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The California Surveyor

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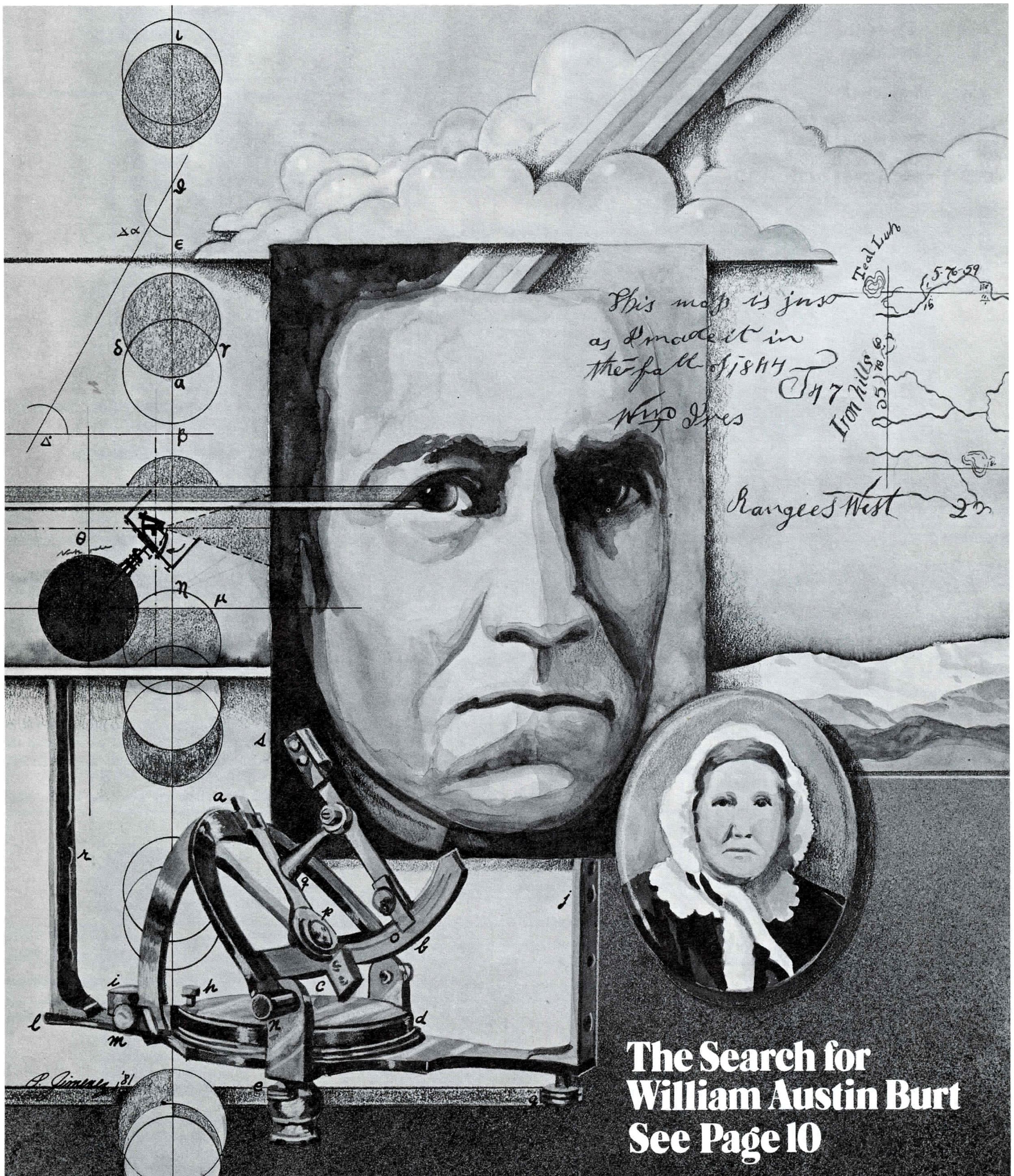

The Search for William Austin Burt

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F.D. "Bud" Uzes (left) and John S. Burt pose with a Burt's Solar Compass at the WFPLS Conference in February 1981. John, great-great-great grandson of inventor/ surveyor William Austin Burt, and Bud have teamed up in this edition to bring readers the story of the man, his work and his inventions. See Cover Story and Perspectives.

On the Cover: "William A. Burt: Inventor, Surveyor, Dreamer."

Cover Illustration: Pat Jimenez, Target Studios.

The California Surveyor

is the quarterly publication of The California Land Surveyors Association and is published as a service to the Land Surveying profession of California. It is mailed to all Licensed Land Surveyors and Land Surveyors in Training in the state of California as well as to all members of California Land Surveyors Association. *The California Surveyor* is an open forum for all surveyors, with an editorial policy predicated on the preamble to the constitution of the California Land Surveyors Association and its stated aims and objectives, which read:

"Recognizing that the true merit of a profession is determined by the value of its services to society, the 'California Land Surveyors Association' does hereby dedicate itself to the promotion and protection of the profession of Land Surveying as a social and economic influence vital to the welfare of society, community, and state."

"The purpose of this organization is to promote the common good and welfare of its members in their activities in the profession of Land Surveying, to promote and maintain the highest possible standards of professional ethics and practices, to promote professional uniformity, to promote public faith and dependence in the Land Surveyors and their work."

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Editorial Material.

All articles, reports, letters and contributions are accepted and will be considered for publication regardless of the author's affiliation with the California Land Surveyors Association. Material should be sent to *The California Surveyor.*

Unless indicated, all articles in this publication are prepared by the editor

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Articles, Reports, Letters, etc., received after the above mentioned date will be placed in the next edition.

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Cover Story

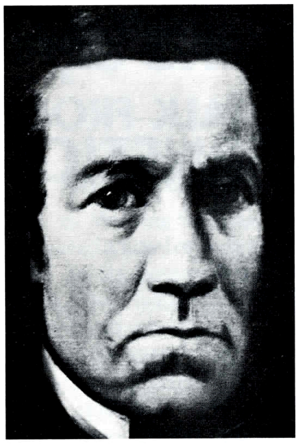


Photo from a portrait of William A. Burt in Michigan Historical Society Museum, Lansing Michigan (by J. S. Burt).

THE SEARCH FOR AN ANCESTOR: PIONEER SURVEYOR WILLIAM A. BURT

By John S. Burt

When California's Gold Rush of '49 created an urgent need for surveys in the West, William Burt's solar compass became the required instrument for running the lines. The Commissioner of the U.S. General Land Office called it the only instrument that could be depended upon in California and Oregon to ensure accurate results at a moderate cost. So why did its inventor allow his patent rights to expire or fail to patent its many improvements?

William Burt also invented America's first typewriter, in 1829, but what recognition is given today to this historical achievement? And why didn't Burt and the members of his surveying party get rich from their discovery of the Marquette iron range in Upper Michigan?

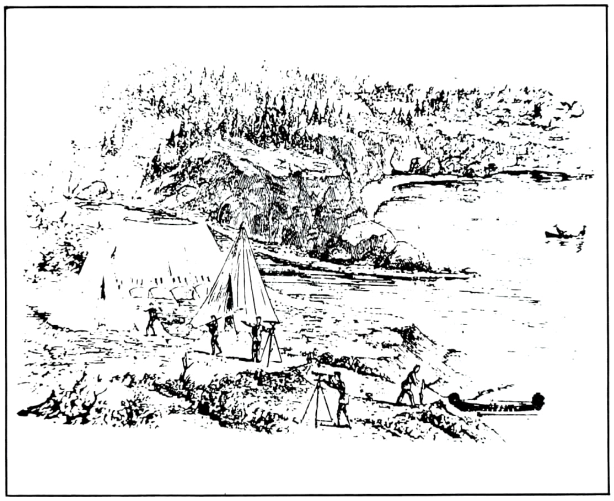
These were just a few of the questions that occurred to me when the Bicentennial arrived a few years ago. At that time my ancestor was as unfamiliar to me as the surveying profession, but today I have great appreciation for both his profession and the contributions he made to it. As youths, my brothers and I had heard about this man who had invented a compass and a writing machine, although nothing really registered except the knowledge we weren't independently wealthy from his efforts. But during this period when many Americans were caught up in the "Spirit of '76", I pulled down from above the rafters in our garage a dust-covered box containing old family records. Two frail notebooks, the pages bound with string, were filled with genealogical data compiled by my grandparents. It appeared that much of the information I sought was here all along, waiting to be discovered. There were family trees, recollections of relatives, war records and tombstone markings all dutifully copied down. There were biographical sketches on William Austin Burt, one written by my great-grandfather, Horace Burt, in connection with Burt's nomination into New York University's Hall of Fame. Before I knew it, several hours had passed in reading through the books, but several questions remained to be answered. The decision was made to add to the items in the box and compile a collection of material to form the basis for a complete story about William Austin Burt. The search was on.

I found that this line of Burts had been in Massachusetts over 150 years when William Austin was born in Petersham in 1792. Richard Burt had sailed with his father from England about 1635, settled near Taunton and later became a local surveyor. By the age of 14, young William had taught himself the principles of mathematics, astronomy and navigation. Like many children of that era, he received limited formal education. At night he studied by the light of a burning pine knot, and during the day he often read from books set in a special holder he devised to read and work at the same time. He dreamed of being a sea captain, but discovered his knowledge could be applied to the land as well. With a quadrant he had built, he determined the latitude of his father's farm. At the age of 18, he bought a broken compass, repaired it and made his first survey near East Aurora, New York.

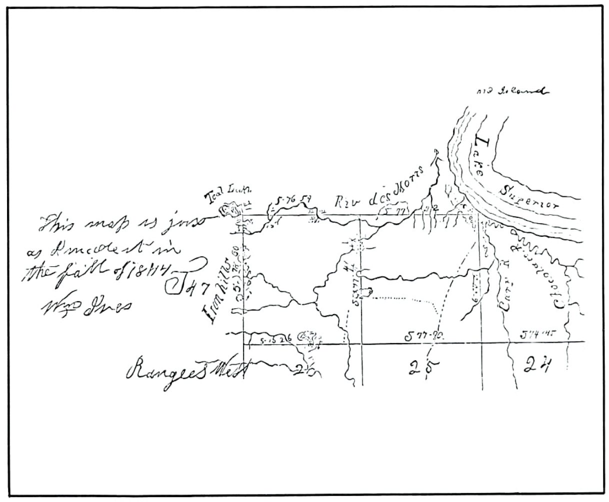
Just before the War of 1812, in which Burt had served two tours of duty, the General Land Office was established within the U.S. Treasury Department to coordinate all public land transactions. In later years, William Burt became well-known to the personnel of this office.

On the 4th of July, 1813, Burt married Phebe Cole, a former neighbor from Broadalbin, New York. He served as a Justice of the Peace and a school inspector, but when a business partnership with his father-in-law failed, he became restless. In 1817, he took a two month trip into the Midwest, as far as St. Louis, and returned home through Michigan territory. One section, which he described in his diary as "poor land", had been abandoned by surveyors attempting to establish the southern point of the Michigan Meridian the year before. Edward Tiffen, then in charge of surveying the two million acre tract, reported that the land was not worth the expense of surveying it. Burt could not have imagined that 23 years later he would establish the northern tip of that same meridian. When he returned to the Michigan Territory in 1822, looking for a job in the U.S. public land surveys, there were already more applicants than jobs available. But he purchased land and, in 1824, moved his growing family to a small settlement in Macomb County.

He continued to build mills, a trade begun in New York, and soon became well-known in the community. In 1826, his neighbors elected him to serve on the Michigan Territorial Legislature, but he soon found the heavy burden of correspondence more than he could keep up with. To solve the problem he conceived the idea of a writing machine. With parts forged in his workshop and type supplied by the editor of a Detroit newspaper, he built America's first typewriter and received a U.S. patent for it in 1829. The mechanism was housed in a rectangular wooden box, about one foot deep, and was the first of the type-sector design, similar to the toy typewriters of this era. Although the process was painfully slow, their promotional efforts generated some interest. Attempts to sell out the patent rights were unsuccessful, and there was neither sufficient capital nor facilities to manufacture the machine. As a result, the project was dropped, and Burt turned his attention to supporting his



1873 illustration of Burt's surveying party camped on the shore of Lake Superior in upper Michigan in 1844. (From C. Tuttle, ***General History of the State of Michigan),*** *Ros Tyler & Co., 1873.*



William Ives map showing the location of the Iron Hills, where Burt's surveying party discovered the rich Marquette iron range in upper Michigan in 1844. (From the ***Geological Survey of Michigan 1873)***

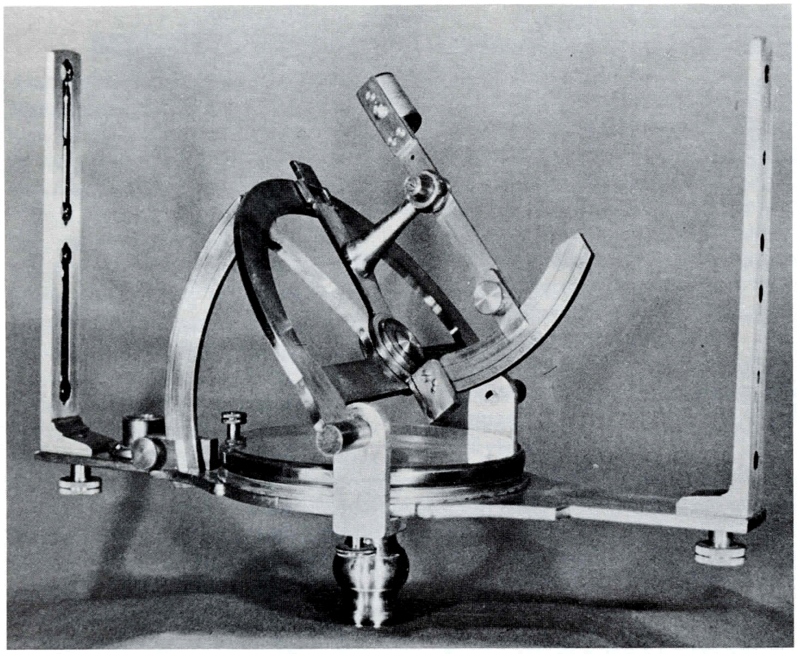
wife and five boys. He was already 38 years old, and had yet to establish his career.

There were as many as 80 applicants for the few surveying jobs available in 1831, but Burt was elected Macomb County surveyor, and later appointed district surveyor by the territorial governor. In his spare time he served as postmaster and Macomb County Circuit Court Judge, and throughout his life he was referred to as "Judge Burt." He soon gained a reputation with the U.S. Surveyor General as "honest and intelligent" and "well acquainted with surveying." On November 23, 1833, he was appointed a U.S. Deputy Surveyor, and given a contract with instructions that better work was expected of him than "was heretofore practised in the north part of Michigan." It was an unpleasant beginning and a financial loss for Burt, as heavy snow, mosquitoes, and swamps delayed completion until the following season. But he had proven his capabilities, and the Surveyor General wrote the Land Commissioner that, "Your friend, Mr. Burt, proves to be an excellent surveyor. For the first contract he has returned the most satisfactory work I have yet met with."

His contract in Wisconsin territory was even more challenging, but his solution to the problems encountered brought him fame as an inventor and a surveyor whose accurate work became a standard for others to follow. Perplexed by the fluctuating needle in his compass, Burt reported that "intersections varied as much as 100 links." He wrote to his wife, Phebe, in May, 1835, that "it is most annoying, this inability as yet to discover a method for doing away with this difficulty or the cause thereof." But that summer, by applying his scientific knowledge and creative mind, he conceived a working model of a solar compass that used the sun as a fixed reference. The first model was built for $25 by William J. Young of Philadelphia, who continued to manufacture the solar compass for many years. It was originally called a "variation compass," since Burt thought its main purpose would be to locate the true meridian and determine the variation of the magnetic needle. Burt soon discovered the lines could be run quicker and more accurately with the solar compass. Its principles and merits were tested by a committee of the Franklin Institute, in Philadelphia, and Burt was awarded a Scott's Legacy Medal and premium of twenty dollars. The new invention was first used by his son, Alvin, near Milwaukee and, on February 26, 1836, it received a U.S. patent.

Phebe Cole Burt, 1792-1864, wife of William Austin Burt. His "Dear Companion."

During the next twenty years, William Burt and his five sons (who all became U.S. Deputy Surveyors) established a reputation for their accurate work on the U.S. public land surveys. Burt's survey of the Fifth Principal Meridian, in 1836, became the basis for all of Iowa's maps and land descriptions. When the Upper Peninsula was added to Michigan, following a boundary dispute, Burt was sent into this dense wilderness to conduct the linear surveys. In 1840, he extended the Michigan Meridian north of the Straits of Mackinac, and established the northern point. (To-



One of the two replicas of Burt's original 1836 model solar compass, manufactured by Gurley in 1961 for the Smithsonian Institution.

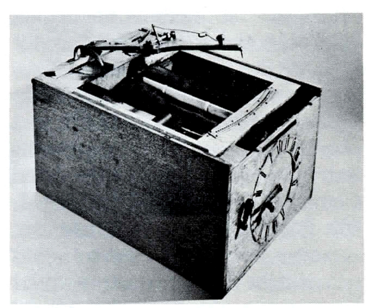
day, on this site, a monument honors the event and, just below the Straits in Lower Michigan, Burt Lake State Park bears his name.)

In 1841, Burt carried out an experiment under Geologist Douglass Houghton's contract that combined both the linear and geological portions of the Upper Michigan surveys at considerable savings. Houghton's Geological Report noted the existence of iron ore did not appear to be of practical importance, but Burt's surveying party proved his assumption grossly inaccurate. In September, 1844, while attempting to close some township lines in Marquette County, they made a discovery that would have a significant impact on the economic development of Michigan and the nation. While using the solar compass, Burt noticed the needle spinning wildly in all directions, "nearly destitute of magnetism." When he called out, "Boys, look around and see what you can find," they each brought back large chunks of iron ore. They had found the rich Marquette iron range, but Burt simply recorded "spathic and hematite iron ore abound on this line," and went on surveying. More important than the wealth that lay in the ground, the discovery had confirmed to Burt the value of his solar compass. It is surprising that none of the surveyors ever attempted to stake a claim, although it was more than a decade before any profits were realized from the mining operations that first began in 1845.

William Ives, compassman in Burt's surveying party in Upper Michigan, took the solar compass to Oregon in 1851, when he initiated the survey of the Williamette Base Line. Burt's invention was required on all of the lines and was, according to the Surveyor General, "the only one that can be used to advantage in the surveys on this coast." Ives had also been with Burt when he completed the northern section of the Michigan-Wisconsin border in 1847. Burt received $18.00 per mile, a record payment in the Michigan public land surveys. The line was resurveyed more than 80 years later by a cadastral engineer who located a bearing tree with Burt's name and marking still inscribed. He credited Burt's original line with being one of the best of the early surveys.

As early as 1842, William Burt was called on to check the work of other surveyors when fraud or inaccuracies were suspected. Sometimes it meant reporting errors in work performed by his friends, but his integrity was never questioned. In one incident, Burt had been surety for work he was later asked to inspect. When the examination uncovered evidence of fraud, Burt honored his bond by making a correctional survey at a personal loss of $3,000. On another occasion, Burt found that fraud had been performed by a former chief topographer for the state geological survey team. By the time it was discovered, however, the surveyor had gone off to California, in search of a fortune in gold that never materialized.

The discovery of gold in California accelerated the need for government surveys between the frontier settlements and the Pacific Coast. Much of the area contained mineral lands, particularly in California and Oregon, and Burt's solar compass would become indispensible for running the lines. The patent on his invention was about to expire when Burt went to Washington, D.C., in December, 1849. He planned to obtain a patent on the many improvements made since 1836, and anticipated "no difficulty" in doing so. Unfortunately, Land Office officials and several congressmen had other ideas. They urged him to "sell out" his patent rights by petitioning Congress for compensation, while allowing his patent to expire. He was asked to write out his views on the best method of conducting surveys and preventing fraud in the future, and he knew full well the important role his solar compass would play. He was also aware that the $350 pricetag had already limited sales to those surveyors who couldn't do the job without it. Since its use would be largely confined to the Government surveys, the Land Commissioner no doubt



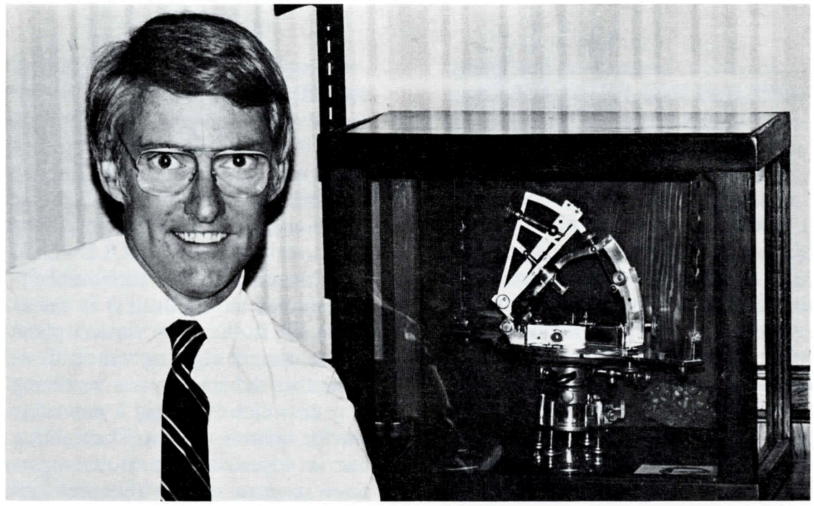
Replica of W. A. Burt's typographer, America's first typewriter, built by Austin Burt in 1893, displayed in Smithsonian Institution.

reasoned that future sales of the instrument depended on their regulations, and therefore their control should be free of royalty payments to the patentee. To a man of Burt's dedication, this appeal must have sounded convincing, particularly since the assurance that Congress would approve his petition came from men he knew and trusted. Unfortunately, the precedent of awarding compensation to a patentee for the use of his invention in Government work had not been established. Burt left Washington without taking action on his patent, in exchange for he assurance he would be compensated by Congressional action and the understanding that the solar compass would be used on all the U.S. public land surveys.

The Commissioner of the General Land Office was anxious to test Burt's solar compass, in 1852, and selected James Marsh to use it on the 260 mile Iowa-Minnesota boundary line. Marsh would run the preliminary line ahead of Captain Andrew Talcott of the Topographical Bureau, and their results would be compared. Burt's solar compass "stood the test most admirably," according to the Surveyor General, and Marsh's line was virtually identical to Talcott's, but at a cost of $6,500 instead of the $32,000 spent by the government surveyors.

So the solar compass was adopted for general use in the U.S. public surveys, but the $20,000 compensation for the inventor never materialized. Several times either the House or Senate passed a bill recommending this action, but they never concurred during the same session. In 1857, a disappointed William Burt again petitioned Congress to at least grant him a patent for the improvements he made to his compass. When it was introduced in the House in February, 1858, but not acted upon, it was the final blow to Burt's long battle for a just compensation. Within three weeks he suffered a severe heart attack from which he never fully recovered. He died August 18, 1858. His heirs continued to petition Congress for compensation until 1900, but their efforts were unsuccessful.

In his final years, Burt added to his accomplishments. In 1851, he exhibited his solar compass at the London World's Fair and received a prize medal and certificate from Prince Albert for his unique invention. In 1852, he helped survey the route of the Soo Canal and, as Chairman of the Soo Canal Committee in the Michigan Legislature, he led the fight to ensure passage of the bill authorizing construction of the canal. In 1855, he authored "A Key to the Solar Compass and Surveyor's Companion" that contained a wealth of practical information to help a surveyor use the solar compass and prepare for a long survey into the wilderness. He also invented an Equatorial Sextant, patented in 1856, that incorporated the principle of his solar compass into an instrument for use on ships.



Author John S. Burt, great-great-great grandson of William Austin Burt, shown with an improved Burt solar, manufactured by W. & L. E. Gurley, and loaned to the Burt collection by the BLM from their supply of solars in the Portland, Oregon office.

In an unfinished autobiography, Burt wrote that he had resolved at an early age to use his abilities to render something profitable to the world or mankind, while it afforded him a decent living. Unquestionably, he succeeded in this goal, but it is a sad conclusion that he was never compensated by the Federal Government for use of his solar compass in the public land surveys.

It is with considerable pride that I have continued to research the life and accomplishments of William Burt, in hopes that a book will someday be written. The Burt collection has grown, thanks to the generous assistance and contributions from relatives, surveyors and historians. It includes a Burt solar compass, manufactured by Gurley, that is on loan from the Bureau of Land Management. Material found in museums and libraries throughout California, Iowa, and Michigan has uncovered much of the story. But I welcome any historical information about William Burt that readers may wish to share, particularly personal recollections in using the solar compass. There has been little written about the early government land surveyors, and the story of William Austin Burt, as a distinguished example, is long overdue.

*Editor's Note: Appearing in this edition of **The California Surveyor** are two articles related to this cover story. Under **Perspectives** is a description by F.D. Uzes of the operating principles of the Solar Compass, and under **Techniques** is Bert Mason's discussion of the applications of solar observations in modern surveys.*

John S. Burt, author of this cover story, welcomes information from readers regarding W.A. Burt and the Solar Compass, and encourages reprinting of this article in other publications. Readers wishing to share information with Mr. Burt may contact him at 1519 E. Concord Ave., Orange, CA 92667.

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OPERATING PRINCIPLES OF A BURT'S SOLAR COMPASS

by F.D. Uzes

About the Author: *F.D. "Bud" Uzes is employed by the California State Lands Commission, where he is in charge of surveying, mapping and related boundary determination work. He is the author of* ***Chaining the Land,*** *a book on California's surveying history, and is co-author of part of Curtis Brown's* ***Boundary Control and and Legal Principles.*** *He is also author of a recently published price guide for antique surveying instruments and books.*

Mr. Uzes is a licensed land surveyor, Chairman of the Surveyors' Historical Society and an avid collector of historic surveying artifacts.

The Burt Solar Compass, invented nearly a century-and-a-half ago, was for several decades the most important surveying instrument used in subdividing government lands. Its mechanism functions somewhat on the same principle as the much older equinoctial sundial, except the meridian is the component desired rather than time. Through use of its simple yet ingenious principles, the solar compass short-cuts the inconveniences of other methods by solving the PZS astronomical triangle mechanically. Finding north with William Burt's device is almost as simple as lighting a match with a magnifying glass.

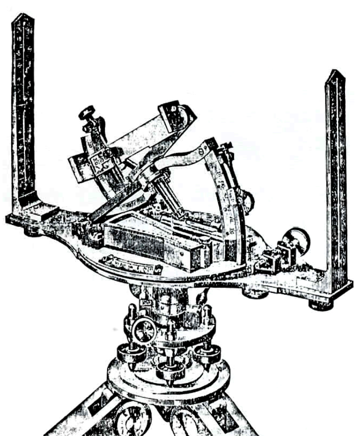

Illustration A.

The solar compass (Illustration "A") is similar in appearance to a large surveyor's compass to which has been added the Burt's solar mechanism. One key element of the solar unit is a small SPINDLE which, when the instrument's horizontal circle (similar to a transit's) is set at 0°00', lies in the same vertical plane as the upright sighting vanes. Connected to the spindle is a revolving limb to which is hinged a moveable bar for sighting the sun. The sighting bar is adjusted by a slow-motion screw, and can move within the limits of +23½° to −23½°, relative to the equator. This is the range of declination through which the sun varies during each year.

Before proceeding further into the operation of the instrument, it should be mentioned that although the instrument is set up on the earth's surface, its principles of operation are treated as if it were located at the earth's center.

Shown in Illustration "B" is a partial Burt solar mehanism located at the earth's center. Note that with the spindle directed in a north-south alignment along the earth's axis, the connected limb revolves in the equatorial plane, and the sighting bar is adjusted to follow the path of the sun at any value of declination.

When the instrument's sights become aligned on the meridian, the following three elements must also be accurately positioned as to their respective settings:

1. The **LATITUDE ARC,** which is set to the co-latitude of the observer. The graduations are reversed, however, so that the value of the observer's latitude is the apparent setting made.

2. The **DECLINATION ARC,** which is set according to values given in an ephemeris, according to the date and time of the observation.

3. The **HOUR CIRCLE,** which requires no accurate presetting as do the other two arcs. Merely pointing the lens bar at the sun sets the hour circle, which is graduated in units of time.

Note in Illustration "C", the latitude arc is set so as to bring the spindle parallel to the earth's axis. Correspondingly, the limb attached at right angles to the spindle revolves parallel to the equatorial plane.

While the unit is obviously offset from its considered position at the center of the earth, no correction is necessary because the eccentric reduction is insignificant considering the accuracy capabilities of the instrument. As the value of the sun's declination (taken from an ephemeris) is set on the declination arc, the sighting bar is correspondingly brought to a position pointing directly at the sun, provided the bar is rotated to correspond with the correct value of sidereal time as indicated on the hour circle. This last setting is simply done by turning the

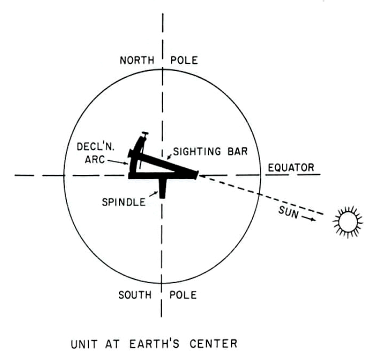

Illustration B.

sighting unit until the sun's image focuses through a small lens onto a silver target.

In actual operation, the latitude and declination values are predetermined and set on their respective arcs. Aligning the instrument to the meridian is accomplished by alternately rotating the combined revolving limb and sighting bar, and the alignment of the instrument's sights. Both of these components can be very closely preset using an approximation of sidereal time, and the magnetic needle. Turning the instrument as a unit causes a raising or lowering of the sun's image on the target, as well as a sideways movement. If the focused dot of light falls off the side of the target when turning the instrument, the sighting limb is rotated so as to again pick up the image. Once the sun's image is correctly located onto the target, the instrument's sight will be correspondingly located in a true north-south alignment. Any additional rotation of the instrument will result in the sun's image moving off target.

Care must be taken in manipulating the revolving limb so that the image of the sun appearing on the target results from a direct line of sight, and is not reflected off the sighting bar. The latter will happen on occasion, and leads to slightly erroneous results. Also, correct adjustment of the unit is very important and must be regularly checked. There are prescribed procedures for this, which include comparison against a true meridian determined by observations on the pole star.

One other factor of concern during operation of the instrument is the time the observations are made. This element has a detrimental affect upon the instrument's accuracy during both very early and late hours through increased refraction, and during midday by an unfavorable rate-of-change condition.

At midday the sun's relative change in azimuth is much greater than the rate-of-change in altitude, and any small errors either in adjustment or in setting the arcs are greatly multiplied. It is best not to use the solar mechanism for about a three-hour period, straddling the noon hour. As for early and late hours, refraction varies from almost 34 minutes at the horizon, to zero at the zenith. Halfway between, the correction is about one minute. Generally,

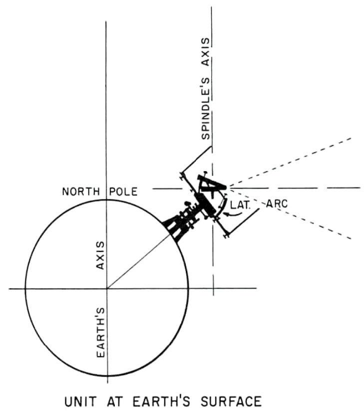

Illustration C.

it is not considered wise to work when the correction is more than 10 minutes. Taking the correction into account is a simple matter, however. The target on the sighting bar is a square, silver plate with double crossed lines engraved in the familiar form of a tic-tac-toe game. Two or three additional horizontal lines are added below the lower horizontal line, separated from one another by the equivalent of 5 minutes of angle. These lower lines enable a surveyor to compensate for the effect of refraction by interpolating the sun's position relative to the lines to correspond with the determined value of refraction.

In the solar transit, unlike the compass, the value of refraction correction must be figured into the basic setting of the declination arc.

While BLM's current Manual of Surveying Instructions describes the technique of plotting a graph to figure the refraction correction, the old timers didn't bother with such elaborate means. Most undoubtedly just "allowed-a-little," while others would refer to a simplified table, one of the best appearing in James Underhill's, "Mineral Land Surveying."

Evaluations have been made from time to time on the accuracy of the Burt solar unit. When the instrument is in good adjustment, tests show any single observation has an uncertainty of about one or one-and-a-half minutes of angle.

Operating one of the old "North-finders" is a unique and rewarding experience, instilling in the user a greater understanding of outmoded surveying techniques, and an appreciation of William Burt's ingenuity.

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Note from Author (Not in the original article.)

The cover Illustration, by Pat Jimenez, Target Studios, was graciously donated to author John Burt April 15, 1982 for the "Burt Project." The framed color Illustration currently is part of the author's William A. Burt collection.