

THE SURVEYOR'S GUIDE

AND

POCKET TABLE-BOOK.

BY B. F. DORR.

SECOND EDITION.

NEW YORK :

D. VAN NOSTRAND,

23 MURRAY AND 27 WARREN STREET.

—
1888.

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PREFACE.

IN offering the following work to the public the author hopes to meet a want long felt by surveyors, and also to furnish a good deal of information that will be especially valuable to persons who are intending to fit themselves for the duties devolving on surveyors.

He commenced the study of surveying and engineering thirty years ago, and has practised surveying in New Hampshire, Ohio, Wisconsin, Michigan, and Iowa, in twenty counties; has conversed with many surveyors in other States, and is in possession of considerable correspondence on the subject; has found a great diversity of opinion and practice on many points. In as simple a matter as the subdivision of a section (not fractional) he has found five different methods pursued.

The Hints to Beginners are drawn from the experience and observation of the author.

The Rules, intended to cover every case likely to occur in a surveyor's practice, are based on United States laws, and have the written approval of the Commissioner of the General Land Office; consequently they will override any State law that conflicts with them, and as fast as the book comes into use will produce uniformity and legality of practice.

It is believed that the remarks on *local attraction*, and how to overcome it with a common needle-instrument, will be peculiarly acceptable to the profession generally.

PREFACE.

The traverse table, and tables of natural sines and tangents, cannot be excelled for accuracy, being taken from A. M. Scribner's plates, and are just what every surveyor needs in his pocket.

There have been plenty of manuals and pocket table-books published for the use of engineers, but they fail to meet the wants of surveyors.

The decisions of Supreme Courts quoted or referred to are good authority on disputed points, and this book puts you on the track of about one thousand of them directly or indirectly.

It is hoped that the illustrations will aid in making every point clear.

B. F. DORR.

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THE SURVEYOR'S GUIDE.

UNITED STATES LAW.

SEC. 2. *And be it further enacted,* That the boundaries and contents of the several sections, half sections, and quarter sections of the public lands of the United States shall be ascertained in conformity with the following principles, any act or acts to the contrary notwithstanding :

1st. All the corners marked in the surveys returned by the Surveyor-General, or by the surveyor of the land south of the State of Tennessee, respectively, shall be established as the proper corners of sections, or subdivisions of sections, which they were intended to designate ; and the corners of half and quarter sections not marked on the said surveys shall be placed, as nearly as possible, equidistant from those two corners which stand on the same line.

2d. The boundary lines actually run and marked in the surveys returned by the Surveyor-General, or by the surveyor of the land south of the State of Tennessee, respectively, shall be established as the proper boundary lines of the sections or subdivisions for which they were intended ; and the length of such lines, as returned by either of the surveyors aforesaid, shall be held and considered as the true length thereof. (And the boundary lines which shall not have been actually run and marked, as aforesaid, shall be ascertained by running straight lines from the established corners to the opposite corresponding corners ; but in those portions of the fractional townships where no such opposite corresponding corners have been, or can be, fixed, the said boundary

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lines shall be ascertained by running from the established corners due north and south or east and west lines, as the case may be, to the water-course, Indian boundary line, or other external boundary of such fractional township.

3d. Each section, or subdivision of section, the contents whereof shall have been, or, by virtue of the first section of this act, shall be, returned by the Surveyor-General, or by the surveyor of the public lands south of the State of Tennessee, respectively, shall be held and considered as containing the exact quantity expressed in such return or returns; and the half sections and quarter sections, the contents whereof shall not have been thus returned, shall be held and considered as containing the one-half or the one-fourth part, respectively, of the returned contents of the section of which they make part.

Approved February 11, 1805.

REMARK.—The above is the Rock on which surveyors must stand, and on which all State laws must be based.

PRINCIPLES, RULES, AND REMARKS,

PREPARED FOR THE GUIDANCE OF SURVEYORS, BY B. F. DORR.

Principle 1.—As long as the point at which the government has established a corner can in any manner be identified, that point must remain the corner.

[See Act of Congress, February 11, 1805, Sec. 2, Prin. 1.]

Principle 2.—If the county surveyor's measurement of any line differs from the measurement "returned" by the government surveyor, the county surveyor must establish, or re-establish, any corner which said line touches, at such distance from the adjacent corner or corners as shall be proportional to the "returned" distance.

[See Act of Congress, February 11, 1805, Sec. 2, Prin. 2.]

REMARK.—The surveyor is governed by this principle every time he establishes a corner equidistant from a section corner and its adjacent quarter post, because his distance and the “returned” distance between any two government corners rarely coincide.

FOR CENTER OF SECTION

Principle 3.—All lines not run and marked by the government surveyor, or which cannot be identified, must be run straight from any given corner to the opposite corresponding corner.

[See Act of Congress, February 11, 1805, Sec. 2, Prin. 2.]

Rule 1.—To divide any section (not made fractional by a meandered body of water or Indian boundary) into quarters:

Run a straight line between the north and south quarter posts, and a straight line between the east and west quarter posts, and at the intersection of these two lines establish the centre of the section.

[See United States Supreme Court Reports, 3d Howard.]

REMARK.—This rule applies to sections 1, 2, 3, 4, 5, 6, 7, 18, 19, 30, and 31, as well as to the full sections, and is based on Principle 3.

Rule 2.—To divide a quarter section into quarters:

1st. Establish a corner on each side of said quarter equidistant from the corners terminating such side.

2d. Run a north and south line and an east and west line between the corners so established, and at their intersection establish the centre of the quarter.

[See Act of Congress, February 11, 1805, Sec. 2, Prin. 1 and 2.]

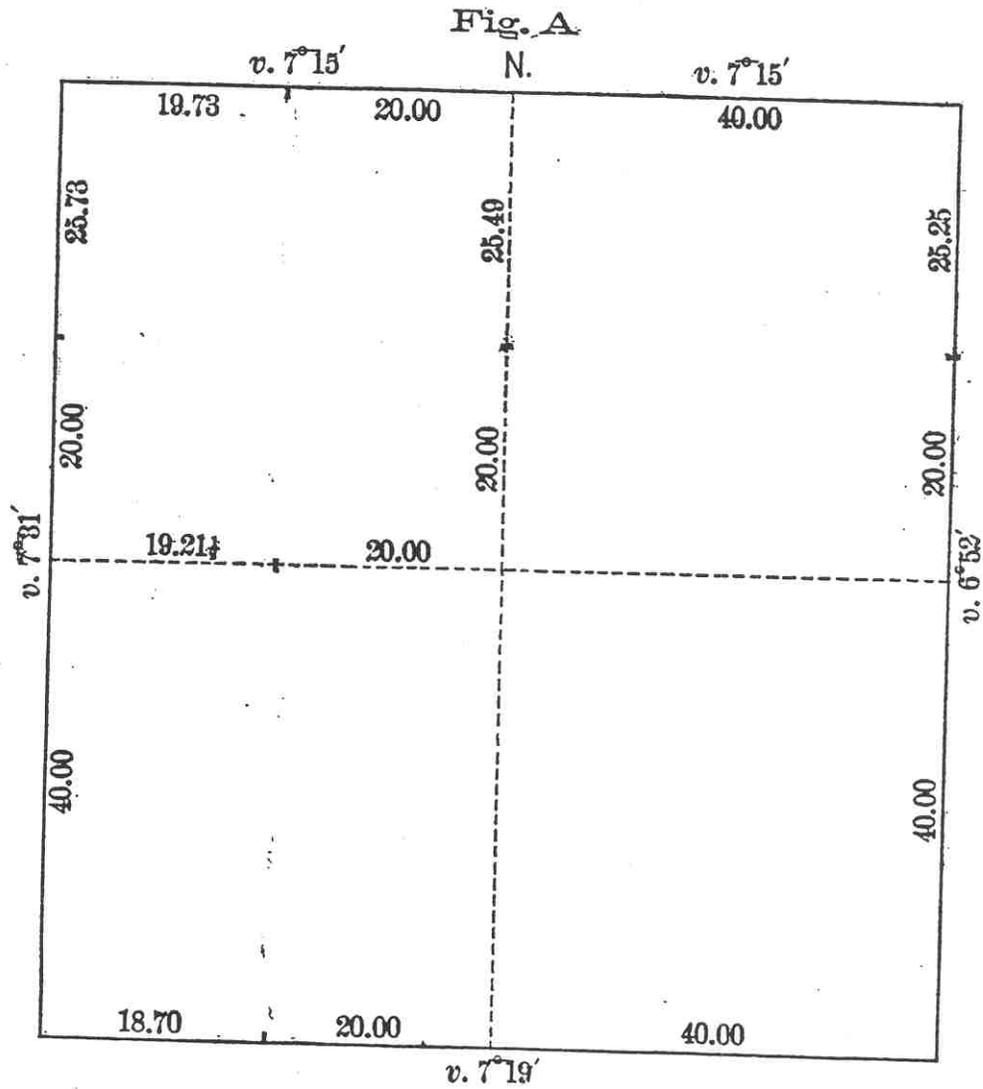
Rule 3.—To establish the corners to the fractional subdivisions in section 6:

1st. Establish the centre of the section according to Rule 1.

2d. If your measurement makes the distance from the east and west quarter posts to the north corners of the section the same as the “returned” distance, establish a quarter quarter-corner on the east section line at precisely twenty chains north of the east quar-

Section 6, Township 24 North,

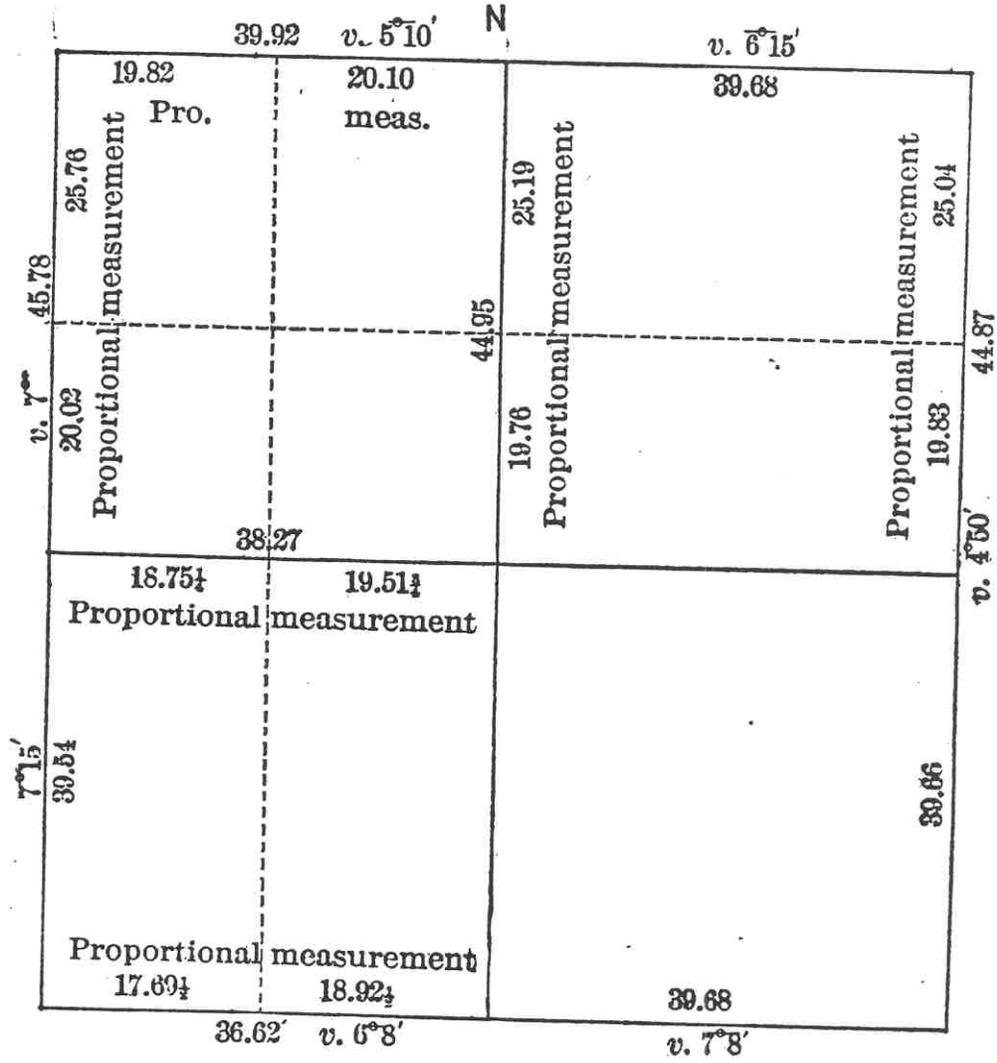
As the government surveyor returned it:



Section 6, Township 24 North,

As I found it:

Fig. B



ter post, and another on the west section line at precisely twenty chains north of the west quarter post. The length of the line from the centre of the section to the north quarter post should be half the sum of the lengths of the lines from the east and west quarter posts to the north corners of the section. If it should prove to be so, establish a quarter quarter-corner on said line at twenty chains north of the centre of the section.

3d. If your measurement makes the distance from the north and from the south quarter posts to the west corners of the section the same as the "returned" distance, establish a quarter quarter-corner on the north section line at twenty chains west of the north quarter post, and another on the south section line at twenty chains west of the south quarter post. The length of the line from the centre of the section to the west quarter post should be half the sum of the lengths of the lines from the north and south quarter posts to the west corners of the section. If it proves to be so, establish a quarter quarter-corner on said line at twenty chains west of the centre of the section.

4th. If, on any of the above lines, your measurement differs from the "returned" distance, or "original" measurement, you will establish your corners in accordance with Principle 2.

REMARK 1.—The second part of Rule 3 can be used in subdividing sections 1, 2, 3, 4, and 5, and the third part in subdividing sections 7, 18, 19, 30, and 31.

REMARK 2.—As the subdivision of section 6 causes inexperienced surveyors more perplexity than any other, the example of actual practice in Figs. A and B, pages 10, 11, is given.

Section 6, Township 24 North, of Range 11 East, of the Fourth Principal Meridian.

Rule 4.—To find the quarter lines through sections made fractional by a meandered body of water :

1st. If a part or the whole of the east line of the section, and of the west line also, is given, then a line running from the given quarter post to the meandered stream or lake, with a bearing which is half the sum of the bearings of the two section lines, will be the north and south quarter line required—*e.g.*, if the east line

has a bearing of $6^{\circ} 30'$, and the west line has a bearing of 6° , then must the said quarter line have a bearing of $6^{\circ} 15'$. See Fig. 1.

2d. If a part or the whole of only one of the above section lines is given, then the quarter line must run parallel with the given section line.

3d. If no part of a section line is given with which the quarter line can be run parallel, then run it at right angles with the section line on which the given quarter post stands. See Fig. 2.

4th. The principles embraced in the previous parts of this rule will govern in establishing the east and west quarter lines. See Fig. 1.

REMARK 1.—The quarter quarter-corners in such a section will be established in accordance with the principles embraced in Rule 3, and the eighth lines in accordance with the principles embraced in Rule 4.

REMARK 2.—The instructions from the government say: "From the given quarter post run due north or south, or east or west, as the case may be, to the water-course," etc.; but as north from any section corner means along the section line, however much that may vary from due north, it follows that north from the adjacent quarter post, on either side of said section corner, must be parallel with said section line, if only said line of the section is given. If both the east and the west lines of the given section are given, as both are held by government to run due north, it follows that the quarter line must take a bearing intermediate between the two.

Similar reasoning is sound in regard to the east and west quarter line, and the eighth lines also.

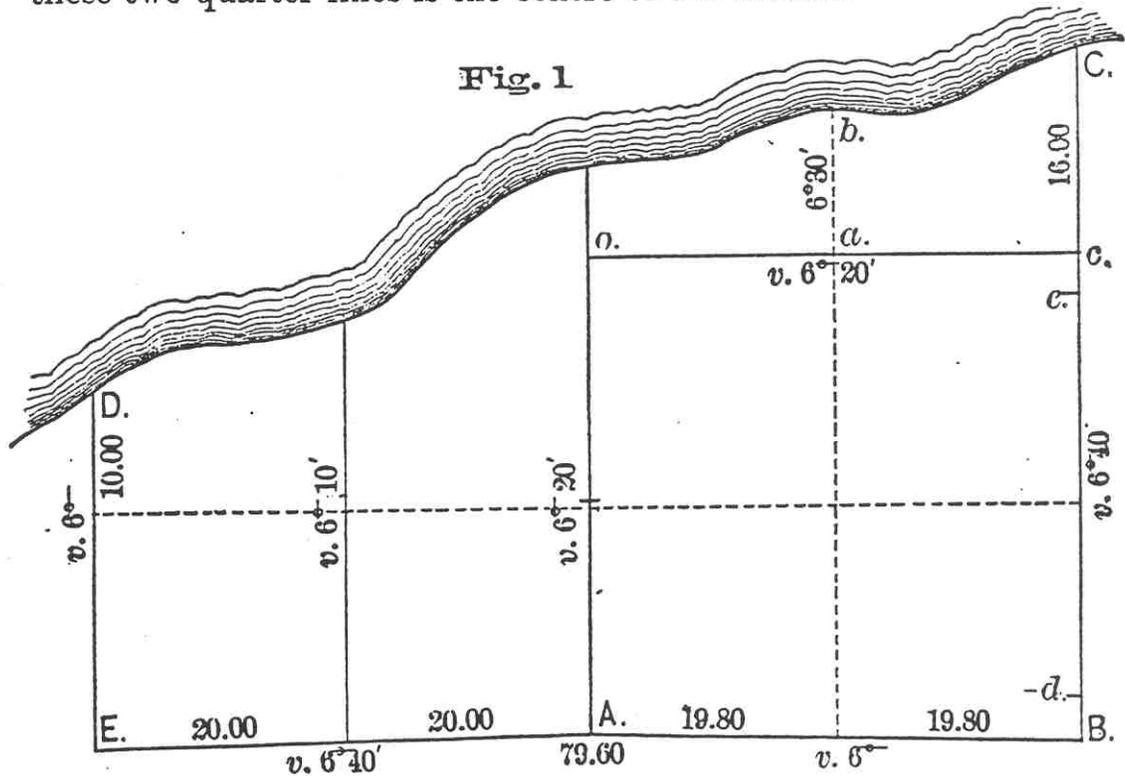
NOTE.—*Figs. 1, 2, and 3, with their explanations, were not forwarded to Washington for approval, but are inserted here to illustrate the prints of which they treat. Neither were the notes which you find written in italics forwarded.*

Let Fig. 1 represent the south part of section 10, made fractional by Lake Michigan. You run the east line, and find the variation to be $6^{\circ} 40'$. The variation of west line, 6° . Then

must the north and south quarter line be run from the S $\frac{1}{4}$ P. to the lake with a variation of $6^{\circ} 20'$.

You find an angle in the south line of the section at $\frac{1}{4}$ P.—the east half of the line varying 6° , and the west half $6^{\circ} 40'$.

You must therefore run the east and west quarter line from the E. $\frac{1}{4}$ P. with a mean variation, or $6^{\circ} 20'$. At the intersection of these two quarter lines is the centre of the section.



It follows that the north and south eighth line through the S.W. $\frac{1}{4}$ must be run from the eighth corner to the lake with a variation of $6^{\circ} 10'$.

The east and west eighth line through this quarter will be determined by the eighth corners at its extremities, and the intersection of these two eighth lines is the centre of this quarter.

Perhaps this is as good a place as any for me to say that I think there are no such things as sixteenth lines, and only four sixteenth corners in a section—viz., the centres of the quarters.

The corner *a* being “returned” as set equidistant from the quarter posts between which it stands, the line *a b* must be run from *a* to the lake with the intermediate bearing $6^{\circ} 30'$.

REMARK.—Quarter posts often stand nearer one section corner than the other, and out of line, as shown in the above.

Suppose you find local attraction in the above section ?

Set your compass at A, and take the bearings of A B and A E. Although these will not be 6° and $6^{\circ} 40'$, they will still differ just $40'$. Therefore E B differs from A B or A E $20'$. Set your compass at B, and take the bearing of B A. Move the vernier $20'$ to the left, and turn your compass till the needle points to W., and you will have the bearing of B E. Then turn your compass toward d , and note the angle E B C. Set your compass at c and turn it towards e to get the bearing of B C at c . Then make the angle $a c C$ equal to E B C, and your compass will be in position to run the line $c o$.

TO RUN A o .

Set your compass at E, and take the bearing of E D, which will differ $40'$ from E A. You have found that B C differs from B A $40'$; therefore A o must differ from E A or A B $20'$ — $20'$ less than A E, and $20'$ more than A B.

Let Fig. 2 represent the south part of section 9, made fractional by a river.

You will notice that A C and A B have different bearings. B C must have half their sum. Run A c at right angles with B C, and at 40 chs. (d) establish the centre of the section. Run $a d$ and $d b$ parallel with B C for the east and west quarter line. Run the north and south eighth lines parallel to, and the east and west eighth lines at right angles with, A c .

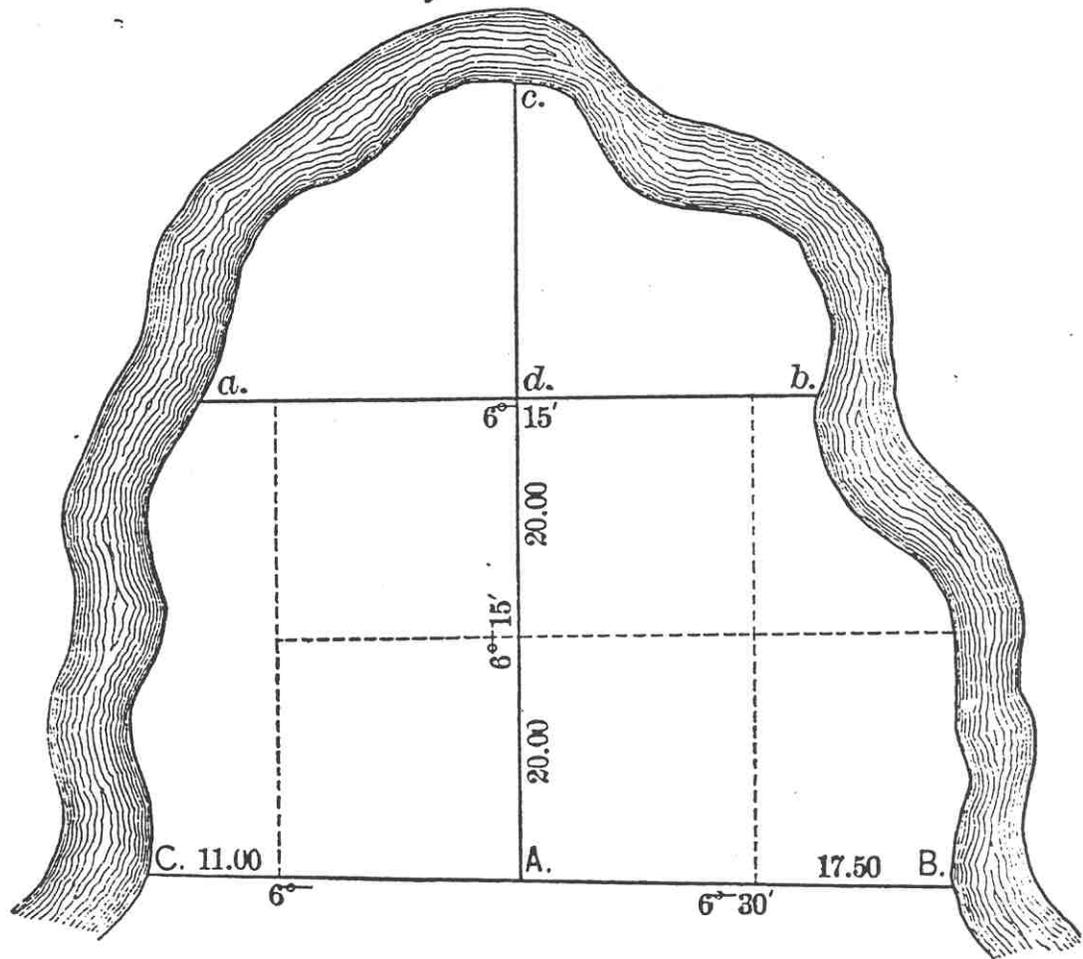
REMARK.—In case of local attraction, refer to the suggestions under Fig. 1, and to those in regard to the correction of a random line where there is local attraction, and you will understand how to overcome it in this case.

NOTE.—For a discussion of the proper subdivision of fractional sections see "Engineering News" of January and March, 1875.

DEFINITIONS.—1. A LOST CORNER is one of whose original position sufficient evidence may be found to re-establish it,

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Fig. 2



2. An OBLITERATED CORNER is one of whose original position there is no reliable evidence.

Rule 5.—To re-establish a lost corner when one or more bearing-trees (or their stumps) are standing:

1st. If two or more bearing-trees are standing, and the "returned course and distance" from each indicates the same spot, re-establish the corner at that spot, making due allowance for the growth of the trees since the corner was first established.

2d. If only one bearing-tree is standing, and you are satisfied that the original field notes of its course and distance from the corner are correct, you will re-establish the corner at the spot thereby indicated.

REMARK 1.—The marks on a bearing-tree (unless there is con-

flicting evidence) are always held to be on the side of the tree which is nearest to the corner.

REMARK 2.—There are often inaccuracies in the field notes. Sometimes one of the cardinal letters is improperly given. Sometimes the course and distance given to one tree belong to another. Sometimes the course is given from the tree towards the corner; but it should always be from the corner towards the tree. Sometimes the number of links distant is given, in place of the number of degrees in the course, and *vice versa*.

Sometimes instead of the angle intended its complement is given—*e.g.*, 55° when 35° is the angle intended. Sometimes the angle is read from the wrong side of the figures—*e.g.*, N. 35° E. is called N. 45° E.

3d. Taking all the evidence obtainable into consideration, you will re-establish the corner where the *weight of evidence* places it.

4th. In the absence of other evidence, the oath of an unimpeachable witness as to the identical spot at which the original corner stood is sufficient to re-establish said corner at the spot which he designates, HE HAVING BEEN PRESENT AT ITS ESTABLISHMENT BY GOVERNMENT SURVEYOR.

NOTE.—*The above phrase in small capitals, with the phrases in same type in Rules 6, 7, and 8, are the amendments inserted by the authorities at Washington in the copy I sent there for approval.*

REMARK.—It is not sufficient that a man says a corner stood pretty near a certain spot.

Rule 6.—To re-establish an obliterated quarter post:

NOTE.—*The bearing-trees at a quarter post are marked $\frac{1}{4}$ S.*

Place it on a straight line between the other two government corners standing on the same section line. If said corners are both section corners, place the quarter post equidistant from them—EXCEPT IN SECTIONS 1, 2, 3, 4, 5, 6, 7, 18, 19, 30, AND 31, IN CASE THE SAME FALL SHORT OR OVERRUN 80 CHS.

NOTE.—*This was an oversight on my part, as Remark 1 under Rule 3 will show.*

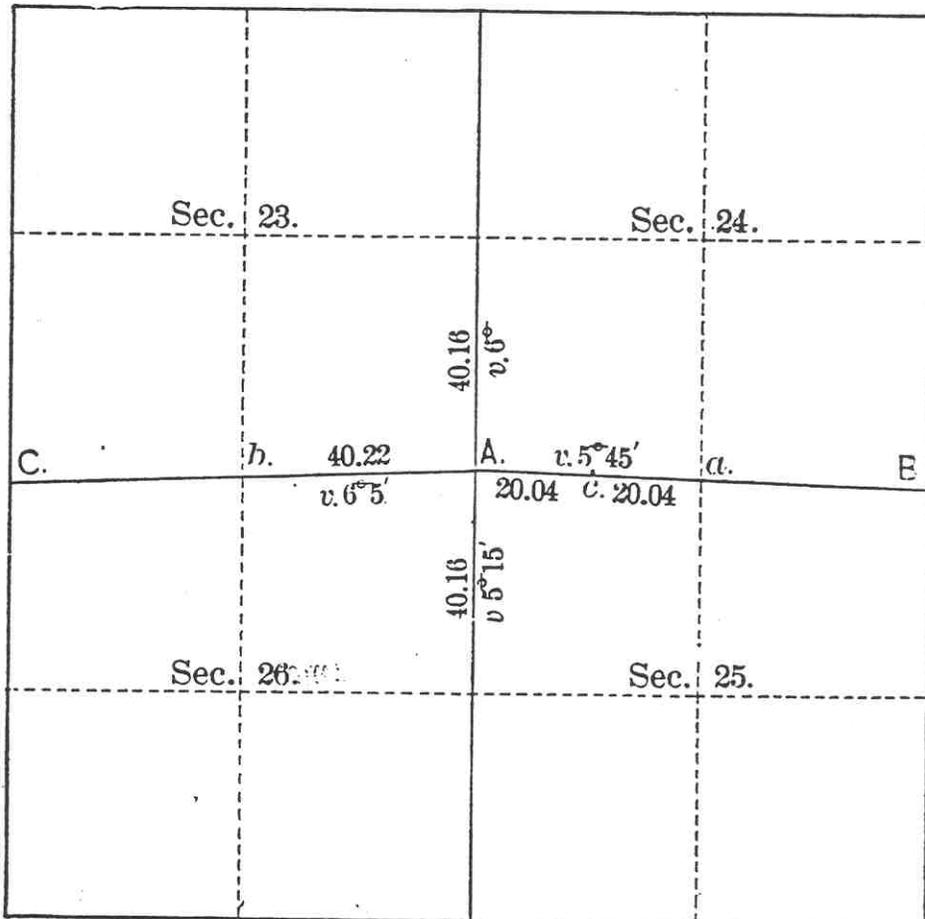
If one or both of said corners are meander corners, place the

quarter post at a proportional distance from them, according to Principle 2.

Rule 7.—To re-establish an obliterated section corner, IN SECTIONS OTHER THAN THOSE IN THE NORTHERN AND WESTERN TIER OF SECTIONS IN A GIVEN TOWNSHIP.

NOTE.—*The above amendment is covered by Exception 1 under this rule.*

Fig. 3



1st. Place it equidistant from the adjacent quarter posts north and south of it; and at a proportional distance from the adjacent quarter posts east and west of it. See Principle 2.

2d. If one of the adjacent quarter posts is gone, use the adjacent section corner; and if that is gone, re-establish it from what data you can gather before proceeding to re-establish the given corner.

Fig. 3 represents a case that occurred in my practice recently, A being the obliterated corner.

The "returned distance" from

A to B was 79.77, making A to $a=39.885$

A to C was 80.05, making A to $b=40.025$

Hence a to $b=79.91$

I found the distance from a to b was 80.30;

$$79.91 : 80.30 :: 39.885 : 40.08$$

NOTE.—In Hawes's "Manual" you will find a more extensive illustration of this principle; but when I wrote these rules I had not seen that work.

EXCEPTION 1.—The section corners on township or range lines must be re-established at proportional distances from the adjacent quarter posts on such township or range lines.

EXCEPTION 2.—If one of the government corners north or south of an obliterated section corner be a meander corner, then must said section corner be re-established at proportional distances from the government corners surrounding it.

REMARK 1.—Some surveyors run two straight lines between the quarter posts surrounding an obliterated section corner, and re-establish it at their intersection. This is manifestly wrong, because the two east and west lines or the two north and south lines meeting at a section corner seldom have the same bearing. They nearly always form an angle. And it is also true that the "returned distance" from a section corner to the quarter post east of it is hardly ever the same as the "returned distance" to the quarter post west of it.

REMARK 2.—The above Rule, Remark, and Exceptions apply)
to township as well as to section corners.

NOTE.—The foregoing rule will apply in ordinary cases. But since the township and range lines are run with greater care, with more accurate instruments, at a greater cost per mile, and we find in practice that they agree with the "returned field notes" much more nearly than section lines, I think it better to disregard said

rule when it would deflect a township or range line more than two rods.

In such cases I would re-establish the required section corner on a straight line between the nearest recognizable corners on said township or range line, and at a proportional distance between them.

Rule 8.—To re-establish an obliterated meander corner:

1st. Commence at the government corner nearest to the meander corner sought, and run a straight line to the "line-tree," SHOULD THERE BE ANY, nearest to said meander corner. Prolong said line to the meandered bank, and there re establish said meander corner.

2d. If there are no "line-trees" between the given corner and the meandered bank, then retrace the "meander line" between the two nearest meander corners, and re-establish the required meander corner at the point which agrees nearest with the "meander line."

GENERAL REMARKS.

If "line-trees" are found on any line, they are held to mark and establish said line, however much they may cause it to zig-zag.

[See Act of Congress, February 11, 1805, Sec. 2; Prin. 2.]

The foregoing Rules, etc., were sent to Washington for approval, and the following was received in reply :

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
WASHINGTON, D. C., March 7, 1874.

In reply I have to say that I have duly examined the document prepared by Mr. Dorr, and find that it embodies correct and equita-

ble principles, and is in the main, in consonance with the surveying laws of the United States.

I have the honor to be, very respectfully,

Your obedient servant,

WILLIS DRUMMOND, *Commissioner.*

REMARK.—Although “line-trees,” or “sight-trees,” are held to mark the line on which they stand, yet, inasmuch as they usually form a crooked line, and the parties interested usually prefer a straight line, I think said trees ought to be disregarded, except when they aid in re-establishing an obliterated corner.

You will recognize them by the two notches on each side.

OBLITERATED GOVERNMENT CORNERS RE-ESTABLISHED BY REFERENCE
TO PREVIOUS COUNTY SURVEYORS' WORK.

I think when you are called to survey in a section which has been subdivided, if you are satisfied that it was properly and carefully done, and there is no question about the position of the corners then set, it is allowable to use such corners in re-establishing any obliterated corner—*e.g.*, if, in Fig. 3, there had been a reliable corner at *c*, I might have set A in line with *a* and *c*, making A *c* equal to *c a*.

CORRESPONDENCE WITH COMMISSIONER GENERAL LAND OFFICE.

The following correspondence is so full and explicit in regard to the ruling of the department on the subject of the proportional measurement that it seems to me desirable that it be inserted here for reference :

WAUPACA, WIS., September 1, 1873.

Commissioner General Land Office, Washington, D. C.:

SIR : Enclosed you will find a printed copy of a letter from your office, bearing date January 9, 1873, addressed to Mr. Melendy, of Shawano. I have in my possession another letter from your office, of which the following is a copy, to wit :

“DEPARTMENT OF THE INTERIOR,

“GENERAL LAND OFFICE,

“WASHINGTON, D. C., January 30, 1872.

“*E. P. Perry, Esq., New London, Wis.:*

“SIR: In reply to your letter of the 8th inst., I have to say that the official plat on file here represents the southeast $\frac{1}{4}$ of the northwest $\frac{1}{4}$ of section 2, township 24 N., range 14 E., Wis., as containing 40 acres, and that the area of the fractional section north of it must be determined without interfering with the said 40-acre tract.

Very respectfully,

“WILLIS DRUMMOND, *Commissioner.*”

The owner of the above-described 40 claims that he is entitled to just 40 acres by my measurement; although thereby the man who owns the fraction north of him must be content with two or three acres less than his patent calls for. It seems to me, from my understanding of your letter of January 9, 1873, and from all the information I have been able to obtain during the last fifteen years, that the fraction and the 40 should share the deficiency proportionally.

Now, if you will be kind enough to explain the matter a little more fully, you will oblige me and others. Do you mean by the letter of January 30, 1872, that what said 40 lacks in width east and west must be made up in length north and south, so that the tract shall contain precisely 40 acres, according to my measurement? And how far north of the centre of said section 2 shall I set the northeast corner of said 40?

Yours respectfully,

B. F. DORR.

DEPARTMENT OF THE INTERIOR,

GENERAL LAND OFFICE,

WASHINGTON, D. C., September 13, 1873.

B. F. Dorr, Esq., Waupaca, Wis.:

SIR: In reply to your letter of the 1st inst. relative to the proper manner of establishing the quarter quarter-corner north of the

centre of section 2, town 24 N., range 14 E. 4th P. M., Wisconsin, I have to say as follows :

The said corner should be established at a distance of *twenty chains—original measurement*—north of the centre of the section. This rule will, of course, necessitate the adoption of a *proportional measurement* if the chaining does not agree with the original distance. The *original* length of the quarter line from the centre of the section to the township line is the *mean* between the east and west boundaries of the *north half* of the section, or 45.85 chains, this being the length adopted in calculating the area of the lots in said section.

My letter of January 30, 1872, relative to the S. E. $\frac{1}{4}$ of N. W. $\frac{1}{4}$ of said section 2, addressed to Mr. E. P. Perry, was based upon the presumption that the county surveyor's chain was of the same length as that of the United States Deputy Surveyor.

Very respectfully,

WILLIS DRUMMOND, *Commissioner.*

REMARK.—I have since written to Mr. Drummond's successor in regard to this same case, and his decision confirms the above.

NOTE.—*For court decisions on this point see Moreland vs. Page, Iowa Reports, vol. 2 Clarke; Jones vs. Kimble, 19 Wis. 430; Westphal vs. Schultz, 48 Wis. 75.*

BEGIN

HOW TO PROCEED

WHEN A SECTION HAS BEEN SUBDIVIDED IN ACCORDANCE WITH SOME STATE LAW WHICH CONFLICTS WITH UNITED STATES LAW.

Resurvey or subdivide said section in accordance with the United States laws and instructions from the Secretary of the Interior, paying no attention to the previous subdivision, only as it may aid you in re-establishing government corners which may have become obliterated.

REMARK 1.—No survey will hold, no matter how many years it

may remain unquestioned, which does not conform to United States law, and the parties interested may as well have the matter decided now as to wait till they have made more valuable improvements.

REMARK 2.—In Iowa ten years, and in Wisconsin twenty years, of undisputed possession give the possessor a valid title.

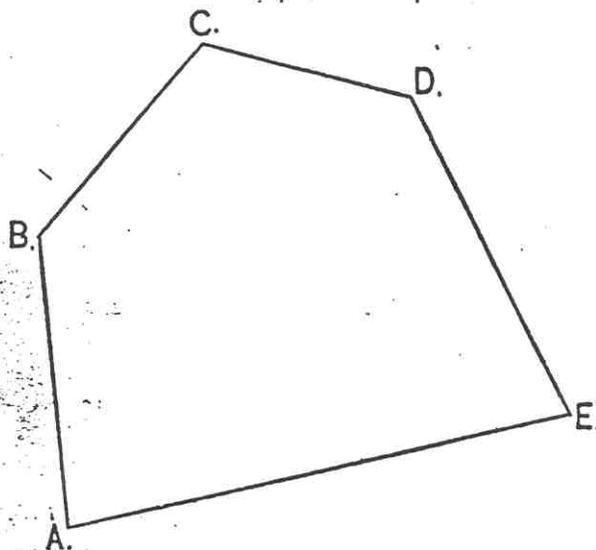
If, in a case of the kind in question, the subdivisional lines established by the previous surveyor have been recognized as boundaries by the parties interested, during as many years as have been prescribed by the State in which the land is situated, then said subdivisional lines have become and are their legal boundaries.

Now, what shall be done with the portions of land which lie between the boundaries thus legalized and the governmental subdivisional lines?

Ans. Nothing, as long as the present owners hold the land; but when they sell they must give a separate description of the land so acquired or lost, as the case may be. *END*

To survey an irregular-shaped field where there is local attraction:

Fig. 4



Let A, B, C, D, E represent such a field.

Set the compass at any corner—*e.g.*, at A. Take the bearing of A B. Move your compass to B and sight back to A. If there is local attraction your back-sight and fore-sight will not agree. Move your vernier till they *do* agree. Then take the bearing of B C, and proceed as before. Continue in this manner around to A. You

will thus get the angles as correctly as though there were no local attraction.

REMARK.—If this plan were pursued in the Eastern and Middle States future surveyors would be saved much of the perplexity which worries present surveyors in those States.

The reading of the vernier when starting at A, and the difference between each back-sight and the previous fore-sight, should be noted in the record of the survey; and then as long as any one of the lines could be determined with certainty there would be no difficulty in retracing the other lines, although the monuments at their extremities were destroyed.

WEIGHT OF EVIDENCE.

In the case of a lost or obliterated corner, I deem it of great importance that the surveyor in re-establishing said corner should give careful attention to the principle of "weight of evidence."

In support of this opinion I quote the following authorities:

Leven vs. Smith, 7 Port. (Ala.), 428: "Each section or subdivision of a section is independent of any other section in the township, and must be governed by its marked and established boundaries. And should they be obliterated a last recourse must be had to the best evidence that can be obtained showing their former situation and place."

Moreland vs. Page, vol. 2 Clarke (Iowa): "That *all ascertained* surrounding monuments shall have their due weight in determining the locality of the unascertained, under the system by which the survey was originally made."

McClintock vs. Rogers, 11th Ill. Reports; Peck: "The law cannot satisfactorily determine in all cases whether course or distance shall control, when they do not correspond; this must be determined by concurring testimony and the circumstances of each particular case. The one that convinces the judgment most must be selected."

Sur.-Gen. H. A. Wiltse to C. Palmer, Oshkosh, Wis.: "You will place the corner where the weight of evidence places it."

Gov. C. C. Carpenter, of Iowa, in instructions to county surveyors: "No surveyor can intelligently subdivide a section unless he is thoroughly conversant with the system by which that section was originally surveyed."

Geo. H. Frost, page 9 *Engineering News*, Jan. 15, 1875: "If there were no good evidence by which to restore the lost corner, we would leave it to the judgment of the surveyor. There are cases where, after all, the good judgment and common sense of the surveyor must be the principal guide to a correct decision."

HINTS TO BEGINNERS.

REASONS FOR AND AGAINST USING A TRANSIT.

For.

The telescope enables you to see closer than you can with open sights, and that is all it has, in my estimation, to recommend it.

I should prefer a transit for village or city surveying, or for work on the prairie.

Against.

It is cumbrous and expensive. It takes too long to clear a path for it, and too long to set it at each station.

REASONS FOR AND AGAINST USING A SOLAR COMPASS.

For.

It is the most reliable instrument that I know anything about, and I believe it to be the best instrument for government surveyors.

Against.

When the sun does not shine it is no more reliable, and is a good deal more cumbrous, than a vernier compass. It is expensive—costs about four times as much as a vernier compass.

A man called twenty-five miles from home to do a day's work

with a solar compass may be obliged to wait three weeks to get sunshine enough to do it in.

REASONS FOR AND AGAINST USING A VERNIER COMPASS.

For.

It is as reliable as a solar compass when the sun does not shine and the solar compass is run by the needle.

A vernier compass with only a Jacob-staff is easily and quickly set up at stations, and is light and convenient to carry over logs, under brush, and through swamps and wind-falls.

The needle of a vernier compass is no more liable to deflection than the needle of a transit.

I think that if a county surveyor has forests to work in, and is only going to keep one instrument, he ought to use a vernier compass with six-inch needle. One costing from \$50 to \$60 will do any county surveyor's work with sufficient accuracy.

I can run a line with such a compass as straight as any man can build any ordinary kind of fence, and think it wasteful for my patrons to spend the time and money necessary to get a line, on which a fence is to be built, any nearer straight than they can build their fences.

I "run" a line a mile long last fall with only my ordinary care. Very few bushes and no trees were cut for me. Some of the parties interested were dissatisfied with the location of my line.

I told them if they could prove that my line was not straight they could move it.

They employed a man with an excellent transit. He told them they must clear a path for him. They did so, and he run it, and decided that there was a bow or bend in my line of just four inches.

If I had taken as much time and pains as he did it is likely that we should have differed less.

Against.

You cannot run so straight a line with a vernier compass as

with a transit, because you cannot discern a distant point so clearly with the naked eye as with a telescope.

It is not so reliable as a solar compass, because when the sun shines the solar compass is run regardless of the needle.

I am free to admit that I should like to own a solar compass, a transit, and a vernier compass; but few county surveyors receive pay enough to justify them in incurring so much expense.

NOTE.—*The above was written twelve years ago. I think now that I should prefer an instrument similar to Gurley's railroad compass, by which I could take angles independently of the needle.*

HOW TO CARRY YOUR COMPASS.

Have a brass cover over the glass to protect it when you are going to and from your work.

Take a strip of webbing $2\frac{1}{2}$ inches wide and 3 feet to $3\frac{1}{2}$ feet long (according to your height), and two strips of good harness-leather $1\frac{1}{4}$ inches wide and 10 inches long.

Double each strip of leather to form a loop. Sew one of them securely on each end of your webbing. When you need to carry your compass a half-mile or more slip one of the loops over the north end of your compass. Grasp your compass with your right hand—compass-face towards your body—and pass the webbing over your left shoulder, and the remaining loop over the south end of your compass, in front of you.

In carrying your compass from station to station grasp the north end of your compass with your left hand, palm up; the face of the compass being kept up, and let it rest on your left fore-arm and on your left hip.

I think this way safe and convenient. I have fallen a great many times while carrying a compass, but have never injured one by a fall.

KIND OF CHAIN TO USE, AND HOW TO KEEP IT CORRECT.

Use a two-pole *steel* chain, No. 12 wire. Your chainmen will keep a two-pole chain nearer straight and nearer level than they would a longer chain.

When you get your chain, stretch it on a floor or sidewalk and mark where the ends come. Test your chain occasionally by this measure, and if you find it too long take out one of the little round links.

Iron chains wear too fast. I have one, that has not been in constant use more than eighteen months, out of which I have taken seven round links or rings.

HOW TO DO UP YOUR CHAIN.

Take one end of the chain in your left hand ; then slide your right hand along the chain to the fourth link, and lay that in your left hand. Continue the operation to the last link. Your chain will then be in the form of a square, one link square.

KIND OF MARKING-PINS TO USE.

Use eleven pins (one to start from), made of No. 4 brass wire; then if your forward chainman comes up behind you when you are setting your compass, his handful of pins will not attract your needle, as iron or steel would. You will thus secure yourself against *one* source of error.

KIND OF FLAGS TO PUT ON THEM.

Take a strip of strong white cotton cloth, $1\frac{1}{4}$ inches wide and 5 inches long. and a strip of strong red flannel of same size, and stitch them together; and then stitch them into the top of your marking-pins.

Flannel alone wears out too soon. I find blue flannel conspicuous in the fall, when the leaves are red.

CHAINMEN.

Let your most intelligent chainman take the forward end of the chain. He will have more judgment in overcoming obstacles, and will straighten the chain more uniformly when he sets the pins, than his comrade would.

If you are obliged, as I am, to change chainmen every day or two, and take green American, German, French, Irish, Norwegian, Swede, Dane, Swiss, Scotch, and Englishmen, I think you will adopt the plan above recommended.

CORNER-STONES.

Before you set a stone for a corner set a marking-pin ten links from said corner. Measure off twenty links, and set another pin in such a direction from the first that the brass at the tenth link will hang over said corner. Let these two marking-pins stand while digging the hole for the stone.

Note the kind, color, length, breadth, and thickness of the stone, and, when practicable, cut a cross on its top or make a hole in it, and put bricks or broken dishes under it.

When the hole is deep enough drop in the stone. Stretch the chain between the two pins, and set the centre of the stone, or the mark on top of it, under the brass at the tenth link.

Urge your employers to have stones set, as in no other way can your work be made permanent.

WHERE TO CARRY YOUR MARKING-IRON.

Attach a loop of leather to it, and drop the loop over one of your boot-straps, carrying the iron inside your boot. If you carry it in your pocket you are liable to get it near enough to your compass to attract the needle.

POCKETS FOR BOOKS.

The pockets in which you carry your field notes should be encased in silk oil-cloth or rubber cloth. They should have covers with a strip of oil-cloth between the lining and the outside, and arranged to button. Then if you are caught in a shower your books and papers will keep dry. If you lie down to drink out of a spring or stream your books and papers will not slip out of your pockets into the water. I wear a short flannel or woollen overshirt, gathering and sewing the bottom of it into a belt of

the same material, which buttons around my waist, with outside breast-pockets.

Sometimes electricity is produced on the compass-glass by friction against clothing. Then one end of the needle adheres to the under-side of the glass. To dissipate the electricity touch the glass in several places with a wet finger.

To ascertain how to move your vernier in order to run farther to the left or right, sight towards some permanent object and move your vernier.

KIND OF FLAG-POLE TO USE.

A strip of inch board two inches wide and ten feet long will make a good one. (You need two of them.) Let it taper a little in width and thickness from bottom to top. Attach an iron point to the bottom. Paint one side of it any common color, and attach a block (in which is a small "level bulb") to that side, in such a way as to determine when the pole stands perpendicular.

Paint the other side of the pole in alternate stripes of bright red, white, and blue, making each stripe one foot long and half the width of the pole wide. Paint one edge of the pole red and the other white.

NOTE.—Suitable level bulbs (about $1\frac{1}{2}$ inches long) can be obtained of any instrument-maker. Blocks should be $2\frac{1}{2}$ inches wide, and set end of grain up. Excavate top end, set level bulb in it in plaster of Paris. Then fasten a piece of brass or copper, with a hole in it, over the top of the block to protect level bulb.

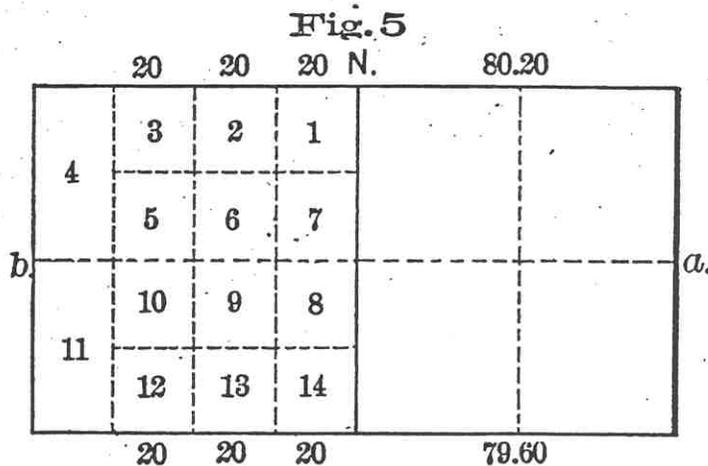
While setting level bulb you can plumb your staff by a plumb-line.

ANOMALOUS SECTIONS.

Occasionally there is much more land on the north or west side of a township than enough for the ordinary fractions.

In Township 25 North, of Range 15 East, in Wisconsin, the sections in the western tier are like this:

The extra divisions are called lots, and numbered as shown.



Remember that government only sets corners on the exterior lines of sections, and that all your lines must be straight from any given corner to the opposite corresponding corner—*e.g.*, from *a* to *b*.

DIAGRAM AND DESCRIPTION OF THE METHOD OF DESIGNATING THE DIFFERENT CORNERS IN A GOVERNMENT TOWNSHIP (FIG. 6).

The descriptions of corners, which you can procure from the District Land Offices, are given according to the diagram.

Examples.

The N. W. corner of section 5 is designated by 'B.

The S. W. corner of section 14 is designated as 14, 15, 22, 23.

The W. $\frac{1}{4}$ P. of section 21 is designated as R to C at 3.

The S. $\frac{1}{4}$ P. of section 8 is designated as I to H at 5. X

The meander corners are designated by the figures 1, 2, 3, etc., placed where the section lines strike the meandered stream.

REMARK 1.—At the section corners on the township lines there are usually four bearing-trees, at all other corners two trees; those at the quarter posts marked $\frac{1}{4}$ S. At interior section corners there are usually four trees marked—one in each section cornering there—with the number of the sections in which they stand; but the two bearing-trees may be distinguished by the B. T. marked on them near the ground, directly under the other marks on said tree.

N.B.—You may have to chop in six inches to find them.

REMARK 2.—On the Pacific coast the lettering of the above diagram would commence with A at the N. E. corner and pass around to the left.

REMARK 3.—I draw the quarter lines and number the quarter posts in red ink, and carry a copy of the diagram (double the size of this) with my copy of government Field Notes.

Fig. 6

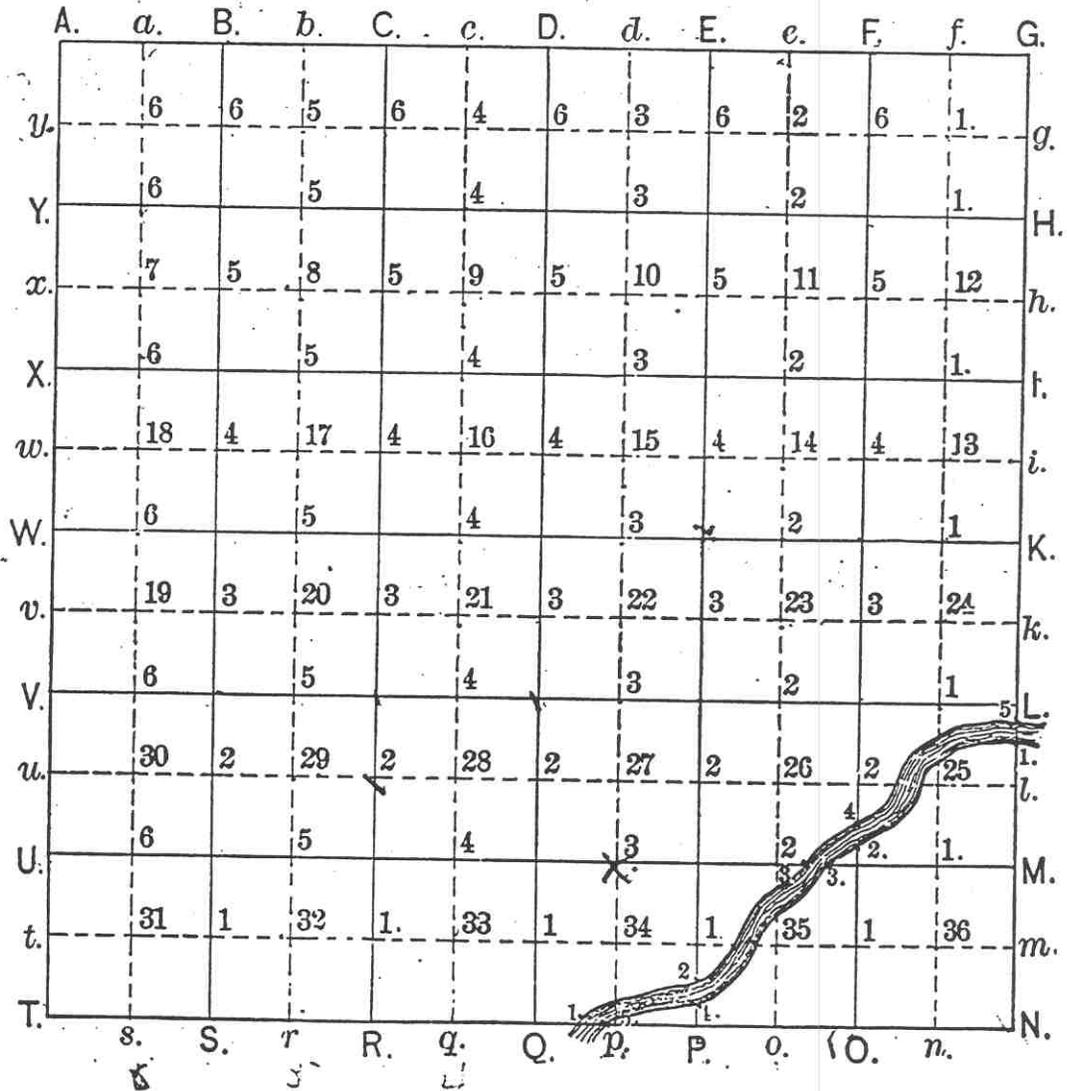
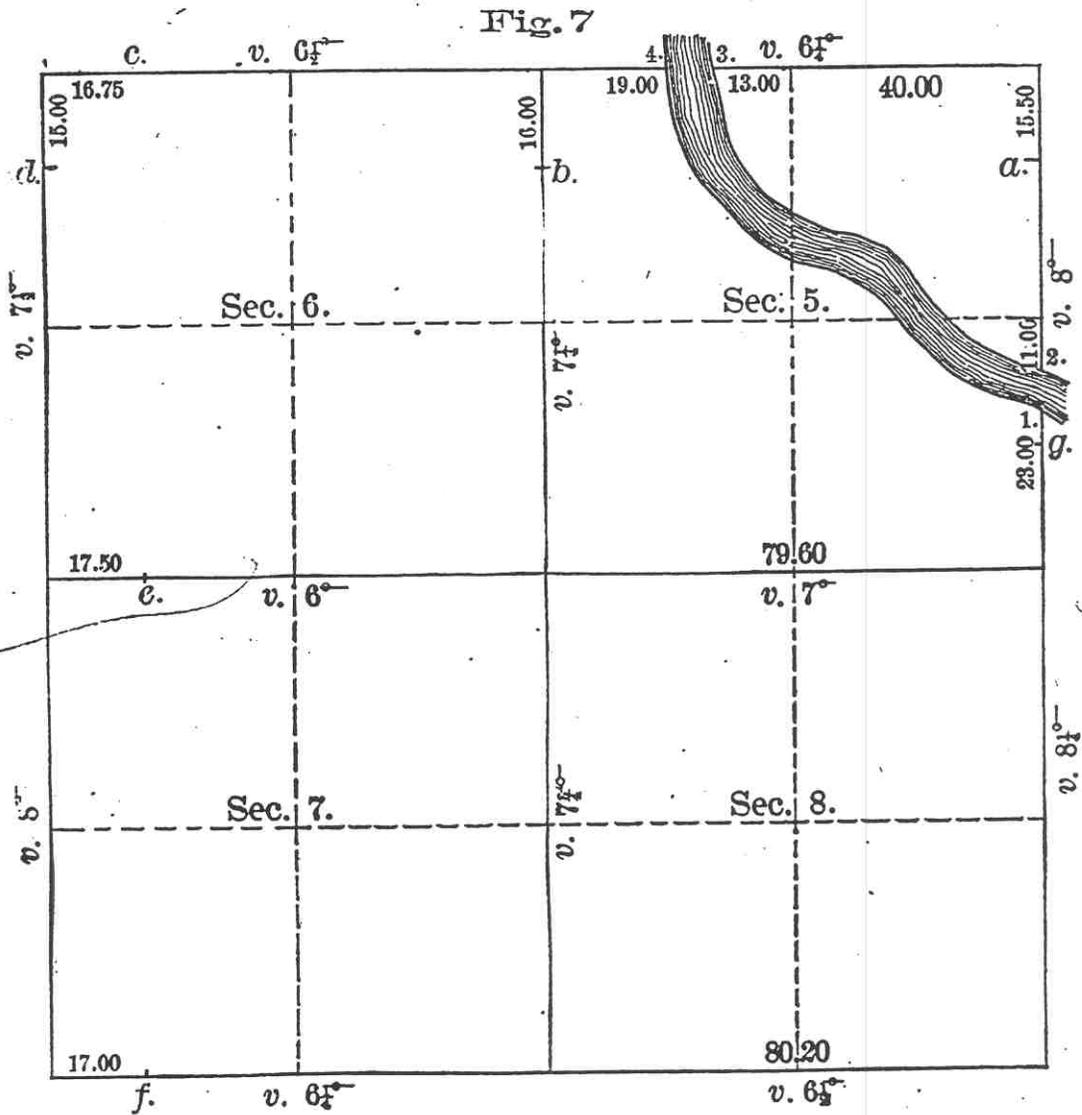


DIAGRAM SHOWING LENGTH OF LINES AS RETURNED BY THE GOVERNMENT DEPUTY SURVEYOR (FIG. 7).

The length of each line from section corner to quarter post is returned as $\frac{1}{2}$ mile, unless otherwise noted on the diagram. *a b c*, etc., are returned as being 20 chains from the nearest quarter post, and at the distance noted on the diagram from the nearest section corner.

The distance of each meander corner (1, 2, 3, 4) from the nearest government corner is also noted.

The length of lines is necessary in order to set the corners *a b c*, etc., and *g* correctly (see Rule 3), and also in case a section corner



becomes obliterated—*e.g.*, if the S. W. corner of section 5 was obliterated, the distance 79.60 would be needed in order to set said S. W. corner at a proportional distance between the south quarter post of section 5 and the south quarter post of section 6 (See Rule 7.)

REMARK 1.—This diagram should also give the numbers of the lots in the sections made fractional by the river.

REMARK 2.—There is not room enough on one of these pages to show a whole township, but the above diagram will show you the necessity of carrying such a diagram with you.

METHOD OF TAKING FIELD NOTES.

Sec. 22, Town. 23, Range 13. April 15, 1874.

MILTON STANLEY, } Chainmen
JOHN SIGLER, } sworn.

Comm. at N. W. cor. Pine stp. mkd. for cor. (Origl.) Stumps of original bearing-trees standing.

Thence South (ver. 7°) 82.48 chs. Varied East 1.52 chs. Found stubs of original B. trees stg. (West quarter post obliterated.)

Thence East (7°) 79.76 chs. Var. South 90 lks. N. E. tree stg. S. W. stump stg. (Origl.) (South quarter post obliterated.)

Comm. at E. $\frac{1}{4}$ P. Origl. trees stg.

Thence West ($6\frac{3}{4}^{\circ}$) 40.08
80.22 Var. S. 23 lks.

Comm. at N. $\frac{1}{4}$ P. Ogl. trees stg., but returned distance to S. W. tree one link too short.

Thence South (6°) 40.80
81.50 Var. E. 4 lks.

At centre of sec. set dark gray boulder $5 \times 6 \times 24$, with hole in top and broken dishes under it.

At West $\frac{1}{4}$ P. light gray boulder $3 \times 5 \times 22$.

At S. W. cor., gray boulder $5 \times 8 \times 18$, with hole in top.

At S. $\frac{1}{4}$ P., gray boulder $8 \times 10 \times 24$, with hole in top.

At $\frac{1}{8}$ between S. $\frac{1}{4}$'s, gray boulder $6 \times 10 \times 30$.

Thence West ($7\frac{1}{4}^{\circ}$) 19.97
39.96 Var. N. 30 lks.

S. $\frac{1}{8}$ on W. line, limestone $4 \times 6 \times 22$, with hole in top.

$\frac{1}{8}$ bet. W. $\frac{1}{4}$'s, flinty boulder $12 \times 12 \times 24$, with + on top.

Thence South ($6^{\circ} 20'$) 20.46
40.96 Hit it.

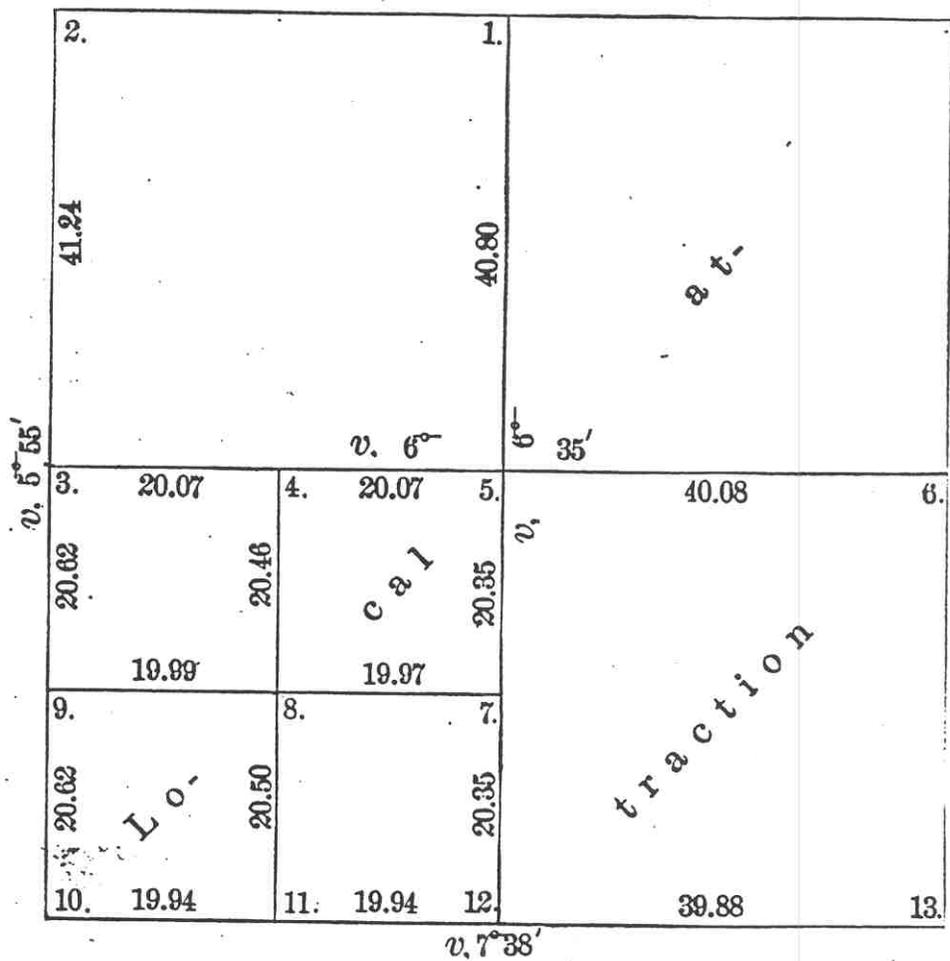
W. $\frac{1}{8}$ on S. line, gray boulder $5 \times 6 \times 18$, with hole in top.

Cen. S. W. $\frac{1}{4}$ } Tank. 20 N., 23 E., 19 lks.
 Ver. $6\frac{1}{2}^{\circ}$ } Birch. 10 S., 4 E., 39 lks.
 Considerable local attraction on this section.

METHOD OF RECORDING A SURVEY.

Plot and field notes of a survey made in Section 22, in Township 23 North, of Range 13 East, April 15, 16, and 17, 1874.

Fig. 8
N.



At 1. Origl. B. trees stg., but returned distance to S. W. tree one link too short.

At 2. Pine stp. mkd. for corner (Origl.)

At 2. Ogl. stps. stg. and notes correct.

- At 3. Origl. corner obliterated.
 At 3. (New) Light-gray boulder $3 \times 5 \times 22$.
 At 4. Flinty boulder $12 \times 12 \times 24$, with + on top.
 At 5. Dark gray boulder $5 \times 6 \times 24$, with hole in top and broken dishes under it.
 At 6. Origl. trees stg. and notes correct.
 At 7. Gray boulder $6 \times 10 \times 30$.
 At 8. Tamk. 20 N., 23 E., 19 lks.
 At 8. Birch 10 S., 4 E., 39 lks.
 At 9. Limestone $4 \times 6 \times 22$, with hole in top.
 At 10. Stubs of ogl. trees stg. and notes correct.
 At 10. Gray boulder $5 \times 8 \times 18$, with hole in top.
 At 11. Gray boulder $5 \times 6 \times 18$, with hole in top.
 At 12. Gray boulder $8 \times 10 \times 24$, with hole in top.
 At 13. N. E. tree and S. W. stp. stg. Notes correct.

MILTON STANLEY, } *Chainmen*
 JOHN SIGLER, } *sworn.*

Vernier for new corners, $6\frac{1}{2}^{\circ}$.

VERNIER TRIPOD,

County Surveyor.

REMARK.—It is necessary that the record of each survey should be separate and distinct, in order that when the copy of the record of a survey is called for to be used in court there may be no uncertainty about it.

FORM OF COPY OF COUNTY SURVEYOR'S RECORD TO CARRY WITH YOU.

REMARK.—The diagram on page 38 represents the S. W. $\frac{1}{4}$ of section 22 in 23—13.

I use "flat-cap" paper 14×17 inches. Put nine sections on each side of a sheet, making each forty-acre tract one inch square, as in the above.

This gives considerable space around the edge of the sheet, and two sheets will contain a whole township.

My reason for using both sides of the paper is that it makes less bulk to carry.

In recording, and in copy of record, I use red ink for numbering corners and for the bearings of lines.

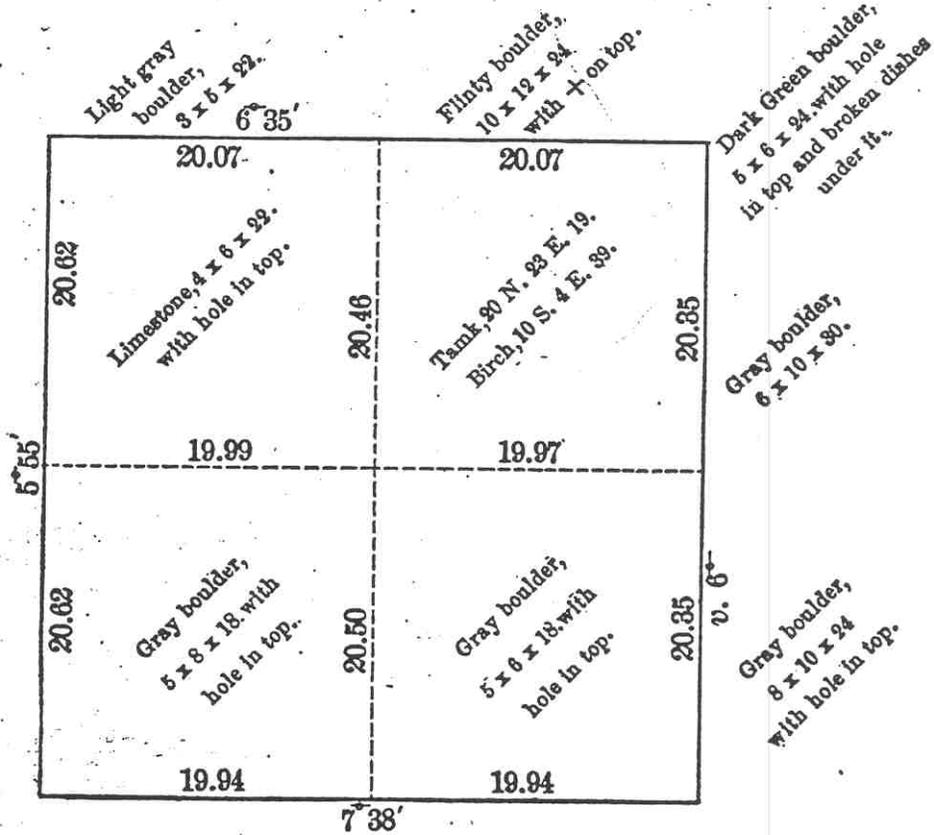


Fig. 9

FOUR METHODS OF CORRECTING A RANDOM LINE..

First Method.

Divide the distance varied by the distance run; the quotient will be the natural sine of the angle of correction.

Example.

Let A B (Fig. 10) be the desired line.

Commence at A with such a bearing as you *guess* will hit B.

At 1, 2, 3 (40 rods apart) set tally-stakes. At 39.78 chs. you find yourself 50 links too far to the right. Dividing 50 links by 39.78 chains, you have .0126 (nearly), which is the natural sine of B A C.

or the number of links that you have "run wild" on each chain in the length of your line. Looking in your table of natural sines, you find that the angle B A C is 43'. Set your compass at B. Move the vernier 43' to the left. Turn your compass till it indicates the bearing with which you started from A; then will your compass point towards A.

At 3, offset $3 \times .126 = .378$ chains, or 37.8 links.

At 2, offset $2 \times .126 = .252$ chains, or 25.2 links.

At 1, offset $1 \times .126 = .126$ chains, or 12.6 links.

REMARK.—If you refer to your traverse-table you will see that 40 chains with a bearing of 45' will cause you to vary 52 links. This serves as a check on the previous calculation.

Second Method.

Some surveyors would not run the line B A. The surveyor would leave his axeman at B and come to 3, and offset to 3'. He would then let his axeman blaze up to him. If the axeman could not see him, he (the surveyor) would yell, and let the axeman blaze to him by the sound.

Third Method.

(See Gillespie's "Land Surveying," pages 206 and 284.)

Multiply distance varied by 57.3, and divide the product by the distance run. The quotient will be the number of degrees contained in the angle B A C.

Example.

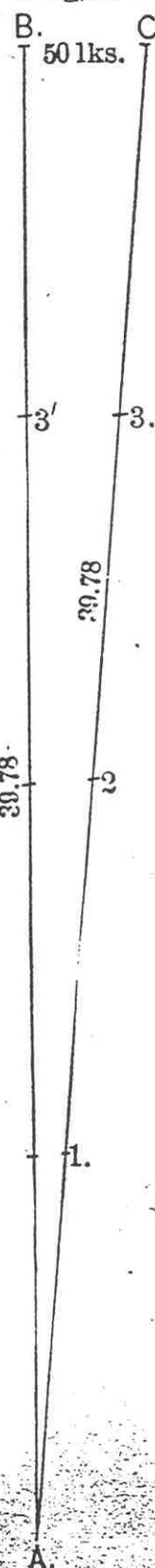
$$\frac{50 \times 57.3}{39.78} = \frac{2865}{39.78} = 72.02 \text{ degrees}$$

43.2120 minutes, the angle of correction.

Fourth Method.

Multiply the natural sine of 1' (one minute)—which is .00029—by the distance run, and divide the distance

Fig. 10



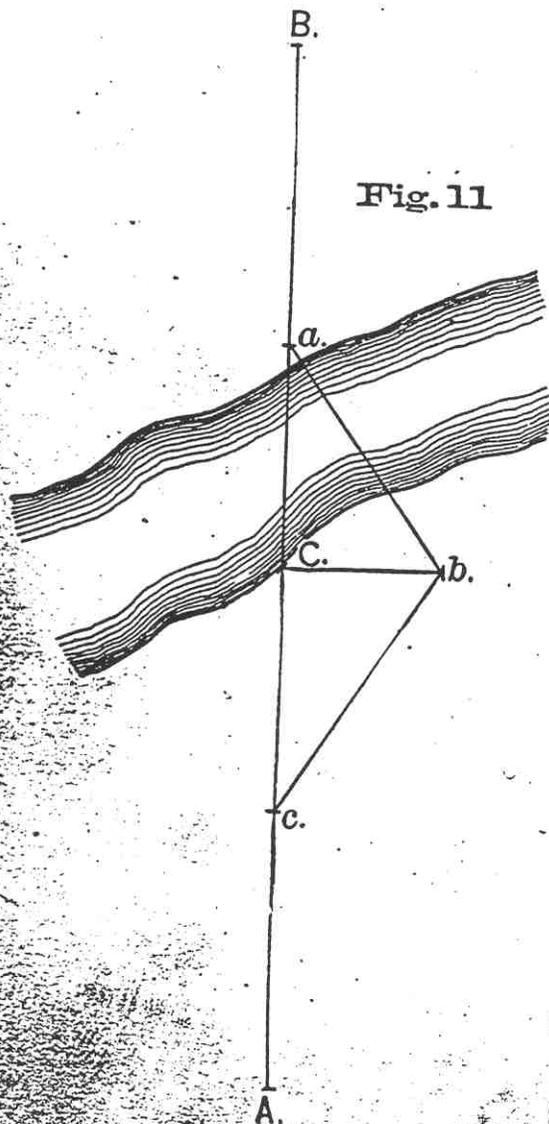
varied by the product. The quotient will be the number of minutes contained in the angle B A C.

Example.

$$\frac{.50}{.00029 \times 39.78} = 43 \text{ minutes, the angle of correction.}$$

REMARK.—I prefer the first method, for the reason that while you are finding the angle of correction you find the number of links to move tally-stake No. 1, and for the other stakes take multiples of that number.

REMARK.—I always “check” my calculation by referring to the traverse-table. In this case 40 chs. for 45' will give you 52 links.



TO FIND THE DISTANCE ACROSS
A STREAM.

1st. *Without any calculation.*

In running the line A B you reach a stream at C.

Set a flag on opposite bank at *a*. Then make an offset from C to *b* of any convenient distance—*e.g.*, four or six rods. Take the angle *a b C*. Then turn your compass till *c b C* equals *a b c*. Send a flag back on the line A B to *c*. Measure the distance *c C*, which will equal *C a*.

REMARK.—The above rule is convenient when the bank at C is cleared land and level; but if the land is bluffy or bushy the following is a better way:

Rule 2—Subtract *a b C* from 90° , which will leave *b a C*.

Then nat sine of *b a C*: nat sine of *a b C*:: *b C*: *a C*.

Example.

$a b C = 14^{\circ} 40'$; $90^{\circ} - (14^{\circ} 40') = 75^{\circ} 20'$; $C b = 150$ links;
 nat sine $14^{\circ} 40'$ is 253195; nat sine $75^{\circ} 20'$ is .967415.

$$.253195 : .967415 :: 150 : 573$$

Check by traverse-table, thus:

	Lat.	Dep.	} making by tra-
$14\frac{1}{2}^{\circ}$	5.81	1.50	
$14\frac{3}{4}^{\circ}$	5.80	1.53	

verse-table for $14^{\circ} 40'$

Lat.	Dep.
5.806	1.52.

Then

Dep.	My Dep.	Lat.	My Lat.
1.52	: 1.50	:: 5.806	: 5.73

NOTE.—If, on account of local attraction, the bearing from b to C differs from the bearing from C to b , move your vernier till they agree before taking the angle $a b C$.

Third Method.

From C set a flag at D and measure an offset to a .

From some point in $C a$ measure the offset $b c$.

Then

$$a b : a C :: b c : C D.$$

To get the point c let an assistant at a put your flagman in the line $a D$, while you put him in the line $b c$ with your compass.

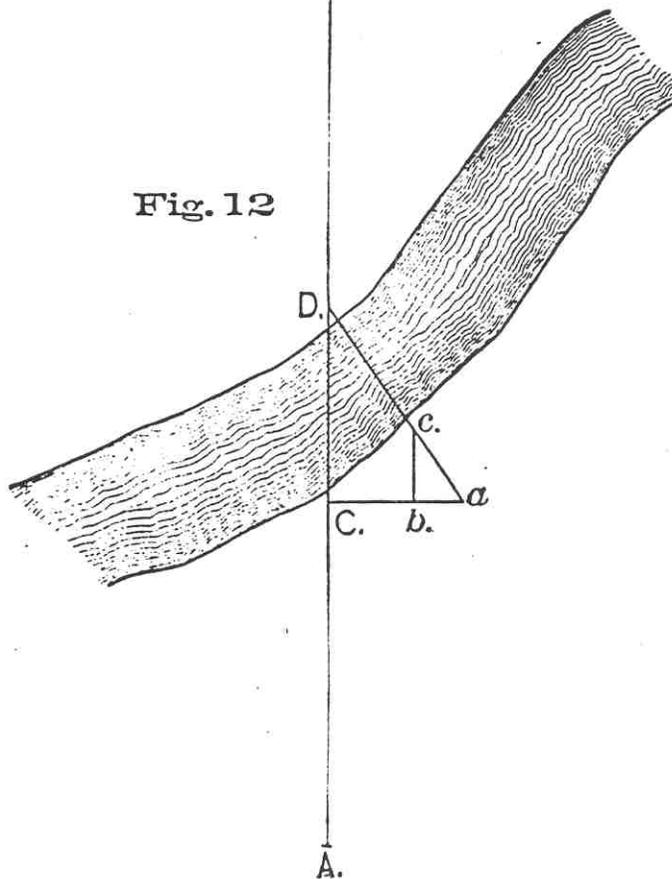


Fig. 12

Example.

Let $a b = 30$ links ; $b c = 70$ links ; $a C = 150$ links.

Then $30 : 150 :: 70 : 350$.

Fourth Method.

From C set a flag at c .

Then offset from C to a .

Run $a b$ parallel with C c .

The distance from a to b will equal the distance from C to c .

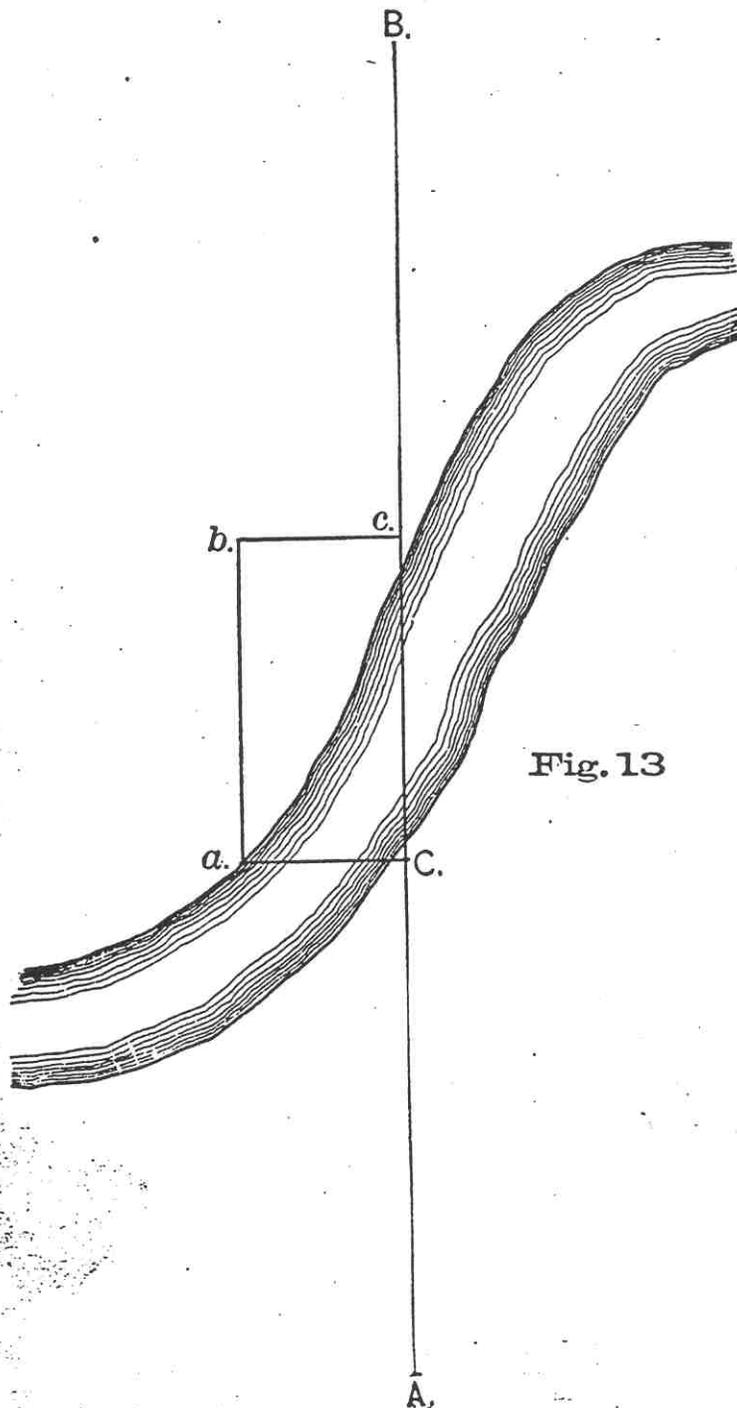


Fig. 13

WHERE YOU ARE
LIKELY TO FIND
LOCAL ATTRAC-
TION.

1st. In low, wet land where the timber is mainly black ash. [I almost always find local attraction where black ash grows.]

2d. Near the edges of tamarack swamps, and sometimes in and near cedar swamps.

3d. Near rocky bluffs.

REMARK.—If you sight back from each

station you will discover any local attraction that may affect your needle, and can guard against it.

In my early experience in surveying, while running a road through a forest, I wanted to strike a certain bridge, of whose direction from where I stood I was uncertain. I sent a man to the bridge to yell; run for him as near as I could guess, and missed him four or five rods. Found the distance to be about a hundred rods. Made a calculation for correction and run back, and hit the stake from which I had started. Felt sure I was all right, but when that hundred rods of road was cut out there was a bow in it of two rods.

HOW TO OVERCOME LOCAL ATTRACTION IN RUNNING A QUARTER LINE.

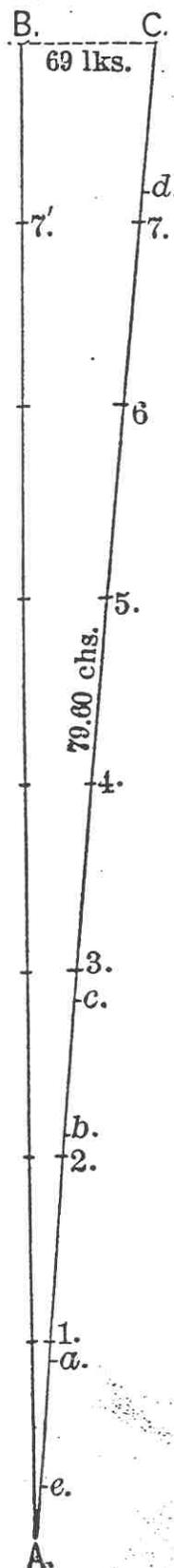
Let A B be a N. and S. quarter line. Commence at A with such a variation of the needle as you *guess* will hit B. Set a flag in the line A C at any convenient point denoted by *e*; move your compass to *e* and sight back to A. Your compass is then in the proper position for setting your flag ahead again. Continue this process till you reach a point C opposite B.

When running the random A C, set a tally-stake at 1, which is ten chains or forty rods from A; then set a smaller stake (*a*) in the line A C, three or four rods from 1. Near each tally-stake (denoted by 2, 3, 4, etc.) set a smaller stake at *b c d*, etc.

Then suppose that, after running 79.60 chs., you find yourself, not at B, but 69 links too far to the right. Dividing .69 by 79.60, you have .00867 as the natural sine of B A C. Looking in your table of natural sines, you find that the angle B A C is 30'. You will observe that your needle is of no use to you from the time you leave A till you reach C.

At C you will need to take the bearing of the line A C, in order to offset at right angles from C to B. While your compass stands in that position move the

Fig. 14
NORTH.



vernier till the needle points to N. Then measure the offset C B. Set your compass at B and move the vernier 30' to the left. Turn your compass till the needle points to S., and you can run a straight line by back-sights to A; but at 7 you will want to set that tally-stake over $7 \times .0867 = 60.7$ links.

Set your compass at 7, and turn it towards *d*. Move the vernier till the needle points to N. Then offset 60.7 links to 7'. Set your compass at 7', move the vernier to the left 30', turn your compass till the needle points to S., and proceed as before. You will probably find that the bearing of the line A C varies at each tally-stake; hence you see the necessity of the smaller stakes *a, b, c*, etc.

REMARK 1.—Of course the same principles would apply in running and correcting any random line where there is local attraction.

REMARK 2.—When running lines I set a stake in my line every 40 rods, or oftener if necessary. Some surveyors set them every 20 rods, and some as often as every 7 rods.

REMARK 3.—If Jacob-staff is used, you must see that it stands plumb at each station. You can plumb it by looking down the standard nearest to you.

If you strike a large tree or other obstruction, set your compass near the tree. Sight back on your line. Move vernier till N. end of needle agrees with course you are running. Then set on opposite side of tree and go ahead.

To find the angle which you need to turn off, in order to run to a given point, when you know the latitude and departure of said point from the point at which you stand :

Rule.—Divide the departure by the latitude. The quotient will be the natural tangent of the angle required.

Example.

Suppose you wish to run to a point that you know to be 60 rods farther north than you are, and 32 rods farther east than you are. Then $32 \div 60 = .5333$, and .5333 is nat tan of $28^{\circ} 5'$, nearly; you would run N. $28^{\circ} 5'$ E.

Suppose said point is 60 rods east and 32 rods north of you. Then $60 \div 32 = 1.875$, and 1.875 is nat tan of $61^{\circ} 55'$, nearly; you would then run N. $61^{\circ} 55'$ E.

REMARK.—This question occurs often in running new roads through forests. There are several rules for solving it, but I find the above the most convenient.

You can “check” in these cases pretty nearly by the traverse-table.

The north end of the needle moves west from eight A.M. to two P.M., and then slowly returns.

The side of a square acre is $3.16\frac{1}{4}$ chs, $208\frac{71}{100}$ feet, $69\frac{57}{100}$ yards, nearly 70 paces.

50×100 yards = 1 acre, very nearly.

TO MEASURE A LINE FROM A CORNER WHICH STANDS IN DEEP WATER
WITHOUT GOING TO THE CORNER.

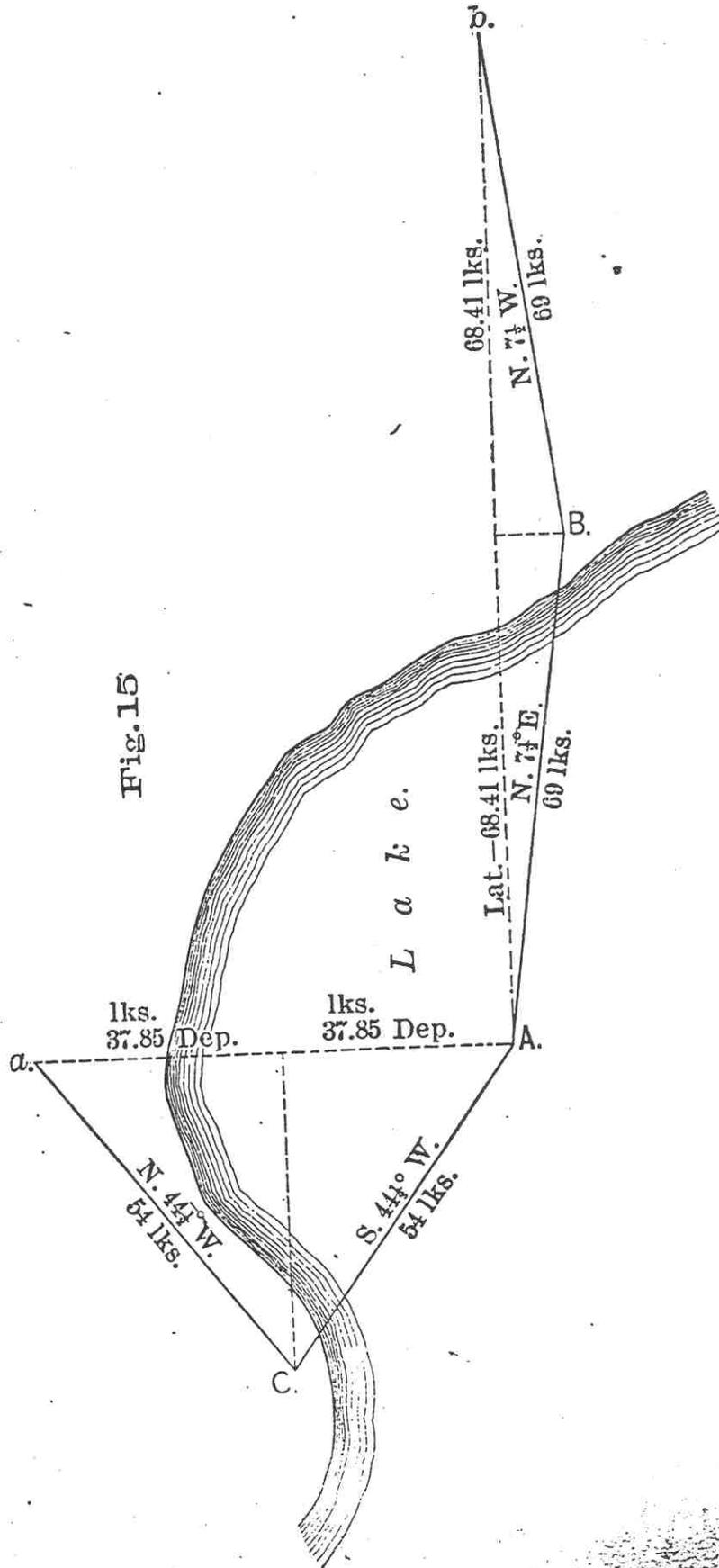
If you wish to run north or south from such a corner, set your compass at the bearing-tree which stands nearest north or south of said corner. Change the E. of the given bearing to W., or *vice versa*, as the case may require. With the new bearing measure the given number of links from said tree. You will then be due north or south of the given corner, and distant double the latitude given in your traverse-table for that course.

If you wish to run east or west from such a corner, set your compass at the bearing-tree nearest east or west of said corner. Change the S. of the given bearing to N., or *vice versa*, as the case may require. With the new bearing measure the given number of links from said tree. You will then be due east or west of said corner, and distant double the departure given in your traverse-table for that course.

Example.

Pine 24 N. $71\frac{1}{2}^{\circ}$ E. 69 lks. }
J. Oak 20 S. $44\frac{1}{2}^{\circ}$ W, 54 lks, } Corner in deep lake,

Fig. 15

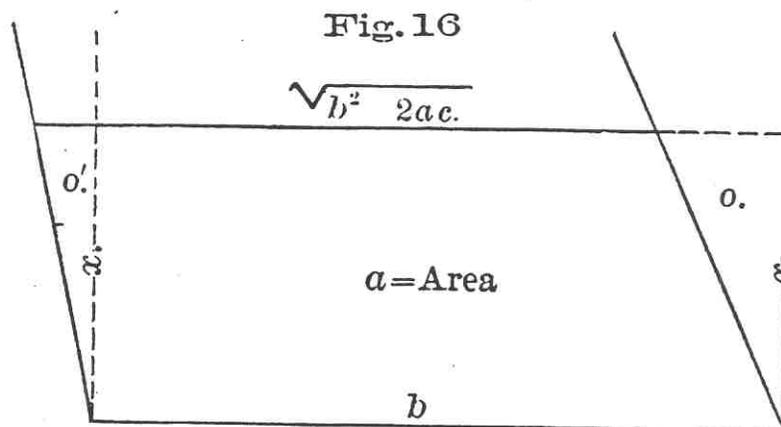


Let A be the given corner, }
 Let B be the Pine, } and the diagram will explain itself.
 Let C be the J. Oak, }

REMARK.—From the above you may easily deduce a rule for establishing bearing-trees for an inaccessible corner.

TO CUT OFF A CERTAIN NUMBER OF ACRES FROM THE SIDE OR END OF A FIELD WHOSE CORNERS ARE NOT RIGHT ANGLES.

1st. When one of the angles is acute and the other obtuse, and the lines converge.



$$c = \text{nat tan } o - \text{nat tan } o' \quad x = \frac{1}{c} (b - \sqrt{b^2 - 2ac})$$

Example.

Let 8 acres, or 80 square chains, be the amount required.

Let $o = 31\frac{1}{2}^\circ$, and $o' = 13\frac{3}{4}^\circ$, and $b = 20$ chs.

The nat tan of $31\frac{1}{2}^\circ$ is .061163, of $13\frac{3}{4}^\circ$ is .030553.

See P. 47

Hence

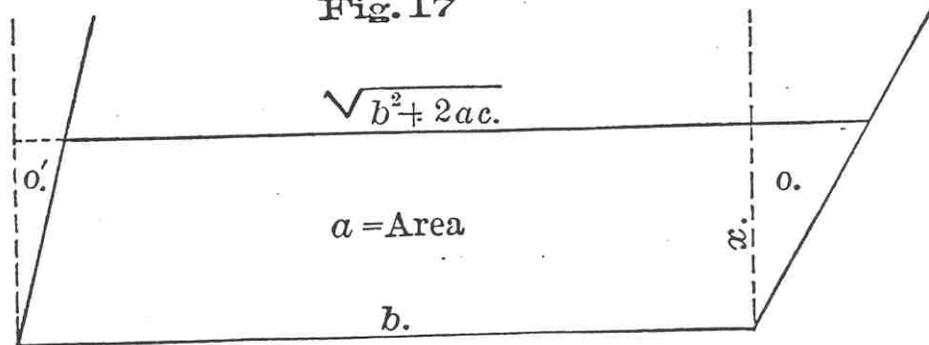
$$c = .061163 - .030553 = .03061$$

$$x = \frac{1}{.03061} \times [20.00 - \sqrt{400.00 - (2 \times 80 \times .03061)}]$$

$x = 4.015$ chs., width of strip to be cut off.

2d. When one of the angles is acute and the other obtuse, and the lines diverge.

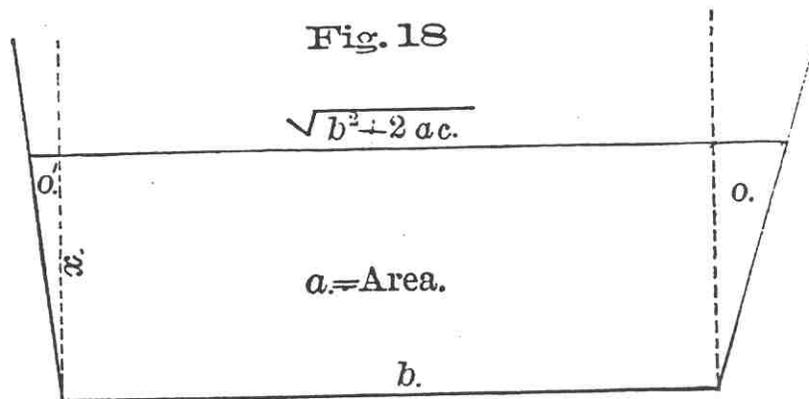
Fig. 17



$$c = \text{nat tan } o - \text{nat tan } o' \quad x = \frac{1}{c} (-b + \sqrt{b^2 + 2ac})$$

3d. When both angles are obtuse.

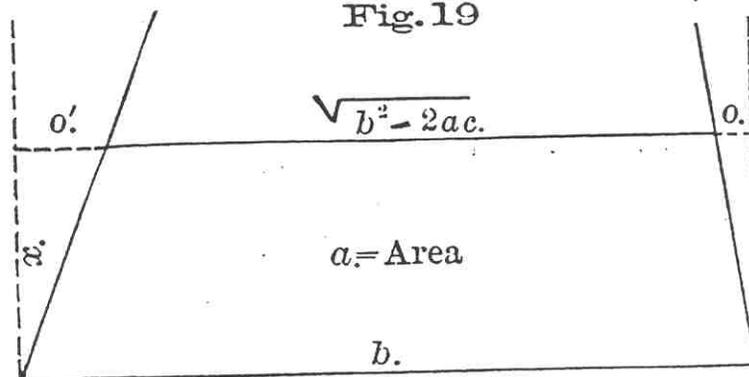
Fig. 18



$$c = \text{nat tan } o + \text{nat tan } o' \quad x = \frac{1}{c} (-b + \sqrt{b^2 + 2ac})$$

4th. When both angles are acute.

Fig. 19



$$c = \text{nat tan } o + \text{nat tan } o' \quad x = \frac{1}{c} (b - \sqrt{b^2 - 2ac})$$

AMOUNT OF ERROR NECESSARY TO VITIATE A SURVEY.

How far from the point at which a corner ought to stand may a corner (set by some previous county surveyor) be, and still be allowed to stand as a proper corner? or, in other words, how small an error in surveying will vitiate a survey?

In France, $2\frac{1}{2}$ feet in measuring 80 rods is the greatest allowable error.

But I think, taking into consideration the kind of chainmen we are obliged to accept, the value of our land, and the obstacles to correct measurement which we meet, that if a corner stands within 3 feet of where it should we ought to recognize it as a valid corner.

HOW TO CARRY YOUR COPY OF THE COUNTY SURVEYOR'S RECORD.

Carry it in a tube $1\frac{1}{2}$ inches in diameter and 15 inches long, made of harness leather with brass cover, and strapped on your back.

That will be large enough to carry one township—diagram and copy of record.

WHAT BOOKS YOU NEED.

You ought to have Gillespie's "Surveying," Hawes's "Manual," and Dunn's "U. S. Public Land Laws," and any other work on surveying that you can afford.

Gillespie's "Surveying" is the most complete work on surveying published in our language. For sale by W. & L. E. Gurley, Troy, N. Y., or D. Van Nostrand, 23 Murray Street, New York.

In Hawes's "Manual" you will find much valuable information in regard to government surveying. For sale by J. B. Lippincott & Co., Philadelphia, Pa.

Dunn's "U. S. Public Land Laws" contains more than 700 decisions of the Supreme Courts of the various States, in which many more decisions are referred to. You will find some conflict of opinion in these decisions. I am informed that the opinions

from the Southern States have less weight in our courts than those of Massachusetts, New York, Ohio, and Pennsylvania. As I understand the Laws and Instructions, some of the State court decisions would fail in the U. S. Courts. For sale by Engineering News Publishing Co., New York.

CASES OF GREAT DISCREPANCY

BETWEEN THE GOVERNMENT FIELD NOTES AND THE ACTUAL GOVERNMENT SURVEY.

Sec. 5, T. 40 N., R. 10 E., Wisconsin. The U. S. Field Notes call the east line of this section about $\frac{7}{8}$ of a mile long. At about 80 rods north of the S. E. corner the Notes call for the Wisconsin River, with meander trees on the south bank. The trees are there. At about 40 chains north of the S. E. corner the Notes call for the Wisconsin River again, with the quarter post in the river. Then for the N. E. corner $\frac{3}{8}$ of a mile farther north, in a tamarack swamp. As a matter of fact the north line of the township passes along within a few feet of the point at which the E. $\frac{1}{4}$ P. of 5 is located, and the $\frac{3}{8}$ of a mile farther north never existed except in the imagination of the deputy-surveyor. He had made a mistake in running up this tier of sections, and rather than go back and correct his mistake he lied $\frac{3}{8}$ of a mile.

The east line and the west line of Sec. 5 both strike the township line about 20 rods east of the corners set on said line for the sections in the next township north. The Field Notes call for about 120 rods instead of 20 rods.

I think this last discrepancy is caused by an error in calculating the distance across Catfish Bay, on the south line of section 35 in this township.

Sec. 3, T. 39 N., R. 10 E., Wisconsin. The Field Notes call for about $\frac{3}{8}$ of a mile between the E. $\frac{1}{4}$ P. and the N. E. corner of this section; but if you go $\frac{2}{8}$ of a mile north of the E. $\frac{1}{4}$ P.

you will find the township line. Then if you wish to see the N. E. corner you will have to go more than a hundred rods west. The course from the E. $\frac{1}{4}$ P. to the N. E. corner is said to be more than 50° west of north.

A part of this discrepancy is caused by the error in calculating the distance across Catfish Bay, above mentioned.

Sec. 14, T. 31 N., R. 11 E., Wisconsin. If you start at the S. W. corner of section 14, and run east 76 rods, and then north 20 rods, you will find two trees marked for a $\frac{1}{4}$ P.; but they are about 90 rods from where the government Notes say the $\frac{1}{4}$ P. is, and *do not agree* with the Notes in *any* particular. In a suit tried in Circuit Court these trees were ignored, and the $\frac{1}{4}$ P. established equidistant from the section corners.

Sec. 5, T. 40 N., R. 10 E., Wisconsin. The irregularities of this section caused a lawsuit. Four surveyors who were called as witnesses differed in opinion as follows: A thought the E. line should run from the S. E. corner to a point in the township line 121 rods E. of the S. E. corner (5) of Sec. 32, 41-10, and that the E. $\frac{1}{4}$ P. should be on such E. line, and 40 chs. from the S. E. corner.

B thought the E line should run from the S. E. corner to the M. C. found at 1, and from there to the point on the township line adopted by A; and that the E. $\frac{1}{4}$ P. should be set at such distance from the S. E. corner—measuring on this crooked line—as would be proportional to the “returned distance” from the M. C. at 1 to the N. E. corner.

C thought the E. line should be run from the S. E. corner to the M. C. found at 1, and the line between these two points prolonged till it reached the Wisconsin River, and the E. $\frac{1}{4}$ P. set on this line at 40 chs. from the S. E. corner.

D agreed with C, except that he would put the $\frac{1}{4}$ P. in the river at such distance from each bank as would be proportional to the “returned distance” between 3 and 4.

Practically, and in harmony with the theory of the survey of this township, D's method is the proper one; and if the stream was not meandered, but 3 and 4 were witness corners instead of

meander corners, D's method would be the correct one. But technically there is and can be no E. $\frac{1}{4}$ P. in this case, and the $\frac{1}{4}$ line should run from the W. $\frac{3}{4}$ P. parallel with the south line of the section (because the south line is the base of survey for this section) till it strikes the river, and no farther.

N.B.—The meander corners at 2, 3, and 4 are obliterated.

The four surveyors and two woodsmen testified to finding the N. W. corner (*a*), the W. $\frac{3}{4}$ P. (*b*), the S. W. corner (*c*), and the S. E. corner (*d*), and several of them to finding the M. C. at 1; but the counsel for defendant took the position that this section had never been surveyed, and that it must be subdivided *pro rata*, or proportionally; and because of the ignorance on this subject that is common to judges, lawyers, and others, it was so decided, causing the plaintiff to lose at least \$800 that was *legally* his due.

NOTE.—*The E. line of this section should be run from the S. E. corner to the river on the line from d to 1 prolonged. See Billingsley vs. Bates, 30 Ala. 378. Permanent objects such as rivers control. See 21 Howard (U. S.), 305.*

It is a surveyor's duty to *fill all the calls* in the deed or patent that he *possibly can*, and in this case he could not very well ignore the river, especially as the N. E. corner was obliterated.

REMARK 1—You will wonder why A run to *x* for his N. E. corner. The Field Notes say the N. E. corner is 30.24 chs. east of the S. E. corner of Sec. 32 in the next township north. There is no sign of a corner there (at *x*), but if the river were not called for in the Notes *x* would be the proper place at which to locate the N. E. corner of section 5.

If the river were not called for a second time B's survey would be correct.

In all the decisions of the Supreme Courts you will notice that whenever a river is mentioned they stick to the river.

REMARK 2.—In considering this case you will probably conclude that surveying affords an opportunity for the exercise of skill, research, judgment, and common sense; that the ability to run a straight line is not sufficient—you must know where to run it.

marked $\frac{1}{4}$ S., but they do not agree with the Field Notes in any particular, and so are ignored. I established the S. W. corner of 9 at *b* by proportional measurement.

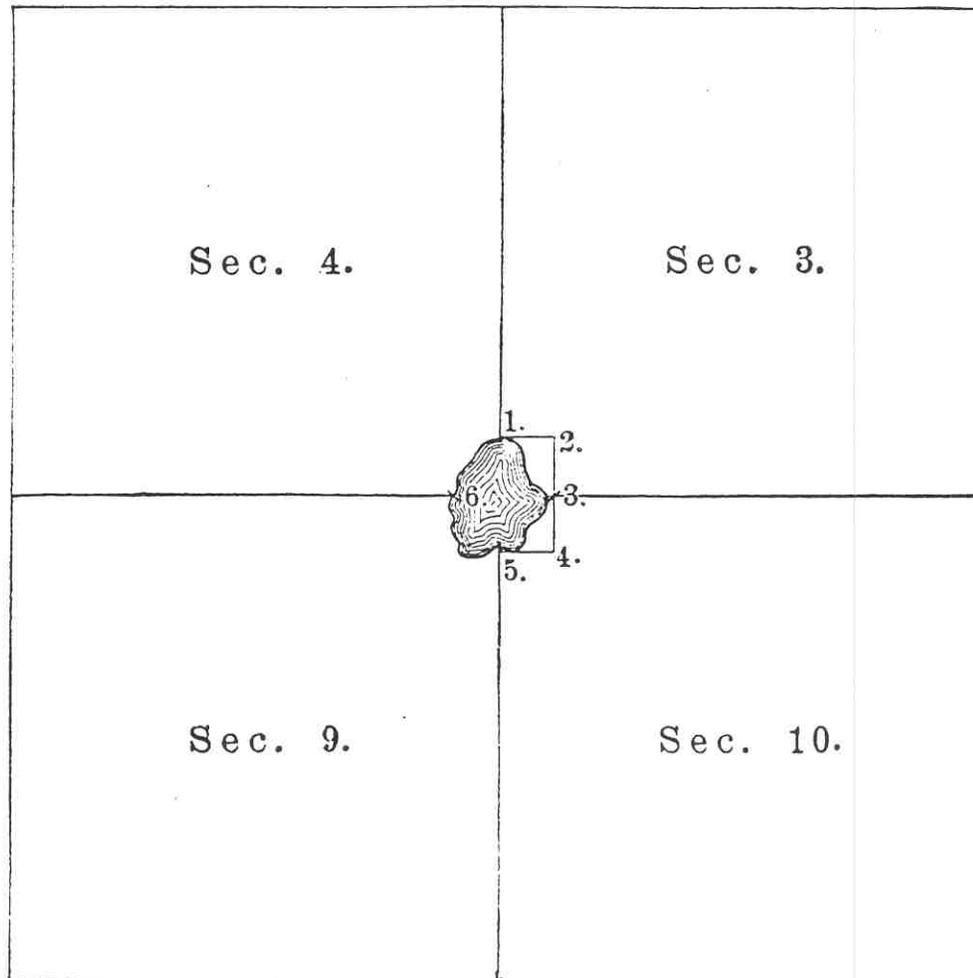


Fig. 22

Suppose that a section corner—*e g.*, 3, 4, 9, 10—is in a lake, and that 1, 3, 5, 6 in the above diagram represent meander or witness corners, and that 3 is obliterated. If there was ice on the lake that I could work on, I would establish the section corner in the lake at distances proportional to the “returned” distances from 1, 3, 5, and 6, and where a line from such section corner to the S. $\frac{1}{4}$ P. of section 3 struck the lake shore I would re-establish the missing corner.

If there was no ice on the lake, I would run and measure the line

1, 2, 4, 5, and re-establish 3 at such distances from 2 and 4 as would be proportional to the "returned" distances of the section corner from 1 and 5.

THE BEARING-TREES CALLED FOR IN THE NOTES
WILL HOLD.

Secs. 9 and 10, T. 33 N, R. 10 E., Wisconsin.

Near the point at which the $\frac{1}{4}$ P. between 9 and 10 should be is a hard maple marked $\frac{1}{4}$ S. It is evident the tree was marked when the original United States survey was made, but the Notes do not call for a maple. About 13 rods south of this marked maple is a hemlock and a birch—both marked $\frac{1}{4}$ S.—and they agree with the United States Notes in every particular, but the letters and figures have been partially chopped off a long time ago.

A similar state of affairs exists $\frac{1}{2}$ mile north. Of course the trees that agree with the Field Notes will hold. It is supposed that the deputy surveyor found he had made a mistake on that line; that he made new corners, and defaced the old ones, but forgot to change his Field Notes.

Technically the *bank* of a body or stream of water is the line where vegetation ceases, and the *shore* is the space between such line and *low-water mark*. See Dunn's "Land Laws," No. 390.

The owners of land or lots adjoining a highway or street own to the middle of such highway or street, unless otherwise specified in deed. See "Land Laws," Nos. 407 and 408.

But the owner has no right to place or leave in such highway or street any obstruction—not even a wheelbarrow or a wagon.

The owner of land on the bank of a stream of water owns to the middle thread of the current—even the Mississippi River, or any other meandered stream (except where the tide ebbs and flows)—unless otherwise specified in deed. See numerous decisions quoted in No. 250, "Land Laws."

But this gives the owner no right to obstruct navigation.

Land bordering on a meandered lake is bounded by low-water mark.

A meander line is not a boundary line. See 7 Wallace (U. S.), 272, and Jones vs. Soulard, 24 Howard (U. S.), 41; also, Kraut vs. Crawford, 18 Iowa, and the numerous authorities therein quoted.

Some men, who ought to know better, hold that some corners are less binding than others—*e.g.*, that a $\frac{1}{4}$ post is not entitled to as much consideration as a section corner. The fact is that even a witness corner is as really a *monument* as a township corner (a witness corner may witness, and thus establish a township corner), and a *monument* will hold the point at which it is placed as long as it can be identified. Therefore any government corner is entitled to as much consideration as any other government corner.

A *witness* corner is one that is placed on the bank of a body or stream of water when a regular corner would come in the water. The field notes show the distance and direction of the regular corner from the witness corner.

WHAT A "MARKED" LINE IS.

The United States law says the lines actually run and *marked* shall be the boundaries. The Instructions direct that the trees nearest the line run—even two rods from it, if there are none nearer—shall be blazed. These only indicate the proximity of the line. The "sight" trees—those which the line actually passes through, and are marked with two notches on each side, and are called for in the field notes—mark the line.

REMARK.—When you find blazes near or on a line that appear to be as old as the survey, it is not certain that they were made by the surveyors. Such blazes are often made by hunters, trappers, or land hunters,

It is a surveyor's duty to retrace the original survey as nearly as possible, to fill or answer as many "calls" in the deed or patent as possible; hence it is necessary that he have the field notes of the original survey.

Government claims infallibility in its length of line and course of line; hence if your chaining does not agree with the "returned" distance, your chain is held to be too long, or too short, as the case may be, and you must resort to proportional measurement. From the S. E. corner of section 31, 37-11 Wisconsin to the E. $\frac{1}{4}$ Post it is N. 20° E. 30.00 chs.; but the Field Notes say it is north 40.00 chs., and it is *held* to be north 40.00 chs.

And yet this is the only practical way to get along, and it rarely works any serious harm to any one. It is more important that our boundaries be permanent than that they be where they ought to have been placed. Want of permanence would result in endless litigation.

Whenever you write out a "survey bill" for a road or a description of land in a deed, remember that north, south, east, and west are too indefinite terms to use in such description or "survey bill." If any of your lines are on section, quarter, or eighth lines, or parallel with or at right angles with such lines, SAY SO. Say north on a line, or as the case may be.

Indefiniteness in description has caused thousands of dollars to be spent in litigation.

Never use the bank of a body of water for a starting-point. Establish some monument by which your starting-point can be identified 1,000 years hence.

I know of a city in which the starting-point for surveys is a stone in the N. E. corner of a certain well. Suppose the well should cave in?