



2026

SURVEYORS'
Conference

Drawing Fire

Don Teter, PS

JANUARY 11-14, 2026 | HERSHEY, PA



Drawing Fire

Surveying, Map Making,
And Engineering
In the American Civil War
Presented by Don Teter, PS
2 PDH

Military glory - that attractive rainbow that rises in showers of blood,
that serpent's eye that charms to destroy. - Abraham Lincoln

Map Types

Sketch or field maps

“Manuscript” maps

Lithographed maps

Field use

Official Records

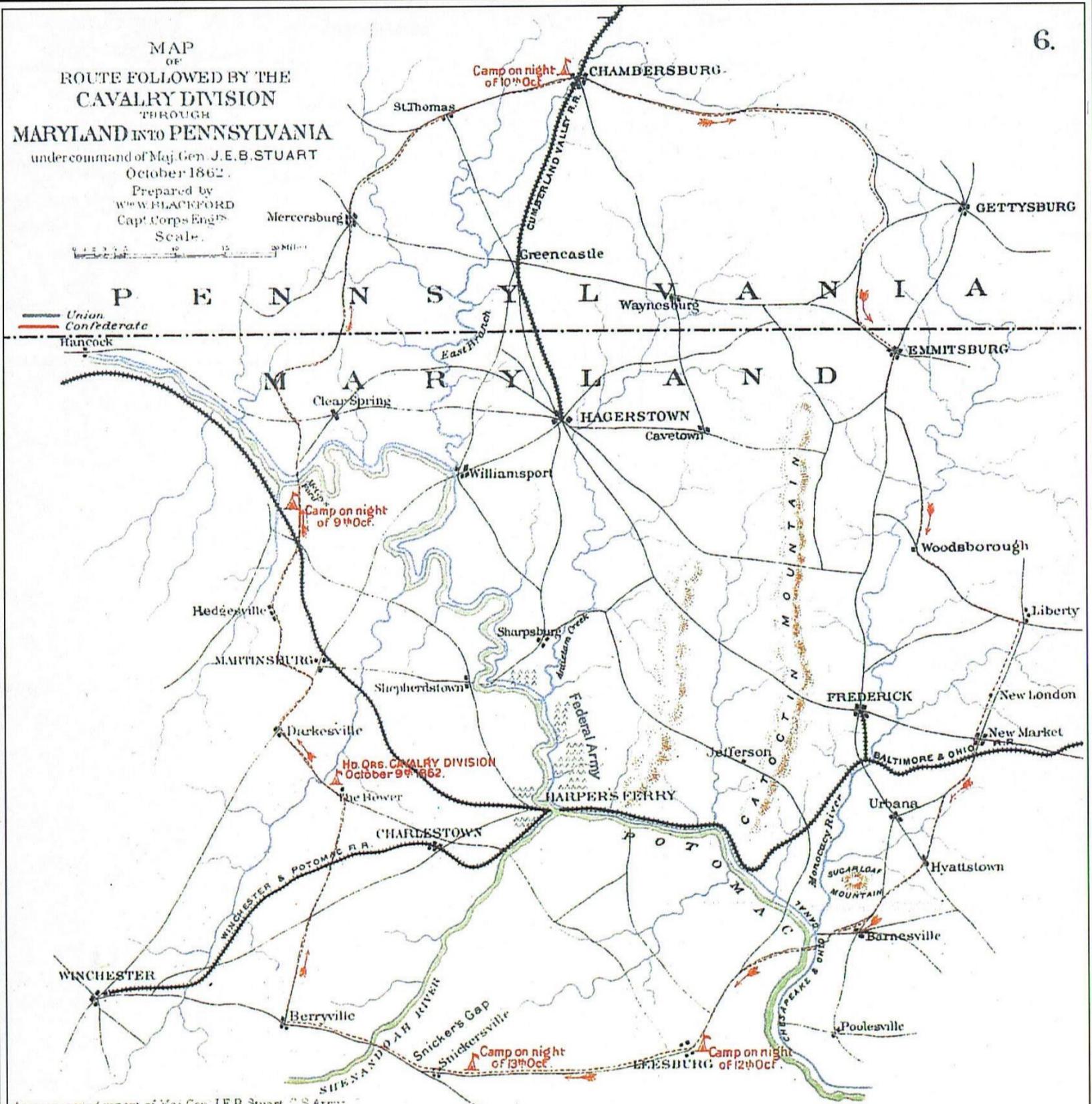
Modern maps

MAP OF ROUTE FOLLOWED BY THE CAVALRY DIVISION THROUGH MARYLAND INTO PENNSYLVANIA

under command of Maj. Gen. J. E. B. STUART
October 1862.
Prepared by W. W. BLACKFORD
Capt. Corps Eng'rs
Scale.



Union
Confederate



Accompanying report of Maj. Gen. J. E. B. Stuart, U. S. Army.
SERIES I VOL. XIX PART 2 PAGE 54

Map Users

Some officers good with maps –

Confederate Generals Robert E. Lee, Thomas Lafayette Rosser;

Union Generals Ulysses Grant (“... *had a way of getting what he needed out of what he had,*” and “*was reported to have an unerring sense of direction, a feel for terrain, and a photographic memory for graphic representations of topography.*” (McElfresh),

John Pope, Philip Sheridan, William S. Rosecrans, William Tecumseh

Sherman, and George H. Thomas “*probably the most conscientious map reader on either side*” (McElfresh)

Some officers not as good with maps –

Confederate Generals Stonewall Jackson (fair) and Jubal Early (poor),

Union General Nathaniel P. Banks “*not adept at topographical matters.*” (McElfresh)

Many volunteer officers completely lacked map training

A Shortage of Reliable Maps

“It was easy, sitting at one’s office table, to sweep the hand over a few inches of chart showing next to nothing of the topography, and to say, ‘We will march from here to here.’”

*Union General Jacob Cox,
about campaigning in the mountains of Western Virginia*

“The Confederate commanders knew no more about the topography of the country than they did about Central Africa.”

*Conf. Gen. Richard Taylor (Zachary Taylor’s son) in 1862
after Seven Days battles within one day march of Richmond*

Commercial and "popular" maps - Atlases, road maps,

State and County boundary maps

Limited market: people stayed close to home, steamboat or railroad

travelers didn't need maps

Some well-known examples

Henry Boye's Nine Sheet Map of Virginia - produced in 1829,

revised by Bucholtz in late 1850's

Fielding Lucas, Jr., Maryland and Delaware, 1852

County maps (e.g., John⁷ Woods in Virginia; Adams County,

Pennsylvania, by G.M. Hopkins/Converse, 1858)

Some more detailed and accurate than others

Eagerly sought by topographers

Limitations of popular maps

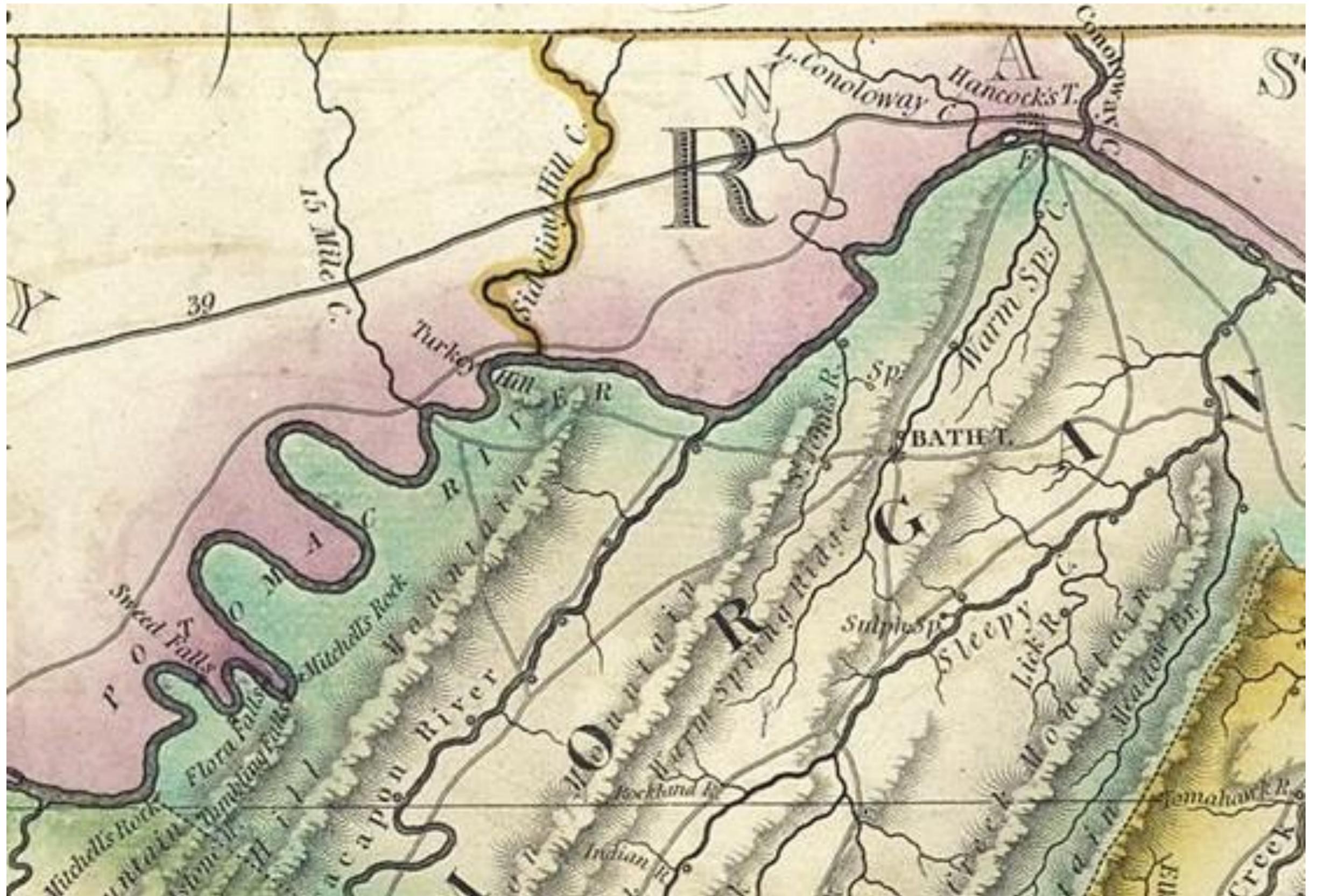
Large areas, small scale

Details skimpy; Distortions and errors common

Place names not consistent or duplicated

Topography not shown, or sketchy and inaccurate

**From Boye
1826 Map,
Berkeley
Springs and
Hancock**



Federal agency maps

Very accurate, limited areas

U.S. Army Topographical Engineers - many good maps of
Great Lakes Region and Far West

U.S. Survey of the Coast - Atlantic and Gulf coasts,
Mountain Region of NC and Tenn.

No government agency maps of most of the ground fought over

Recon and Scouting

Hardships and dangers

Sharpshooters killed, wounded, or chased mappers,
who were often distracted by their work.

Stumbling into pickets on recon work.

Artillery fire, often while distracted.

Capture, often while distracted.

Potential arrest as spies, even by own side

Observations

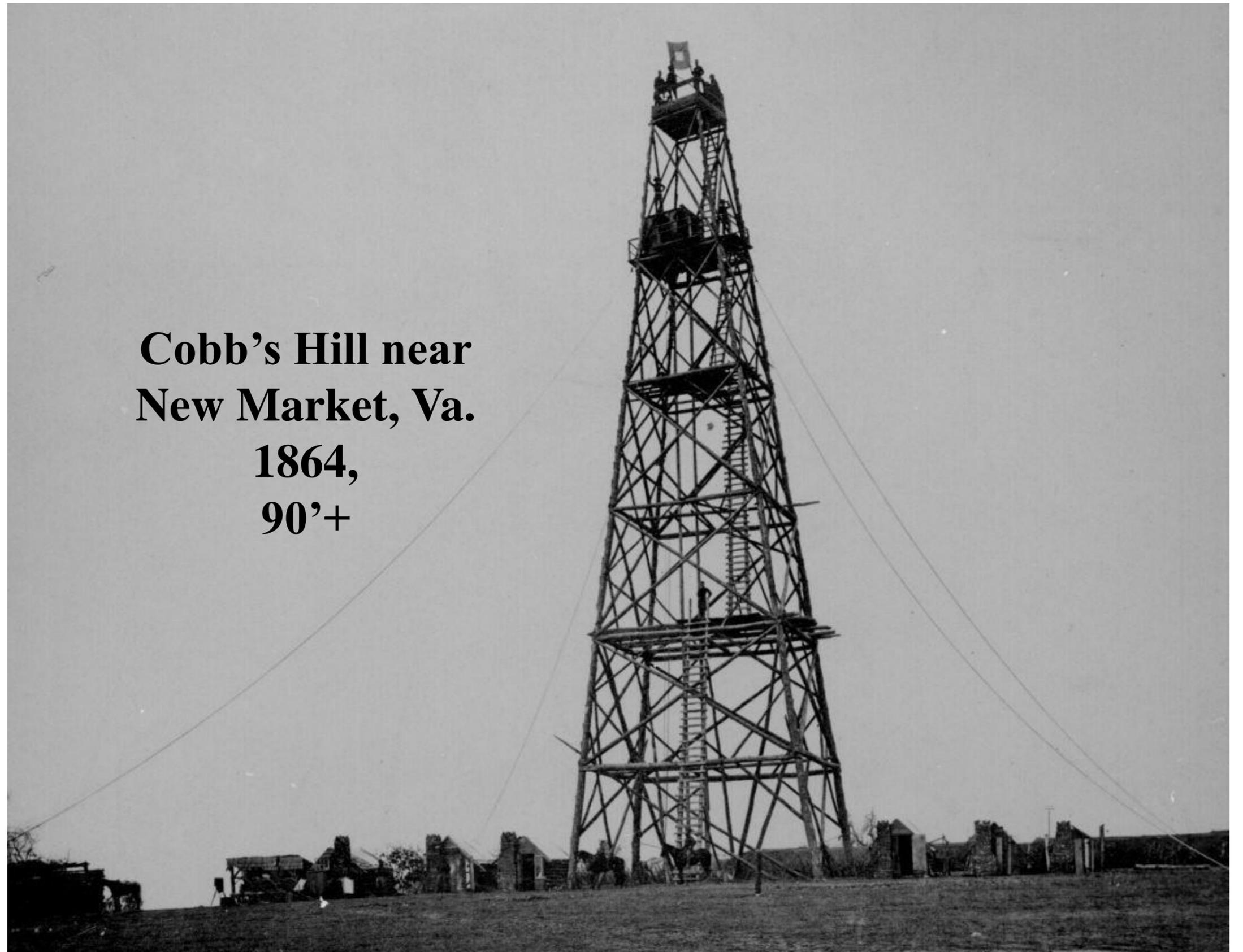
U.S. Signal Corps on the Rapidan, Virginia



**Telescopes, field glasses;
Vantage points on mountains or hills**

**Log towers
houses, churches, etc.**

**Cobb's Hill near
New Market, Va.
1864,
90'+**

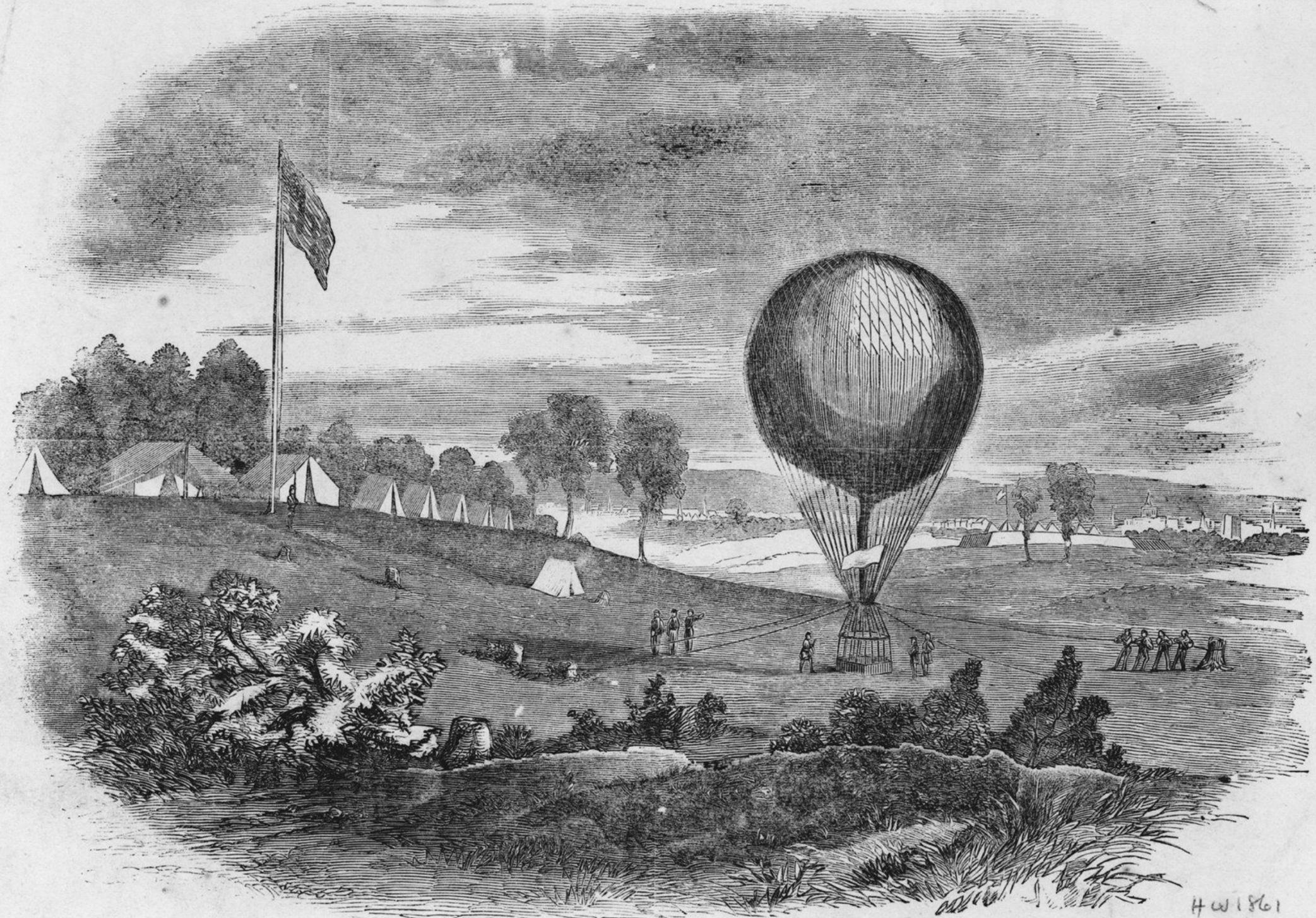


Professor Thaddeus S.C. Lowe's gas-filled Union balloons, some Confederate mostly hot-air balloons, communication difficult, telegraph tried, balloons eventually abandoned

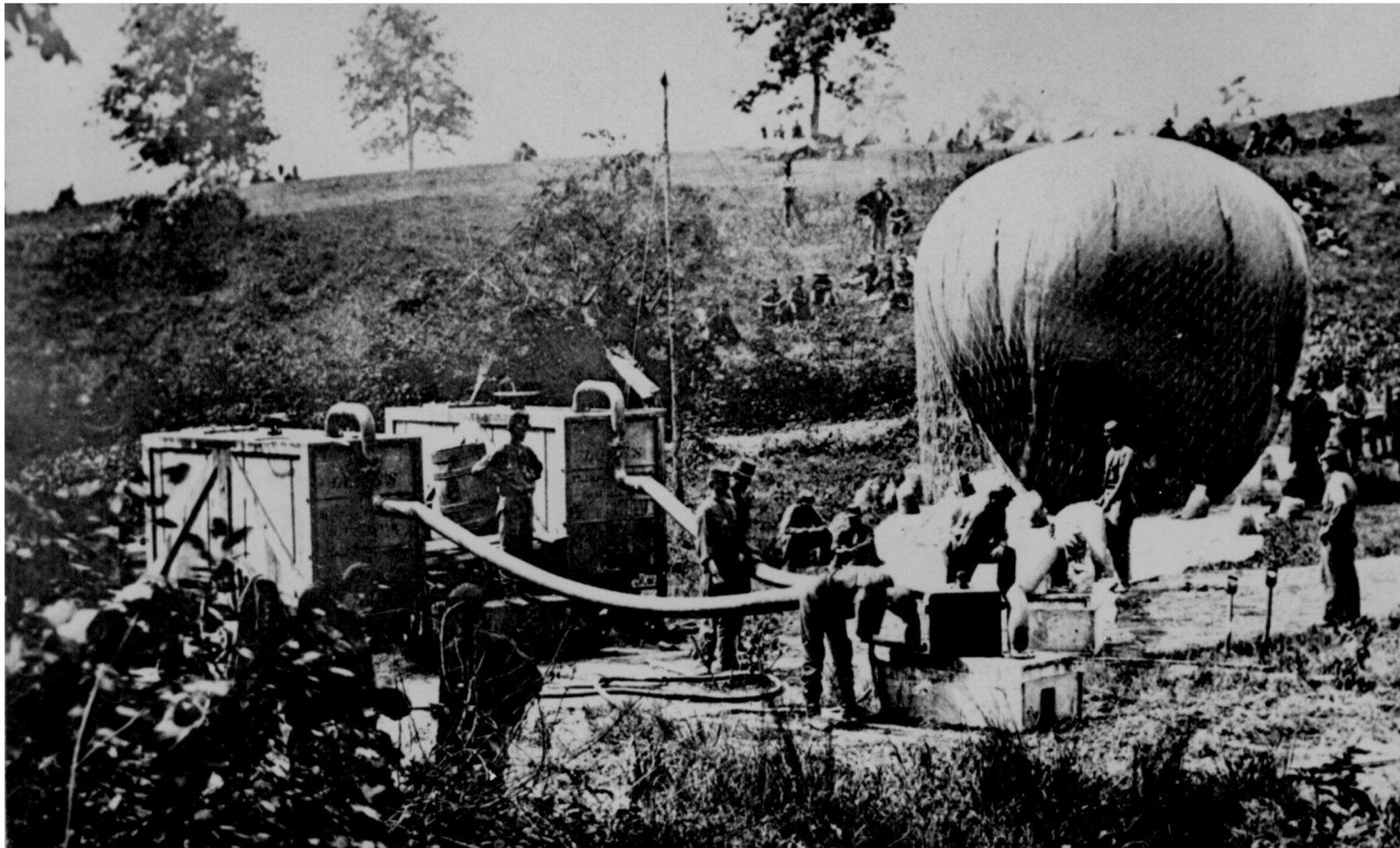
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**Aeronaut Lowe,
Fair Oaks, Virginia 5/31/1862**



THE WAR BALLOON AT GENERAL M'DOWELL'S HEAD-QUARTERS PREPARING FOR A RECONNOISSANCE.—SKETCHED BY ED. PIETSCH.—[SEE PAGE 687.]



Inflating Federal observation balloon “Intrepid”, Battle of Fair Oaks, VA, May 1862.

John Wise’s *A System of Aeronautics* (1850) gave a recipe of 144 pounds of sulfuric acid added to 125 pounds of iron shavings to make 600 cubic feet of hydrogen gas in one hour.

Lowe's Big Adventure

Preparing for a transatlantic crossing attempt, made a test flight with the balloon *Enterprise*, on the early morning of April 19, 1861, two days after Virginia seceded. Went off course to Unionville, SC, where he was put under house arrest as a Yankee spy.

Having established his identity as a man of science, he was allowed to return home, where he had received word from Secretary of the Treasury Salmon P. Chase to come to Washington with his balloon.



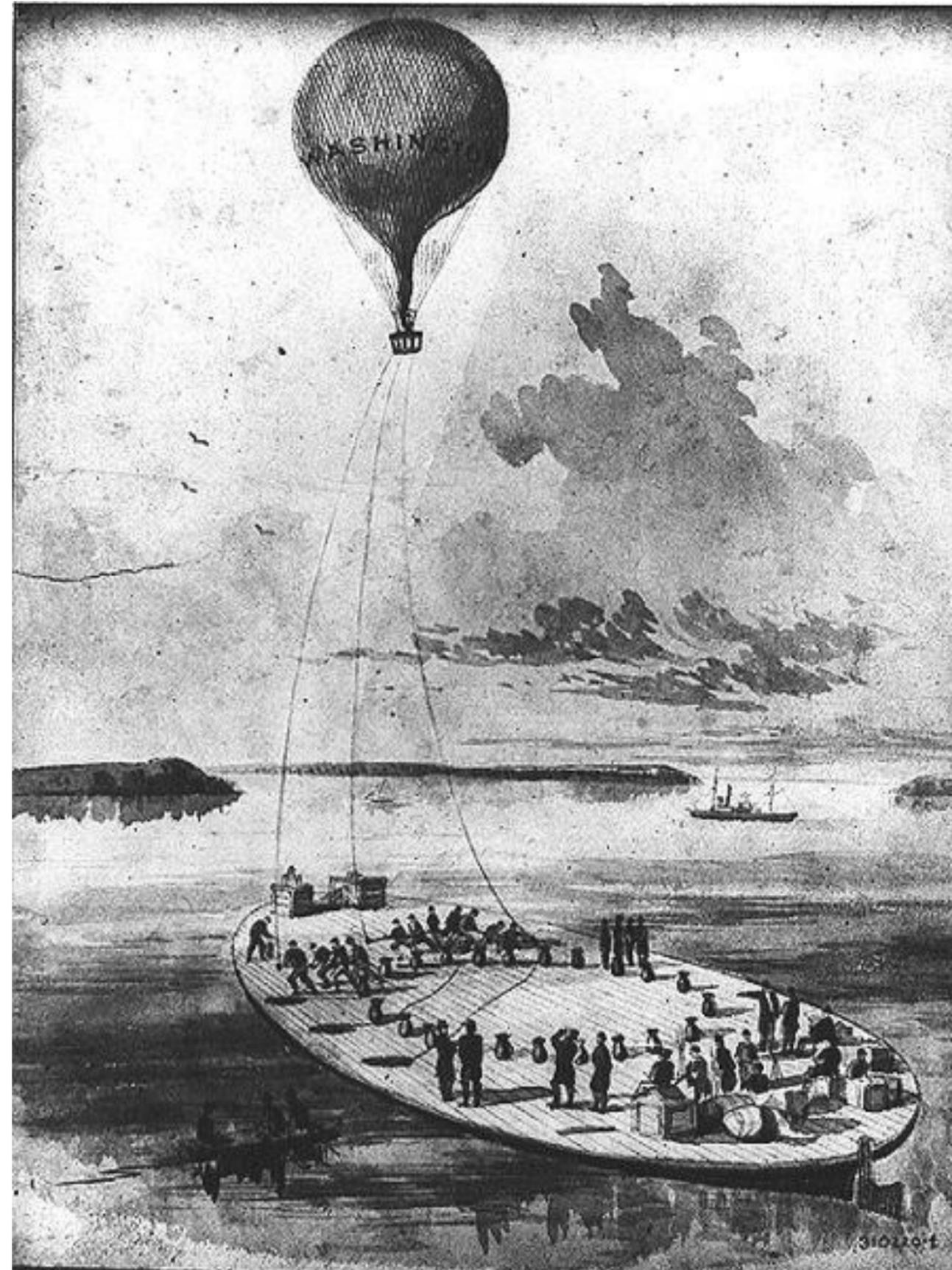
Lowe's intended flight from Cincinnati shown in red. Actual flight in blue.

CC BY-SA 3.0,

<https://en.wikipedia.org/w/index.php?curid=7577622>

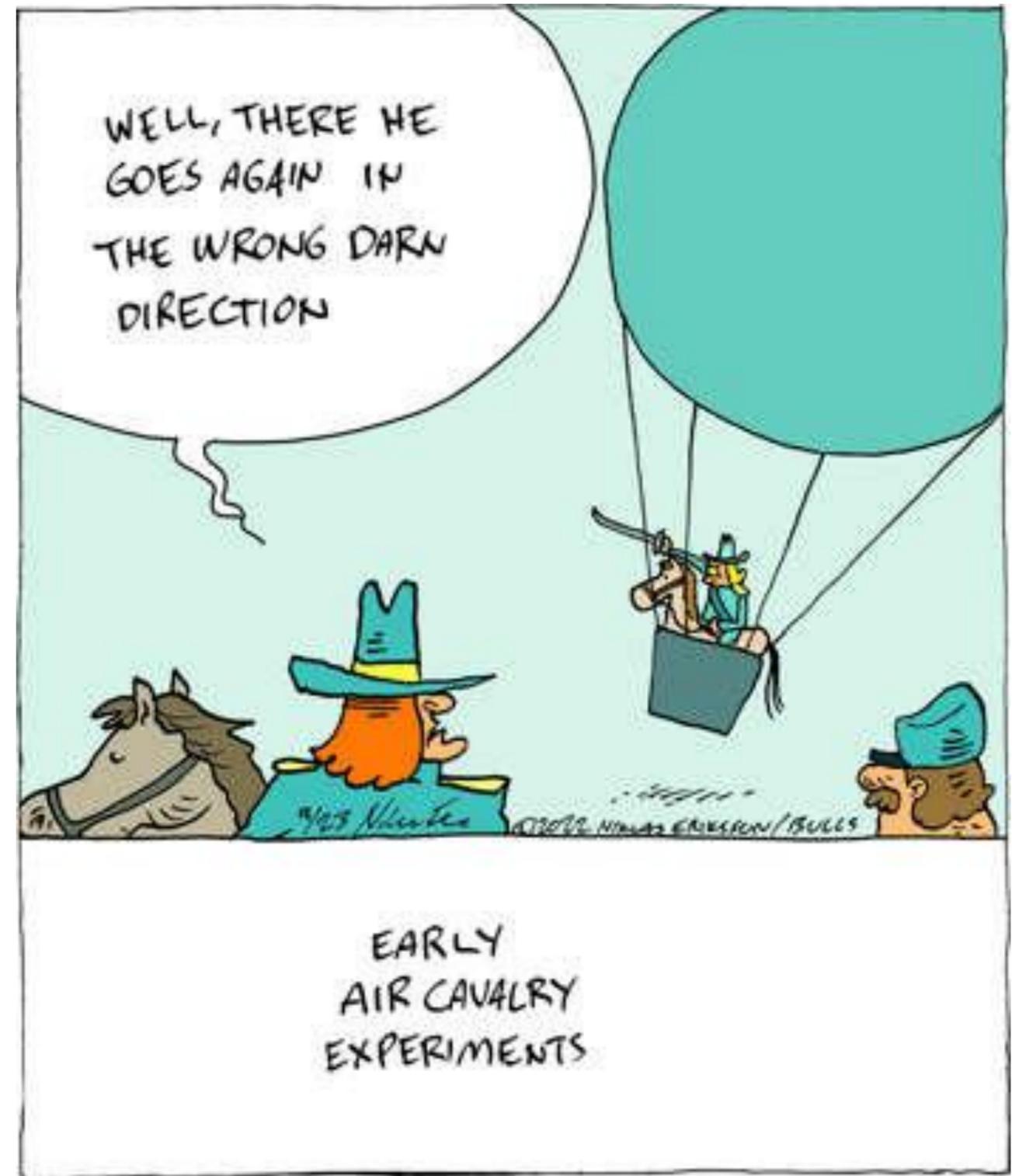
**Observation balloon tethered
To a coal barge:
The world's first aircraft carrier?**

18





19



The Reluctant Aeronaut, Lt. (Later General) George A. Custer

Measuring Directions

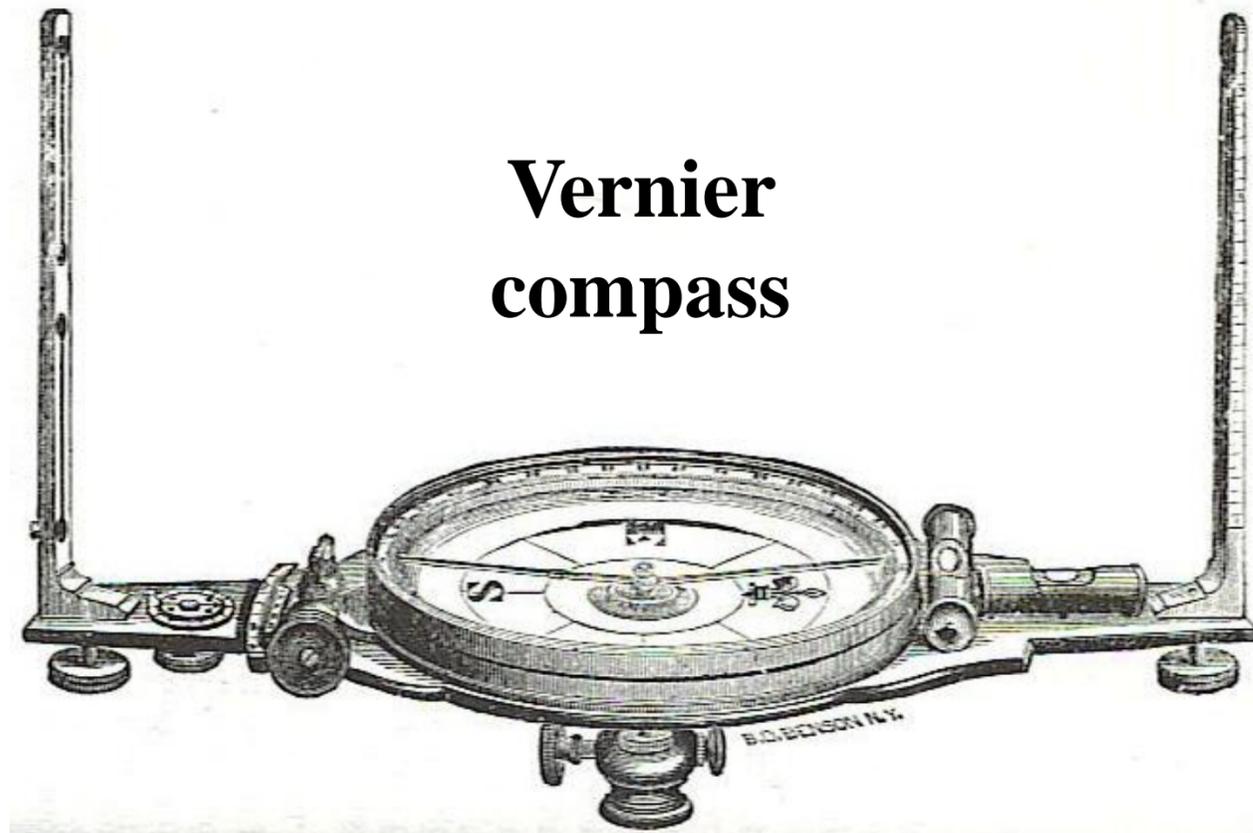


**Sisson theodolite,
(Smithsonian)**

20



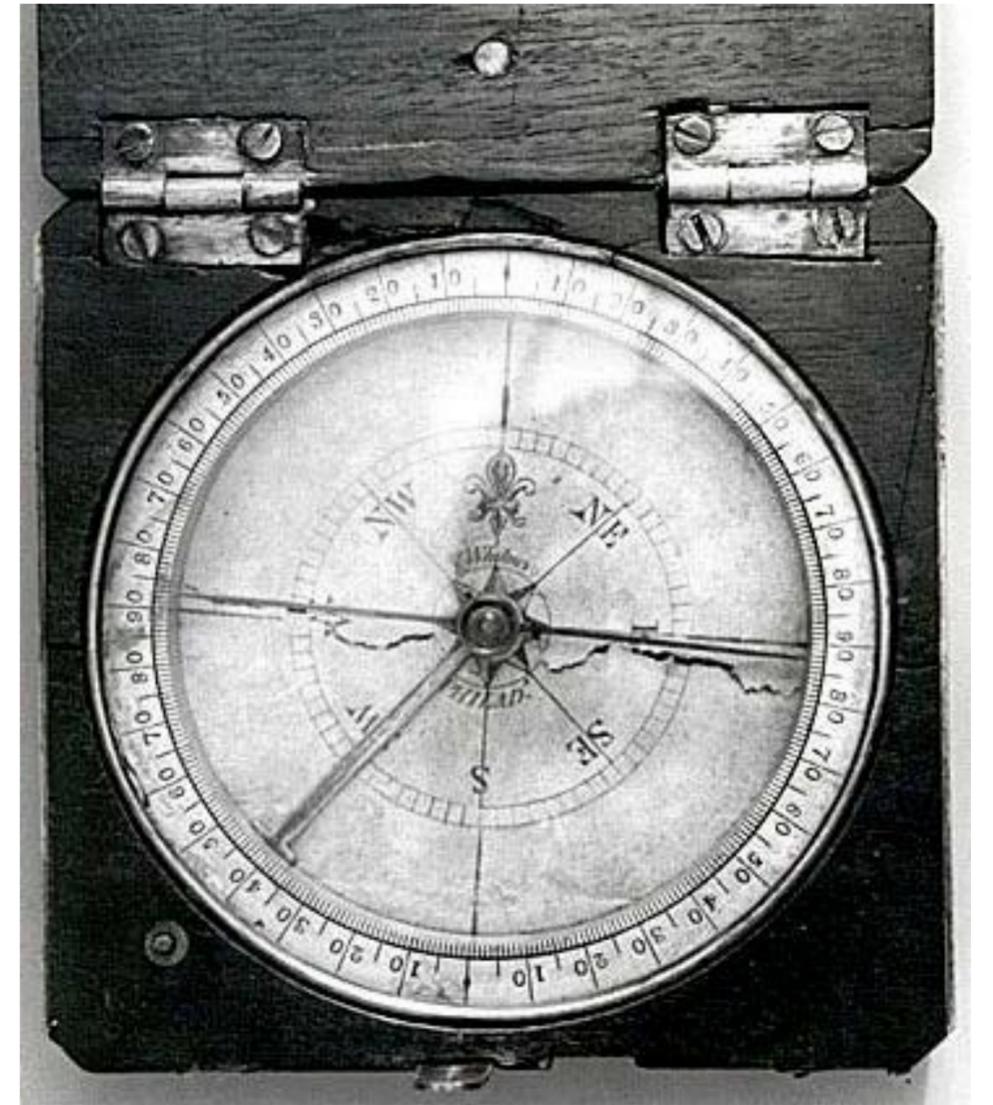
**Wm. J. Young transit,
1850's (Smithsonian)**



**Vernier
compass**



Prismatic Compass



Pocket Compass

Rough Distance Measurement

Indirect

**Use of dimensions of known objects in distance – steeple, house, chimney, window panes, marching units of troops;
In dry West, Easterners might think 10 miles was only two or three**

Direct

Length of horse, hand length/width, arm span, etc., measuring road or bridge widths, etc.

Pacing: Steady and measured, e.g. Ambrose Bierce, 18 paces = 50 ft. (2.8' ea.)

Scale adjusted for shorter paces climbing and descending hills

Counting horse paces: Surprisingly accurate, generally 400 yards = 436 paces (2.75' ea.)

Map scales were sometimes given in horse paces

Timing human or horse travel, measuring distance with a pocket watch

Wagon wheel revolutions

More Precise Distances



Surveyors Chain (Gunter's)

24

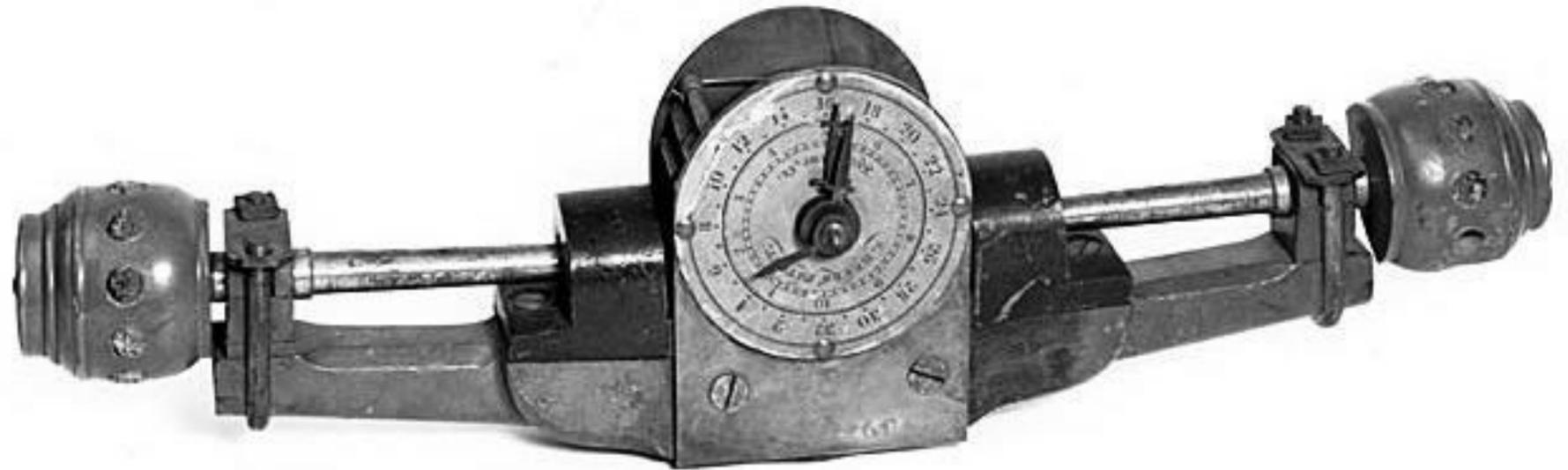


**Chesterman survey tape
(Smithsonian)**



**John Wayne
& Wayweiser**

Odometer



Slopes and Elevations

**Infantry could handle
45 degrees (100%);**

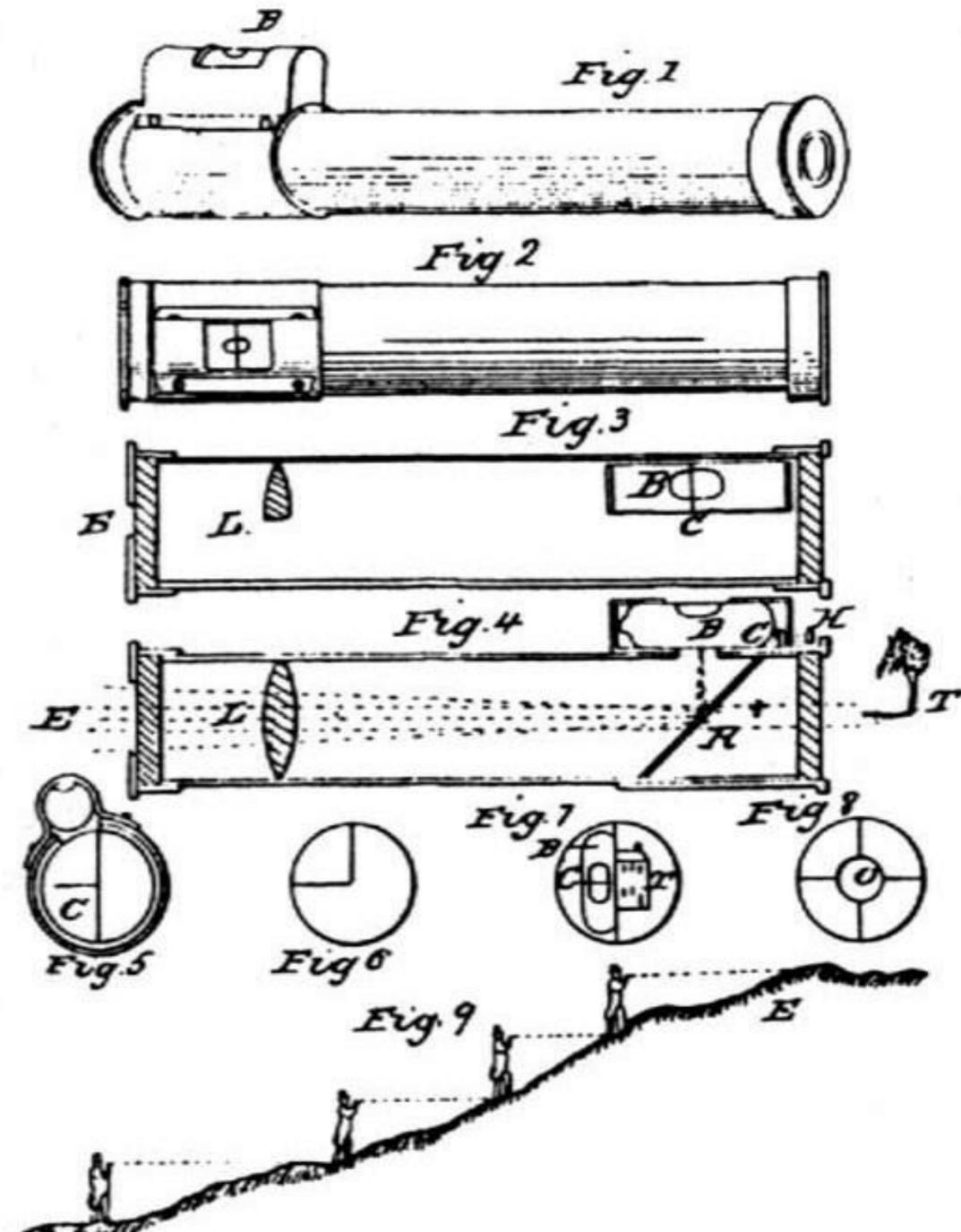
Cavalry 30 degrees (57 1/2 %);

Artillery 10 degrees (17 1/2 %).

Virginia turnpike legal maximum was
generally 4 degrees (7%) or slightly more

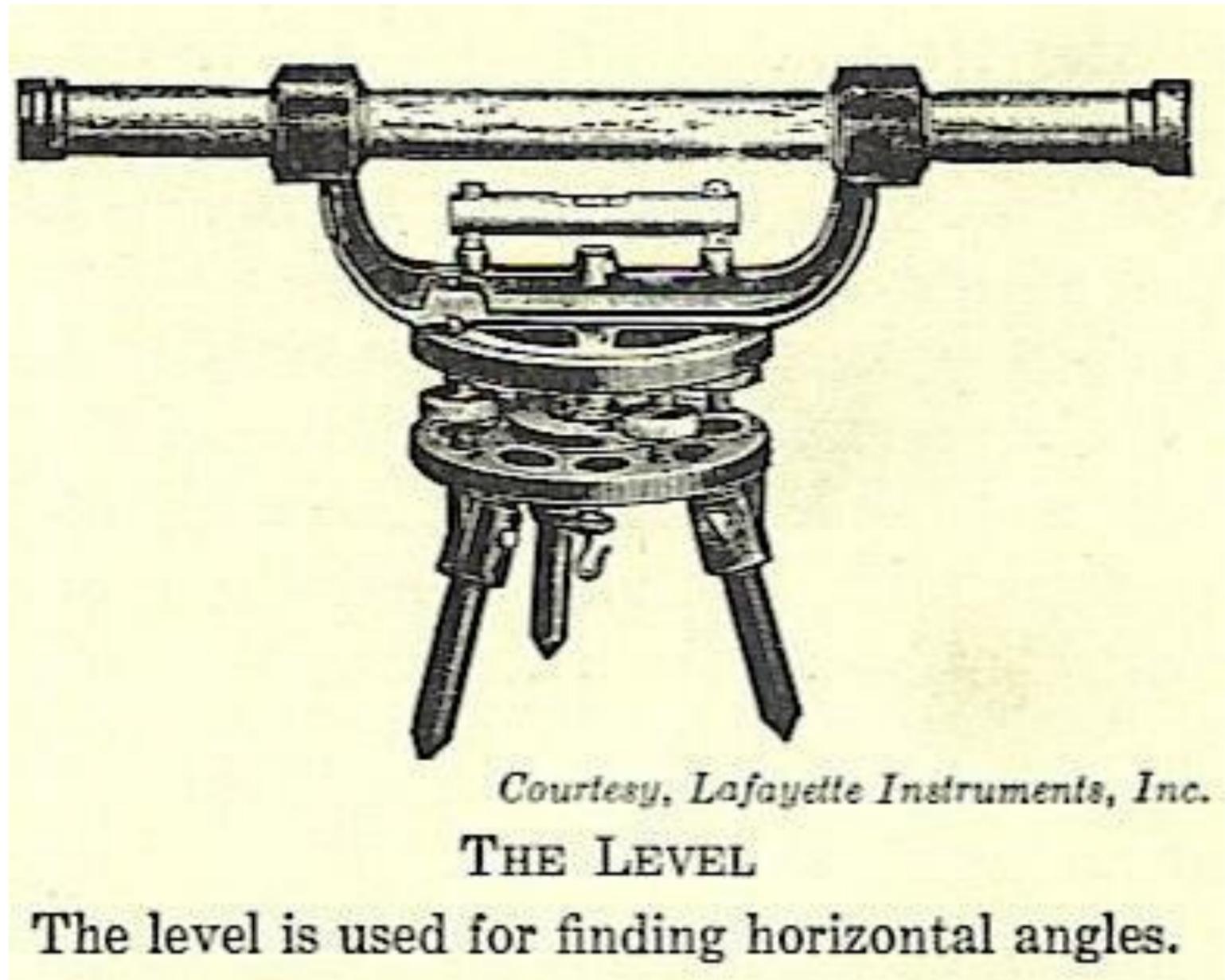
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Locke Hand Level



Locke level patent drawing,
1850 (from Backsights, SHS)

Hand level and distance
Balanced ruler on finger
Building foundations
Fence posts or telegraph poles
Panoramic views of railroads
or rivers



From George M. Hayes and Murray J. Leventhal,
Plane Trigonometry, 1938, Note confusing caption.

Barometric Elevations

Aneroid barometers somewhat fragile and costly

"Rudimentary but reasonably satisfactory" (McElfresh)

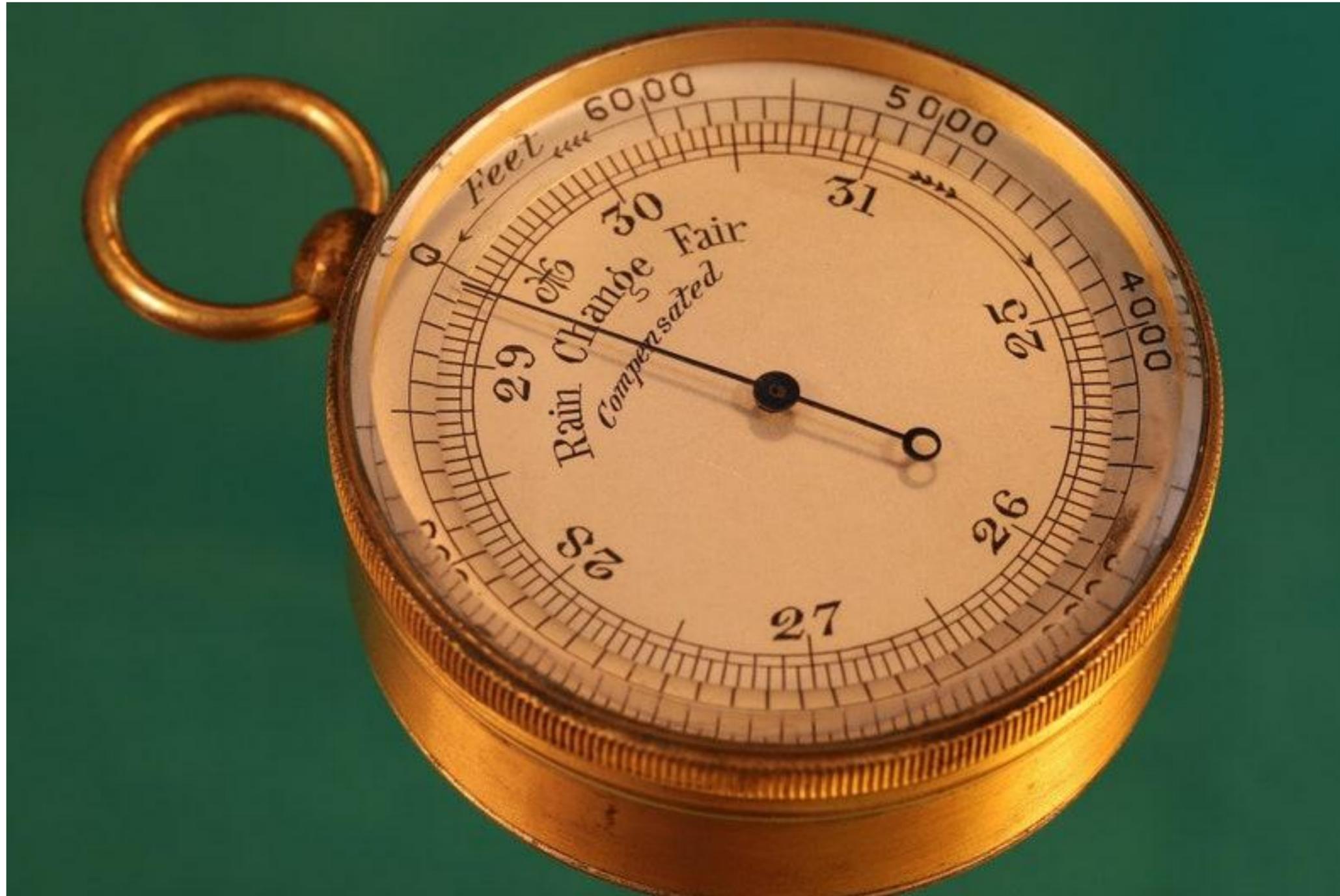


Aneroid barometer,
1849

28

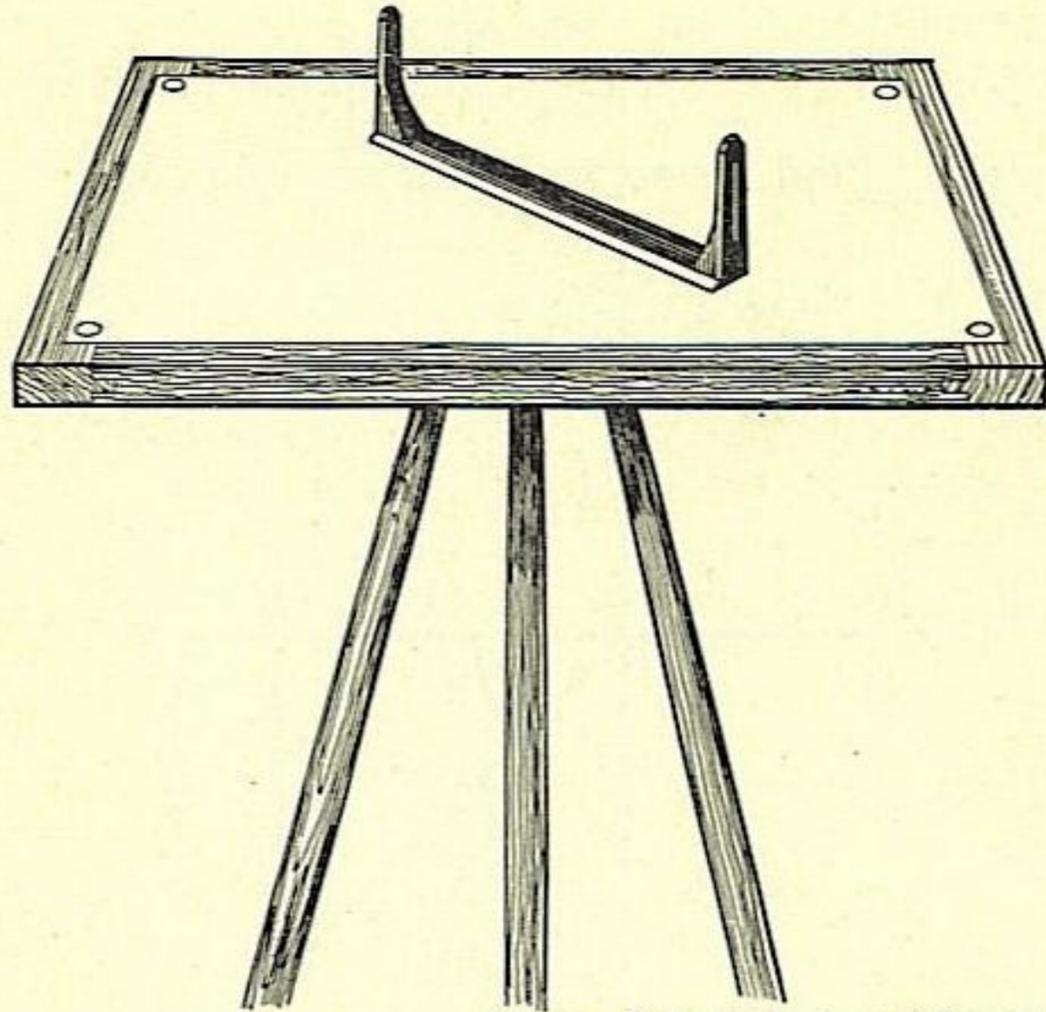


Aneroid barometer, 1870



Aneroid Barometer, 1890's

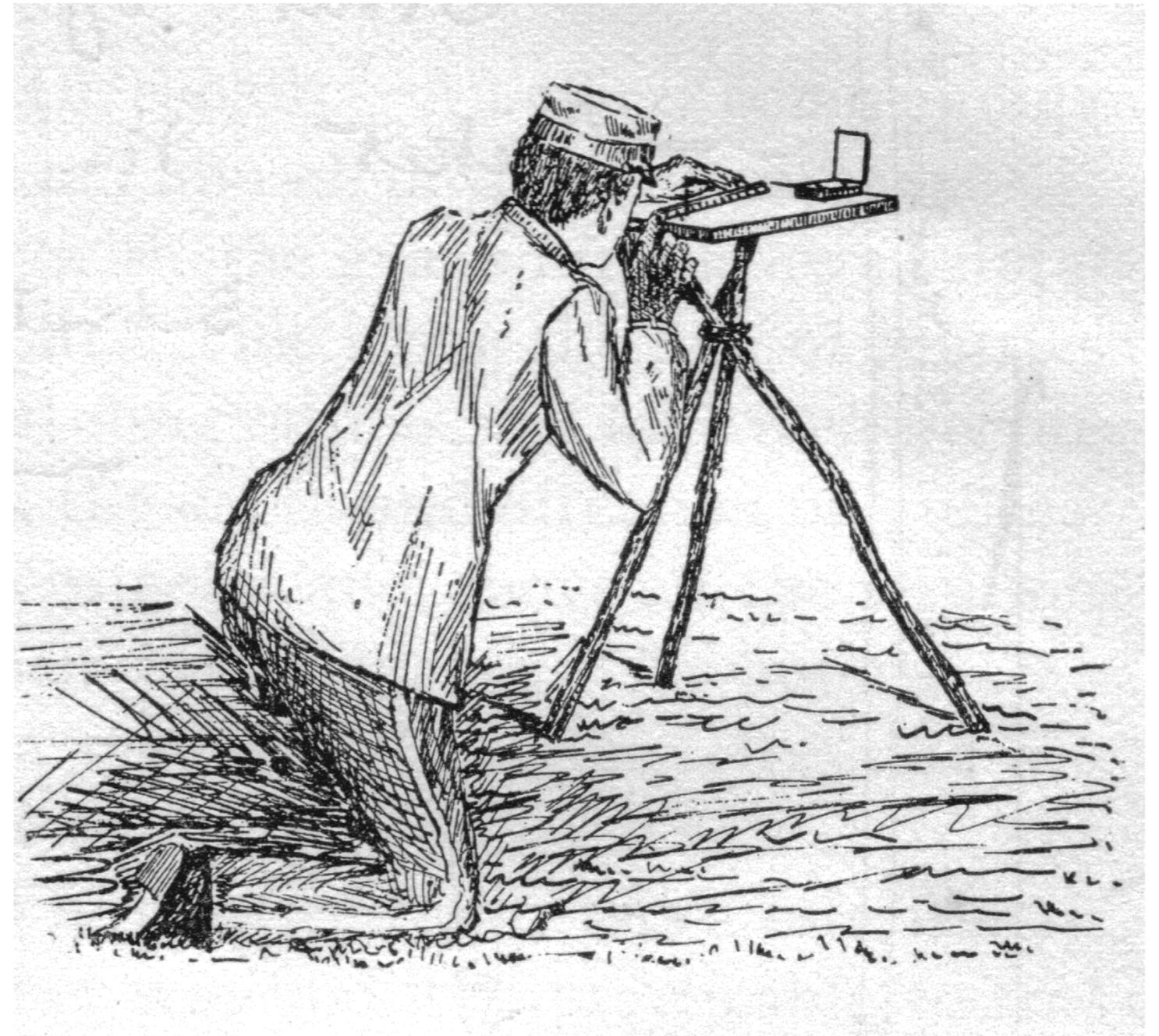
Plane Table Mapping and Triangulation



Courtesy, Lafayette Instrument Company

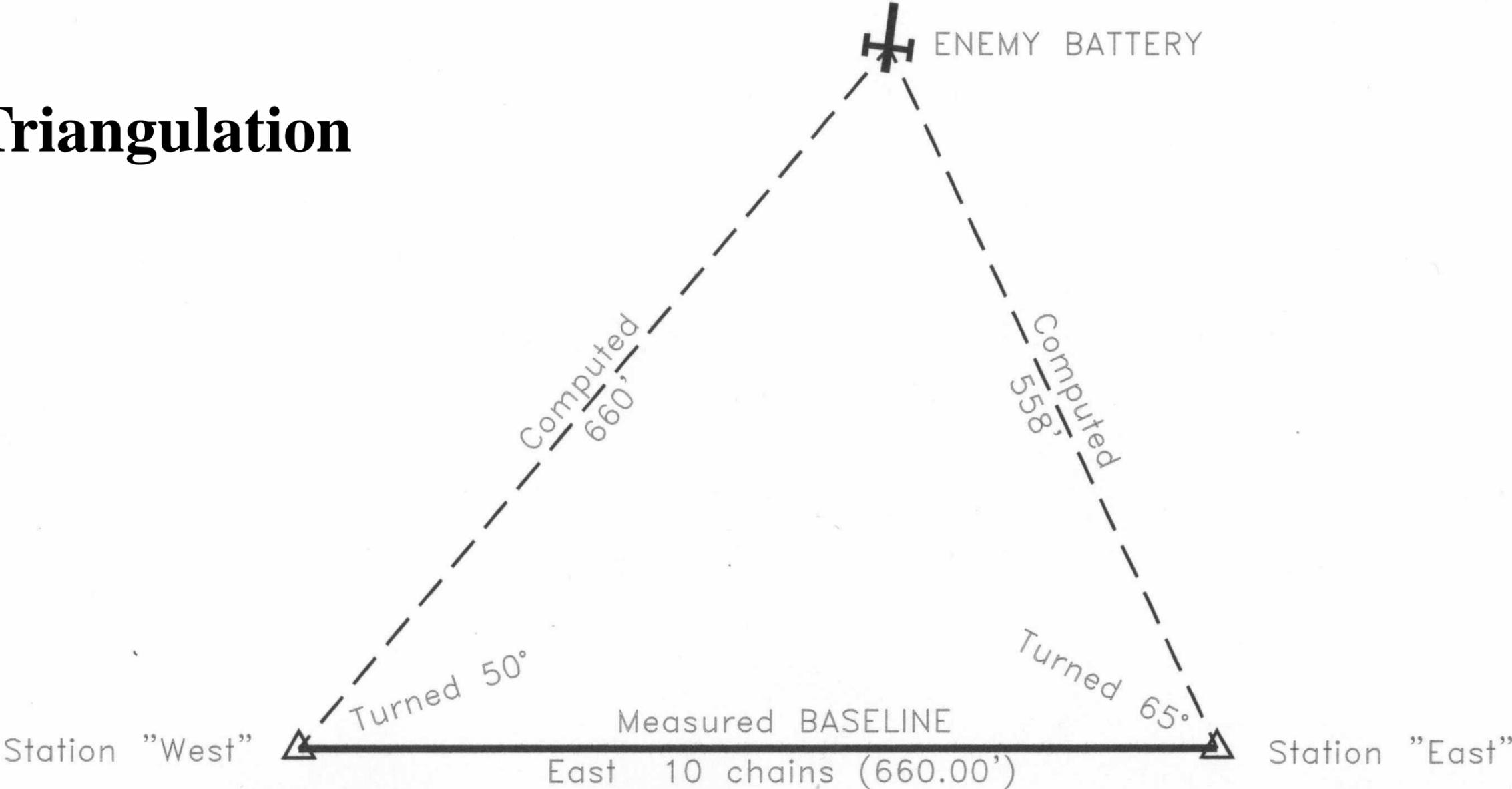
THE PLANE TABLE WITH ALIDADE

The plane table is used for mapping the details of a region directly in the field. A sheet of drawing paper is fastened to the drawing board. The alidade is used for sighting.



From George M. Hayes and Murray J. Leventhal,
Plane Trigonometry, 1938

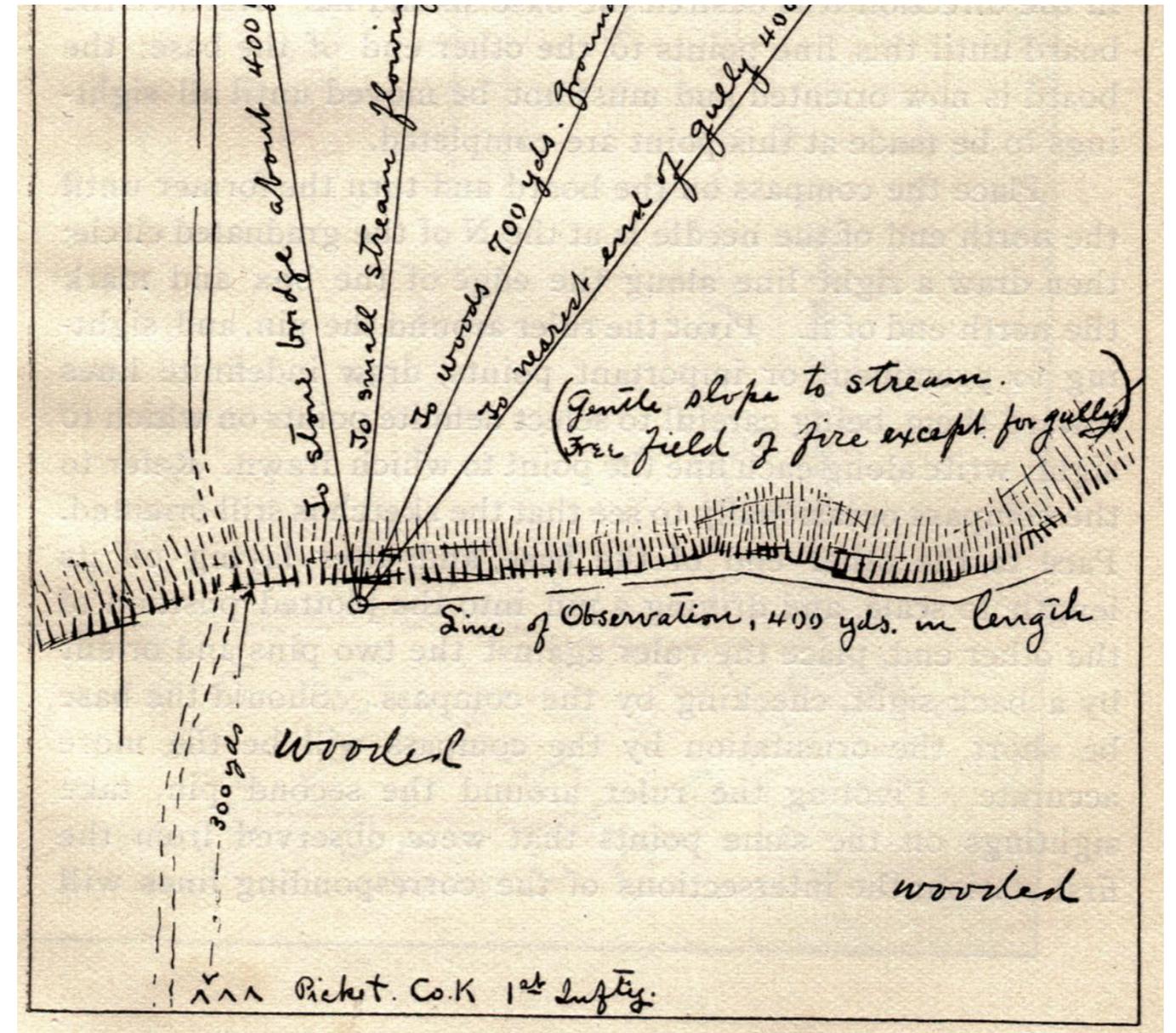
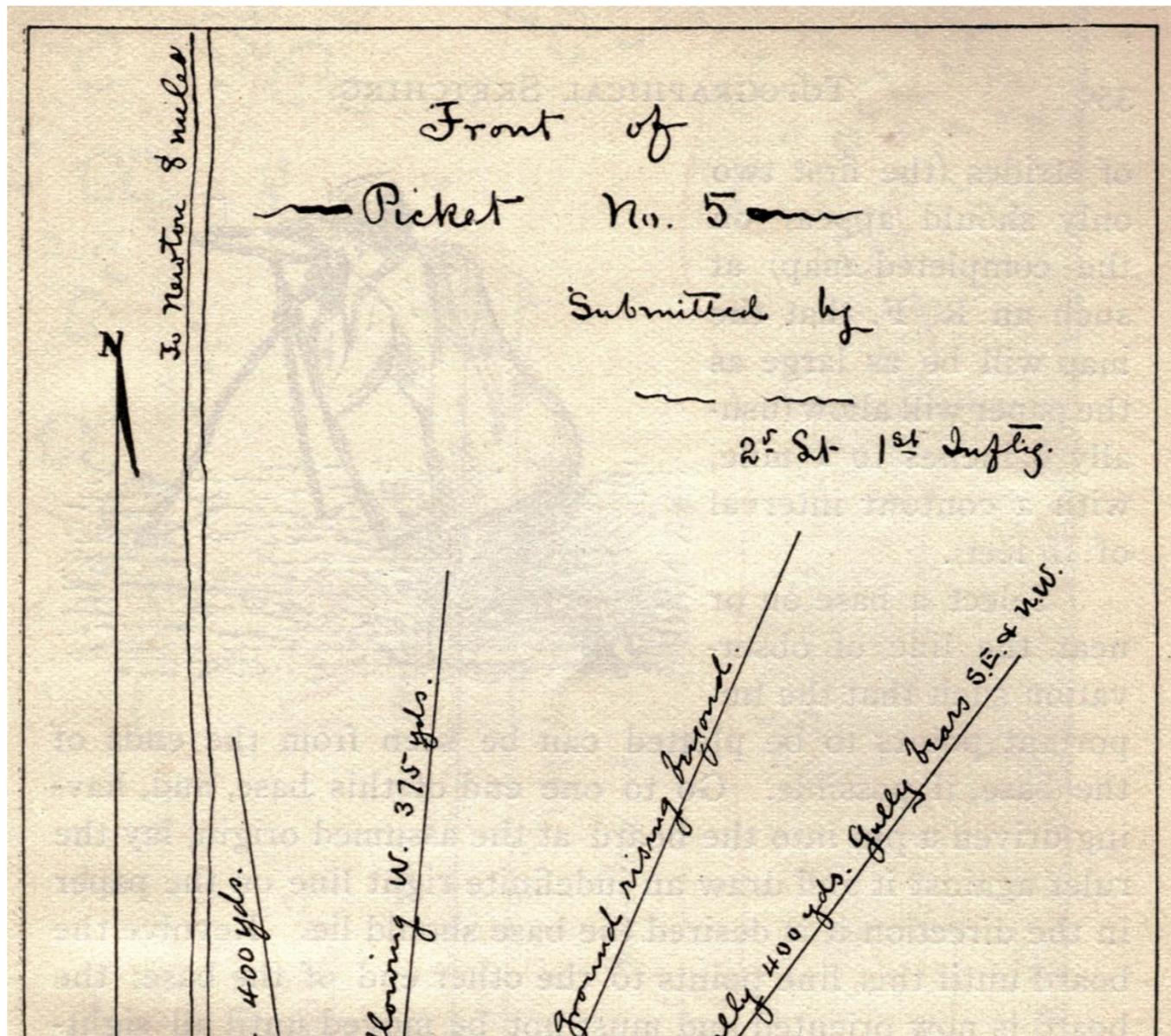
Triangulation





Plane Table Mapping, Fort Beauregard, Manassas, Va.

Laying Off a Map



Measurements and Observations

Timeliness more important than precision, but accuracy critical;

General location and relative positions essential;

Readability important,

Ranges could be corrected by artillery,

Stealth often important, recon and mapping could reveal an army's intentions

Effects of errors sometimes mitigated by wide distribution of identical maps.

Crew Size

Many worked alone or with little help:

Jed Hotchkiss (Confederate General Stonewall Jackson's mapper);

W.W. Blackford (Confederate General Jeb Stuart's mapper)

Small groups could get closer to enemy and often avoid detection

Safety in larger groups

Some recon₃₅ work required force

Local Advice

Local guides and advisors: willing or not ("spies, scouts, refugees, travelers, prisoners, preachers, and peddlers", Union mapper William E. Merrill called them his "motley crew")

Local residents: white southerners voluntarily helpful to Confederates; sometimes helped Yankees but could try to deceive; White southerners sometimes forced to help Union; Country doctors particularly knowledgeable; Farmers and their sons, info limited in scope but they knew "every pig trail"

Slaves and "Free coloreds": eager to help Union with valuable details, could sometimes exaggerate, had tremendous freedom of movement

Local Surveyors

Knew the area and its residents;

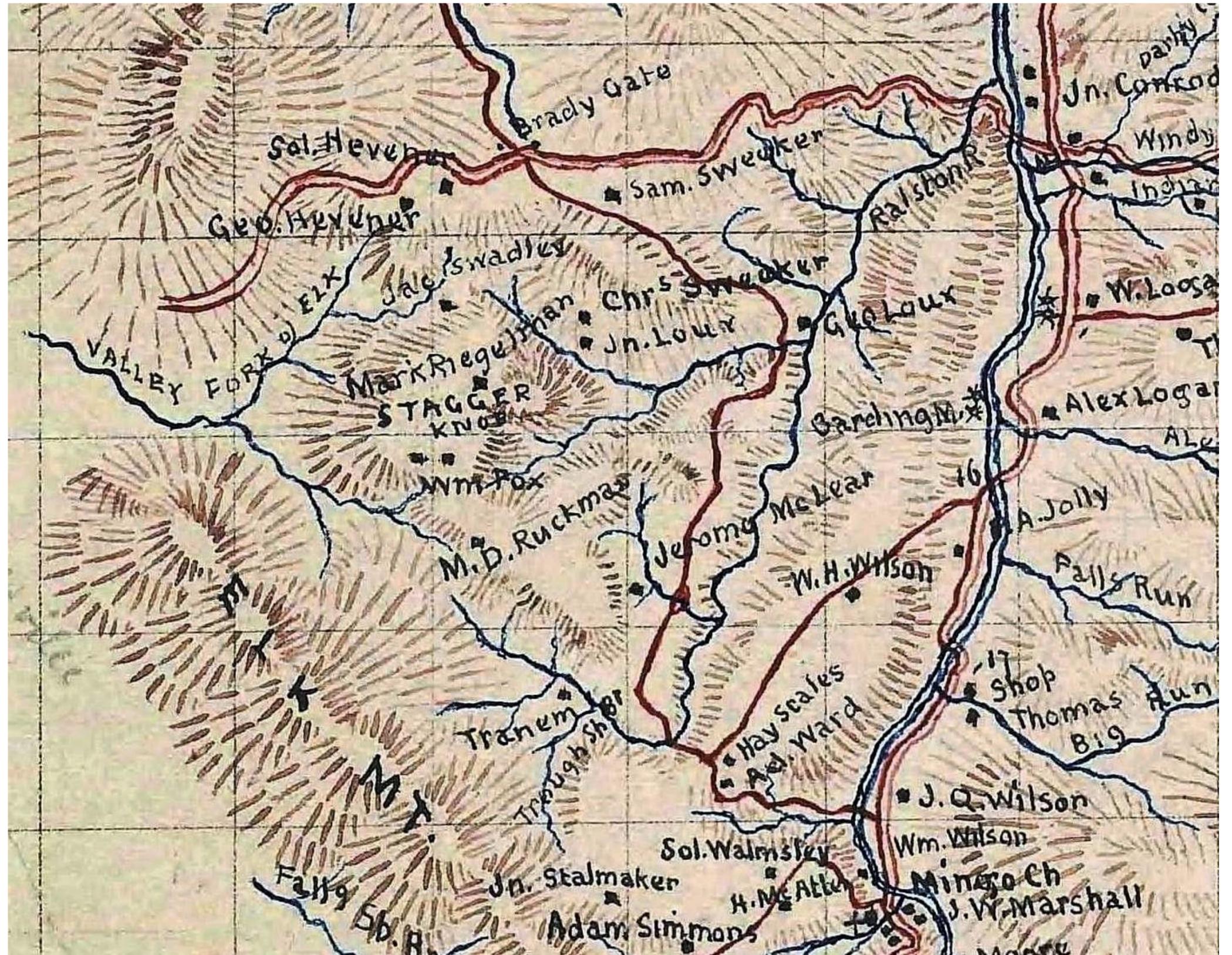
Had mapmaking and map reading skills;

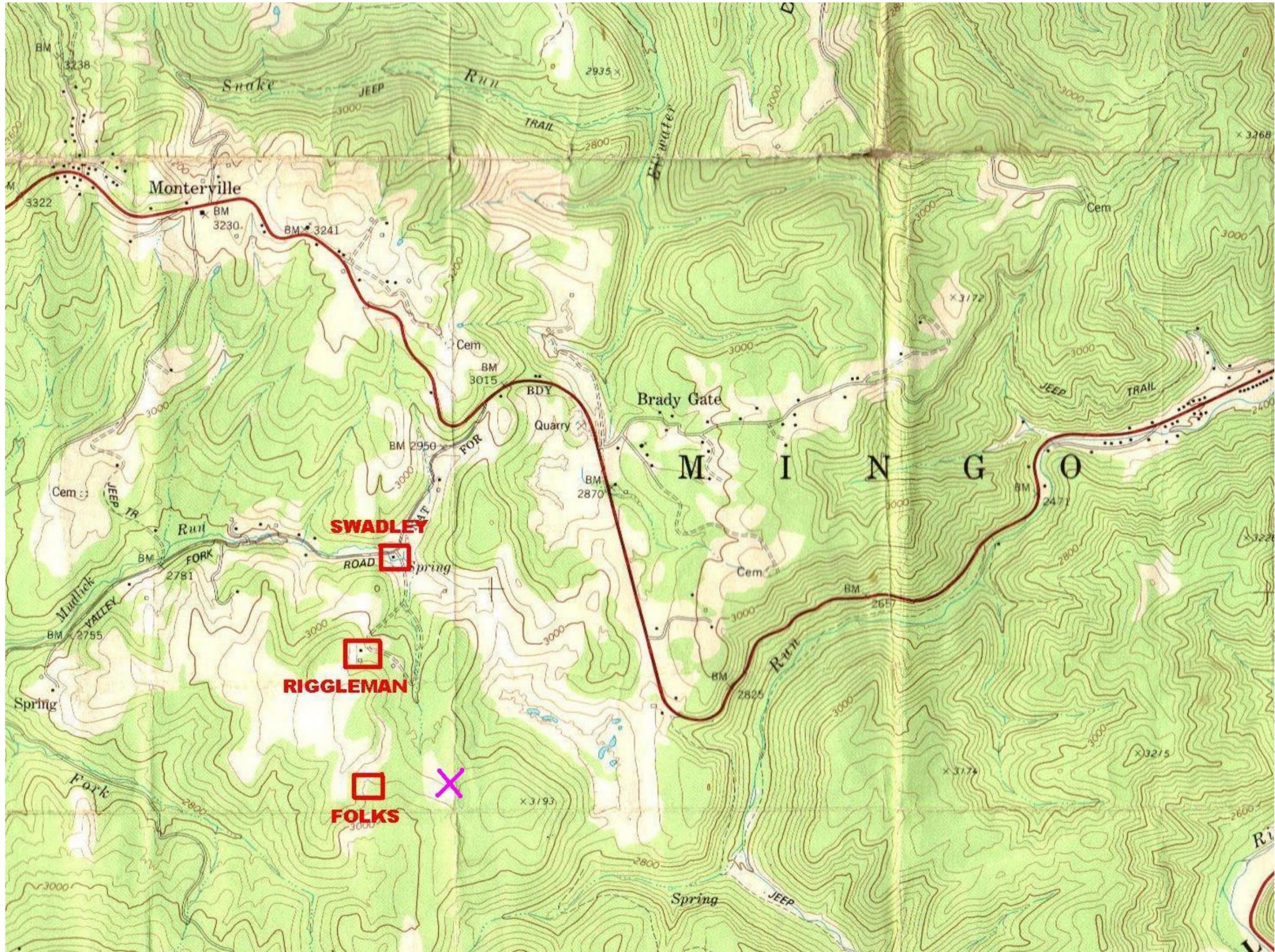
Had some maps

Some joined the topo service, such as

Berkeley County (West) Virginia Surveyor S. Howell Brown

Portion of Upper Tygart
Valley map by Jed.
Hotchkiss, 1861, with
help from local surveyor
Jacob Conrad





Mapping in the saddle

Sometimes 25 to 30 miles a day

Compass; drawing board on pommel or wrist;
pencil and eraser strung to buttonhole (stale bread eraser); soft paper.

Ruler in pocket or boot:
scale, straight edge, balanced on finger to estimate distant grade.

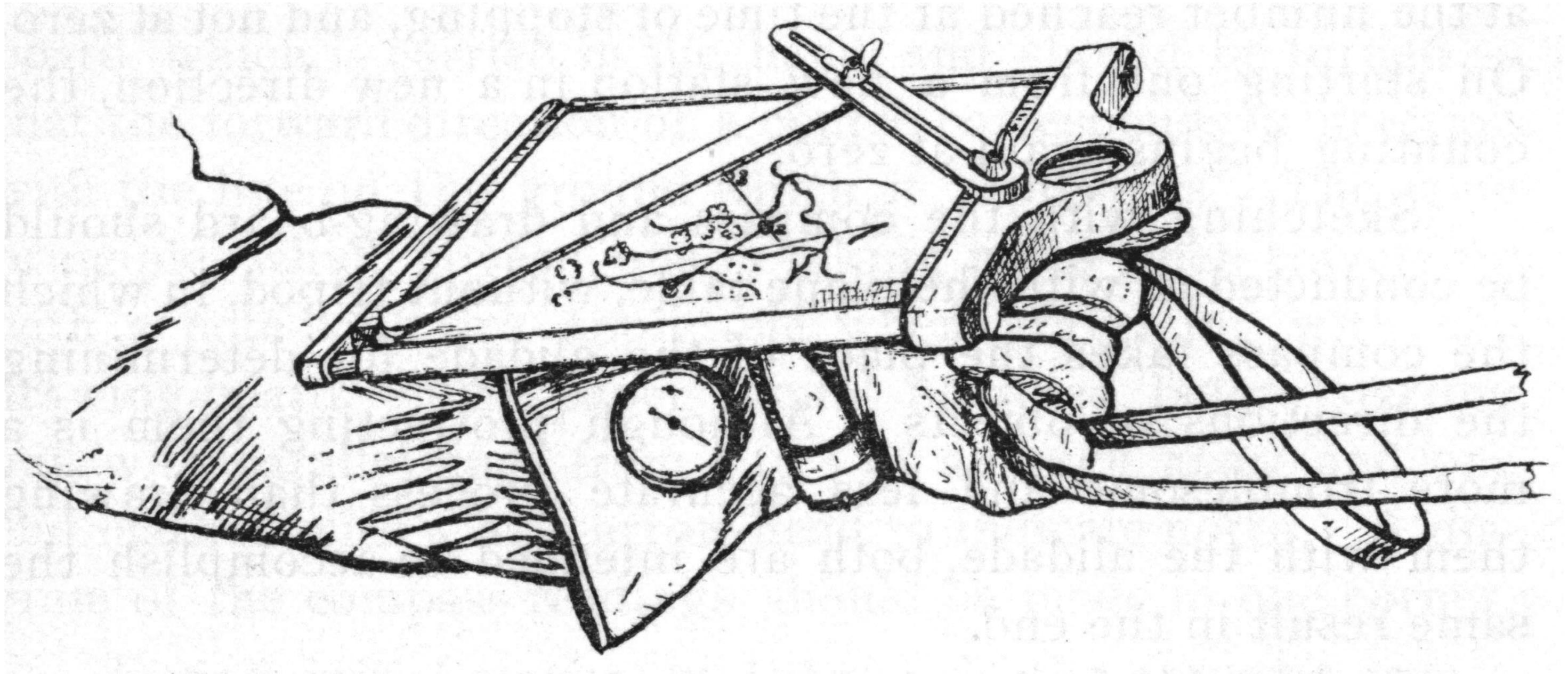
Field book:

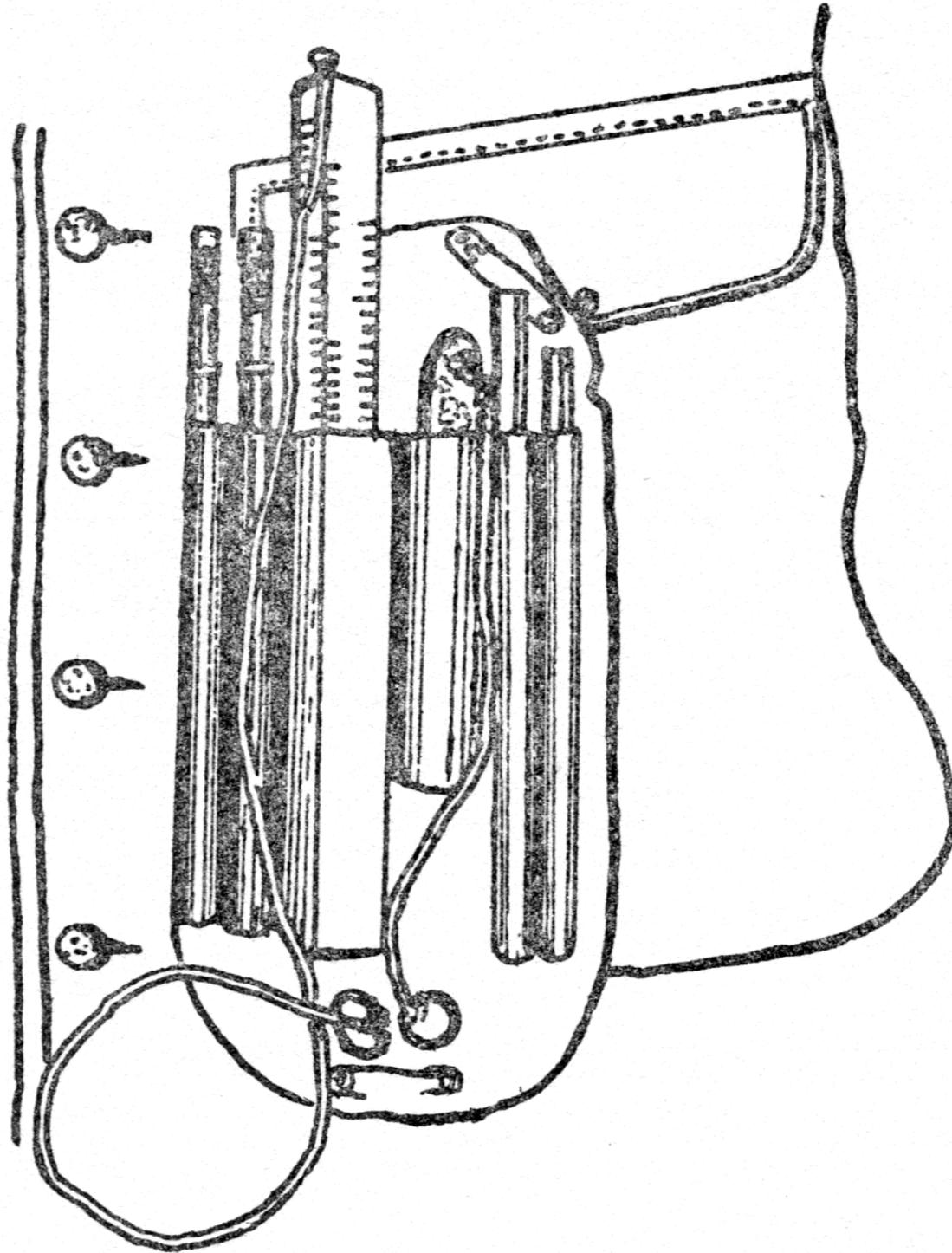
Left page - compass headings and distances

Right page - sketch map, pages keyed to connect

Mapping in the Saddle

Drafting Board, Barometer





Mapping in the Saddle
Drafting tools on shirt or vest

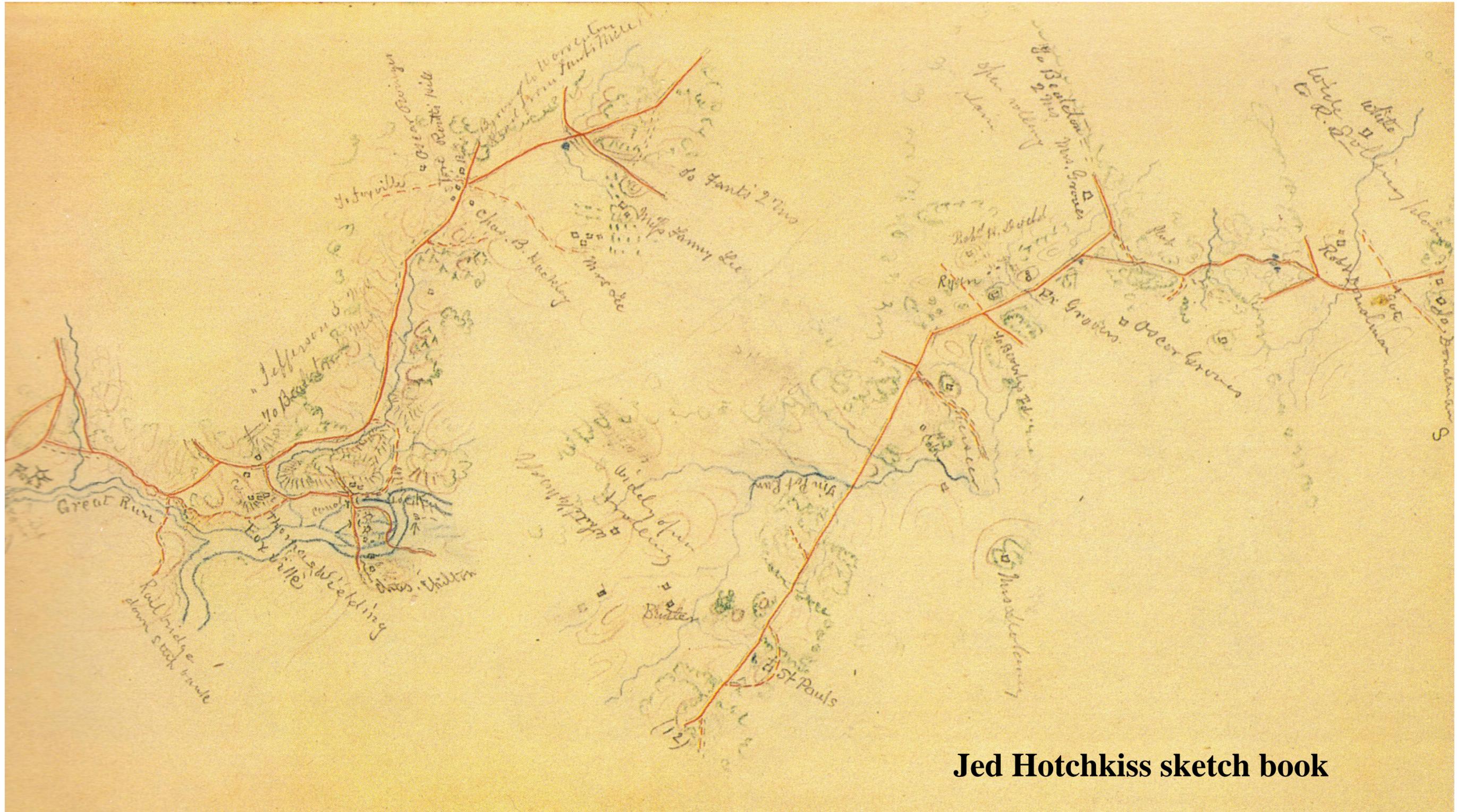
This volume is my field sketch book that I used during the ~~Civil~~ War. Most of the sketches were made on horseback just as they now appear. The colored pencils used were kept in the places fixed on the outside of the other cover.

These topographical sketches were often used in conferences with Generals Jackson, Ewell and Early.

The cover of this book is a blank Federal Commission found in Gen. Milroy's quarters at Winchester.

Jed. Hotchkiss

**Cover of
Jed Hotchkiss
sketch book**

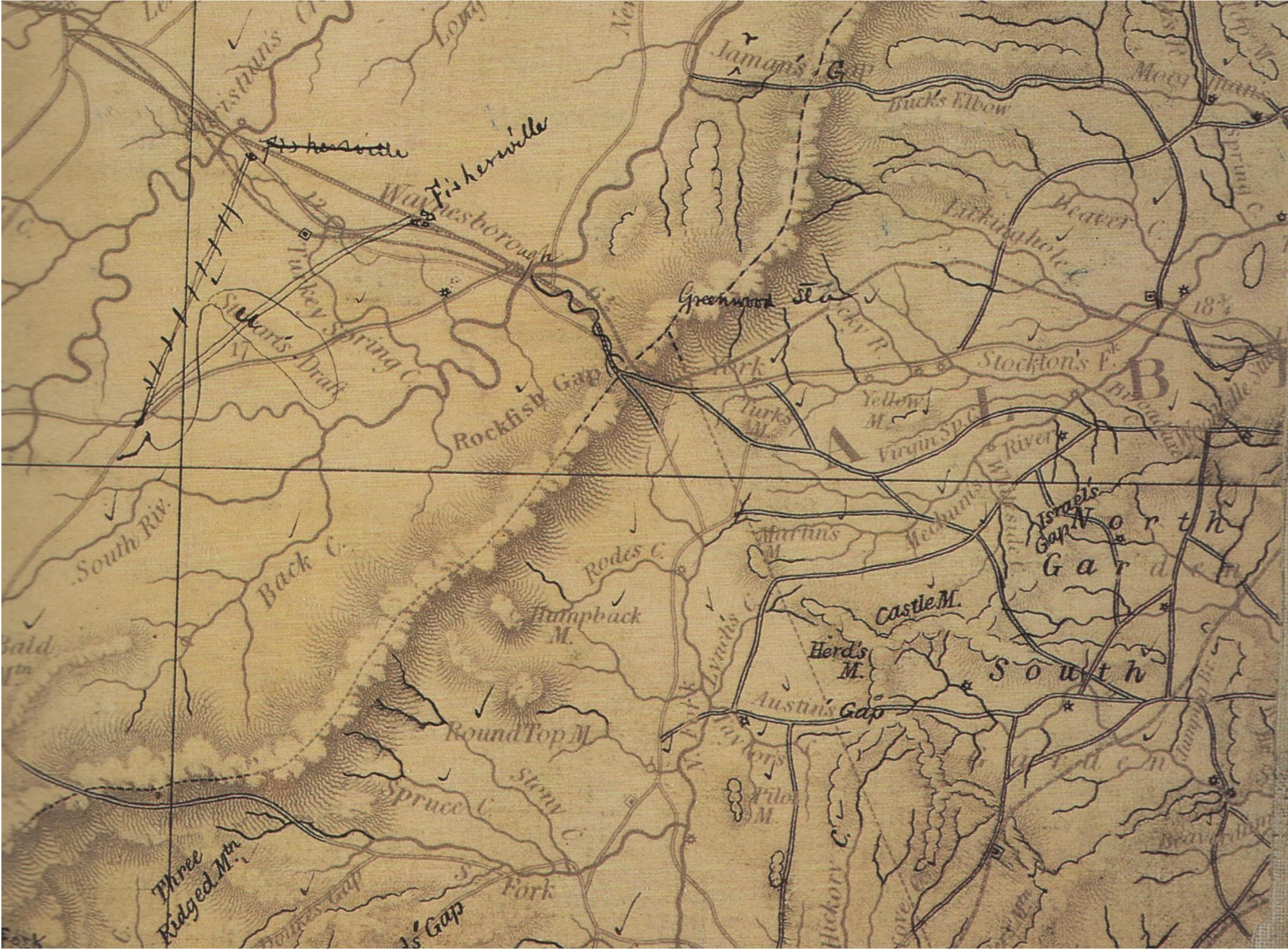


Jed Hotchkiss sketch book

Evaluating base maps

**Published commercially or by military,
"In-house" like Hotchkiss map of the Valley.
Various other sources, any map could help,
Corrections made by topogs as they traveled**

**Hotchkiss corrections to
9 sheet map of Virginia
(Miller)**



Assistants (Aides and Escorts)

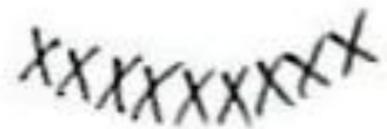
Often a uniformed soldier as guard or lookout;
Helpers gathered additional information - Side roads or lanes, Resident's names
and place names, Ford depths, bridges, etc.

Wagon driver with equipment and supplies

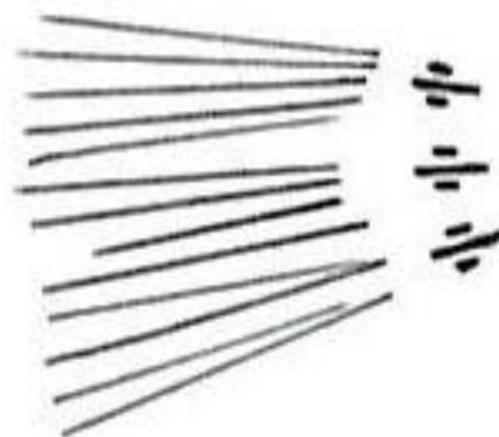


**HQ baggage
wagon**

Map Symbols



Abatis



Artillery Battery
with field of fire



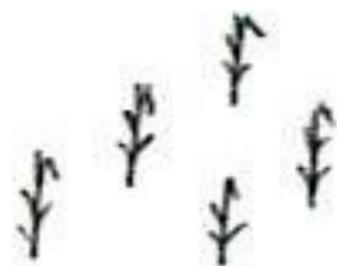
Grist mill



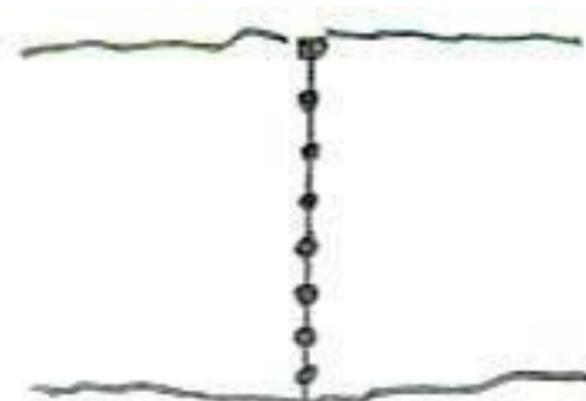
Burnt House



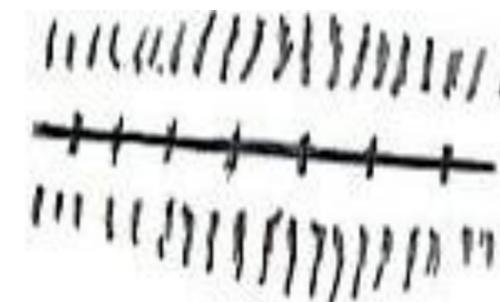
Sawmill



Cornfield

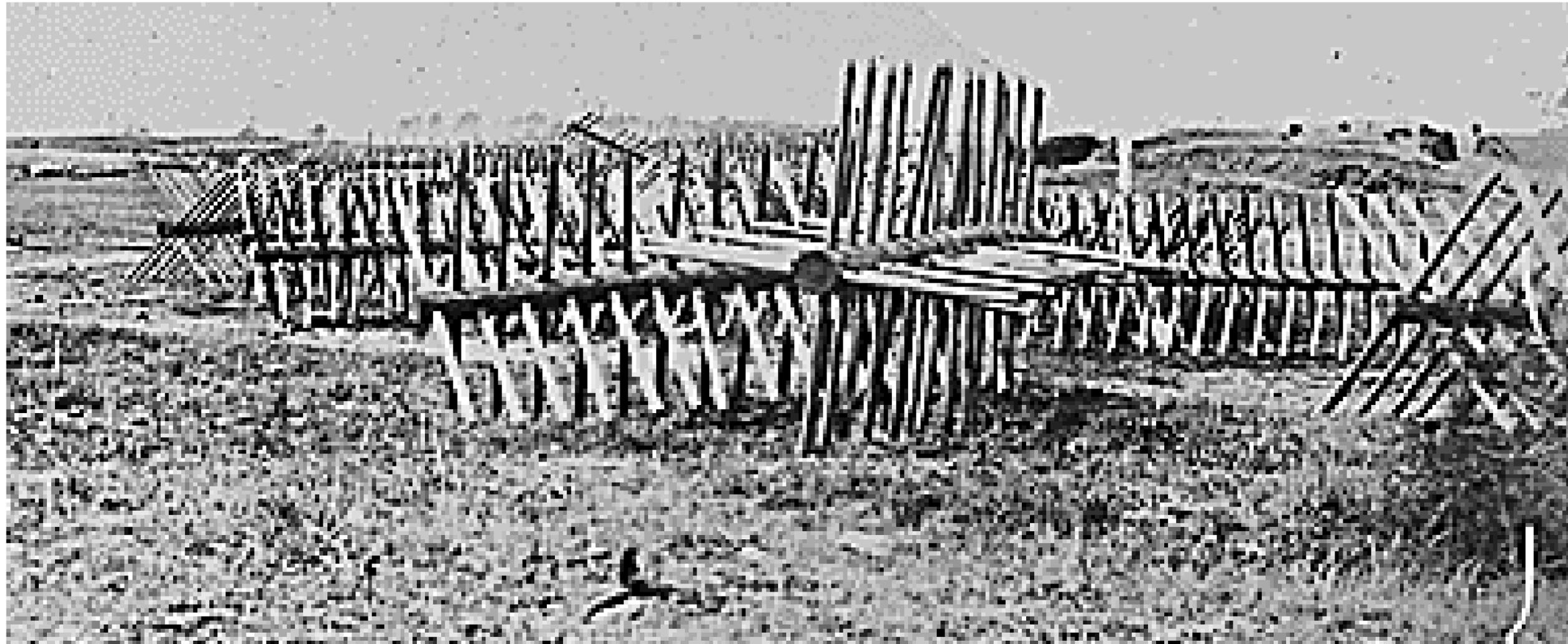


Ferry



Railroad in cut

Engineering Projects



From Ambrose Bierce's Devil's Dictionary - ABATIS, *n.* Rubbish in front of a fort, to prevent the rubbish outside from molesting the rubbish inside.

**Reproduction abatis
Pamplin Historical
Park, Petersburg, VA**

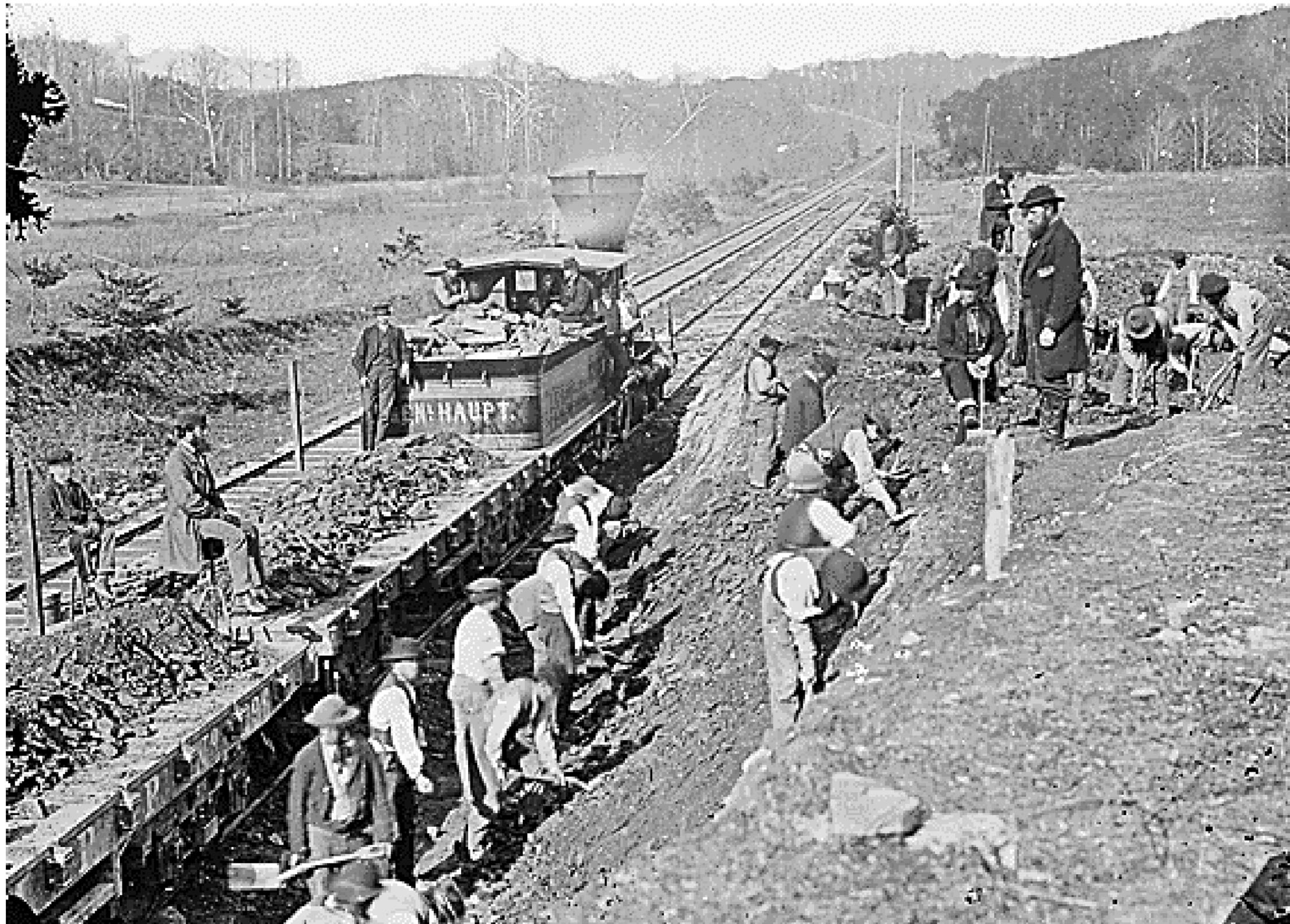




Making Gabions in Front of Petersburg



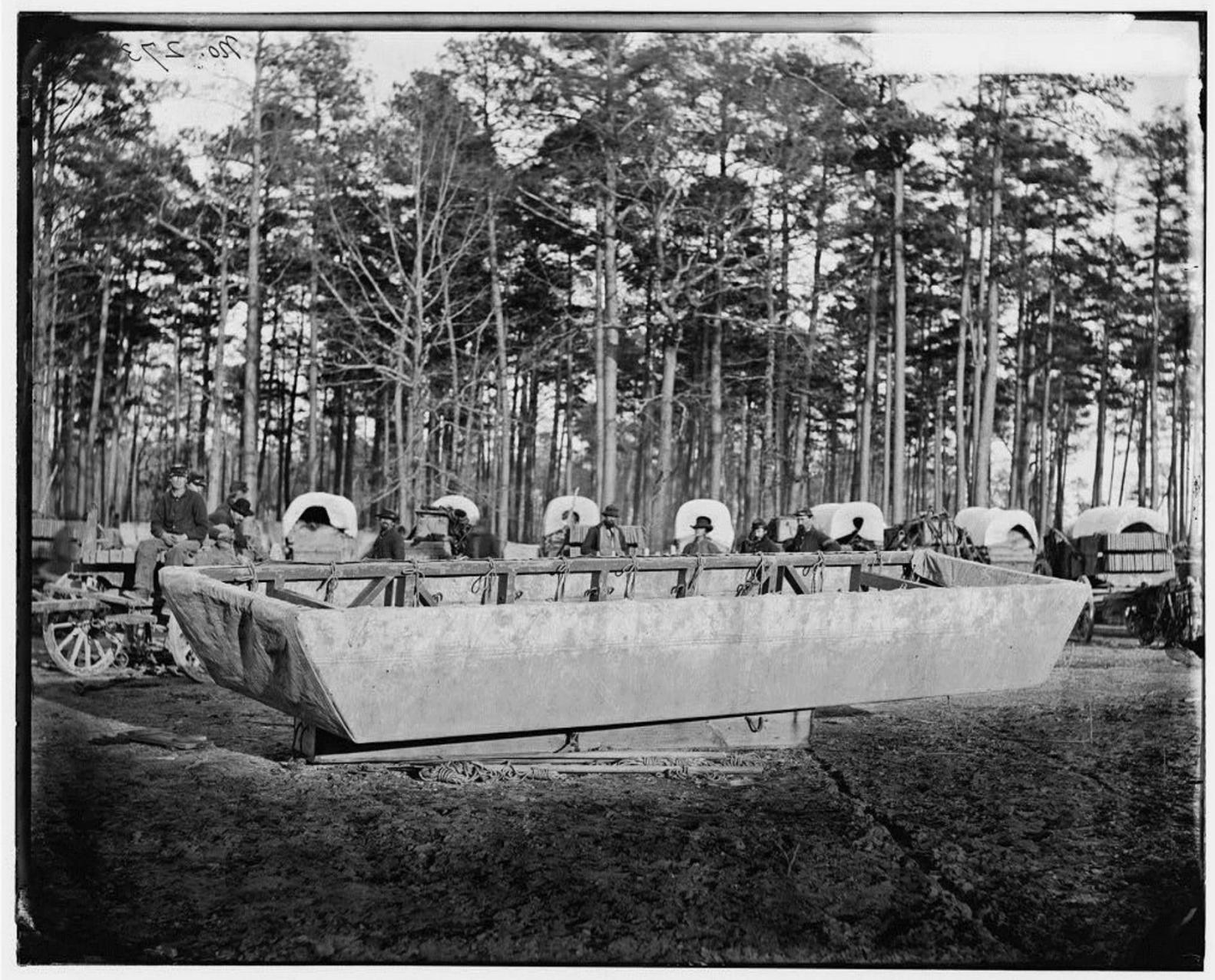
Fortification in Front of Atlanta, 1864



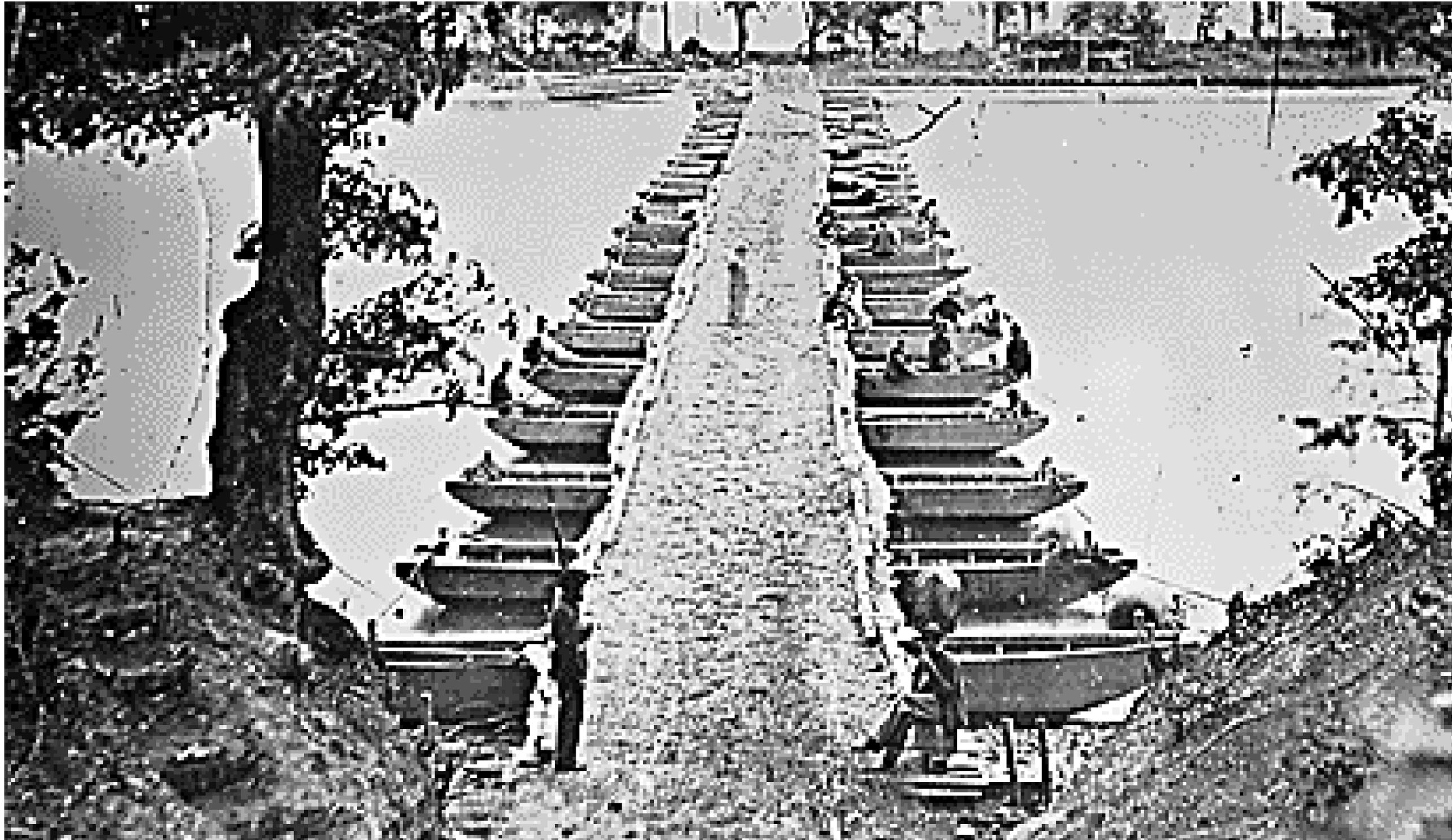
**Excavating for a “Y”,
Devereux Station,
Orange & Alexandria
RR;
General Herman
Haupt, Chief of
Construction &
Transportation, U.S.
Military Railroads,
supervising on bank,
engine named in his
honor.**



**Federal Engineers bridging the Tennessee
River at Chattanooga, March 1864**



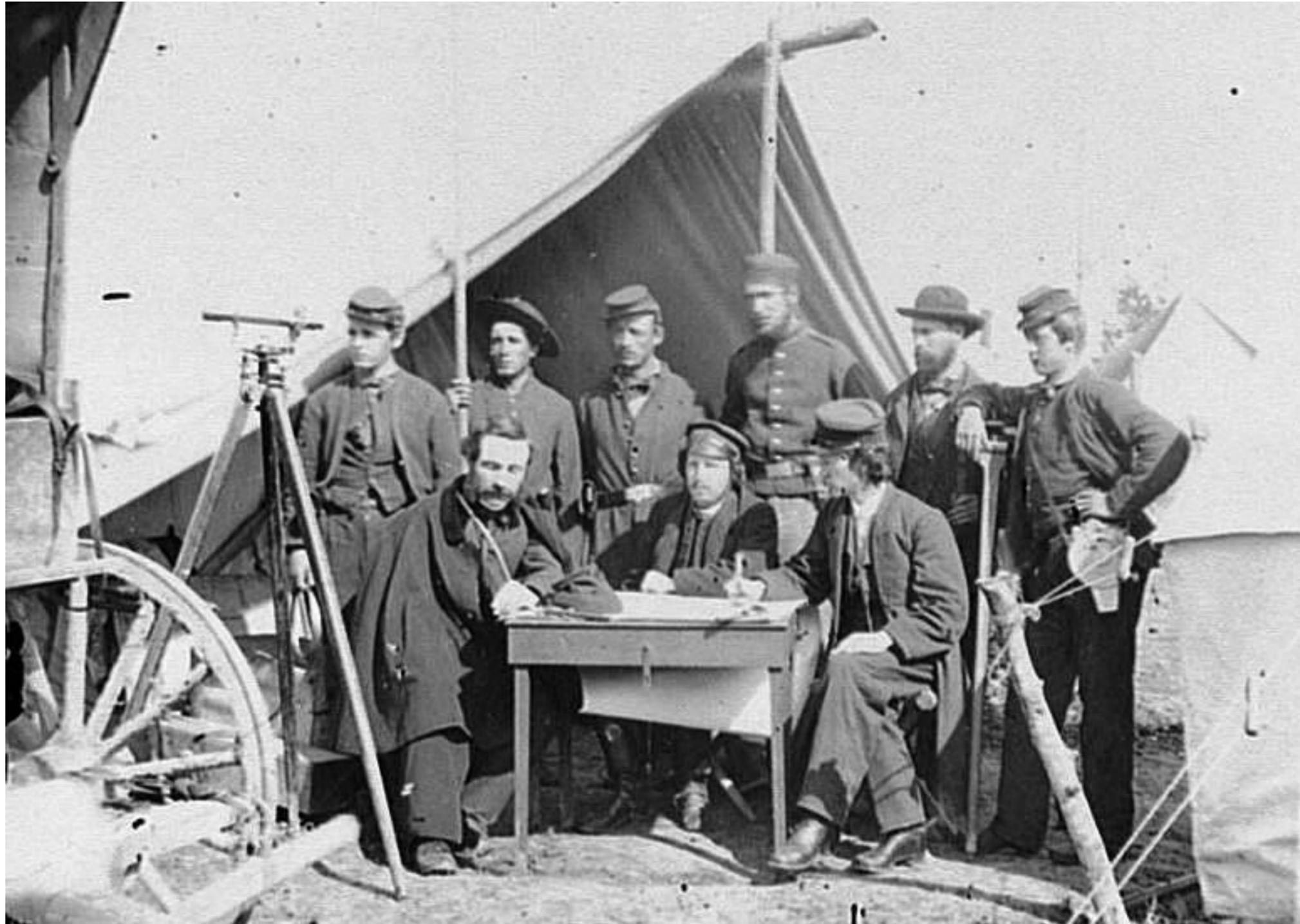
Pontoon Boat



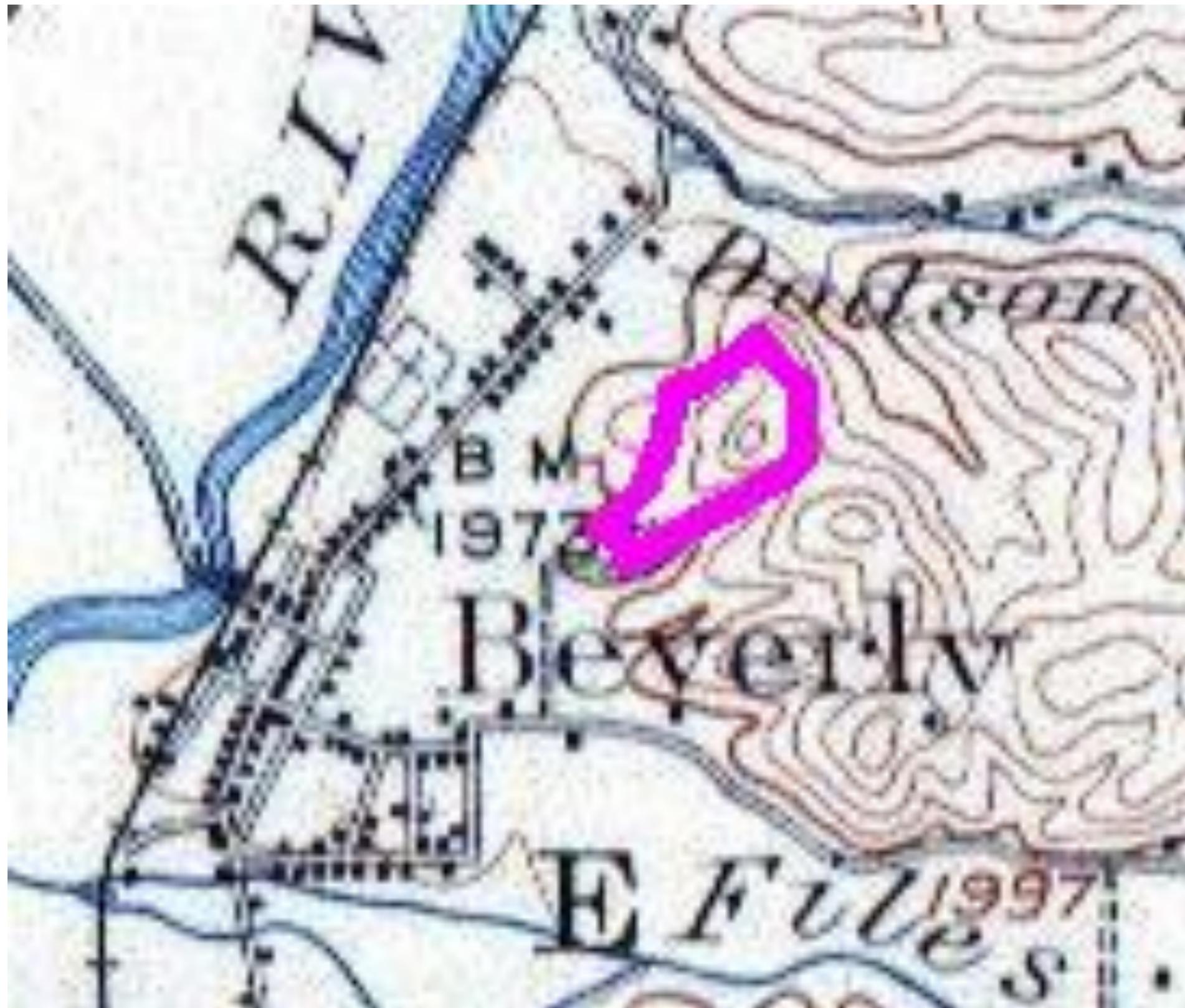
Federal pontoon bridge on the James River at Deep Bottom, Virginia



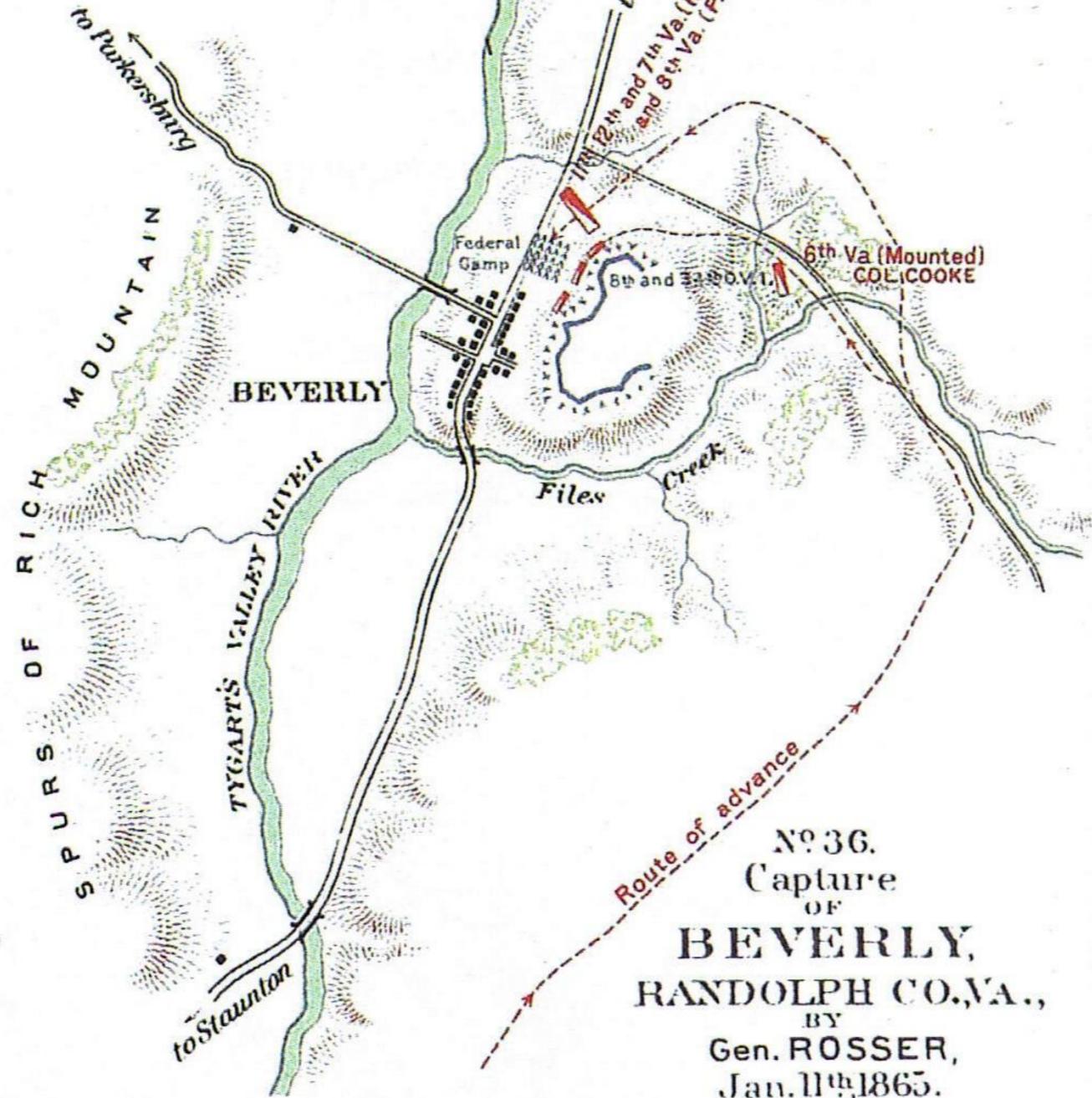
Headquarters, 50th New York Engineers, Petersburg, Virginia, November 1864



Topographical Engineers, Camp Winfield Scott



15' USGS, ELKINS, 1909



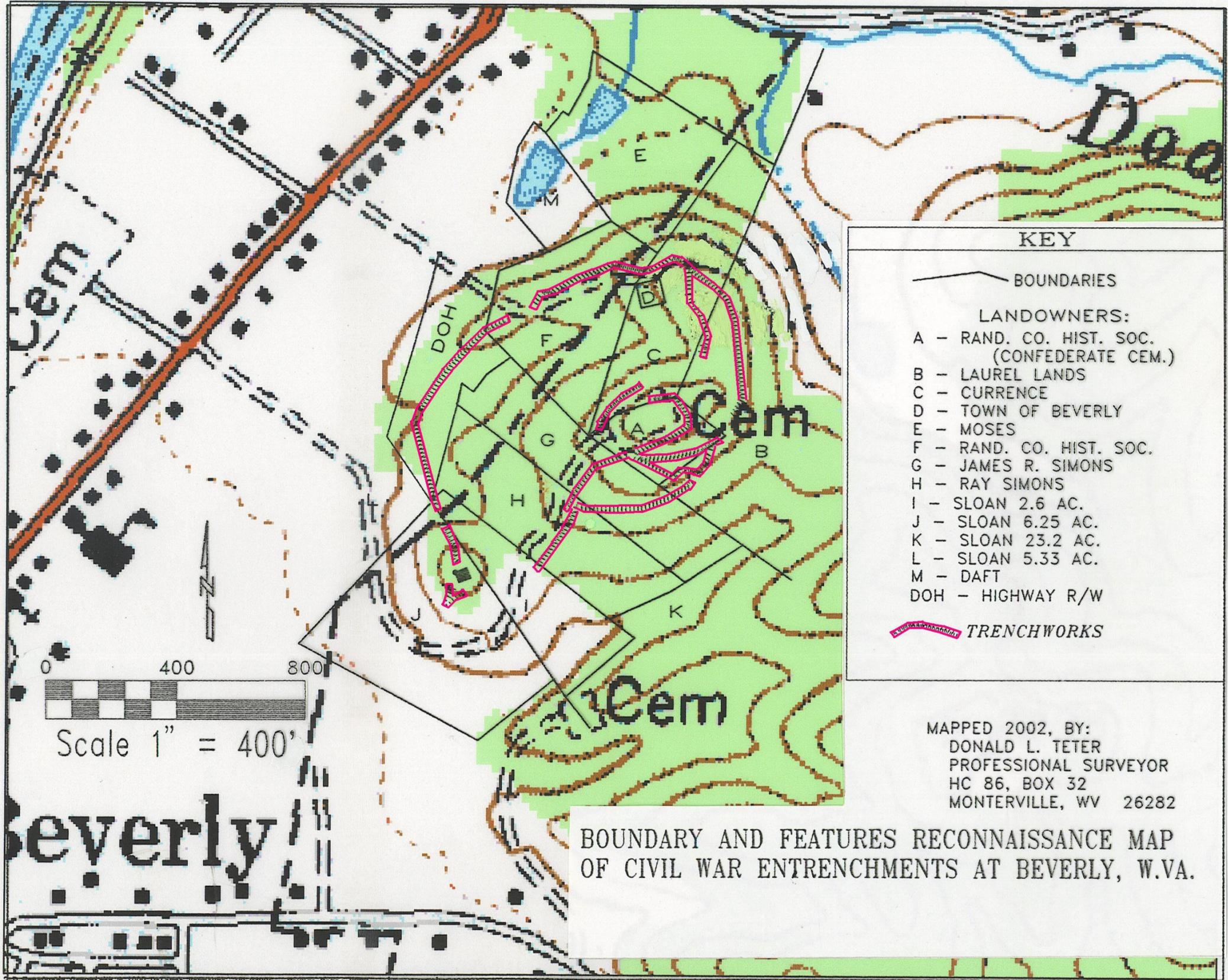
No 36.
 Capture
 OF
BEVERLY,
 RANDOLPH CO., VA.,
 BY
 Gen. ROSSER,
 Jan. 11th, 1865.

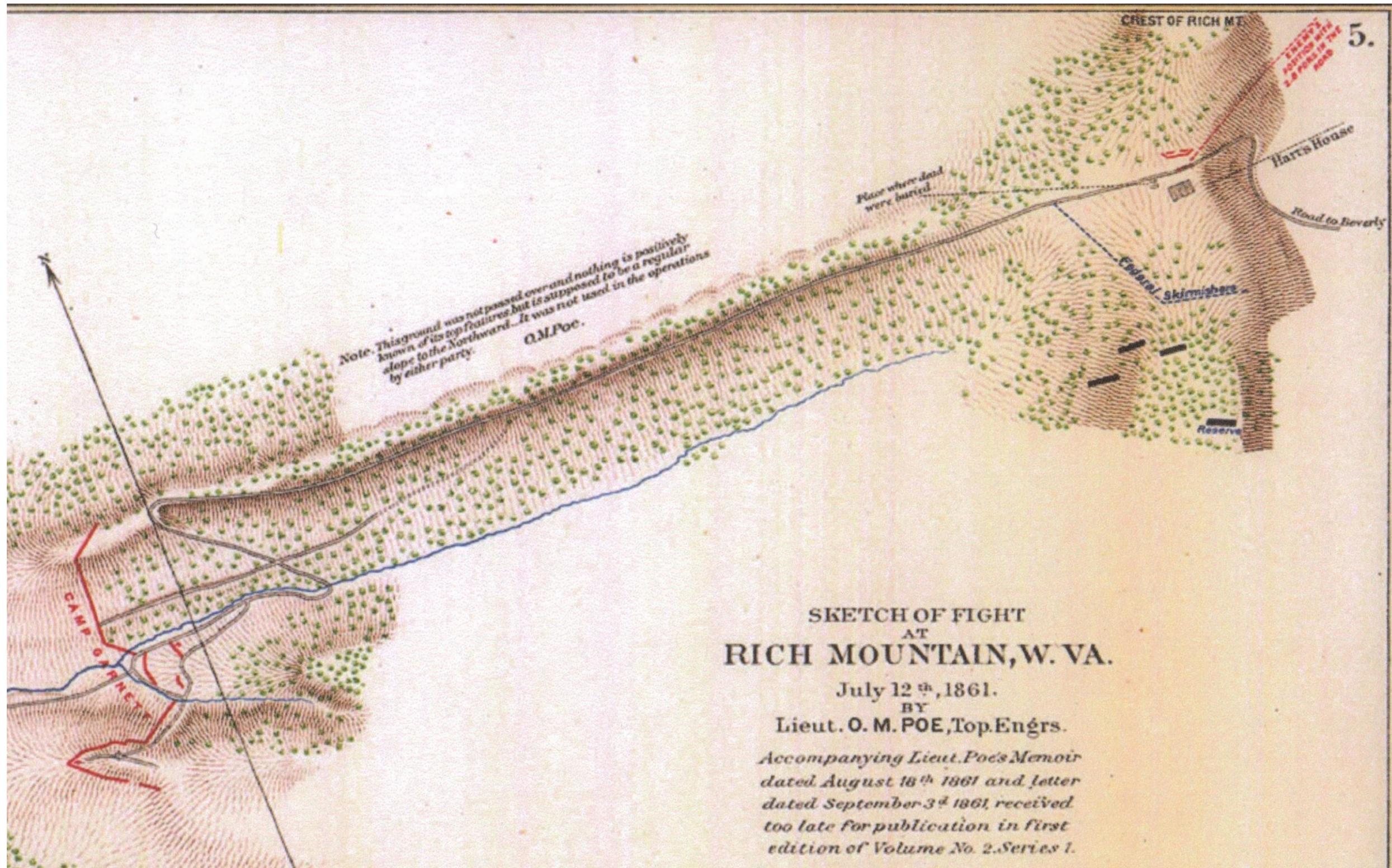
BY
 JED. HOTCHKISS, Top. Eng. N.D.
 Scale



Top. Eng. Office N.D. January 28, 1865.

— Confederate
 — Federal



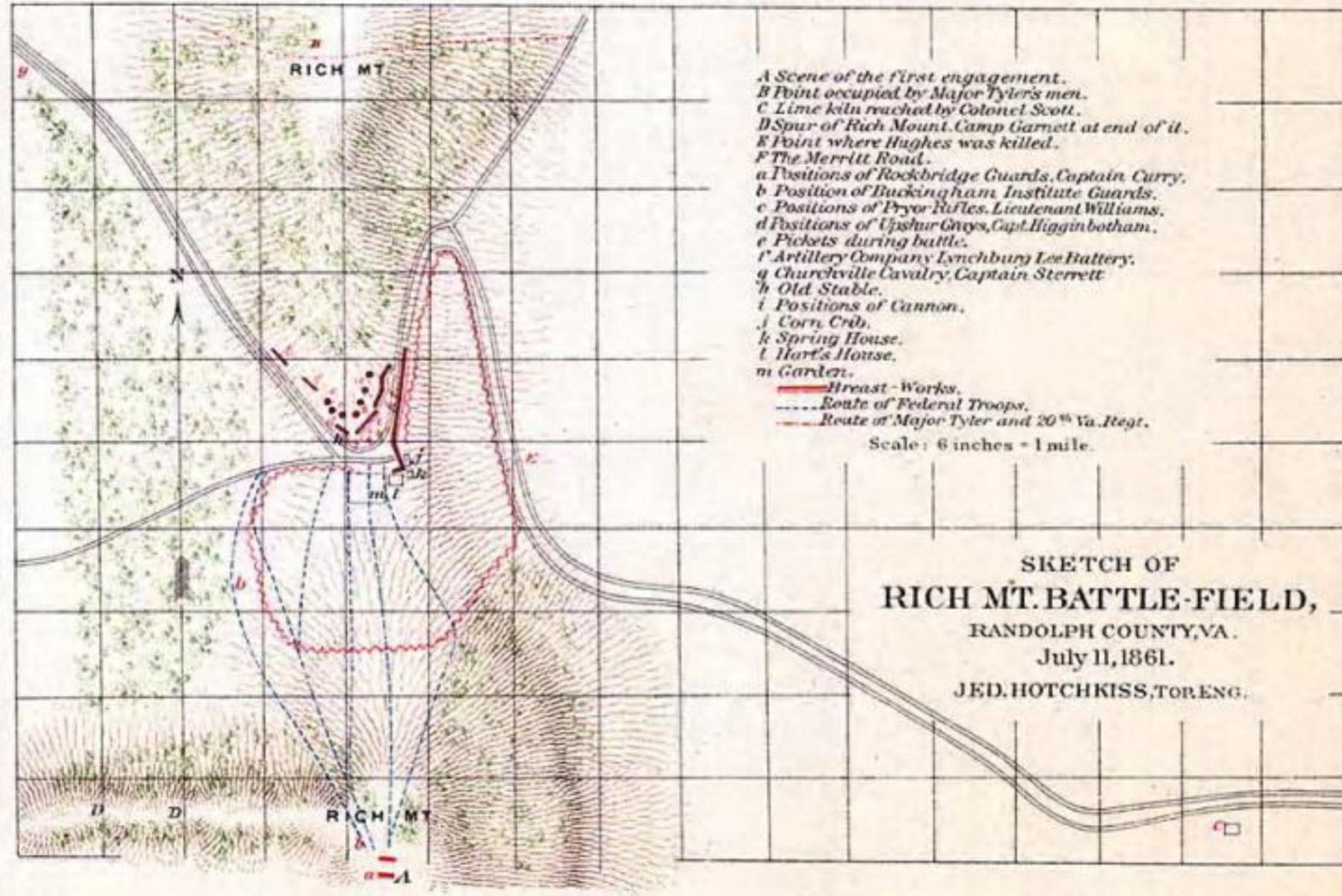


SKETCH OF FIGHT
AT
RICH MOUNTAIN, W. VA.

July 12th, 1861.

BY
Lieut. O. M. POE, Top. Engrs.

Accompanying Lieut. Poe's Memoir dated August 18th 1861 and letter dated September 3^d 1861, received too late for publication in first edition of Volume No. 2. Series 1.



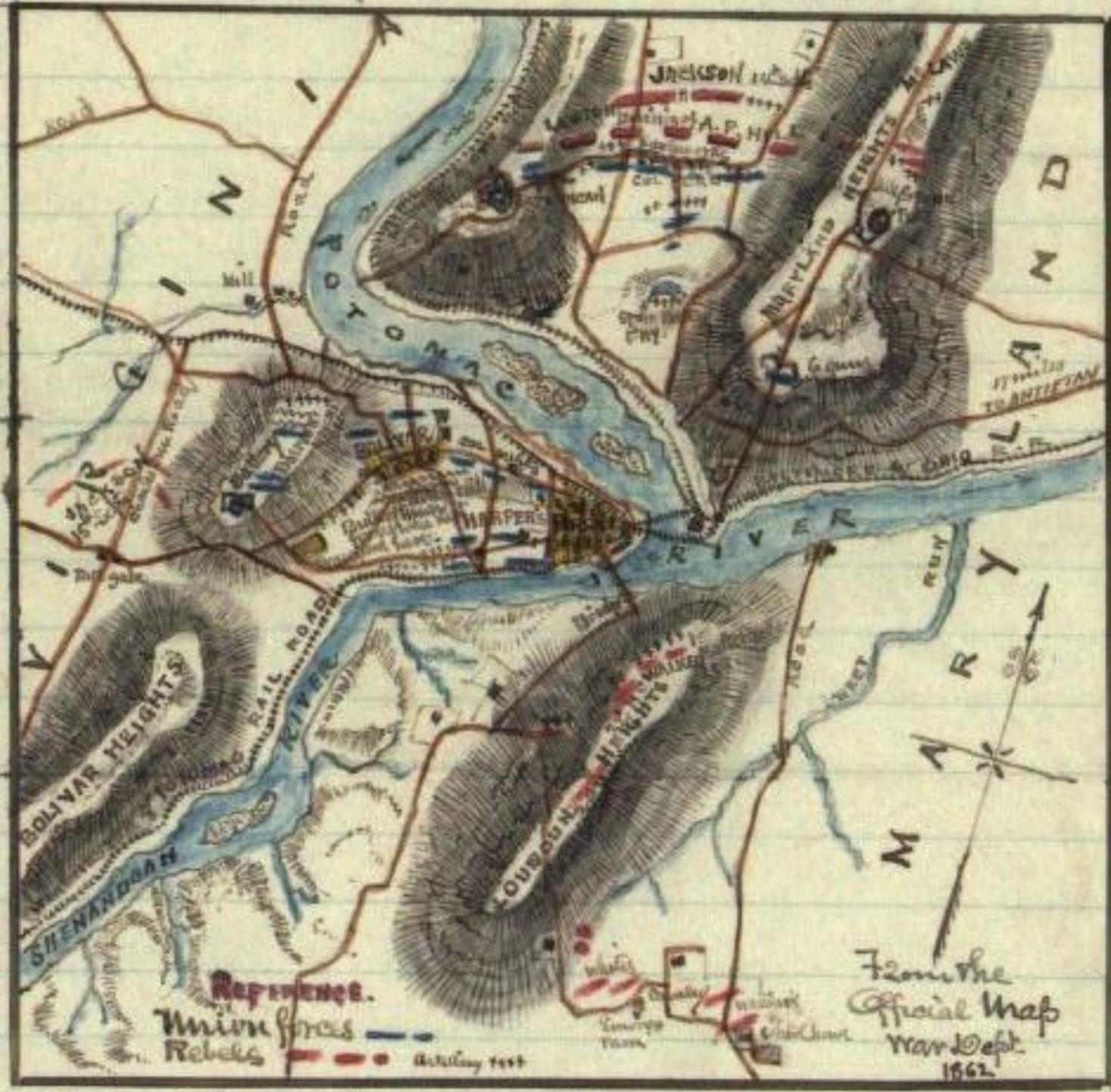
A Scene of the first engagement.
B Point occupied by Major Tyler's men.
C Lime kiln reached by Colonel Scott.
D Spur of Rich Mount. Camp Garnett at end of it.
E Point where Hughes was killed.
F The Merritt Road.
a Positions of Rockbridge Guards, Captain Curry.
b Position of Buckingham Institute Guards.
c Positions of Pryor Rifles, Lieutenant Williams.
d Positions of Upshur Greys, Capt. Higginbotham.
e Pickets during battle.
f Artillery Company Lynchburg Lee Battery.
g Churchville Cavalry, Captain Sterrett.
h Old Stable.
i Positions of Cannon.
j Corn Crib.
k Spring House.
l Hart's House.
m Garden.
 — Breast-Works.
 - - - - Route of Federal Troops.
 ——— Route of Major Tyler and 20th Va. Regt.

Scale: 6 inches = 1 mile.

SKETCH OF
 RICH MT. BATTLE-FIELD,
 RANDOLPH COUNTY, VA.
 July 11, 1861.
 JED. HOTCHKISS, TOR. ENG.

THE ATTACK ON HARPER'S FERRY VA

by JACKSON, September 14th and 15th - 1862.



1862

Total Union loss. 44 killed - 173 wounded. 73 pieces of artillery & 15,000 muskets

Union force which surrendered were 11,589 men + officers and 5 commanding officers = 11,594.

About 864 negroes, women and children were captured and sold at Richmond. The paroled prisoners were marched to Frederick City Md. thence to Camp Parole Annapolis Md.

{ Before the surrender all the Union Cavalry under Col Davis of 12th Illinois Cavalry and Col Amos Voss with the 5th New York Cavalry - Col B. F. Davis escaped across the Potomac and reached Antietam 16 Sept

73 { pieces of artillery and much Ammunition and military stores fell into the hands of the enemy. The guns on the Heights were spiked by Col Ford's men and thrown off the cliffs. They were subsequently recovered by the Union artilleremen after the Battle of Antietam. Enemy captured 15,000 muskets also.

Union forces were Commanded by Col. Dixon S Miles (mortally wounded) and Brig Gen. Julius White - Miles put up 2 flags of truce of surrender which the enemy did not see, but kept up the artillery fire. Miles was struck by a piece of shell and died from the wound soon after.

Century 19



Ambrose Bierce



Jedediah Hotchkiss

SESSION EVALUATION

