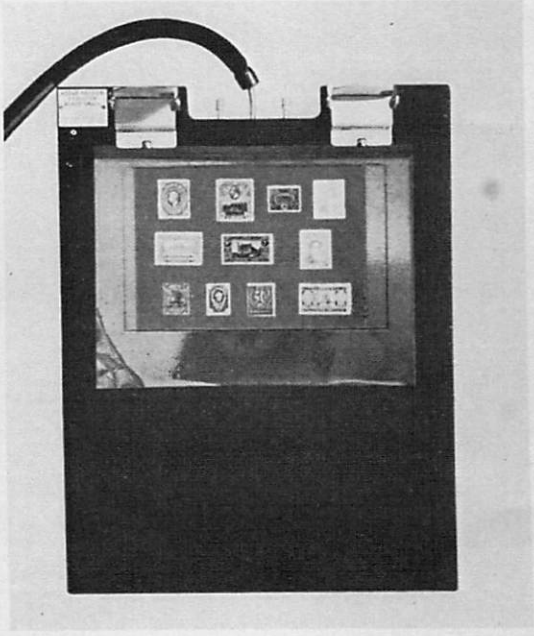
The philatelic value of a stamp is determined not only by its rarity but also by its condition. Tears, thin spots, damaged areas, and margins that are too narrow will reduce its worth. Unscrupulous artists are able to repair damaged stamps so well that their handiwork sometimes cannot be detected by the naked eye, high magnification, or studies with ultraviolet light. Also, postage stamps have been counterfeited so cleverly that experts have found it extremely difficult to distinguish them from the original. Therefore, a detailed study of such important aspects as design, cancellation, paper, and watermark is often necessary to determine the authenticity of rare examples. The x-ray examination of postage stamps makes apparent many of these details that otherwise would be most difficult, if not impossible, to visualize.

We use three technics in the x-ray analysis of postage stamps. Examples of the results obtained are shown in Figure 1. With the first, which we call "low-voltage radiography," the x-rays themselves produce the image. In the second method, which we term "x-ray autoelectronography,"* an image is produced by the electrons emitted from the metallic pigments in the ink of the design. In the third, which we call "x-ray electronography,"* an image is obtained with electrons emitted from a sheet of lead foil placed over the stamp. The first technic produces an image of the design of the stamp and faintly shows the paper structure; with the second, only the design is revealed; the third permits visualization of an image of the paper structure and of the watermark.

Film Holders

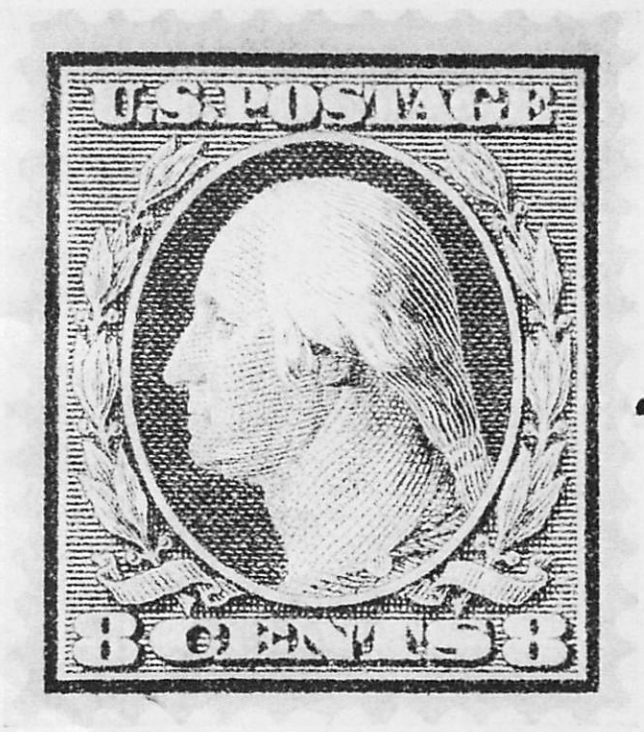
With each technic, the stamp to be x-rayed must be in close contact with the film; otherwise a blurred image will result. A satisfactory device for the purpose is a Kodak Vacuum Register Board (Figure 2).

FIGURE 2—Kodak Vacuum Register Board arranged for low-voltage radiography. The stamps and film are covered with Kodapak Sheet.



*EDITOR'S NOTE: X-ray autoelectronography is also known as reflection radiography and secondary electron photography. X-ray electronography is a term applied to the procedure also designated as electron radiography, electron photography, secondary electron radiography, and beta radiography. References to articles in which these synonyms have been used may be obtained from the Medical Division, Eastman Kodak Company, Rochester 4, New York.

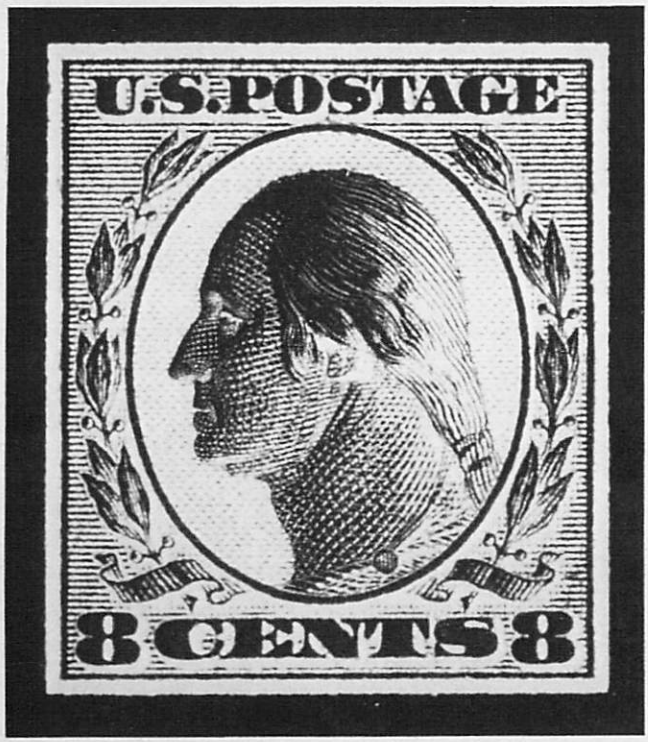
A: Photograph.



B: Low-voltage radiograph.

FIGURE 1—Postage stamp issued by the United States in 1908.

C: X-ray autoelectronograph.



D: X-ray electronograph.

It is unlawful to make radiographs of stamps of the United States of America or other countries without specific authorization from the Chief of the U. S. Secret Service, Washington, D. C. The authors have received this permission.

The small-sized board, which accepts films up to 11 by 14 inches in dimensions, is quite adequate. It is made of heavy sheet aluminum and is scored with air channels on the face. A flexible plastic covering laid on the board is pressed tightly against the base by atmospheric pressure when the channels in the board are evacuated. The choice of covering material depends on the technic employed, as indicated later in this article.

Evacuation of the vacuum device is accomplished by means of a small vacuum pump or an aspirator. A simple faucet aspirator pump is satisfactory because only a small amount of vacuum is required. A water trap should be inserted in the line between the board and the aspirator in order to prevent any backflow.

The use of a device similar to a Kodak Vacuum Register Board is essential for low-voltage radiography because of the thin material of low x-ray absorption used for the cover. The register board is desirable, although not necessary, for the other two technics that employ much higher kilovoltages. For the latter, a standard x-ray cassette may be employed if there is enough pressure to keep the stamp and photographic film in close contact. To insure such contact, a piece of cardboard may be placed in the back of the cassette to fill the space normally occupied by intensifying screens.

Film

For the x-ray examination of postage stamps, the film utilized must have fine grain, high contrast, and reasonable speed. Medical x-ray film has too much graininess. The emulsion per se of Kodak Industrial X-ray Film, Type M, on the other hand, is very satisfactory. The presence of emulsion on both sides of the film, however, poses the problem of parallax. This can be avoided if the image on one side is eliminated by the methods described by Sherwood,[1] in which one emulsion is chemically removed or waterproofed to prevent development. The most satisfactory, easily obtainable recording material is a photographic film, Kodak Contrast Process Ortho. The 5 by 7-inch size permits the simultaneous radiography of about 12 stamps.

Inasmuch as most x-ray laboratories have available standard x-ray processing solutions, we employ, as a practical measure, a developing solution made with Kodak Rapid X-ray Developer. For best results, the Ortho film is developed in this solution for 4 minutes at 68 F with constant agitation.

1. SHERWOOD, H. F.: Methods for Eliminating the Image on One Side of Double-Coated X-ray Film. *P. S. A. Jour.*, 19B:151-152, November, 1953.

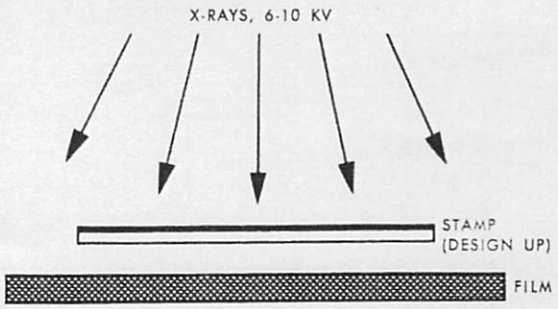


FIGURE 3—Arrangement of materials for use in low-voltage radiography.

Technic

Low-Voltage Radiography

In this technic, the x-rays are utilized directly (Figure 3). The amount of x-ray absorption depends upon the different components of the postage stamp itself—the paper, the inks used in the design, and the inks employed in the cancellation. X-rays are absorbed by the various elements according to their atomic number; the higher the number, the greater the absorption. Printing inks may contain different concentrations of these elements. A design heavily printed with a concentrated ink of very low atomic number may absorb more x-rays than a lightly printed design of high atomic number. To make a valid analysis, therefore, it is necessary to radiograph together a questionable stamp and one known to be genuine. The early "classic" stamps were generally printed with metallic inks. Cancellations were, and still are, usually printed with a carbon ink of such low effective atomic number that it does not absorb x-rays appreciably. Therefore, a low-voltage radiograph of a stamp printed with an ink containing a metallic pigment and cancelled with a carbon ink will show the design of the stamp without superimposition of the cancellation.

With the technic of low-voltage radiography, acetate sheet, such as Kodapak Sheet, 0.001-inch thick, is used as the covering material for the vacuum board (Figure 2, page 75). This material is sufficiently radiotransparent and homogeneous so that its image is not superimposed on that of the stamp. If several stamps are to be x-rayed at the same time, they are placed on the sheet of film, either face up or down, and so arranged that there is sufficient space between them to preclude overlapping. When Kodak Contrast Process Ortho Film is used to record their images, the vacuum register board must be loaded as well as exposed in rooms with safelight

illumination provided by a Kodak Safelight Filter, Wratten Series 2.

Only very soft x-radiation will be absorbed sufficiently by stamps to give adequate subject contrast. Hence, a low-voltage, beryllium-window x-ray tube specifically designed for use with a low-voltage x-ray machine should be utilized. Six kilovolts have been found to be most satisfactory. Kilovoltages as high as 10 or 15 also will produce acceptable results, although the contrast will be slightly lower. Other technical factors are as follows: ma—25; time—70 seconds; target-film distance—15 inches.

The stamp reproduced as Figure 1A (page 74) was printed with an ink containing metallic pigment. It was issued in 1908 by the United States Government. The low-voltage radiograph (Figure 1B, page 74) shows clearly the design of the stamp. Because of some degree of x-ray absorption by the paper, a faint image of the paper structure is apparent. The cancellation, being a carbon ink of low atomic number, is not seen in the radiograph.

X-ray Autoelectronography

In this procedure, electrons rather than the x-rays are employed to create the image on the film. When irradiated with x-rays of suitable wave length, the postage stamp itself emits electrons. The quantity of this emission depends upon the atomic number of the elements present in the pigments of the inks used, the amount of ink, and the components of the paper.

A stamp that has a design printed with an ink whose metallic pigment is of high atomic number, such as mercuric oxide, will emit more electrons than a stamp printed with a metallic ink of low atomic number, or an ink containing carbon or organic dyes. The components of the paper usually are of low atomic number and hence will emit very few electrons. For these reasons, in the x-ray autoelectronograph shown in Figure 1C (page 74) the design of the stamp is clearly visualized, but the cancellation is not seen. Also, the electronic emission from the paper was so small that its image was imperceptible. It must be realized also that the film received an over-all x-ray flash density of from 1.0 to 1.5, on which is superimposed the electron exposure from the elements in the ink. It is the ratio between these two exposures that determines the contrast of the image.

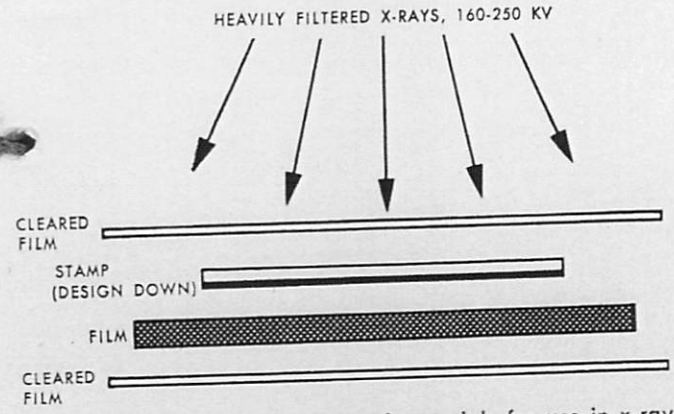


FIGURE 4—Arrangement of materials for use in x-ray autoelectronography.

Since the stamp, whose ink is the principal electron emitter, and the film are inside the vacuum register board, any lighttight material, pliable enough to be pressed into the vacuum channels by atmospheric pressure, may be used as a covering material. Also, in this technic, there is little possibility of the image of the covering material being superimposed on that of the stamp. For the cover, we use flexible black vinylite sheet plastic similar to that employed in the Kodak Darkroom Apron. However, as mentioned earlier, a standard x-ray cassette may also be utilized.

In carrying out this technic, Kodak Contrast Process Ortho Film is placed on the Kodak Vacuum Register Board, emulsion side up (Figure 4). The stamps to be irradiated are placed face down on the film. The film and stamps are protected from extraneous electron emission by two sheets of cleared x-ray film—one placed underneath the photographic film and one under the cover. This precaution is necessary since both the aluminum sheet forming the vacuum register board and the vinylite plastic covering are sources of minimal amounts of electron emission.

Technical factors employed for the x-ray autoelectronograph (Figure 1C) are as follows: kvcp—200; ma—10; time—2.2 minutes; target-film distance—30 inches. A 5-mm copper filter is utilized at the x-ray tube to remove most of the soft x-rays. The kilovoltage used is not critical; satisfactory results may be obtained between 160 and 250 kv. Also the thickness of the copper filter is not too important. As the kilovoltage is increased, the filtration can also be increased from 5 mm to as much as 12 mm of copper in order to obtain radiation of shorter effective wave length.

X-ray Electronography

The purpose of this technic is to show only the details of the paper structure and watermark and not the printed design of the stamp. This is done by placing in contact with the stamp a metallic material of high atomic number such as lead, which, when irradiated with x-rays, produces an electronic

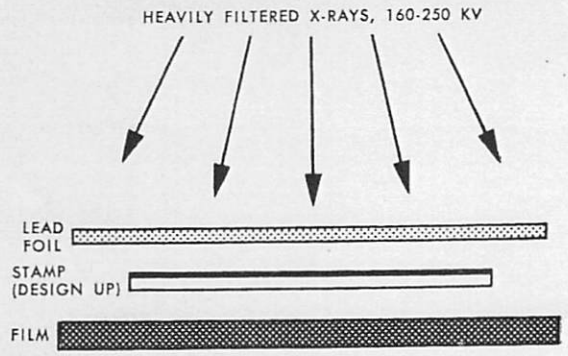


FIGURE 5—Arrangement of materials for use in x-ray electronography.

emission sufficient to penetrate the stamp (Figure 5). The lead intensifying screens employed in industrial radiography are very satisfactory. They should be free from imperfections.

The electronograph shown in Figure 1D (page 74) reveals the fine details of the paper structure and double line "S" watermark with no superimposition of the design image. Of course, electrons from the lead screen and x-rays that have penetrated the screen irradiate both the stamp and the film. The electron emission from the metallic ink is usually small compared to the emission from the lead; consequently, the ink design is rarely seen. For this procedure, Kodak Contrast Process Ortho Film is first placed in the selected holder, emulsion side up. The stamps to be irradiated are next arranged on the film, face up. A lead industrial intensifying screen, 0.005 to 0.010 inch thick, is laid over the stamps. Black vinylite sheet plastic is used to cover the vacuum register board. The stamps are irradiated through the lead screen (Figure 5).

The technical factors utilized in making the x-ray electronograph (Figure 1D) are as follows: kvcp–200; ma–10; time–1.2 minutes; target-film distance–30 inches. A 5-mm copper filter is placed at the x-ray tube to remove the soft radiation. These factors may be varied, as mentioned in the section on x-ray autoelectronography.

Photographic Problems

For several reasons we have found it necessary to consider the radiograph as a negative from which prints are made without the use of any intermediate step. The contrast of the radiographic images is very low, but this can be considerably enhanced in the prints. The details of the image are so fine that the use of an intermediate negative would be liable to lower their visibility in the final print.

The photographic prints are made usually as 2 times enlargements, as this size not only is appropriate for our exhibit sheets but also is sufficient to permit ready visualization of the finer details of the image. Kodabromide Paper, F surface, contrast grade No. 4 or 5, is developed in Kodak Dektol Developer, mixed one part developer to two parts water. The prints are ferrotyped for brilliance.

In this article, emphasis has been placed on the technical aspects of three types of radiographic examination of postage stamps. The philatelic value of these procedures has been discussed in other articles in which studies of specific stamps, postal cards, and postal stationery have been analyzed in detail. A bibliography is appended for those who may be interested in the philatelic aspects of the subject.

ACKNOWLEDGMENT: The authors wish to express their appreciation to Mr. John Patterson, Jr., Photofinishing Division, Advertising Department, Eastman Kodak Company, Rochester, New York, for his very useful assistance in perfecting the photographic technics used in this study.

Bibliography

CHEAVIN, W. H. S.: Photographing Stamps by X-rays. ***London Philatelist, 54:*** 130, December, 1945.

———: Numerous articles on the x-ray investigation of postage stamps have also been published in British and European philatelic journals and more recently in the United States in the ***Weekly Philatelic Gossip,*** Holton, Kansas, Volumes 56, 1953; 57, 1954, and 59, 1955.

POLLACK, H. C., and BRIDGMAN, C. F.: X-Ray Philately. In Barr, J. H. (Editor): ***Seventeenth American Philatelic Congress Book.*** Published by John W. Stowell Publishing Company, Federalsburg, Maryland, 1951, pp. 167-171.

———: X-Ray Philately. I. Introduction. ***S. P. A. Jour.*** (Published by the Society of Philatelic Americans, J. Elmer Zinsmeister, Editor, 340 N. Pine Avenue, Chicago 44, Illinois), ***14:***601-604 August, 1952.

———: X-Ray Philately. II. Printing Inks. ***Ibid., 15:***71-75, October, 1952.

———: X-Ray Philately. III. Papers. ***Ibid.:***245-249, January, 1953.

———: X-Ray Philately. IV. Watermarks. ***Ibid.:***297-299, February, 1953.

———: X-Ray Philately. V. Watermarks—Second Section. ***Ibid.:*** 390-393, April, 1953.

———: X-Ray Philately. VI. Pseudowatermarks and Varnish Bars. ***Ibid.:***443-445, May, 1953.

———: X-Ray Philately. VII. Burelages. ***Ibid.:***505-507, June, 1953.

———: X-ray Philately. VIII. Sardinian Letter Sheets. ***Ibid.:***607-611, August, 1953.

———: X-Ray Philately. IX. Quadrille Papers. ***Ibid., 16:***20-23, September, 1953.

———: X-Ray Philately. X. Repaired Stamps. ***Ibid.:***127-130, November, 1953.

———: X-Ray Philately. XI. Forgeries. ***Ibid.:***308-311, February, 1954.

———: X-Ray Philately. XII. Inverted Centers. ***Ibid.:***453-454, May, 1954.

———: X-Ray Philately. XIII. An Unusual Cape of Good Hope Triangle. ***Ibid.:***553-555, July, 1954.

———: Philatelic Research with X-Ray. ***Stamps, 85:***50-54, October 10, 1953.

———: X-Ray in Philately. ***Radiology, 62:***259-261, February, 1954.