Yesterday in U.S. Stamp News: A USPS Watermark Primer

by Louis E. Repeta

(From U.S. Stamp News, March-April 2000)

Abstract

A watermark is any distinguishing mark or pattern deliberately incorporated in paper during its manufacture. Philatelists are generally more acutely aware of watermarks than are most people, because postage stamp designs are printed on paper that is either watermarked or unwatermarked, and it is important to know and understand the distinction.

The goal of this article is to present the basics of the USPS watermarks found in postage stamp paper. Since the watermark is inherently allied to papermaking it is necessary to begin with a brief history and evolution of paper development.

Postage stamp paper was purchased by the Bureau of Engraving and Printing from private contractors in cut-to-size sheets from rolls produced on the Fourdrinier machine. Therefore, a superficial knowledge of the basic principles employed in this papermaking process is essential.

The Development of Paper

Paper is a dried matted or felted sheet composed chiefly of vegetable fiber. It is formed on a porous surface, from a water suspension of individual fibers of different lengths and diameters. Although its name is derived from the word papyrus—the name given to a paper-like substrate fabricated from thin sections of an Egyptian reed that have been pressed together—modern paper is not at all like the Egyptian writing material.

The earliest handmade paper was produced in China in the first century (A.D. 105) by Ts'ai Lun, from the inner bark of the mulberry tree, and using a mold of bamboo strips. This raw material is still used today to produce the "native paper" of China and Japan.

Some fifty years later, about A.D 150, Tso Tzu-yi improved the papermaking process. Long silk fibers (a protein) were added to strengthen the finished product, and fibers from many non-woody plants such as rice straw, hemp, bamboo and esparto were employed. Fibers obtained from old rags and fish nets, which are long and strong and contain a high percentage of cellulose, the essential element of paper, were incorporated.

The technique of papermaking was zealously guarded by the Chinese for 600 years. Then, during a war in A.D. 751, the Arabs captured some Chinese papermakers, and a papermaking industry was established at Samarkand. The Arabs substituted cotton for the bark and hemp in their paper. For them, cotton was a much more common material. This "cotton-paper" was slowly brought westward from Baghdad to Egypt, and then on to Morocco and across the Mediterranean to Spain.

In Europe during the Middle Ages, prior to the use of paper, specially prepared skins of young animals, parchment, or vellum were the base materials used for official letters and official documents. The earliest paper mill in Europe was built in the eleventh century in the Moorish dominated portion of Spain. There, flax was abundant and substituted for cotton.

Over the next 100 years, the craft of papermaking spread throughout Europe. Only Italy, which enjoyed a vigorous trade with the Levant and, as a result, had access to an abundant supply of "cotton-paper," was interested in the new "flax-paper" until the middle of the fourteenth century.

In the thirteenth century, however, Italian papermakers contributed several improvements to the process of making paper by hand. They more thoroughly ground the fibers with metal beaters to produce a shortfibered product with better density, and they employed a gelatin sizing.

The surfaces of dried paper were almost always "sized"—that is, coated—by hand-dipping the sheets in a solution of starch, flour paste, or various kinds of animal glue. Sizing is used to stiffen the paper and control paper's capacity to accept ink without absorbing it. Unsized paper—newsprint or blotting paper, for example—is much too absorbent, with the result that ink spreads, or feathers, and causes blurred printing.

The paper industry made considerable technological progress during the Industrial Revolution. In 1798, the first papermaking machine was conceived by a Frenchman, Nicholas-Louis Robert, a young clerk in the Didot Paper Mill. Unfortunately, although his machine was patented, it was not very successful, and a myriad of circumstances—financial and psychological, as well as political—prevented him from perfecting it.

Henry and Sealy Fourdrinier, London stationers, acquired the rights to this invention from John Gamble, Didot's brother-in-law. With their financing and the mechanical ingenuity of Bryan Donkin, a successful machine was built by 1803 and in commercial use by 1812. Ironically, in the process of developing the machine, the Fourdriniers ruined themselves financially, but to this day both the machine and the process carry their name.

The Fourdrinier has been mechanized and automated since its invention, but the basic process—the almost universal method used to produce machine-made postage stamp paper—remains the same.

The introduction of papermaking machinery brought the cost of paper within reach of the common man and,

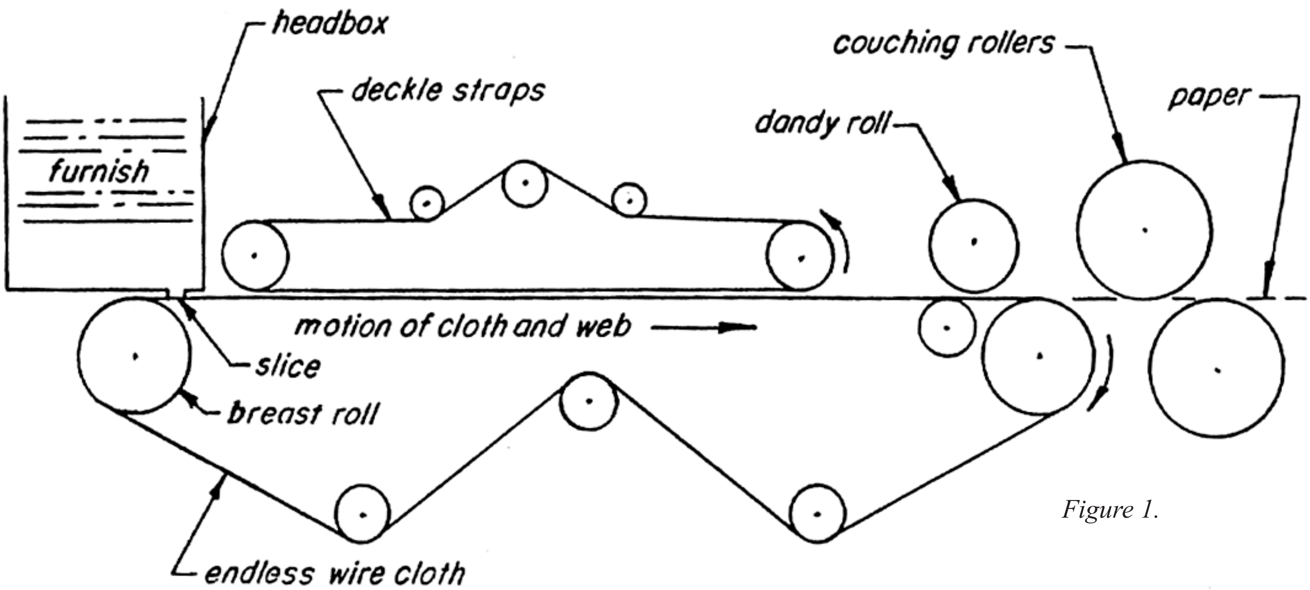

Figure 1.

thus, dramatically increased the market for paper. This, in turn, caused a tremendous increase in demand for raw materials, and it became imperative that a fiber substitute be found to augment the limited supply of hemp, cotton and linen. But it was not until 1867 that wood grinding machinery and the sulfite process were invented.

One of the essential elements of paper is cellulose. A colorless, odorless, white, nonvolatile carbohydrate, cellulose exists in almost pure form in cotton and flax. It also is found in soft wood but in this material, the cellulose fibers are bonded with lignin to form the woody tissue. With the sulfite process, an acidic sulfite liquid is used to disintegrate and separate the bonding material, the lignin, from the cellulose fibers. Today, the sulfite and kraft processes are the major methods of producing pulp for papermaking.

Papermaking Process

The basic papermaking process, which has not changed in almost 1,900 years, involves two major steps:

(1) breaking down the raw material in water to form a suspension of macerated individual fibers called pulp, and

(2) forming paper sheets by spreading the fiber suspension on a porous surface through which the excess water can drain. Paper is manufactured by three basic methods: by hand, by the Fourdrinier horizontal machine, and by the Dickinson cylinder machine.

Machine-Made Paper

Among the properties of cellulose materials is their ability to absorb water into their fibers, to "be wetted." However, this in itself is not enough to create an effective bond between fibers during paper manufacture. To produce the required bond, water has to be forced, "beaten," into the fibers during the pulping process. This roughens or frays the outer surface of the fibers and causes an internal loosening as well. Later in the papermaking process, as the water drains away and is removed by suction the surface tension of the water draws adjacent fibers toward each other, and the frayed outer surfaces knit together.

When machine-made paper is manufactured, the hydrated cellulose, having been washed, beaten, and frayed, is mixed with sizing and several loading agents, such as clay, kaolin, or gypsum, which are used to fill the spaces between the fibers and to give the paper an even texture and increased opacity and weight. These additives also promote cohesion of the paper fibers and prevent capillary attraction of the fibers to the liquid printing inks. This slurry is called "furnish."

On a Fourdrinier machine, furnish is pumped into the headbox, as shown in Figure 1. From the headbox it moves through a very narrow horizontal opening called a slice and flows onto a rapidly moving endless belt made of wire mesh or cloth. Deckle straps moving at the same speed and positioned on each side of the endless wire mesh form a lip or boundary to prevent the furnish from moving off the mesh. The sideways bumping of these straps with the unfinished paper imparts a rough, irregular edge to the paper that simulates the deckle edge found on handmade paper.

The wetted cellulose fibers, in particular the coarser fibers, tend to arrange themselves parallel to the direction of motion of the wire mesh, and the paper develops a "grain." A gentle sideways vibration of the wire mesh helps to separate water from the furnish and promotes interweaving of the fibers, which gives the paper strength and density.

The woven wire mesh of the Fourdrinier machine has natural high points. When the finished wove paper is held to a light source, these high points appear as a regular pattern of pinpoint thins. Considerable variation exists in the strength of these characteristic impressions, which can range from very apparent to barely discernible.

"Couching" rollers, initially wooden cylinders covered with felt, are located at the end of the continuous wire mesh. These apply pressure to the moist sheet, smoothing it and squeezing out water to improve paper formation. To speed drying, the web is passed over a series of steam-heated drying cylinders. The surface of the dried paper is then smoothed by steel calender rolls, and the continuous web of paper is wound on a reel.

Let us examine two characteristics of Fourdrinier machine-made paper that are a consequence of the method of production. First during manufacture, machine-made paper is subjected to tension (stretch) applied in the direction of web flow. Therefore, after wetting, Fourdrinier machine-made paper shrinks more across the web than along the web as it dries.

Second, when paper is dampened, the fibers expand more in diameter than in length. Because the fiber alignment of Fourdrinier machine-made paper tends to be lengthwise, in the direction of the web, it expands and shrinks more across the web than along the web.

The "wetting down", process required until the mid-1950s rendered paper soft and pliable, which ensured a quality product when stamps were printed from intaglio plates. But the uneven expansion of dampened machinemade paper, coupled with the fact that the outside edges dry faster than the center resulted in uneven contraction. This led to serious problems during the subsequent perforating process. Until the introduction of the electric-eye perforating system in the mid-1930s, as many as one-third of the sheets perforated were commonly rejected.

Collectors who try to make exact size and perforation measurements often forget that machine-made paper is affected by humidity and dryness, which produce minor expansions and contractions, respectively. Further, they sometimes fail to take into account the fact that more heavily sized paper exhibits smaller variations from these causes.

These variations can account for small differences in measurements made across the grain with a perforation gauge, which may amount to as much as one-fourth of a perforation in two centimeters. Such minor variations are not philatelically significant, especially when stamps soaked off cover are being measured.

Watermarks

A watermark, initially called a "wiremark" or "papermark," is an unpigmented distinguishing mark or pattern created in the paper during or after its formation. It may be a numeral, a figure, a letter, a symbol, a geometric shape, or any combination of these, and it may appear lighter or darker than the surrounding paper when held to a light source.

The term watermark is really a misnomer, because the process used to thin or thicken paper is not dependent upon water to any significant degree. The watermark design is an integral part of the sheet of paper and cannot be removed without destroying the paper itself.

Prior to 1894, United States postage stamps were supplied to the Post Office Department by private contractors. The Bureau of Engraving and Printing was awarded the contract to print U.S. postage stamps on February 21, 1894, and a formal four-year agreement was reached June 9, 1894 to be effective July 1, 1894 (POD Order No. 59).

The postage stamp designs were to be retained, but triangular decorations were added in the upper corners to distinguish the Bureau's product from the stamps printed by the American Bank Note Company, the previous supplier.

In 1894, the first postal issue supplied by the Bureau was printed on unwatermarked paper (Scott Nos. 246-263). This paper was the remainder stock obtained from the ABNC when the Bureau assumed the contract. The 1895 second postal issue was printed on watermarked paper (Scott Nos. 264-278).

Watermarks, or their absence, aid in the classification of postage stamps. For example, the first two U.S. Bureau series, are identical in design, color, quality of paper and perforation gauge. But the unwatermarked 1894 issue catalogues at a premium over the watermarked 1895 series.

In 1878, the Bureau first began printing revenue stamps for the Treasury Department and a paper watermarked with double-lined Roman capitals "USIR" (United States Internal Revenue) was introduced (Figure 2). Each square inch of stamp paper bears some portion of the watermark design, which was applied in a rectangular format of horizontal rows and vertical columns.

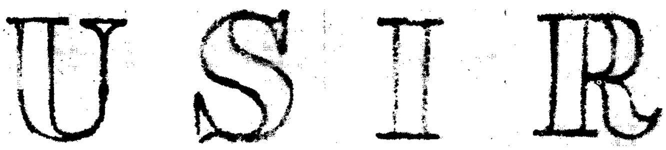

Figure 2

Postage stamp paper was initially viewed as security paper that required control and accountability. The "USIR" watermark served to identify and act as a control on the revenue paper stock.

It was logical to use the "USIR" watermarked paper as a model for the new postage stamp paper; just change the "IR" to "PS." The "USPS" double-line Roman capital letters were arranged in the same rectangular format on the dandy roll and were impressed into the paper across the width of the web in an upright attitude.

Contrary to popular belief, the use of watermarked paper for printing U.S. postage stamps was not initiated to deter forgers. The watermark was used as a control on the paper stock, and to fulfill legal requirements that government securities be printed on a special paper.

The misconception is rooted in a statement published on Page 307 of the June 1, 1895, issue of the prestigious American Journal of Philately: "We have seen the 2 cent stamp of the current issue printed on watermarked paper, its appearance being due to the counterfeiting which was discovered recently."

Actually, it was a coincidence that postage stamps printed on watermarked paper appeared at about the same time a large quantity of forged stamps was discovered in Chicago, in April 1895. The "deterrent" thesis should have been completely debunked and laid to rest by Winthrop S. Boggs' article, "Notes on United States Watermarked Postage Stamps." Published in the July 1895 issue of *The London Philatelist*, it introduced evidence that the Bureau of Engraving and Printing intended from the very beginning to manufacture postage stamps on watermarked paper as soon as the small remainder of paper stock from the previous printer, the American Bank Note Co., was exhausted.

Also, the watermarked stamps appeared only nineteen days after the discovery of the counterfeit stamps, not enough time for the BEP to procure watermarked paper, print and distribute these stamps to post offices and put them on sale.

Fourdrinier Paper Watermarks

For approximately fourteen years after the introduction of the Fourdrinier process, from 1812 to 1826, all machine-made paper was wove paper and was produced unwatermarked. Then, on January 11, 1825, an English patent was granted to John and Christopher Phipps for a cylindrical roller to produce "laid" paper on the Fourdrinier.

In 1826, John Marshall invented a light, hollow cylinder covered with a very fine woven brass gauze to add watermarks to machine-made paper (Figure 3). On the Fourdrinier machine, this cylindrical device, called a "dandy" roll or egoutteur, is positioned just ahead of the rollers, near the end of the continuous wire mesh (see Figure 1).

The shapes or designs of the watermark, called "bits,"

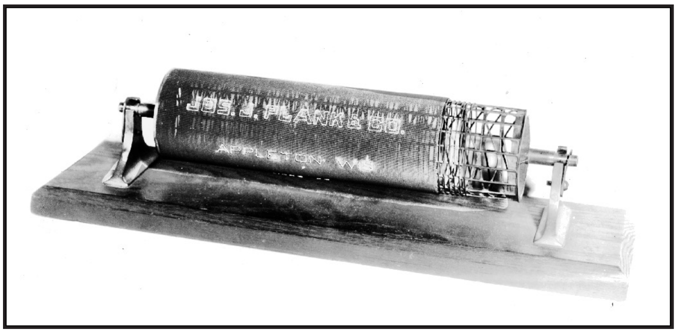

Figure 3. A dandy roll. Note that the woven brass gauze has been cut away at the right to reveal roll construction details. (Courtesy of the Dard Hunter Paper Museum.)

are fastened with a fine brass wire or solder, at prescribed intervals, to the wire mesh that covers the dandy roll. Duplicate bits are fashioned by hand, manufactured by electrotyping, or stamped from sheet brass with a die. As a safeguard, bits are thin, both to minimize the possibility of damage to them, and to prevent them from being knocked off the dandy roll.

An allowance for distortion is factored into the watermark design to account for shrinkage and stretch of the paper being formed. There is no formula or set rule used to determine this allowance, however, because there are numerous variables in the papermaking process. This knowledge is gained only through experience.

On the Fourdrinier machine, the cylindrical axis of the dandy roll is perpendicular to the grain or direction of paper flow. As the moist unfinished paper is squeezed by the dandy roll, the bits emboss the watermark impression into the web of paper at right angles to grain direction. The fibers of the partially formed paper are displaced sideways by the bits, so the edges of the watermark are somewhat uneven.

Watermarks produced in Fourdrinier machine-made paper are not as sharp as those produced in handmade or cylinder machine paper. Several factors contribute to this poorer watermark quality.

The vividness of the watermark depends upon the amount of pressure the dandy roll exerts on the moist paper. This is a hand adjustment that requires experience and judgment. Therefore, at the beginning of a production run a less prominent watermark is more apt to occur. Further, the dandy roll impresses the watermark design in the paper before any significant drying has taken place. At this stage of fabrication, the paper possesses some resilience, and is able partially to recover its initial thickness, resulting in a less distinct watermark. Finally, a poor watermark may be produced if the paper is too wet when it passes under the dandy roll.

Both handmade and machine-made papers have what is called a "good side," the surface that is to receive the printed impression, and a "wire side," the side adjacent to the wire mesh during the papermaking process. The good side of handmade paper is the upper face, the side away from the watermark. The good side of machine-made paper is the side the dandy roll presses against. Finished sheets of paper, both handmade and machine-made, are usually packaged good side up.

In addition to the classic dandy roll method, two other techniques—the Behrend method and the dry-impressed process—may be used to generate watermarks in Fourdrinier machine-made paper. Neither method was ever used to produce a watermark in U.S. postage stamp paper.

To return briefly to the subject of irregular paper shrinkage: Asymmetric watermarks and large watermarks that thin a substantial portion of the paper promote uneven paper shrinkage during wetting down and when printed sheets are gummed. In 1898, John N. Luff suggested reducing the size of the U. S. watermark to ease the uneven paper shrinkage problem. A five-percent reduction, from 100 to ninety-five letters per complete pane (margins included), coupled with a decrease in letter size was implemented in 1910 when a single-line water-mark replaced the double-line watermark (Figure 4). The single-line watermark layout was applied in a distinctively different format, best described as a staggered form of diagonal rows. Although this watermark may have had a positive effect on irregular paper shrinkage, it caused severe detection woes for collectors.

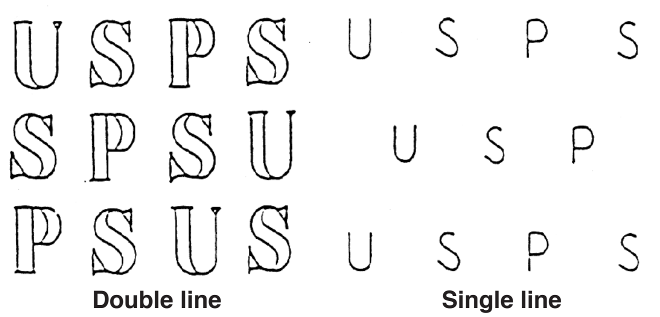

Figure 4. In 1910 the USPS (United States Postage Stamp) watermark was changed from a double-line to a single-line image to reduce the problem of uneven paper shrinkage.

Yesterday in U.S. Stamp News:

A USPS Watermark Primer

Part 2

by Louis E. Repeta

Watermark Classification

Watermarks have been incorporated in postage stamp paper both intentionally (ninety-five percent) and unintentionally (five percent). Official watermarks are designs that were intentionally produced in the paper, by order of the stamp-issuing authority. Unofficial watermarks are designs that were included in postage stamp paper without specific instructions from the stamp-issuing entity, but that were condoned, or officially ignored.

One general classification scheme distinguishes among various types of watermarks according to their purpose. Four watermark groups can be defined: decorative, papermakers', functional, and security.

The **security** watermark was conceived as a means of using the watermark design to guard against postal forgery by making duplication more difficult, and to serve as a control on the paper stock.

Technological advances, such as automated sheet counting equipment, coupled with phosphor tagging and electronic scanning equipment, rendered security watermarks obsolete and sounded the death knell for the dandy roll. Geometric perforating has been introduced as a further safeguard against postal forgery.

Another watermark classification scheme employed is related to how the design is incorporated into the paper. The watermarks in U.S. postage stamp paper are produced by a slight thinning of the paper during its formation which renders the paper more **translucent** at the watermark design. This is called a negative watermark.

A third classification scheme for watermarks on postage stamp paper defines them according to their arrangement in the sheet of paper. The arrangement employed in U.S. postage stamp paper is known as a **multiple** watermark.

A sheet of paper with a multiple watermark contains a design that is repeated regularly and at close intervals in a systematic pattern over the entire sheet. Each finished stamp shows portions of several watermarks. Occasionally, a stamp will show a well-centered, complete watermark, but in addition this stamp will also contain portions of adjacent watermarks that clearly identify the pattern as a multiple watermark. Variations of multiple watermarks are known as column, repeated, simple, and spaced designs.

A **stitch** watermark, found only in machine-made paper, is a result of fibers settling over the stitches that join the ends of the endless wire belt. These stitches, which run the full width of the paper, are the chief cause of this kind of watermark, but they are not necessarily the only one.

This type of watermark may also be caused by stitches used to join the ends of the wire gauze that covers the dandy roll, or by stitches used to mend a tear in the endless wire cloth. In the latter case, the stitch watermark would probably extend only a few inches and could run parallel, perpendicular, or at an angle to the width of the paper.

In most cases, a stitch watermark appears as a series of short parallel lines running completely across the stamp, either vertically or horizontally, about 1 mm apart and from 2 1/2- to 3mm high. The design may be fine or coarse, regular or irregular. It should be possible to find examples of stitch watermarks in many stamps printed on machine-made paper. However, these watermarks are slight and may be ironed out during subsequent paper-finishing operations. Further, sheets of stamps that contain stitch watermarks may be routinely discarded by inspectors.

Two distinct varieties of the stitch watermark exist, both related to the method used to sew the ends of the wire cloth together. One method employs an "over and over" stitch that passes down through the cloth, across the gap, up through the cloth, and back to the starting point, a sewing machine stitch. The second technique utilizes an "over and under" stitch that passes up through the cloth, then down through the space between the ends of the wire cloth, and up through the other end of the cloth . This is the type of stitch used to sew baseball covers together,

Pseudo-Watermarks

A pseudo-watermark, an artificial or false watermark, is not a true natural watermark but a facsimile that yields a watermark effect. Pseudo-watermarks can be produced by different methods, which result in several distinctive finished forms.

Occasionally, a collector finds a stamp that was never printed on watermarked paper, yet irregular thin spots show in the form of lines, curled and twisted. This irregularity in the paper is due to bits or clumps of pulp that adhere to the wire gauze surface of the dandy roll and were impressed into the paper. The paper was thinned at these locations and a false watermark created.

Watermark Attitudes

When viewed from the good side of the paper—that is, with the stamp design oriented right side up—an **upright** watermark reads from left to right, with the watermark design right way up. In short, an upright watermark reads the same way as the postage stamp. Any deviation from upright constitutes a variation in watermark attitude.

Different watermark attitudes clearly denote changes in watermark position, but should not be classified as errors.

Also, upright watermarks are not universally "normal." On U.S. postage stamps printed from 400-subject plates, the "normal" doubleline watermark reads vertically or sidewise. It is imperative to know what the intended "normal" position was for a particular issue.

After printing, rectangular sheets of paper with an upright watermark will yield four watermark attitudes: upright, reversed, inverted, and a combination inverted/reversed. If the sheets of paper are cut square, four additional sidewise watermark attitudes are possible: sidewise, sidewise reversed, sidewise inverted, and a combination sidewise inverted/reversed. The maximum number of different watermark attitudes possible is eight. These are illustrated in Figure 5, with the "US" portion of the large-serif, double-line letters of the "USPS" watermark.

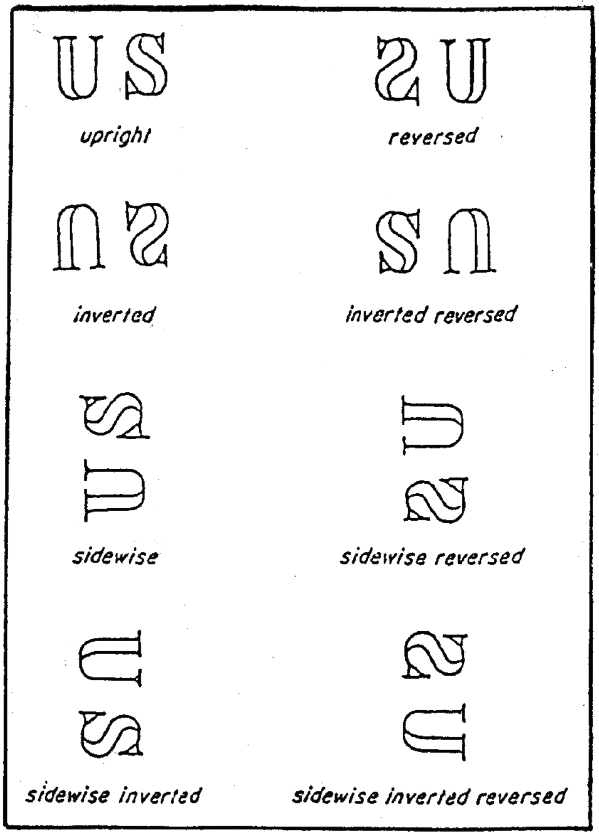

Figure 5. Watermark attitudes viewed from the good side of the paper, with the stamp design oriented right side up.

A **reversed** watermark occurs when the stamps have been printed on the wrong side of the paper, the side opposite the good side. In relation to the printed page, the watermark design is in the correct attitude, right way up, but it reads from right to left and the design is backward.

An **inverted** watermark is obtained when the sheet of paper is loaded in the printing press good side down with the watermark design wrong way up. When viewed from the printed side, the watermark is upside-down relative to the stamp design, and reads from left to right.

An **inverted/reversed** watermark occurs when the paper is loaded in the printing press with the watermark design wrong way up and the good side of the paper facing the printing plate. It is a combination of the inverted and reversed watermark attitudes. When viewed from the printed face, the watermark is upside-down relative to the stamp design and reads from left to right.

A **sidewise** watermark results when the paper is positioned in the printing press good side up, with the watermark reading up.

A **sidewise reversed** watermark occurs when the paper is loaded in the press wrong side up, but with the watermark design in the correct attitude.

A **sidewise inverted** watermark results when the paper is inserted good side up in the printing press, but with the watermark reading down—on its side relative to the stamp design.

A **sidewise inverted/reversed** watermark occurs when the sheet of paper is fed into the press with the watermark in the sidewise inverted attitude but with the wrong side up.

Watermark attitude changes generally occur on postage stamps printed on sheet-fed printing presses. They result from the incorrect placement of paper in the press. Both sides of machine-made paper are quite uniform in surface finish and texture, so there is usually little necessity for a printer to consider carefully whether the good side of each sheet is placed right side up in the press, or whether there is a top or bottom.

It is not likely that pressmen examine every sheet of paper prior to printing to see whether the watermark is right way up. On the paper used to print U.S. stamps, the lower right hand comer of the rectangular sheets is beveled, that is, cut at a forty-five degree angle, to provide an orientation mark to help the pressmen place the paper properly in the press.

Since the sheets of paper used to print U.S. postage stamps are rectangular rather than square in shape, the four "sidewise" attitude variations seldom occur. It is not likely that a rectangular sheet of paper would be loaded sidewise in a printing press.

The wetting-down procedure, the dampening of paper prior to printing, affords an opportunity for the paper handler to stack sheets of paper erroneously and, thus, to contribute to variations of watermark attitude.

Many definitive stamps were printed from 400-subject plates with the watermark upright. Others were printed from 200-subject plates with the watermark sideways. A few definitives were printed from both 400 and 200-subject plates, and these stamps may be found with an upright or sideways watermark.

Rectangular sheets of paper are generally cut so the grain runs parallel to or with the long dimension, and the watermark is upright. Some copies of the 1-cent and 2-cent stamps (Scott 279 and 279B), printed from 400-subject plates have a sidewise watermark instead of a "normal" upright watermark. Budd W. Dickey explained in the November 1980 issue of *The United States Specialist* that these postage stamps that exhibit sidewise watermarks were probably printed on paper stock cut the wrong way by the manufacturer from incomplete, imperfect rolls in an effort to salvage as much paper as possible.

The design of the watermark also plays a role in determining the maximum number of watermark attitudes that are possible. A symmetric design will not yield different attitudes regardless of how the paper is positioned in the printing press. The maximum number of attitudes, eight, can occur only when the design is asymmetric, for example, taken by itself the letter "S" of the double-line watermark of the United States. The upperhalf of the "S" is smaller than the lower-half of the "S" (Figure 6).

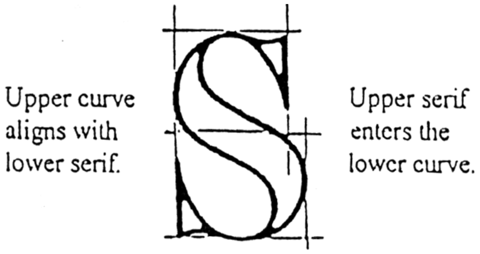

Figure 6. The double-line "S" watermark.

A watermark design symmetric to two axes exhibits ninety-degree rotary symmetry and yields only two different attitudes, while designs that are symmetric to one axis either horizontal or vertical, are said to possess 180-degree symmetry and yield four different attitudes. The letter "U" of the single-line watermark of the United States, taken by itself, can exist in four possible attitudes as shown in Figure 7.

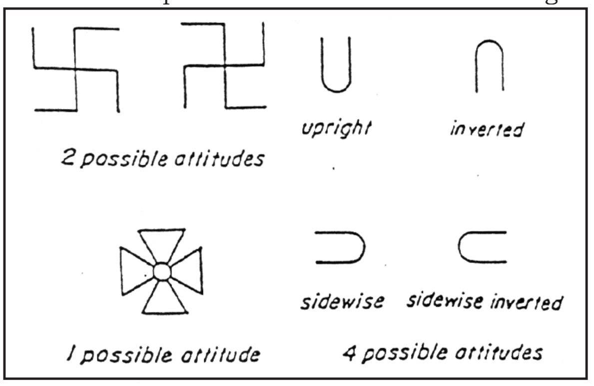

Figure 7. Watermark attitudes as a function of symmetry.

Errors of Watermark

It is not uncommon for a bit or a portion of a bit to be damaged, or to fracture and fall off the dandy roll, thus causing an error in the watermark. Sometimes such errors are caught, and the missing or damaged bit is replaced with a substitute of the proper design, possibly creating a minor variety. Sometimes a bit with the wrong design is incorporated, creating an error.

Errors are also caused when the wrong paper is used to print stamps—i.e., watermarked rather than unwatermarked paper, paper with the wrong watermark, or paper intended for a different issue.

The 6-cent and 8-cent flat-plate stamps of the First Bureau series (Scott 271a and 272a) were accidentally printed on revenue stamp paper watermarked with double-line Roman capitals "USIR" rather than double-line Roman capitals "USPS." Because the "U" and the "S" are common to both papers an identifiable error must contain an "I" or an "R": watermark. Because only one letter, or a portion of one letter, appears on each stamp, additional difficulty may be encountered because parts of the letter "P" readily can be confused with the letters "I" and "R."

The value of the watermark as a control on the paper stock or as a deterrent to forgers was seriously questioned. As a result, this requirement for postage stamp paper was abandoned. A contract for unwatermarked postage stamp paper was awarded effective July 1, 1916. The first unwatermarked postage stamp to be issued since 1895, became available on September 25, 1916, the 2-cent carmine (Scott 463). By the end of March 1917, all postage stamps were printed on unwatermarked paper.

Two watermark varieties (errors) appeared after the use of watermarks was discontinued. The first occurred when a quantity of imperforate 2-cent Washington sheet stamps from old stock (Scott 344) were gauge 11-perforated (Scott 519).

The second stamp was the 1-dollar Wilson of the Fifth Bureau series (Scott 832). The "error" stamps were erroneously flat-plate printed on USIR watermarked paper rather than on unwatermarked paper (Scott 832b). This watermark is always sideways and can be found in several attitudes. It is usually quite faint, and only a portion of a letter appears on each stamp. Since the watermark would be masked by the perforations, multiples and stamps with the margin attached are quite desirable.

Watermark Detection

To be able to see and identify the watermark in stamp paper is the goal. To accomplish this, it is helpful to know what the watermark design looks like, and how it is distributed in the paper. The illustrations in the catalogue usually, but not always, show the watermark in an upright position, as viewed from the printed face of the stamp. This tends to lead to some confusion, and caution should be observed when the watermark is viewed from the back of the stamp. Small-format singles are the most troublesome specimens to work with, but multiples, blocks of four or larger pieces present fewer detection problems.

If a full-sized illustration of a watermark design is available, a mirrored copy can be made. It is an easy task to cut a stamp-sized opening in the center of a 2-inch by 3-inch piece of card stock. This template can then be moved over the watermark design, and all possible watermark appearances are available, as viewed from either the front or the back.

A vertical format sheet stamp with a double-line watermark may yield one of the following possible configurations:

1. A single letter fairly centered and fairly complete.
2. Small portions of two separate letters.
3. Small portions of three separate letters
4. Small portions of four separate letters.

The majority of these stamps will show portions of the watermark letters, and copies with a fairly complete letter are scarce.

A vertical format stamp with a single-line watermark may yield one of the following configurations:

1. A single letter fairly centered, scarce.
2. Small portions of two separate letters.
3. Small portions of three separate letters.

The majority of these stamps will show portions of two or three watermark letters—never portions of four letters.

As a prerequisite, a good technique to test for watermarks must be developed. Expertise in any area of philately comes with handling large quantities of the same stamp. There is no substitute for this "hands on" process, and it is wise to obtain the experience early. As Stephen G. Rich succinctly pointed out, "Testing for watermark will forestall your being stuck with counterfeits of many older stamps."

Watermarks are usually detected by holding the stamp to a light source. A frosted white bulb is best, because it distributes the light evenly, and sometimes a subdued light is more effective than an intense light. Some watermarks are quite apparent to the unaided eye. In other cases, the stamp must be held at every conceivable angle to the eye and light before the watermark can be located and identified. Many watermarks can be detected in this way, or by placing the stamp face down on a black mat, which can then be tipped and turned at various angles to the light.

Unfortunately, not all watermarks are readily seen by the unaided eye. At times, the detection of a watermark is an exasperating experience. This difficulty is compounded when the watermark is masked by the perforations, veiled by a cancellation, or hidden by the reflected glare of its color. It then becomes necessary to employ a watermark detector to expose the design. This fact may have prompted H. L. Lindquist to define watermarks as "invisible marks made in stamps to promote the sale of cups, tweezers and benzine."

The most common detector is a watermark tray, a shallow black dish made from an inert material such as glass or plastic. The tray is used in association with a quick penetrating, fast drying fluid that does not deposit a residue and does not disturb paper, ink, or gum. Such solvents as benzine or cigarette lighter fluid have been used successfully in the past but, for reasons of safety, their use is controversial.

When this detection technique is employed, the stamp is placed face down in the tray and wetted with fluid. When the fluid penetrates the paper, the index of refraction of the paper fiber is changed, and the wet paper becomes somewhat transparent. Light is transmitted through the stamp toward the black undersurface and absorbed.

The thinner parts of the wet paper allow more light to pass through and reflect the least amount back to the viewer. They also allow the black background to show through with greater intensity. For stubborn cases, it may be necessary to repeat the wetting process several times, allowing the liquid to evaporate completely between successive wettings. Wetting with liquid is better than immersion.

Some stamps require a longer time in the fluid for a watermark to appear, while other specimens show the watermark quickly, although it becomes blurry in a few seconds. How a watermark develops depends on the sharpness of the watermark design in the paper, the porosity of the paper, and the speed of penetration of the liquid. A watermark incorporated on the back of a stamp will show up quicker than one located on the printed face.

It is not difficult to identify the U.S. double-line Roman capital USPS watermark, but it is often an arduous task to determine if a single-line USPS watermark of the 1910-1916 period is present.

The color of a stamp will sometimes interfere with the visibility of even a well incorporated watermark. This is particularly noticeable with yellow, orange-yellow, orange, pale olive-green and light brown-colored postage stamps. When these light-colored stamps are placed face down on a black surface and wetted, light that passes through the paper is reflected back by the ink instead of being absorbed by the black background. The ink color is highlighted more than the paper thickness difference, and a clear contrast between the thick and thin portions of the paper is hidden behind this glare, making watermark detection difficult.

A complementary colored filter placed between the line of sight and the stamp tends to neutralize the stamp color and dampen its glare. The complementary filter changes the light stamp ink to black, cutting the glare and allowing the watermark to be seen. Although helpful, this technique is not a panacea for the detection problem.

First, it is impossible to obtain a filter that is the exact complement of the stamp color. Second, light-colored inks are not pure colors, but mixtures. Yellow, for example, contains a large amount of which comes through a blue filter as dark blue rather than black. As a filter material, colored cellophane does not work as well as a high-quality photographic filter, because cellophane is not made in pure colors. Table 1 shows a suggested list of filter colors.

Table 1. Suggested Filter Colors

Stamp Color	Filter Color
Yellow	Deep blue or purple
Salmon-red	Blue or purple
Red-orange	Green or blue
Orange	Medium blue or deep blue
Light green	Red
Olive-green	Purple
Ultramarine	Green

The following alternate detection technique can also be employed. Place a wetted stamp face down on a thin piece of clear glass, to the underside of which is attached a colored filter similar to the color of the stamp. Direct this assembly to a low intensity diffused light source with the back of the stamp closest to the viewer's eye. The unit can be tilted and turned through various angles until the watermark can be seen and identified.

Neither of these techniques works in a consistently satisfactory manner for the single line watermarks. In addition, cancellations cannot be filtered out, and care must be exercised not to mistake the "oily" lines adjacent to the cancel for portions of the watermark. Further, these detection methods do not differentiate between true watermarks that were incorporated during paper formation and dry-impressed, or bogus watermarks.

A number of commercially available dry watermark detectors are now available that strive to make "off cover" detection easier. They represent a most welcomed technological advance in this area, but once a good wetted techniques mastered, it will produce equivalent results. Remember that the watermark, when viewed from the face, as in a mechanical detector, most often appears in the attitude shown in the catalogue. When viewed from the back, as in the immersion method, the design usually appears in reverse of the catalogue illustration.

The determination of whether a stamp on cover contains a watermark has always been a perplexing problem for collectors. Two techniques, based on the fact that watermark design is either thicker or thinner than the surrounding paper, have been described in the literature. Photosensitive paper or photographic film is the common denominator of these methods.

The first, advocated by Gravell, is simple and does not require sophisticated equipment. A piece of photosensitive paper is placed inside the cover with the emulsion facing the stamp. The assembly is held together firmly and exposed to an ultraviolet light source, which darkens the film. After exposure, the film should reveal the watermark design.

One drawback of the method is that exposure times are subject to a host of variables and may be as long as forty-five minutes. Another is that, unfortunately, this method does not produce acceptable results in all cases. The cancellation also prints, which is troublesome if it obscures the watermark, or if it is misinterpreted as a portion of the watermark.

Theimer describes another detection technique, in which photographic film is exposed to beta rays emitted from a carbon-14 source. The thinner portions of the paper allow more radiation (light) to pass through to the film. After the film has been developed, the image of the negative watermark shows as a darkened design. Acceptable results have been obtained using a variety of qualifying tests.

Exposure times with this method are quite long, up to twenty-four hours, but as a positive result the effect of the cancellation is neutralized. The specialized light source required renders this method prohibitive for general use.

Several benefits are derived from these two techniques. Both provide a permanent record of the results and Theimer's method seems to be very reliable. Both methods are technically able to differentiate among dry impressed, opaque, and translucent watermarks. Dry-impressed watermarks contain the same amount of paper fiber as the surrounding paper. Therefore, the same amount of light passes through the watermark to the film as through the adjacent paper. The result is a uniformly exposed piece of film.

Other unique features can be used to classify a stamp properly, even when the watermark cannot be noted. For example the 50-cent Franklin of the U.S. 1912 issue was initially printed using 200-subject plates (Scott 422), because a sufficient supply of paper (double-line watermarked) was available to meet the anticipated low demand for the denomination. A 400-subject plate was prepared later, and the stamp was then printed on single-line watermarked paper (Scott 421).

The single-line watermarked stamp always has a slight offset on the back from the still wet, more heavily inked portions of the sheet below, usually the frame lines. Because the offset is under the gum, both used and unused copies of the single-line watermarked stamp can be identified.

The U.S. 2-cent single-line watermarked stamp, perf 11 (Scott 461) is quite scarce, and many fakes have been fabricated using the 1912 imperforate as a base. The distinctive shade, pale carmine-red, of the real item is helpful. The unwatermarked 1-cent and 2-cent U.S. postage due stamps of 1916, perf. 10, may be distinguished from their watermarked brethren by their rose shade (Scott J59 and J60).

As stated earlier, the unwatermarked 1894, and the watermarked 1895 issues are identical in design, color, quality of paper and perforation gauge. During the early days of operation the Bureau experienced difficulty perforating stamps. Therefore, stamps showing "rough" perforations, or perforations with the chad (punched paper disc cutting) partially adhering to the stamp are usually the unwatermarked 1894s.

From 1869, until the end of 1895, arrows without guide lines were incorporated on the printing plates to aid cutting the sheets into panes. After December 4, 1895, guide lines were added to the printing plates, or new plates with arrows and connecting guide lines were first used. Therefore, when the stamp has a guide line, or guide lines, it is a series 1895 stamp whether the watermark is discernible or not. As an aside, the much maligned, straight edged, guide line stamps are scarcer than the completely perforated stamps.

Conclusion

We are now at the end of the discussion of **"USPS"** watermarks in postage stamp paper. Although many areas of the subject were treated in detail, the major goal of this article was to familiarize readers with the material, and to be didactic rather than definitive. It is my hope that some serious interest in watermarks has been stimulated, and that a technical solution to watermark detection problems will be achieved in the near future.

Selected Bibliography:

Boggs, Winthrop S. "Notes on United States Watermarked Postage Stamps," *The London Philatelist*, Vol. 67 (July 1958), pp. 121-33.

Dickey, Budd W. "Watermark Varieties," *U.S. Specialist*, Vol. 51 (Nov. 1980), pp. 538-40.

Froom, H.A, *U.S.P.S. Watermarks*, San Diego: H.A. Froom, 1941.

Gravell, Thomas L., Jr. "Watermarking Stamps on Cover," *The American Philatelist*, Vol.84 (Nov. 1970), p. 996.

Gravell, Thomas L., Jr. "Additional Data—Watermarking Stamps on Cover," *The American Philatelist*, Vol. 85 (July 1971), pp. 654 & 656.

Lindquist, Harry L. "Philatelic Terms Cleared Up," *The Collectors' Journal*, Vol. III, No. 3 (Oct. 1912), p. 53.

Repeta, Louis E. "Watermarks in Postage Stamp Paper," *The American Philatelist*, Vol. 101 (Feb. 1987), pp. 128-143.

Rich, Stephen G. "Watermark Problems," *Western Stamp Collector* (Oct.8, 1954), p. 3.

Theimer, Ernst T. "Beta Emission Radiography as a New Philatelic Tool," *The American Philatelist*, Vol. 97 (July 1983), pp. 620-22.

Williams, L. N. and M. "Watermarks," *Foundations of Philately*, Section 1, 2nd ed., pp. 46-64, The Philatelic Foundation, Feb. 1960.