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THE BROTHERS RITTENHOUSE

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BIOGRAPHICAL SKETCH

Bud Uzes has forty years surveying experience in both the public and private sectors. His current practice offers consulting services in surveying and boundary determination, specializing in wetlands litigation. He is a graduate of the University of San Francisco and is licensed in California and four other states. Bud is active in surveying history and has written books and articles on the subject. He is a collector and exhibitor of antique instruments and books.

ABSTRACT

Historic instruments bearing the name Rittenhouse are among the most prized by American surveyors. They were made by two brothers, David and Benjamin. Depending on which brother was the maker, their instruments were typically either innovative, highly decorated, or a combination of both. They were well made and technically reliable. The brothers had other skills and notable career achievements as well, particularly David.

DAVID RITTENHOUSE

David Rittenhouse (1732-1796) was a celebrated leader in several different disciplines. Although lacking a formal education, he distinguished himself as an astronomer, mathematician, surveyor, teacher, and maker of clocks and mathematical instruments. He also served as a legislator, administrator, financier, state treasurer, and the first director of the United States Mint. Along with his friend, Benjamin Franklin, he is considered one of the leading American scientists of his time. He was a Fellow of the Royal Society of London, and received a doctorate of laws from the College of New Jersey in 1789. Two years later he succeeded Franklin as president of the prestigious American Philosophical Society. Thomas Jefferson served as vice president of the Society under Rittenhouse, and followed him as president.

SURVEYOR

David Rittenhouse made topographic surveys for roads and rivers, and he likely performed property surveys as well. He was the City Surveyor of Philadelphia for part of 1774. The most significant and widely known of his field work dealt with laying out boundaries between states. This work typically involved the ranging of lines of either latitude or longitude, according to positions determined from his astronomical observations.

Rittenhouse worked on jurisdictional lines involving Delaware,

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Massachusetts, New Jersey, New York, Ohio, Pennsylvania, and Virginia. He helped run the 90-mile westward extension of the Mason-Dixon line and set the southwest corner of Pennsylvania. From this location, a party of four commissioners including David Rittenhouse, Andrew Ellicott, and General Andrew Porter, together with 30 men, ran north in 1785 to set the Pennsylvania-Virginia boundary. Along the way, they set a post on the north bank of the Ohio River. That marker, described in the journal of General Richard Butler as "the post set up by Mr. Rittenhouse," was adopted later that year by Thomas Hutchins as the Initial Point for the survey of the Seven Ranges (Butler, 1847; Porter, 1880). The Rittenhouse post thus became the starting point for subdividing the public lands of the United States under the Land Ordinance of 1785.

ASTRONOMER AND CLOCKMAKER

David is known as the foremost American astronomer of his period, and for his extraordinary clocks. On one occasion, his interests in the two disciplines merged. He constructed a high precision pendulum clock for use in conjunction with observations for the transit of Venus on June 3, 1769. For that event, he also constructed an astronomical quadrant, an equal altitude instrument, and an astronomical transit. Rittenhouse made many contributions to astronomy through both observations and ingenuity. He was the first American to use a spider web for the cross hairs in a telescope, although unknown to him they were previously introduced in Europe.

Clocks by David Rittenhouse are considered to be among the nation's finest. One he built in 1774 was refused by the intended buyer Joseph Potts as too large. Today it is considered to be not only his personal masterpiece, but the finest American clock ever built (Drepperd, 1947). It has a complicated mechanism, providing astronomical information as well as time. Rittenhouse also made two orreries of unprecedented refinement that brought his mechanical skills to the attention of scholars.

COMPUTER

The Pennsylvania Method for calculating areas of irregular tracts by double meridian distance uses only one column for the DMD portion of the calculations, instead of separating them into north and south elements, as was the former practice. It also makes the mathematics quickly self-checking, thereby saving valuable time when errors occurred. The Pennsylvania Method replaced the original DMD procedure during the 19th century, and survives to the present day. This writer used the Pennsylvania Method for over thirty years before getting a programmed computer.

One source states that the method was used in the Surveyor General's Office in Philadelphia as early as 1785 (Gibson, 1785). Another credits the method to "Dr. Rittenhouse" (Flint, 1835, pp. 116). John Lukens, Surveyor General of Pennsylvania, was a close friend of David Rittenhouse. They worked together on several projects, including the 1769 observations of the transit of Venus. Whether or not Lukens learned the method from Rittenhouse is unknown.

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INSTRUMENT MAKER

Several of the instruments made by David Rittenhouse show mechanical ingenuity. Some are artistically decorated, others not. He is generally credited as the inventor of the vernier compass, but there is no clear record of this. It has been suggested that the design may have originated in Europe, and Rittenhouse may instead have introduced it in America.

He began making clocks while in his teens, and probably began making instruments in the late 1760's. It is not known from whom he learned to make these instruments, but the task would not have been difficult for one so mechanically inclined. Although he must have studied actual instruments, he probably gained important knowledge from published works. On February 21, 1767 Thomas Barton wrote to Rittenhouse, encouraging his brother-in-law to build an orrery, and urging him to purchase N. Bion's well-illustrated and informative book: The Construction and Principal Uses of Mathematical Instruments, translated by Edmund Stone (Rice, 1954). The fact that Rittenhouse built an azimuth compass mounted in a wood base, quite like the one pictured by Stone, suggests that he did in fact have access to the book (Smart, 1962). So does the fact that Bion explains how to divide a circle into one-degree increments, the usual graduation found in Rittenhouse compasses.

The Revolutionary War interrupted Rittenhouse's manufacturing, and afterward he engaged in other activities, including state boundary surveying. Nonetheless, in 1780 he sought good optical glass for grinding telescope lenses, and reportedly produced surveying instruments into the 1780's.

David Rittenhouse probably produced less than two dozen surveying instruments, and less than seventy-five clocks (Eckhardt, 1955). By way of comparison, Thomas Whitney advertised in 1820 that he had produced about 500 surveying compasses during the preceding thirteen years.

Rittenhouse did not have a consistent instrument signature. His instruments appear to be the work of several hands, suggesting apprentices or assistants. The engraved letters and numbers vary in quality, even on the same instrument. Some of David's instruments are absent of decoration, in contrast to those of his brother's. Some instruments are likely to have received more of Rittenhouse's personal labor than others. Those include the compasses with special devices like the rotating dial, vernier, solar device, and automatic needle lifter.

VERNIER AND VARIATION COMPASSES

It is not known when David Rittenhouse made his first vernier compass, or if indeed he actually invented this important instrument which enables a surveyor to compensate for the angular difference between true and magnetic north. Whatever the case, nineteenth century Americans knew the vernier compass as a "Rittenhouse compass," or the "compass upon Rittenhouse' s construction" (Mansfield, 1804; Tiffin, 1815; Gurley, 1869). According to Abel Flint: "It was well known

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to the celebrated Rittenhouse that his compasses did not agree, and he was never satisfied as to the cause of it. To remedy this defect, if it can be called a defect, he constructed his compass with a nonius or vernier scale (as some call it) that all of them might be so regulated by a meridian as to agree. The meridian should be established by the motion of the heavenly bodies, and made permanent by durable monuments" (Flint, 1835, pp. 95)

Within a few decades of its introduction the vernier compass had become the basic instrument specified in the instructions for the surveys of the public lands of the United States. Its popularity declined in the 1840's after the introduction of Burt's solar compass, which was more reliable in areas with local magnetic attraction. Still, the vernier compass continued to be accepted until 1894 for certain types of public work. Its use in non-government work continued much longer, with production by several major manufacturers continuing into the 1920 ' s and 1930 ' s. It still appeared in the 1949 edition of Gurley's "Manual". Today its features are still found in small forester's and geologist's compasses.

As a practical surveyor, David Rittenhouse was well aware of the problems of magnetic variation and how it changed over time and place. He researched the differences in needle readings between various compasses for the same alignment of the sights. He also made at least one instrument designed for measuring the earth's magnetic variation. This innovative instrument, which should probably be termed a variation compass, incorporates the mechanism of the vernier compass, perhaps without that result intended. One wonders if it was a precursor of the vernier compass. An example is now owned by the

New York State Library at Albany.

The variation compass has two unique features: several concentric circles cut into the compass face, and a small brass solar device which fits over the pin once the needle is removed. Accessories include a spirit level attached to a small straightedge, and a wooden case with adjustable brass legs for leveling.

The equal-altitude method of determining the magnetic variation is as follows. With the vernier reading 0 degrees on the ring, align the sights in the magnetic meridian, and remove the glass cover. Replace the compass needle with the solar device. Sunlight will pass through the hole in the solar device, creating a spot of light on the dial. Wait for the spot to touch one of the concentric rings. Without disturbing the sighting alignment, rotate the dial so the image touches the north-south line. Read the arc value appearing opposite the vernier. Repeat the operation in the afternoon, when the light spot is in the same position relative to the concentric ring. Now rotate the dial until the spot just touches the opposite side of the north-south line. The line halfway between the two vernier readings is true north. The angular difference between that direction and magnetic north is the variation of the needle. If the sun's bearing is known, the variation can be determined from a single pointing. With his appetite for scientific experiment, it is likely that David Rittenhouse operated the variation compass using both methods.

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D. Rittenhouse Philadelphia variation compass.
Photo courtesy of the New York State Library at Albany.

The graduated ring of the variation compass rotates a full 360 degrees, and can thus accommodate the morning and afternoon values of the sun's bearing. The usual vernier compass, by contrast, has only enough adjustment for the range of the anticipated magnetic variation. For example, a circa 1810 Thomas Whitney vernier compass has a 20 degrees reach from 10 degrees E to 10 degrees N. Built for surveys in the eastern part of the United States, it would not suffice in the west, where the variation can exceed 23 degrees E.

AUTOMATIC NEEDLE LIFTER

Four known surveying compasses are not specific as to which of the Rittenhouse brothers was the maker. All are marked Rittenhouse without a first name, and are believed to be made under David's direction rather than Benjamin's. One such instrument now in the National Museum of American

History was reportedly given by David Rittenhouse to President George Washington.

Another is a surveyor's plain compass with an automatic needle lifter. This device mechanically guards the sharp center pin against wear during non-working conditions. A small lever protrudes downward from inside the unit's staff socket.

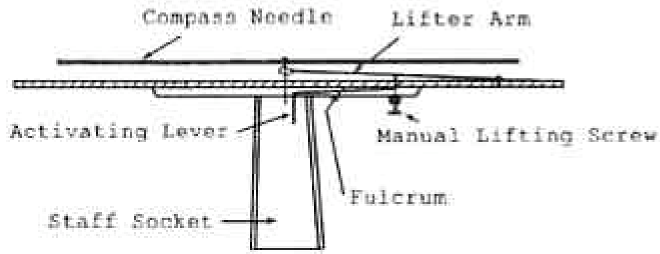

Diagram of the automatic needle lifting mechanism.

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Pushing up on this lever causes the compass needle to be lowered onto the pin. This occurs automatically when the instrument is placed upon a tripod or staff. When removed from the support, the lever returns causing the needle to be lifted off the pin. No earlier examples are known, and it is possible that David Rittenhouse invented this device.

BENJAMIN RITTENHOUSE

Benjamin, the younger brother of David, was a master craftsman, and maker of fine compasses and clocks. All known compasses by him are highly decorated, and works of art. His compasses were reported in 1898 to be the best available. Benjamin also held other important positions, both public and private. He was born in Norriton township about 1740, and died in Philadelphia in 1825.

Having an older brother interested in mathematical instruments and the sciences was influential upon Benjamin. David was responsible for the early training of his younger brother, and oversaw his apprenticeship (Barton, 1813, pp. 138). Probably while in his early twenties, Benjamin moved to Worcester Township. There he was primarily involved in making clocks, which involved machining with metals. This played a part in his being selected in 1776 to set up and run a factory to produce gun locks. They were made to supply the American forces in the Revolutionary War. He served as the superintendent of the factory until 1779.

After the war he returned home to Worcester and again began producing clocks and mathematical instruments. He also engaged in other activities. This included a position as head grain measurer in 1790, and Associate Judge of Montgomery County. He held the latter position for nearly ten years. He was also a member of the state Assembly. In addition, Rittenhouse worked at times as a surveyor. In 1789 he was on a project involving the Schuylkill River.

Some of Benjamin Rittenhouse's instruments and clocks are dated, others are not. The earliest Benjamin Rittenhouse compass marked with a date is 1786. He also made chronometers in that year.

By the Act of May 18, 1796, Congress authorized the survey and sale of lands northwest of the River Ohio. The Act specified that chains used in the survey were to be adjusted to a standard kept for that purpose. Benjamin Rittenhouse made the standard chain, and advised government officials it may be depended upon as accurate. It was sent to Surveyor General Rufus Putnam in 1797.

Both William Lukens Potts (1771-1854) and Benjamin Evans (1776-1836) started working with Benjamin Rittenhouse in about 1796. That is the year his brother David passed away. Potts was with Benjamin for about two years, then later worked independently. Evans, a nephew of the Rittenhouses, worked with Benjamin until 1801, the year of Benjamin's bankruptcy.

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Some compasses are signed "Rittenhouse and Potts," and some are signed "Rittenhouse and Evans." The year 1796 reportedly appears on a Rittenhouse and Evans compass.

Many of the compasses produced by Benjamin Rittenhouse had a nonius, or vernier. That innovation was so useful to surveyors, and the instruments so well made, that the Rittenhouse name came to be identified the vernier compass. While David was the first to develop the feature, it was Benjamin's compasses that brought the widespread recognition.

RITTENHOUSE CHAIN

The principal author of a significant historical treatise on surveying instruments, first published in 1899, stated that a "chain of Rittenhouse, which comprised 80 links or 66 feet, was quite generally used in American mines until Eckley E. Coxe and others started a reformation, some twenty-five years ago, in favor of the steel band." Benjamin Smith Lyman challenged this unusual statement (Scott, 1902). Similar doubt is expressed here.

Eighty-link chains could have been used or manufactured by either or both of the Rittenhouse brothers. It should not be identified with them, though, as if it were their invention. The English surveyor Vincent Wing introduced the 80-link chain during the second half of the 17th century (Wing, 1700). The links on this chain are each 9.9 inches long. Wing argued that his chain was better than the Rathborne and Gunter varieties, as it simplified calculations of area when land was measured in perches. A perch (or pole, or rod) is 16 1/2 feet long. Many 18th century surveys used both linear and square perches as the units of measure. According to John Gummere, the author of a popular surveying textbook, 80-link chains were still in use in America in the early 19th century (Gummere, 1833).

RITTENHOUSE AND COMP^Y

A vernier compass signed *Rittenhouse and Comp^Y*, said to have been used by Abraham Lincoln, is kept in the Lincoln Park Museum at Petersburg, Illinois (Gum, 1865). One investigator suggests that this compass may have been made by Benjamin Rittenhouse and his son David (Forman, 1988a & b). That possibility has much merit. County tax records show David worked with his father from 1800 to 1802. The instrument lacks the decorated compass rose typically found on Benjamin's instruments, but that might be expected on a piece made primarily by a young man whose skills were only moderately advanced. Signing the instrument David Rittenhouse would be misleading, as that would suggest it was made by young David's well-known uncle.

CONCLUSIONS

David and Benjamin Rittenhouse made several significant

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contributions to the surveying profession. Their talents produced mechanical innovations that aided surveyors for over a century. The instruments they made are highly prized for both their technical features and decorative design. The brothers were also leaders in community life, and served their community and the young nation with distinction.

ACKNOWLEDGMENTS

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