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 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.

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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° 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.