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ELEMENTS
OF
MILITARY SKETCHING
AND
MAP READING

BY
CAPTAIN JOHN B. BARNES
FIFTH U. S. INFANTRY

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PREFACE

THE publication of this book was undertaken with a view of providing a text-book suitable for beginners in the subject of Military Sketching.

To the original book has been added chapters on Map Reading and Landscape Sketching.

The diagrams in the first seven chapters were executed by Captain P. A. Larned, 10th Infantry.

J. B. B.

May 1, 1917.

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ELEMENTS
OF
MILITARY SKETCHING

CHAPTER I

SCALES

A PRACTICAL knowledge of sketching is an important part of the military education of officers and non-commissioned officers. When maps of the country are not available, commanders try to obtain sketches as guides in marching, and in the selection of combat or outpost positions, camp sites, etc. Such sketches must be made by members of the command.

A *topographical map* is a graphical representation, or pen picture, of a portion of the earth's surface. It is made with survey instruments and is supposed to be accurate.

A *sketch* is a crude map, made without accurate instruments for measuring distances, directions, or ele-

vations, usually made hastily, and often with little opportunity for reconnoitering the ground. Sketches are of two general classes, viz.: ROAD SKETCHES and AREA SKETCHES. Area sketches are of three kinds: (*a*) *Position,* (*b*) *Outpost,* (*c*) *Place* sketches.

A ROAD SKETCH is one of some particular route passed over by the sketcher, showing the direction, distance, elevations, description of the bridges, fords and all other important topographical features on the road and for a distance of three or four hundred yards on either side. (Fig. 29.)

A POSITION SKETCH is one made by a sketcher who has access to all parts of the area sketched. It shows all the topographical details, as in a road sketch, of some military position or extended area. (Plates *A* and *B,* and Fig. 31.)

An *outpost sketch* is one of the ground along a friendly outpost line, and as far towards the hostile position as practicable. The sketch is necessarily made from the rear or along the line of observation. Points are located by intersection, or by traversing, i. e., passing over the ground.

A *place sketch* is one of an area, made by a sketcher from one point of observation, as the proximity of the enemy prevents moving about. Distances are estimated and directions taken by sighting along the ruler or pencil.

To be able to make an acceptable sketch (frequently

under adverse conditions) requires a knowledge of the principles and a proficiency in execution that the average man acquires only by considerable practice.

All military sketches are made *to scale*; that is, one unit of length on the sketch represents a certain number of like units on the ground represented by that sketch. For example, if the scale of a sketch is 3 inches to one mile, any distance of three inches on the sketch represents a corresponding ground distance of one mile, and one inch on the sketch would represent one-third of a mile on the ground, etc. When the sketch is completed the scale to which it is drawn should be indicated on it. It may be expressed in one of three ways:

(*a*) In *words* and *figures*, as, 3 inches=1 mile; meaning that 3 inches on the sketch or map represent 1 mile on the ground.

(*b*) By what is known as "REPRESENTATIVE FRACTION" (abbreviated R.F.)—a fraction, the number above the line showing units of length on the map, while the number below the line shows the corresponding distance on the ground represented by the map, thus:

R.F. $\frac{1}{21120}$ means that 1 inch, or 1 unit of any measure on the map, represents a distance of 21120 inches, or units of that measure, on the ground. If the scale of a map were 4 inches to the mile, then 4 inches

would represent 63360 inches (1 mile) on the ground, or,

$$R.F.\ \frac{4}{63360}\ \frac{\text{(map distance)}}{\text{(ground distance)}},$$

as the R.F. is usually written with the numerator unity, we would have:

$$\frac{4}{63360} = R.F.\ \frac{1}{15840}.$$

(*c*) The scale may be represented *graphically*. A graphical scale is a line of any length drawn on a map or sketch and divided into parts, each part being marked, not with its actual map length, but with the ground distance which it represents. For example, instead of writing 3 inches=1 mile, we may draw a line 3 inches long on the map and mark it 1 mile. Subdivisions of this line represent shorter distances and are marked with their respective values.

The scales on American (military) maps and sketches are:

1 inch (approximately) to the mile, or $R.F.\ \frac{1}{62250}$ (Geographical Survey Maps).

3 inches to the mile, or $R.F.\ \frac{1}{21120}$ (Scale used for road sketches).

6 inches to the mile, or *R.F.* $\frac{1}{10560}$

(Scale generally used for area sketches).

12 inches to the mile, *R.F.* $\frac{1}{5280}$

(Scale used for fortification plans, war game maps, etc.).

Less frequently used are the scales of 2 inches to the mile: $\left(R.F. \frac{1}{31680}\right)$, and 4 inches to the mile $\left(R.F. \frac{1}{15840}\right)$.

The scale reading yards, meters, miles, etc., usually found on a completed map is called *"reading scale."* In making a sketch, however, a *"working scale"* is used.

The distances on the ground may be measured by pacing, taking the time of a horse's trot or walk, counting telephone poles, and multiplying by their interval, counting the revolutions of a wheel, by speedometer, estimation, etc. In any case it will be necessary to have a "working scale"—that is, a scale of units of length used in *measuring the ground distances.*

The units of length of any reading scale are of a fixed and standard value such as yards, meters, miles, etc., while the value of the units of any working scale depends on the means used for measuring the distances.

The working scale does not appear on the completed sketch.

Our regulations prescribe that road sketches be made to a scale of 3 inches to the mile, (contour intervals 20 feet), and area sketches 6 inches to the mile, (contour interval 10 feet). These two scales are the only ones you will probably ever use.

The usual means of measuring ground distances is by pacing, or, when mounted, taking the time of a horse's trot or walk. You can determine the length of your pace in inches by stepping over a known distance two or three times, using your normal pace. To give the most accurate results, the course should be several hundred yards in length and over undulating ground. The average man steps from 30 to 36 inches. The average horse covers a mile in 8 minutes at a trot and in 16 minutes at a walk. In "gaiting" a horse a course of at least a mile should be gone over several times at a trot, and at a walk. In making a scale for pacing use a *stride* (a double step) as the unit of measure, counting each time your left (right) foot strikes the ground.

Assume that it is desired to make a road sketch, scale 3 inches to the mile, distance to be measured by pacing. You must have a working scale of your paces, or strides. You find that your stride is 60 inches. You will take an average of 1056 strides in covering a mile (63360 inches divided by 60). You might draw a line 3 inches long and divide it into 1056 equal parts,

each part representing one stride, but as such number of divisions is not practicable to make or work with, a smaller number of divisions each representing a certain number of strides should be made. Also, instead of having a scale of a length to represent exactly 1056 strides, you will find it more convenient to have the line represent 1000 or other even number. Take 1000 for example.

You can find the exact length of this scale by a simple proportion:

$$1056 : 1000 : : 3 : x = 2.84.$$

A line 2.84 inches long equals 1000 of your strides. In other words, when you have completed 2.84 inches of your sketch you will have covered a distance equal to 1000 of your strides. Because in making a sketch you will have to plot (draw in) the features at various distances, you must so divide your scale that you can plot from it any desired number of strides, as 25, 100, 500, etc.

To actually construct the above scale, draw a line 2.84 inches long, taking the distance accurately from your ruler (*A*—*B* Fig. 1) and divide it into a number of equal parts; 5 parts would be a convenient number in this case, each part representing 200 strides. To accurately make this division, draw the line *A*—*C* an indefinite length and from your ruler lay off 5 spaces of an equal and convenient length on it, beginning at

A. Now draw a line from the 5th division on *A*—*C* to *B*. Draw lines parallel to this line through the other 4 points on *A*—*C*, cutting *A*—*B*. *A*—*B* is now divided into 200 stride lengths. As smaller divisions should be

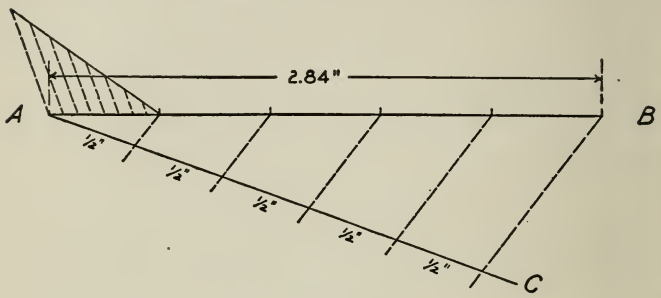


FIG. 1.

made, by the same method divide the first division on *A*—*B* to read 25 strides. Now erase all the lines except *A*—*B*, mark the subdivisions with their respective values as in Fig. 2 and you have the completed work-

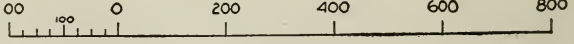


FIG. 2.

ing scale by which you may plot from 25 to 1000 strides. Distances smaller than 25 strides take from your scale by estimation. A scale is more convenient to work with if constructed to read even hundreds, or divisors of one hundred of the unit of measure.

By actual trials over a measured course a horse is found to trot a mile in an average of 7 mins. 40 secs. Then 7⅔ minutes equals 1 mile, or 1760 yards. Select 10 minutes as a convenient value for your scale;

$$7\tfrac{2}{3} : 3 : 10 : x = 3.9 = 10 \text{ mins.}$$

Using the method described above construct a working scale 3.9 inches long to read minutes of trotting and subdivide the first division to read 10 or 15 seconds.

In figures 2B, 2C and 2D scales are accurately constructed for sketches 3 inches to the mile for pacing, and by taking the time of a horse's walk or trot. The one desired can be taken off on a piece of cardboard and thus save actual construction. If a scale of strides is desired, divide the number showing the total length in paces by 2, changing the intermediate values 4, 8, 12, 16, etc., to read 2, 4, 6, 8, respectively. To use these scales in making a sketch 6 inches to the mile, it must be remembered that the subdivisions will have just half their original numerical value.

CHAPTER II

CONVENTIONAL SIGNS AND ABBREVIATIONS

A MILITARY sketch to be of value, must not only be reasonably accurate as to distances and directions, but must also show the condition of the ground as to cultivation, natural features, and all other features of possible military importance, as railroads, telegraph lines, bridges, streams, habitations, etc.; also the form of the surface of the ground itself. In order to represent the different conditions it has been necessary to adopt standard graphic signs, called *CONVENTIONAL SIGNS*. The conventional signs given in Figs. 3 and 10 will answer all requirements for field maps and sketches.

In addition to the conventional signs, the following abbreviations are authorized by our Field Service Regulations for use on field maps and sketches. When words are used they must be written in full, or abbreviated as shown. These abbreviations must not be used for other words than those shown in the table. Words not in the table are not as a rule abbreviated.

A.	Arroyo.	Ar.	Arch.
abut.	Abutment.	b.	Brick.

B.S.	Blacksmith Shop.	Long.	Longitude.
bot.	Bottom.	Mt.	Mountain.
Br.	Branch.	Mts.	Mountains.
br.	Bridge.	N.	North.
C.	Cape.	n.f.	Not fordable.
cem.	Cemetery.	P.	Pier.
con.	Concrete.	pk.	Plank.
cov.	Covered.	P.O.	Post Office.
Cr.	Creek.	Pt.	Point.
d.	Deep.	q.p.	Queen-post
cul.	Culvert.	R.	River.
D.S.	Drug Store.	R.H.	Roundhouse.
E.	East.	R.R.	Railroad.
Est.	Estuary.	S.	South.
f.	Fordable.	s.	Steel.
Ft.	Fort.	S.H.	Schoolhouse.
G.S.	General Store.	S.M.	Sawmill.
gir.	Girder.	Sta.	Station.
G.M.	Gristmill.	st.	Stone.
i.	Iron.	str.	Stream.
I.	Island.	T.G.	Tollgate.
Jc.	Junction.	Tres.	Trestle.
k.p.	King-post.	tr.	Truss.
L.	Lake.	W.T.	Water tank.
Lat.	Latitude.	W.W.	Water Works.
Ldg.	Landing.	W.	West.
L.S.S.	Life-saving Station.	w.	Wood.
L.H.	Lighthouse.	wd.	Wide.

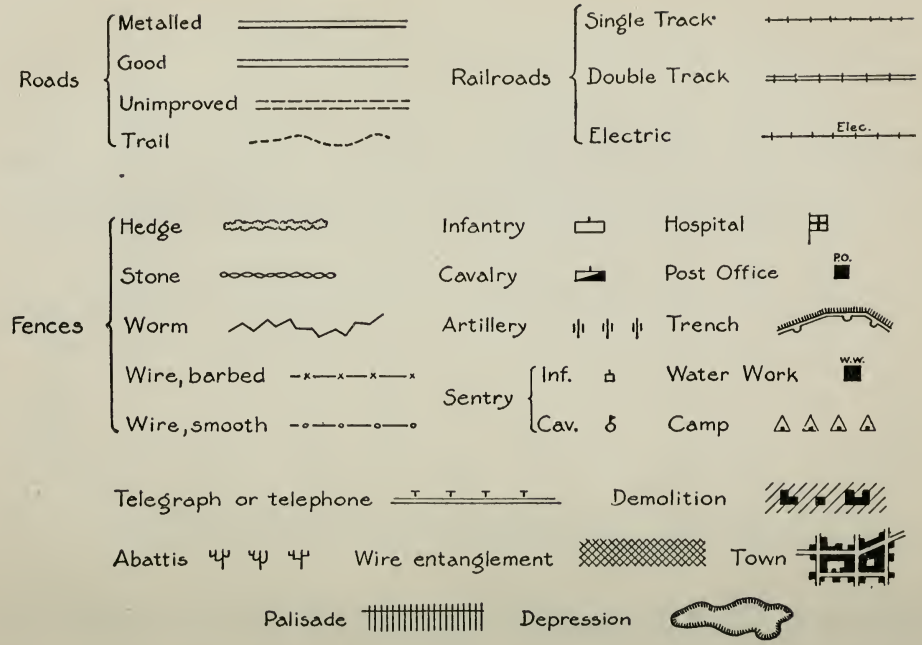
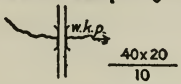

Roads
Metalled
Good
Unimproved
Trail
Railroads
Single Track
Double Track
Electric
Elec.
Fences
Hedge
Stone
Worm
Wire, barbed
Wire, smooth
Infantry
Cavalry
Artillery
Sentry
Inf.
Cav.
Hospital
Post Office
P.O.
Trench
Water Work
W.W.
Camp
Telegraph or telephone
Demolition
Abattis
Wire entanglement
Town
Palisade
Depression

FIG. 3.

Bridge

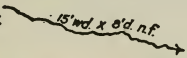
Indicate character and span by abbreviations.

Example: 

Meaning wooden king post bridge, 40 feet long, 20 feet wide, and 10 feet above the water.

Streams

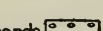
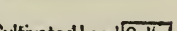
Indicate character by abbreviations.

Example: 

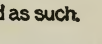
Meaning a stream 15 feet wide, 8 feet deep, and not fordable.

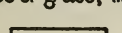
House Church School house S.H.

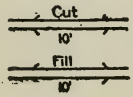
Woods

Orchards  Cultivated Land 

If boundary lines are fences they are indicated as such.

Brush, crops or grass, important as cover or forage 

Cemetery  Trees, isolated

Cut and fill — 

cut 10 feet deep

fill 10 feet high

FIG. 10.

CHAPTER III

SOME SKETCHING INSTRUMENTS

THE Cavalry Sketching Case is a small drawing-board with a compass set in. The paper is tightly rolled over two metalic rollers on opposite ends of the board. An arm with a brass scale (3 inches to the mile) is fastened to it, freely moving around a pivot. This arm with the graduations on the bottom of the board is also used for measuring slopes in the manner described below, the movable ruler taking the place of the pendulum. The graduations are for slopes of 1° to 20°. There is a strap on the reverse side of the board for fastening it to the wrist.

A good device for sketching is a simple plane-table (a smooth board about 16 inches square mounted on a tripod) with a compass set in. Slopes are measured with some form of hand level or slope board. The board is oriented by means of a compass or by "back-sighting." The paper is held in place by thumb tacks. (Fig. 4.)

A modification of this device, always available, is a smooth board or piece of stiff cardboard about 12″x14″ and a loose box compass. A ruler, paper, thumb tacks,

pencils, scales, soft rubber eraser and a pocketknife complete the equipment. Under service conditions, hasty sketching will usually be done with such improvised plane table. Any paper that will stand erasing is suitable. Tracing paper is the best. 2H to 4H pencils are generally used, except with tracing paper when B

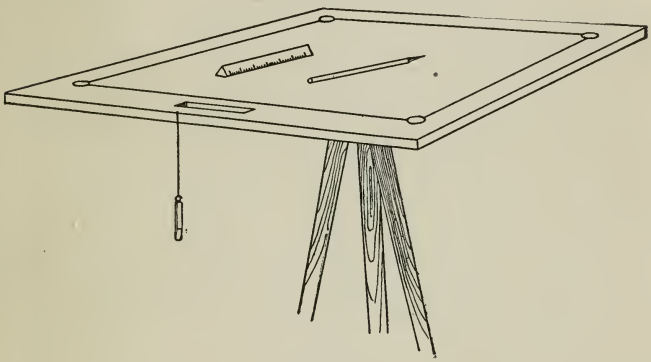


FIG. 4.

or HB pencils are preferable. When sketching by pacing, a pace tally for registering paces or strides is convenient. When sketching mounted a stop watch should be used. The board may be mounted on a tripod or not as desired.

A *slope board* is a simple device for measuring degrees of slope. It is constructed as follows (Figs. 5 and 6): Suspend a small weight on a string, thus

forming a crude plumb-line and bob. Attach the free end of the string to the middle point of one edge of a rectangular board (the drawing board). If this edge of the board is kept uppermost and level the plumb-line, or pendulum, will hang perpendicularly bisecting the board. Mark a point, (O), on this bisecting line

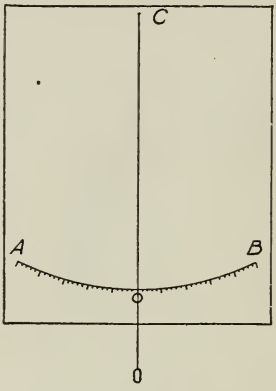


FIG. 5.

near the bottom. If the level of the upper edge of the board is disturbed by sighting the pendulum will *appear* to move forward or back of O. This apparent course of the pendulum (Fig. 6) is a sector that can be divided into degrees. In the diagrams, from *C* to line *A*—*B* is assumed to be 5.7 inches, and the divisions on *A*—*B* are 1-10 of an inch apart. Each divi-

sion on a slope board so constructed reads an angle of 1°.

To use, sight at the object along the edge (top) of the board at an elevation on the object of about 5 feet (height of your eye) and read the degrees registered

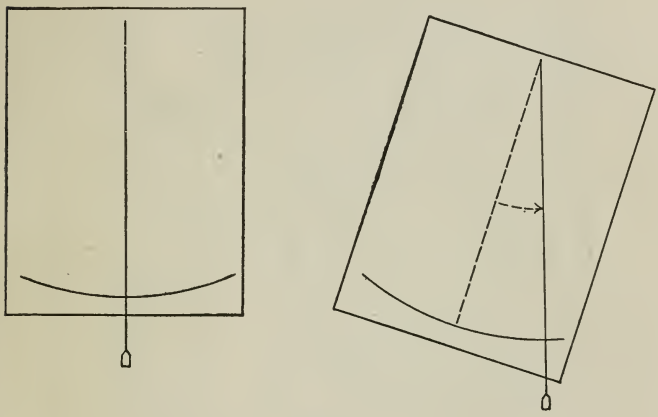


Fig. 6.

by the pendulum (Figs. 7 and 8). Forward is a minus and backward is a plus elevation. It is usually more convenient to use both hands in sighting and to hold the plumb-line in place against the board with the left thumb when it is turned to be read. The slope board is constructed on the under side of the drawing board. It is difficult to get accurate results with a slope board

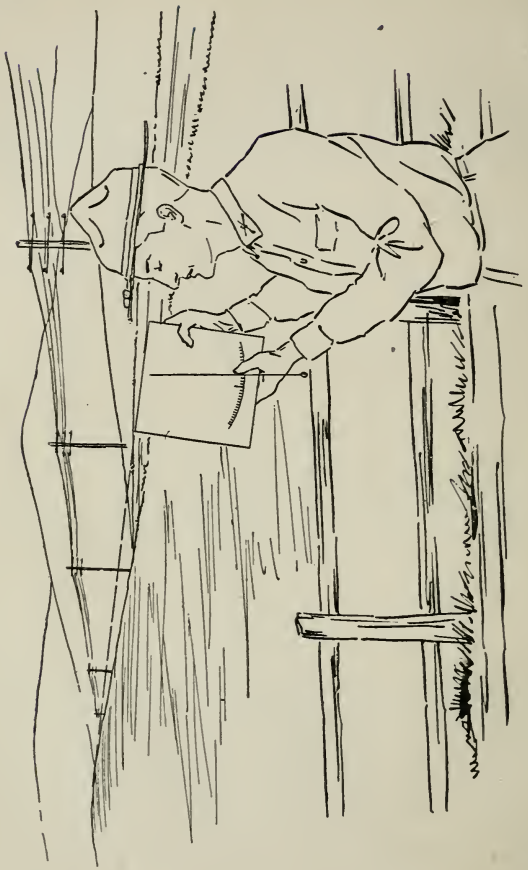


FIG. 7.

in windy weather. The Service Clinometer is a simple and handy angle measuring instrument, and should be used when available.

A 6-inch triangular ruler makes a good straightedge

FIG. 8.

for sighting or for drawing lines. The scales may be pasted on it.

BOX COMPASS (Fig. 9).—A simple box, or needle compass is preferable for the beginner. The graduations may be clockwise from 0° to 360°, contra-clockwise 360° to 0°, in quadrants or half circles. A compass graduated contra-clockwise (i.e., in the reverse

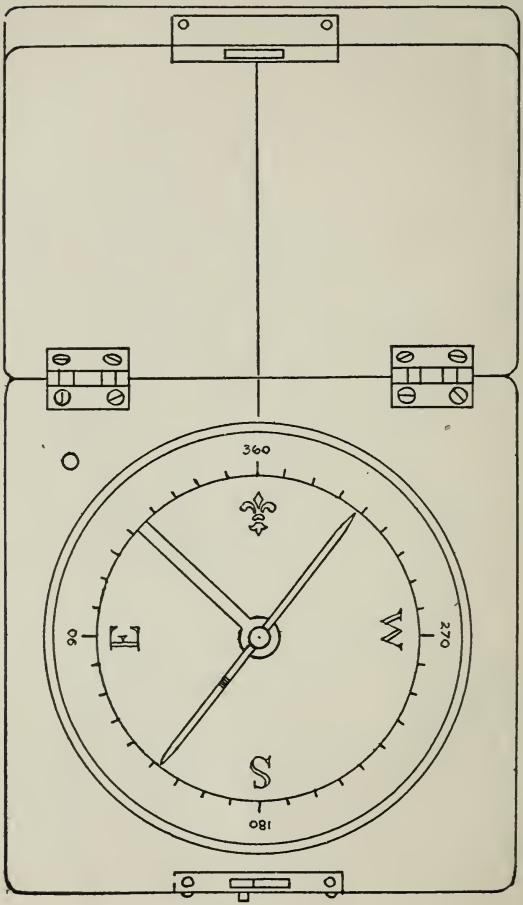


FIG. 9.

order of the graduations on the face of a clock) is the better as it reduces chances of error in reading. Attention is invited to the arrangements of the cardinal points on the dial of the box compass (Fig. 9). Note that E is to the left of N. This reversion of E and W

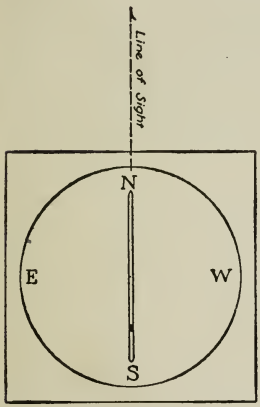


FIG. 11.

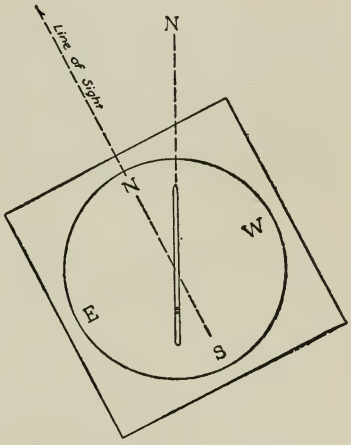


FIG. 12.

has been purposely made to facilitate the reading. As for example, assume the first course of a road to be magnetic north. In this case the position of the compass needle when taking the bearing will be as in Fig. 11. The road later turns NW (Fig. 12). At this point sight in the new direction along the sighting

line on the compass-box lid. The needle will leave N and move toward W (on the dial). Take the reading from N to the needle—so many degrees NW. The index or north end of the needle has remained fixed, while the sighting line of the compass has moved *towards the west* (the new direction) and W on the compass face has approached the needle. If a reversion of the cardinal points E and W had not been made, the reading would obviously be more difficult, and it is very probable that the sketcher, while working rapidly, would have read so many degrees NE if this reversion were not clearly shown by lettering.

CHAPTER IV

ORIENTATION—RESECTION—INTERSECTION

ORIENTATION is placing a map in its true relation to the ground it represents, so that if it were possible to compress this ground to the size of the map, each point on the map might be placed directly over the corresponding point on the ground. It is, in practice, bringing the direction line on the map to point north and south.

As a rule maps have their true north (and south) indicated by a line which is called the *True Meridian.* Sketches also have a direction or meridian line, located by means of the compass. It is called the *magnetic meridian.* These lines will not usually coincide as there are few localities where the compass needle points true North. It points toward the *magnetic North,* which is usually several degress East of West of true North, depending on the locality and the time. This deviation of the needle is called *magnetic variation* or *declination.* In the United States it is from 0° to 25°.

Consequently there may be two direction-lines on a map, the "true" north and the "magnetic" north

(Fig. 13). In the figure the declination is 14° 30′ East.

The true meridian lies in the direction of the North

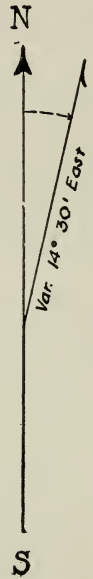


Fig. 13.

Pole. Its location never changes, but the magnetic meridian as indicated by the compass needle, is variable because of magnetic influences. The magnetic

meridian is usually represented by a spear, one side of the point or the feathers of which is missing, while the true meridian is represented by a spear completed.

Sketches, being made by compass, necessarily have a *magnetic* direction line, while maps are usually made by *true meridian.*

To orient a map or sketch which has the magnetic meridian indicated, it is only necessary to bring the magnetic north of the map to point in the same direction as the north end of the compass needle.

When one has only the true meridian indicated, to orient by the compass, construct a magnetic meridian if the declination be known.

To do this, place the meridian of the map directly under the needle of the compass while it is pointing to zero; then *keeping the map fixed,* rotate the compass *in the direction of the inclination of the needle,* until the needle has passed over degrees on the compass-ring equal to the amount of the declination. Now draw a line in continuation of the N-S line of your compass. This line will be the magnetic meridian.

In Fig. 16, a road *A—B* is plotted on the map; the magnetic N and S line is indicated. You are standing on the road and desire to orient the map. Lay the compass on the map so that the N-S line on the dial is parallel to the N-S on the map. Turn the map (without disturbing the position of the compass on it) until the north end of the needle points towards N

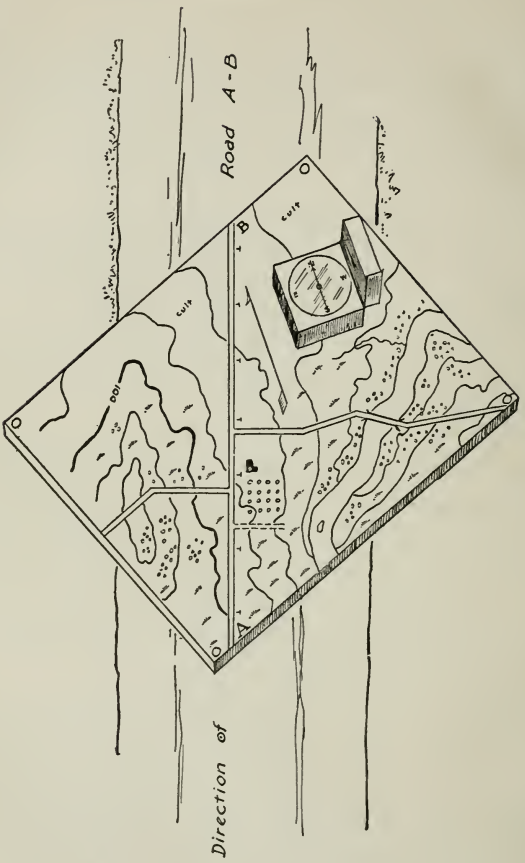


FIG. 16.

on the compass face. The map is now oriented, and *A*—*B* has the same direction as the road on the ground.

When there is no meridian line on the map (or when you have no compass or other means of orienting by using a meridian line), if you can locate on the

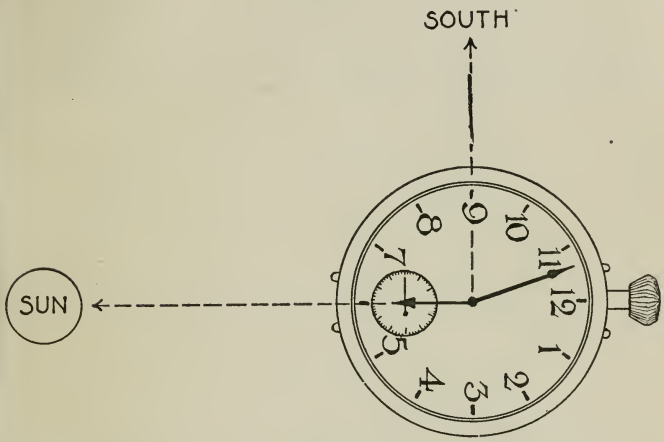


FIG. 14.

map your position and some other point that you can identify on the ground, draw a line connecting these two points on the map. Now hold the map so that this line points from you towards the object, and your map is oriented. Or, if two points visible on the ground can be identified on the map, turn the map so

that a line passing through them lies in the same direction as the line joining the points on the ground.

When you have no compass for orienting your map or sketch you may find the approximate true North by the following method, when the sun is shining: Point the hour hand of your watch toward the sun. A line drawn from the pivotal center of the dial midway between the hour hand and XII will point South and a prolongation of this line in the opposite direc-

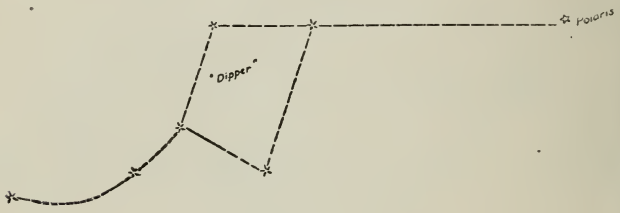


FIG. 15.

tion. To point the hour hand in the direction of the sun, hold a straw perpendicularly between the sun and the watch and bring the hour hand in its shadow (Fig. 14).

At night the approximate true north may be determined by the Great Dipper (Fig. 15). The North Star lies nearly in prolongation of a line of the two outer stars of the bowl of the Dipper.

Figure 17 illustrates that if the compass-needle and

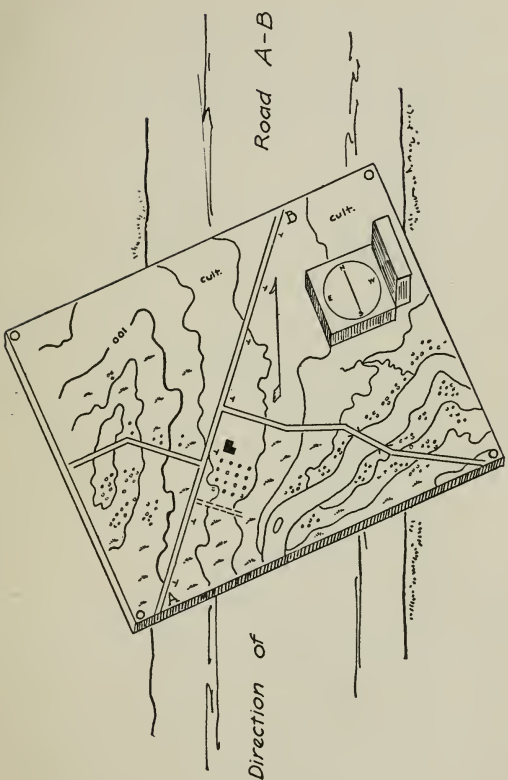


FIG. 17.

FIG. 18.

the direction line on the map do not coincide the map is not oriented.

Resection is a method of locating unknown points by taking bearings of two or more known points (Fig. 18). You think you are on some point of the road *A—B*, and vou want to locate your exact position on

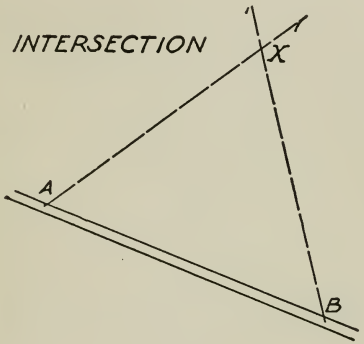


Fig. 19.

the map. Facing *B* there are two distinct landmarks on the left,—the top of the hill (*X*) and the cottage in front of the pine-wood, both of which you can locate on your map and identify on the ground. Keeping the map oriented, sight towards the hill until the point (*X*) on the map and the actual top of the hill are in the same line of sight. Plot this line of sight

by drawing a *back* line through *X* across the road. This line, obtained by connecting three points (top of hill, *X*, yourself) would sufficiently locate your position on the map if you were certain you were on the road *A*—*B*.

In order to definitely determine this, a similar

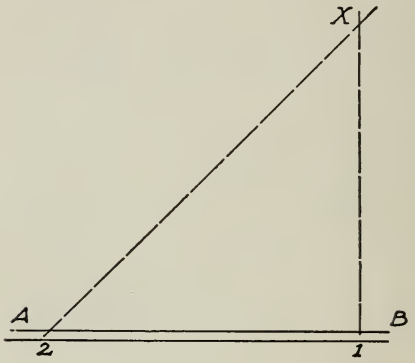


FIG. 20.

sight is taken on the cottage and this line of sight plotted in the same manner. Both lines will cross at a certain point. The point of their intersection is your exact place on the map, as you are on the line *S*—*X*, and also on the line *S*—*Cottage*. Resection may be used to advantage as a check on the sketcher's position.

INTERSECTION is the same principle applied in reverse order to locate and plot points situated off the course of the sketcher, or to which it is not desired to traverse (Figs. 19 and 20). Suppose you are on the road *B*—*A* (Fig. 20), and desire to plot an object several hundred yards off the road. Stop at any point on the road (as 1), orient the sketch, sight on the object and plot the line of sight by drawing an indefinite straight line from your position *towards* the object. After having marched a certain distance (as at 2) a second sight is taken and this line of sight is plotted in the same manner. It will intersect the first line. The point of intersection locates the object on your paper. This method is very accurate provided the distance from 1 to 2 is accurately measured and plotted. The sightings should be taken from such positions that the angle at *X* will be as nearly 90° as practicable, as the smaller this angle the less accurate will be the intersection. Intersection is used extensively in position and outpost sketching. In road sketching it is principally used to locate points, such as hills or important landmarks, distant from the course of the sketcher.

CHAPTER V

CONTOURS AND CONTOURING

A MAP or sketch showing an area only without showing the configuration of the ground and the relative elevations of all points (although it accurately represents all other natural and artificial features) would generally have little military value. The shape of the surface is shown on a map by means of lines called *contours,* which are lines cut from the surface of the earth by imaginary horizontal planes at equal *vertical* distance from each other (Fig. 22); i.e., lines of equal elevation. In other words, any point on any given contour has the same elevation above datum plane (usually taken at sea level) as all other points on that contour. On the ground contours are, of course, imaginary.

Horizontal distances (ground distances) are measured on a map by means of map scales, while the scale for contours is one for measuring *vertical* distances between adjacent contour planes.

A simple demonstration of the theory of contouring is the following: Of a soft material (clay or wet sand) form a small irregular figure, giving it the shape

of a hill. (Fig. 21.) Pass several horizontal planes (pasteboard) through this figure, carefully preserving an *equal vertical interval* between the planes. (Fig. 22.) Where a plane passes through the figure, by drawing its shape with a pencil, an exact outline of the form of the ground at this particular level will be obtained. (Fig. 23.) Cut each pasteboard along the

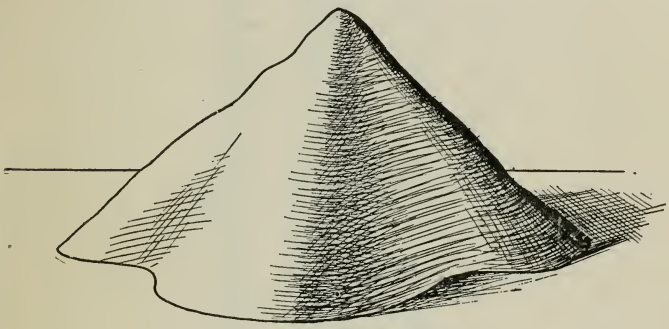


FIG. 21.

pencil marks and file, as in Fig. 24. Press the pasteboard to the bottom of the staff, and you have the way this hill would be represented on a map. (Fig. 25.)

The picture of the same hill (Fig. 26) is shown as it would appear on a map by Fig. 26*A*. The horizontal distance between contours, as from *A* to *B* (Fig. 26*A*), is called *Map Distance* (abbreviated M. D.) when thus

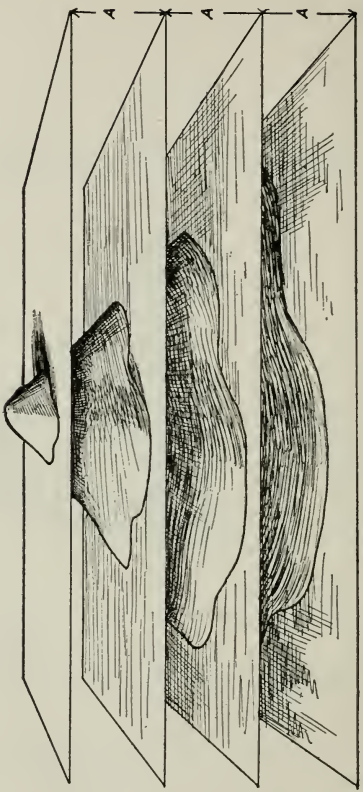


FIG. 22.

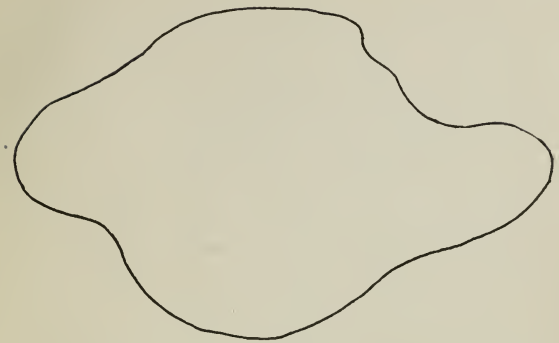


FIG. 23.

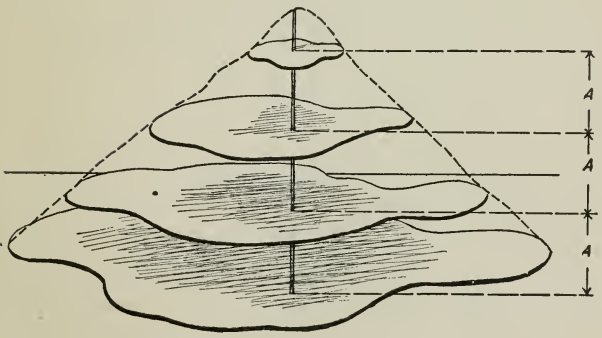


FIG. 24.

plotted to scale on a map. M.D. is, therefore, the plotted *horizontal or level* distance between adjacent contour lines. (Map Distance is always measured perpendicularly to the contour at that particular point.)

Vertical Interval (abbreviated V.I.) is the *vertical* distance, or difference in elevation of the adjacent

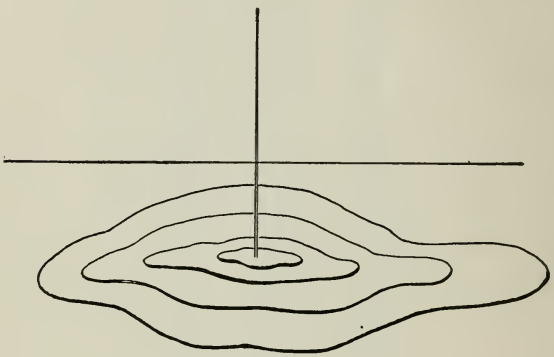


FIG. 25.

contour planes *a,a,a* (Fig. 26. See also Figs. 22 and 24). Assuming that this V.I. is 20 feet, the differences in elevation of *A, B, C, D,* (Fig. 26), is then 20 feet. It will be seen that the total M.D. between *A* and *E* (Figs. 26 and 26*A*) is greater than the total M.D. between *F* and *E,* though the elevation of *E* (top of the hill) is of course the same in both cases; also that *F*—*E* is steeper ground, and that the contours

FIG. 26.

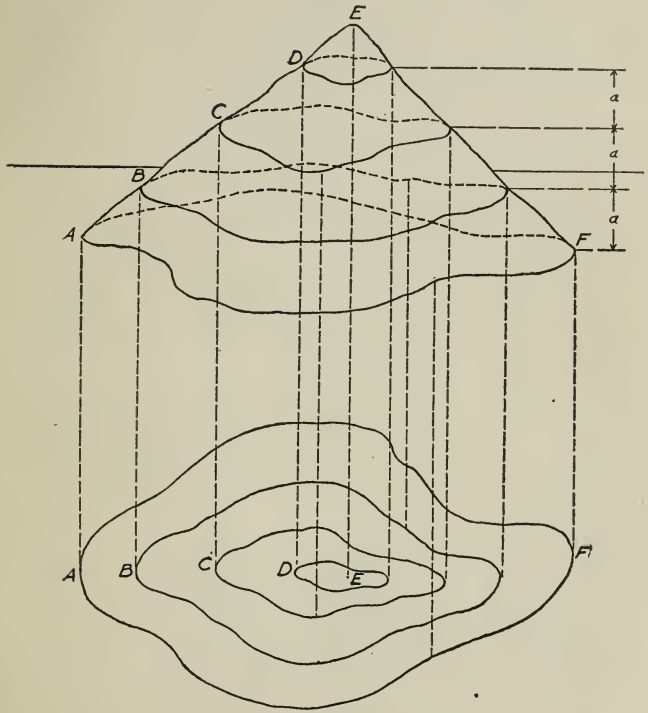


FIG. 26A.

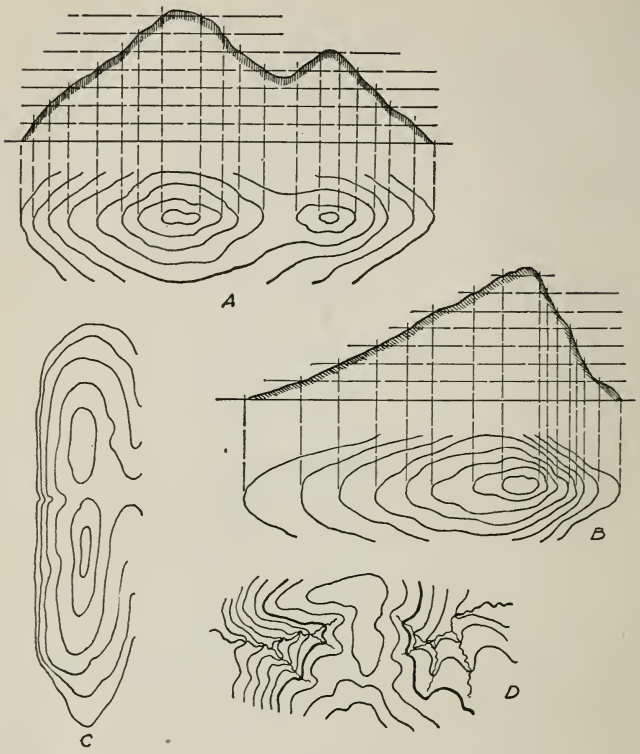


FIG. 34.

between *F* and *E* on the map are closer together than the contours between *A* and *E*. In other words, the steeper the ground the closer will be the contour lines, and the reverse (see Fig. 34*B*). The following additional points will assist you in accurately representing ground forms by contouring:

(*a*) All points on any contour have the same elevation above datum (Fig. 22).

(*b*) In a uniform slope contours are equally spaced.

(*c*) Contours of different elevations do not cross or run into each other, except in case of an overhanging or vertical cliff.

(*d*) Every contour closes on itself or runs off the paper.

(*e*) The manner of showing a hill top is by the small closed contours in Figs. 34*A* and *B*.

(*f*) The manner of showing a saddle (or col) is indicated in Fig. 34*A*.

(*g*) The manner of showing watersheds is illustrated in Figs. 34*A*, *B* and *C*.

(h) Water courses are shown as in Fig. 34*D*.

It will be seen that watersheds are convex, the higher contours bulging out toward the lower ones, and that in water courses the contours are convex *towards the source of the stream*, the lower contours bending sharply towards the higher ones.

M.D. (*map distance*) depends on the slope of the ground represented. It can be calculated for various

degrees of slope and a scale of M.D. constructed by which the distance between contour lines on the map for any degree of slope is shown. This scale is based on the fact that in a slope of 1 degree there is a rise of 1 foot in 57.3 feet of horizontal distance. This ratio holds good for any degree of slope. It is not absolutely correct, but sufficiently so for use in military sketches. On a 1 degree slope we would then get an elevation of 20 feet in 1146 feet of horizontal distance (20×57.3), and on a 5 degree slope a rise of 20 feet would occur in 229 feet horizontal distance.

$$\frac{(20 \times 57.3)}{5}$$

The M.D. of any degree of slope can readily be found by the following equation: (V.I.$\times$57.3) divided by the degree of the slope=the ground distance in feet between contours.

As seen above on a 1° slope there is a rise of 20 feet in a horizontal distance of 1146 ft. This distance equals .65 of 1 inch on the map if 1146 is plotted to a scale of 3 inches to the mile: then a slope of

1°=.65 inch
2°=.32 "
3°=.22 "
4°=.16 "

5° = .12 inch
6° = .11 "
7° = .09 "
8° = .08 inch, etc., when plotted to this scale, (and just twice this map distance when plotted to a 6-inch scale).

Lay off these distances from your ruler and you have the scale of M.D. for 3-inch map, V.I. 20 feet. (Fig. 27.)

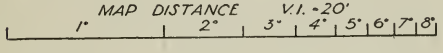


FIG. 27.

The normal interval between contours is as follows: On a sketch of

3 inches equals 1 mile, V.I. 20 feet;
6 inches equals 1 mile, V.I. 10 feet;
12 inches equals 1 mile, V.I. 5 feet, or always 60 *divided by the number of inches to the mile.*

In a road or position sketching contours are located and plotted as are other features, slopes being measured or estimated, and the scale for M.D. applied to determine their map distance apart.

Suppose from your position to some other point to

be plotted on the sketch you find a difference in elevation of 3°. After measuring (or estimating) the ground distance between the points, and plotting it on your paper, apply the scale of M.D. for a 3° slope to this plotted distance as many times as it will go. This gives the *number of contours* between the two points (difference in elevations), but if the ground is not a sloping plain the correct *spacing and shaping* of the contours to conform to the shape of the ground must be done by estimation.

If the elevation of your starting point above datum or sea level is not known, any elevation for the point may be assumed. As a matter of convenience, any initial elevation should be some hundreds of feet as 500, 1000, etc., etc., a sufficient elevation being taken to assure having no contour with a minus value in case the course runs to much lower ground. In sketching it must be understood that the *exact determination of the elevation of points above sea level is not usually essential*, but that the great value of contouring is in showing on the map the *relative* elevations of such points, and the *form and degree of slope* of the ground itself.

In Fig. 8 the reading of the slope board is plus 4°. The hill is then said to have a slope of 4 degrees; intersect, traverse or estimate the distance between the point of sighting and the top of the hill (Fig. 7), which is found to be, say, 500 yards. Plot the posi-

tion of the hill top on your sketch and apply the scale of M.D. along the line of sight to determine the

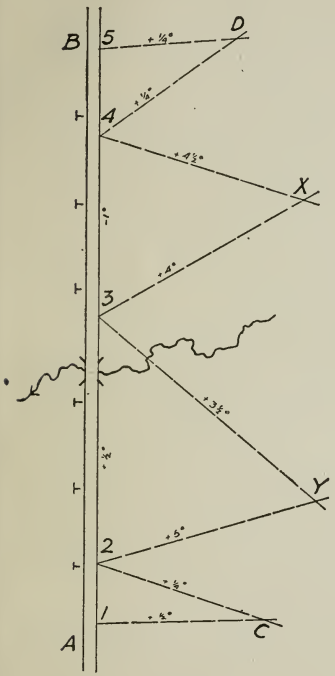


Fig. 28.

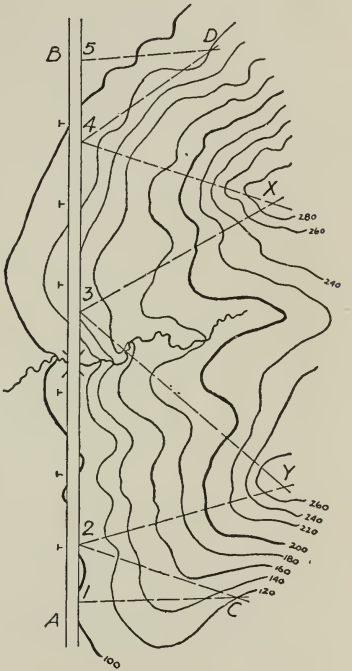


Fig. 28A.

number and approximate location of contours. If the slope is not uniform, the number of contours (height

of hill) remains the same, of course, but the exact location of the contour lines must be determined by estimation as noted above. As the steepness of the slope varies in going from the sighting position to the top of the hill, the M.D. between adjacent contours will vary accordingly. (Fig. 26*A* and 34*B*.)

In Figs. 28 and 28*A* a road (*A*—*B*) passes a hill. The highest points of the elevation (*x* and *y*) are located by intersection from the road. As the road is being traversed it is not difficult to determine the lowest points of the hill, that is, where the slope loses itself in the level of the road, and at *C* and *D*. As each of these points is sighted on, measure the slope to it along that sighting line (disregarding any immediate irregularities in the steepness) and apply the slope card for the determined degree of slope, indicating the contour points. As soon as the location of each point (*c, Y, X, D*) is determined (by completing the intersection), plot contours of the same elevation through the indicated points, tracing their immediate course by estimation (Fig. 28*A*). Number each contour as soon as you have started it.

Contours are but conventional signs to show ground forms. In sketching it is not contemplated that they be accurately located, or that all ground be shown in exact detail. Do not attempt to measure every change of slope.

For example, measure the angle of slope from the

top of a hill to the valley, disregarding intermediate irregularities. After traversing and plotting the distance, trace in the lowest contour, and then trace in the others between the lowest and the top of the hill by eye.

Contours cross streams at right angles. Do not draw them across roads. Stop at the road and continue them on the other side.

CHAPTER VI

ROAD SKETCHING

To begin a road sketch, stand in the middle of the road and hold the board squarely in front of the body while facing in the general direction of the route to be sketched. The starting point is marked (1), (station 1) (Fig. 29). With the beginner all changes of direction should be thus marked serially. With more experience such data would be omitted.

If a drawing board with no compass set in is being used, lay a compass (preferably a box compass) on the board and gently turn until the needle is over the N and S line on the face of the compass. The needle being settled, draw a line parallel to, or in prolongation of it. Mark the north end N. This line is the N and S line of the sketch and *with reference to this line all subsequent directions are determined.*

Keeping the needle parallel to the plotted north and south line, sight along the ruler in the direction of the road by moving the ruler (using station (1) as a pivot), until the ruler and the road are in the same line of sight. Draw an indefinite line *forward* along

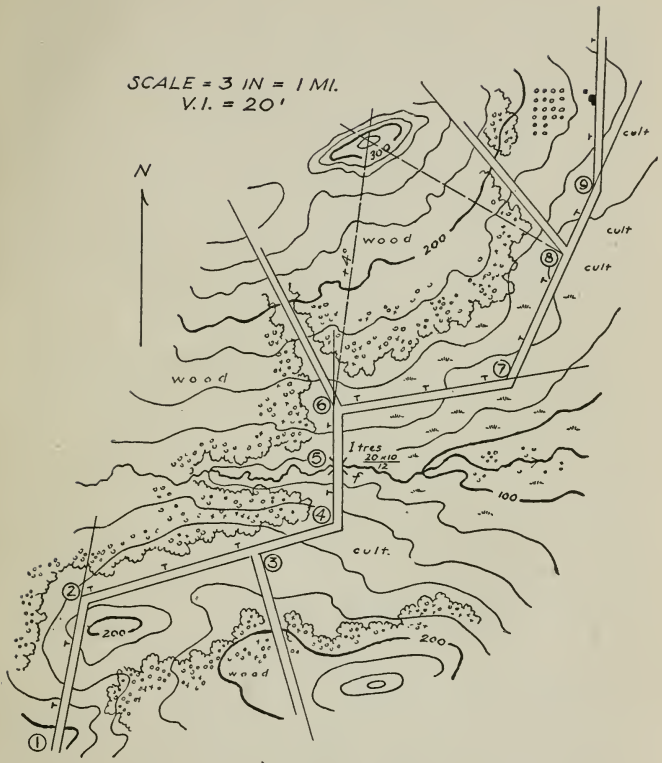

SCALE = 3 IN = 1 MI.
V.I. = 20'
N
300
200
wood
cult
cult
cult
wood
1 tres
20 x 10
100
cult.
200
200
wood
1
2
3
4
5
6
7
8
9

FIG. 29.

the ruler while holding it firmly in place with the other hand. Measure the slope toward (2) and measure or estimate the slopes to the right and left. Plot the surrounding details at (1) including the contours. Step off with the right foot (if the distance is being measured by pacing), counting a stride each time the left foot strikes the ground. Plot the distance to scale. When a change of direction occurs, stop, orient the board and draw the new direction line. Observe the "lay" of the ground, measure the slopes and draw in contours as you go along.

It is customary to take in all the military details within 300 or 400 yards of the road traversed, and conspicuous landmarks, high hills, etc., by intersection or estimation to greater distances, depending on the object of the sketch. Cuts, fills, ravines, woods, etc., should never be overlooked as they may have tactical value. In traversing it is not necessary to stop and plot each feature as it is reached. Notes can be made of features and distances and the "plotting in" done when it becomes necessary to halt on account of a distinct change of direction. For example, from (1) after getting the direction of (2) pace (or otherwise measure) the distance without halting to plot, having made notes en route of the location of the edges of the woods to the right and left, the position of 200 hill and the place where the road crosses low ground west of it; at (2) lay off the distance from (1)

and complete the sketch to that point. Then stand in the middle of the road (board oriented) and sight toward (4); at (3) it will be necessary to halt to get the direction and degree of slope of the side road. Continue to (4), and in laying off the distance, lay off the whole number of strides from (2). If, for example, you have 360 strides from (2) to (3) and 130 from (3) to (4), in plotting (4) lay off the whole distance 490 strides from (2). This method lessens the accumulation of errors because of taking distances from your scale less frequently.

At (4) sight towards (6). Halt at the stream to get its direction and description of the bridge. Continue in this manner. If you are not using a pace tally be careful that hundreds of strides are not gained or lost. To guard against this make a mark on your paper each time you count a hundred. Erase these marks before starting on again. During each sighting be careful that the board is kept oriented, i.e., in the same position relative to the compass needle as when starting out.

The hill 320 is located by intersection. Sight on the hill from station (6), plotting the line of sight and indicating on it the degree of slope; take a second sight from (8), or (9). The point of intersection locates the hill on your paper and its elevation is determined by applying your scale of M.D. along the intersecting lines.

Telephone or telegraph wires, steel or iron ores have a magnetic influence on the compass needle and will deflect it if close by. This deflection must be guarded against in orientation by keeping as far away from such substances as practicable. If you cannot get but 25 yards away stand directly under the wires, in the center of the railroad track, etc. In this position the magnetic influence will be exerted equally in lateral directions, and will not seriously interfere with the accurate orientation. If such precautions are not practicable, orient by backsighting, i.e., bring your last direction line to point towards your last station, disregarding the fluctuations of the compass needle at this station.

In road sketching it often happens that a change of direction of the route causes the sketch to run off the paper as in Fig. 30 (lower half). When this occurs, draw a cross-line at right angles to the edge of your paper, through the point where the drawing runs off (*A*—*B*). Draw a new north and south line and begin a new sketch above the line *A*—*B*. (If the general direction of the route is known, the starting point on the paper should be selected with a view of getting as much of the sketch as possible on that sheet.) We may thus have a series of sections of the same route. Number these sections in sequence. The sketch is finally completed by pasting the several sections together, or on a larger sheet in their proper order.

In the figure, part (2) is a continuation of part (1). When putting the sections together point *A* is laid on point *B*, care being taken to make the north and

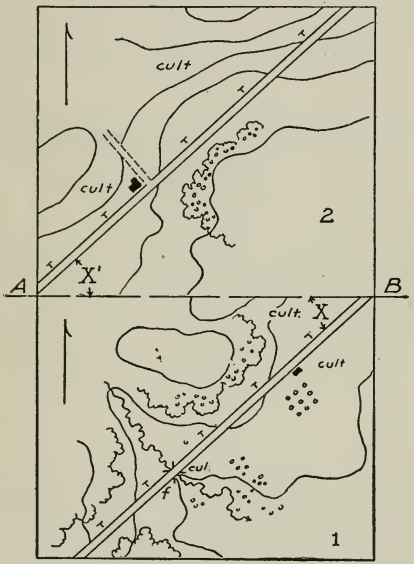


FIG. 30.

south lines of all sections parallel. If the north and south lines are not parallel it will have the same effect as inaccurate orientation, causing an error of direction in the completed sketch.

To complete the sketch a simple "legend" or title, with the name of the sketcher, is added, describing the route, scale, vertical interval, etc., etc. (Fig. 32). Written titles will answer all purposes, though printing is generally used.

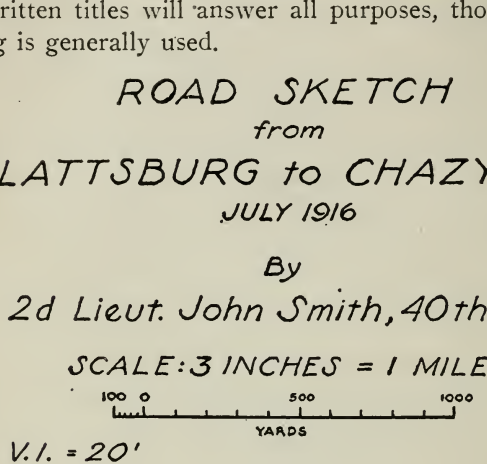


FIG. 32.

With sketches that are not intended to serve as the basis for blue prints, different colored pencils may be used to indicate the different features. For example, contours in red, woods in green, water courses in blue and roads in yellow. This may be done during or after finishing the field work, as an aid to readily reading the sketch.

A canvas pencil holder with five or six compartments in which pencils and erasers fit in snugly can

be readily made, and pinned to the shirt, or the pencils, etc., should be tied to your buttonholes with strings. Otherwise you will be constantly losing them.

Other points to be observed in sketching are:

(*a*) Be sure intersection and resection points are well marked to avoid sighting back on the wrong point.

(*b*) Keep in view the scale of the sketch and the fact that you cannot show minute details. Put in only controlling features.

(*c*) Be sure to keep orientation during sightings. It is sometimes convenient to lay the board on the ground, fence, etc., while sighting. Check your orientation by back-sighting on your last station.

(*d*) Do not leave a station until all the details up to that point are put in. Finish the sketch as you go.

(*e*) Avoid excessive care in plotting minor details.

(*f*) In sketching a broken course, such as a zig-zag or crooked road, do not take a sight at every change of direction. Take a sight as far ahead as you can see, and put in intermediate bends by estimation. The fewer the sights, the greater will be the final accuracy.

All officers and non-commissioned officers should be capable of readily making a hasty reconnaissance or place sketch, as such sketch accompanied by a written report will generally give more complete and clear in-

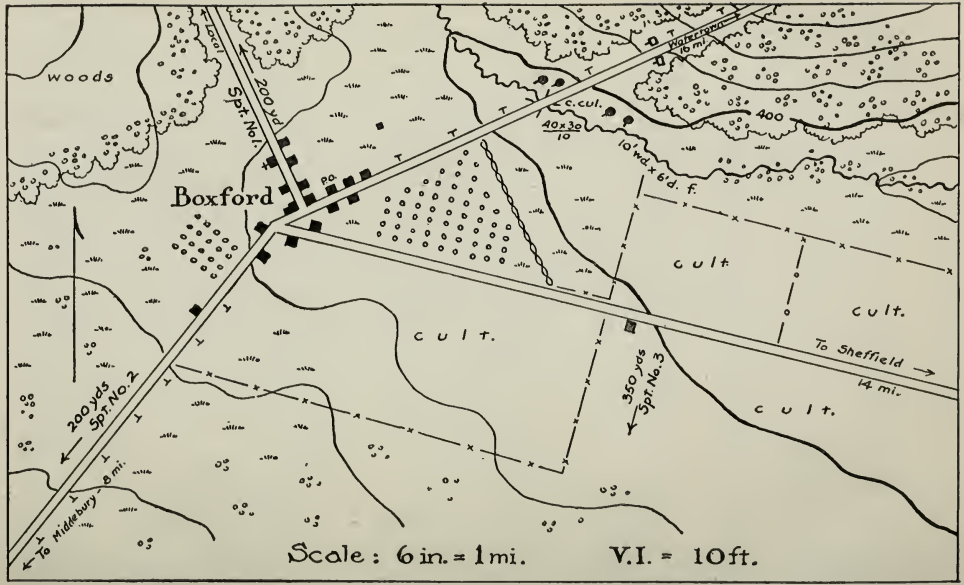

woods
Local
Spt. No. 1
200 yd
Boxford
P.O.
c. cul.
40x30
10
10' wd. x 6' d. f.
Waterford
16 mi.
400
cult.
cult.
cult.
cult.
To Sheffield
14 mi.
350 yds
Spt. No. 3
200 yds
Spt. No. 2
To Middebury - 8 mi.
Scale: 6 in. = 1 mi.
V.I. = 10 ft.

FIG. 33.

formation than can be conveyed by any written report alone. As the proximity of the enemy will prevent moving about, it will usually be necessary to make the sketch from one station and sometimes with only a notebook and pencil. The report to accompany the sketch shown in Fig. 33 might be as follows: "Boxford and Watertown are joined by an improved road; hostile sentries can be seen along the edge of the wood on the north side of the river near the bridge. From the woods west of Boxford our troops could easily win the fire-protection of the houses, which are generally of brick. The cultivated ground east of Boxford affords no cover. Natives state that the creek is easily fordable 200 yards east of the bridge."

CHAPTER VII

POSITION SKETCHING

THE ordinary military map is an example of a *position* or *area map* made with accurate instruments, and involving considerable time in its preparation, but a *position sketch* must usually be expeditiously made, and may range in accuracy from the crudest *outpost* or *place* sketch to a correct map, depending on the time and means available for its preparation. Position sketches are for the purpose of showing prospective battlefields, camp sites, etc., when no maps of the area are available (Plates *A* and *B* and Fig. 31). Position sketches are made with a plane table and tripod (Fig. 4).

In making the sketch, the first effort should be to plot on the paper the location of prominent features, such as railroads, roads, fences, streams and water courses, woods, houses, prominent hilltops or water sheds, and sometimes even single trees. These plotted points will later help to locate and "fill in" the other features and important ground forms near them. All of these features are located by the base line methods (intersection, resection and

traversing). A base line is a traverse (or measured course) within the area to be sketched, as from *A* to *D* (Plate *B*), on which are two or more points and from which intersections can be made to locate other prominent features. Base lines and other traverses are measured by pacing and are plotted as carefully as possible. The base line should be one-fourth to two miles long depending on the area. As a general rule its length should not be less than one-third as long as the greatest dimension of the area. Its ends should be marked by some well-defined point, as telegraph poles, trees, or some improvised object. A base line need not be one continuous straight line, but with an irregular base line more care is required than when working from a single straight line. It will usually not have the same elevation throughout, though a level base line is desirable.

In the sketch (Plate *B*) the forks of the road, the houses, the bridge, etc., are located by intersections from the base line *A*—*D*. The line *A*—*D* was selected because points *A* and *D* are on prominent ground and visible from each other, the distance *A*—*D* can be measured by pacing, other prominent features can be sighted on from *A* and *D*, or from points on the line *A*—*D*.

The points and lines referred to above, when plotted on the paper, give a network called "control" over the area. After this control is obtained, the remaining

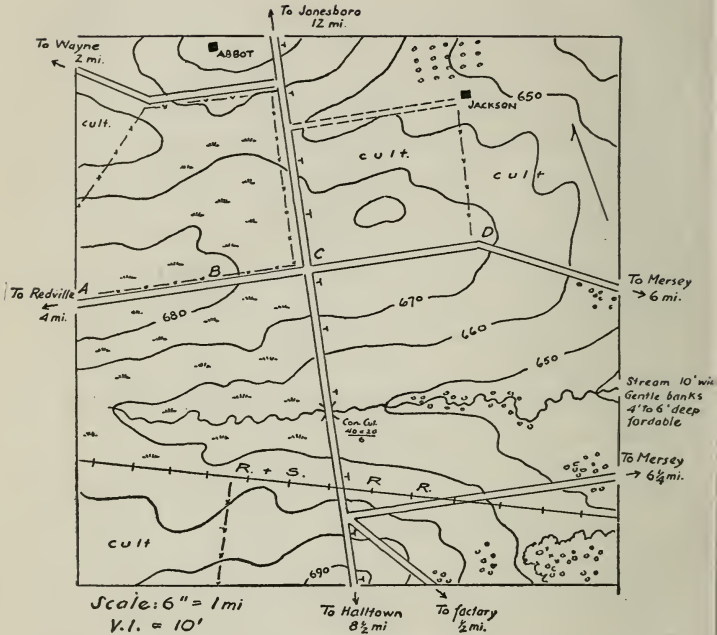
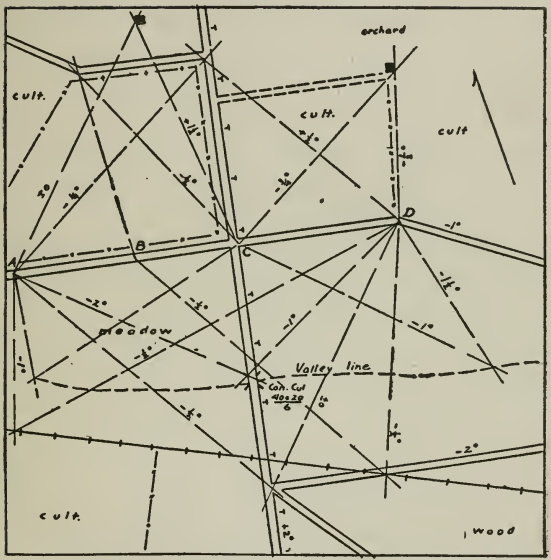

To Jonesboro
12 mi.
To Wayne
2 mi.
ABBOT
JACKSON
650
cult.
cult.
cult.
cult.
D
C
B
A
To Redville
4 mi.
To Mersey
6 mi.
680
670
660
650
Stream 10' wide
Gentle banks
4' to 6' deep
fordable
Con. Cut
40 ± 20
0
To Mersey
6¼ mi.
R. + S.
R.
R.
cult
690
Scale: 6" = 1 mi
V.I. = 10'
To Halltown
8½ mi
To factory
½ mi.

PLATE *A*.



Horizontal framework for Position Sketch.

Scale: 6 in = 1 mi.
V.I. = 10'

PLATE B.

details including contours, cultivation, etc., can be readily filled in, as any feature will be near some point or line already located on the paper.

As an example, set up and orient the board at one end of the base line, as at *A*. Draw a meridian near the edge of your paper. From this first station sight on *D* and draw your direction line towards it; then sight on other easily distinguishable points, such as hilltops, stream junctions, isolated trees, etc., drawing light lines from your position towards the objects sighted on; this is the first step in locating such objects by intersection. Indicate on each line you draw the degree of slope to the object sighted on; traverse towards *D*, halting when necessary to sketch in details or sight on other objects, being careful to keep oriented during each sight. This orientation is usually done by backsighting on *A*. At *D*, or favorable intermediate points, as *B* or *C*, complete the intersections begun as far as possible; you will now have a number of objects and prominent points located on your paper; if necessary traverse to these points along the lines of sight, filling in as you go. Contouring of any section of the sketch is more readily and accurately done after the drainage system (watersheds and water courses) in that section have been plotted. The elevation of your starting point is known or assumed, and by taking the degree of slope to all points sighted on and applying your scale for

M.D. approximate contour points are located. The actual tracing of the contours to show local ground forms will be done by eye. Do not attempt to contour a section of ground until you have passed over it, and do not leave a station until all details up to that point have been drawn in.

Plate *A* and Fig. 31 are examples of completed position sketches.

A theoretical knowledge of sketching will not, without considerable practicable application, make one a proficient sketcher. Military sketches to be of much practical use, must usually be made rapidly. While reasonable accuracy is desirable, too great refinement retards the progress, and adds but little to the practical value of the sketch. As much care as is consistent with rapid work should be exercised in measuring courses and plotting. Data concerning bridges, streams, condition of the roads and other tactical features should be noted with care consistent with the object of the sketch. This should be done by marginal notes as in Figs. 46 and 47. Distances to objects off the route must usually be determined by estimation or intersection, slopes estimated, and contours interpolated. The ability to correctly *estimate* the degree of slope between two points is soon acquired by practice. Most sketchers use the method of estimating the difference in *contour intervals* between the sighting point and the object. For example, if one is at an

elevation of 400 and sights on a point which he estimates to be 3 contours higher (or lower) he traces the proper contour through that point, and draws in the intermediate ones by estimation.

Experience will show the sketcher the way to many short cuts besides the ones above mentioned, such as rapid orientation, skill in drawing and an "eye for ground" in contouring.

CHAPTER VIII

MAP READING

By map reading is meant the ability to grasp not only the general features of a map, but to form a clear mental picture of the appearance of the ground represented.

Map reading is very simple, and the average man can learn sufficient about it for all practical purposes in one or two lessons.

The beginner will do well to omit all thoughts of sand tables, clay models, horizontal equivalents, determination of true meridians and all such technical terms that only serve to make map reading seem difficult.

It is not at all necessary to be able to make a map before learning to read one, though a practical knowledge of map making has taken you over the same ground and given you an understanding of the terms used in map reading.

If you are teaching map reading, use a 12-inch map hung on the wall, or enough 3-inch maps to give one to each two men.

If you are learning map reading without an instructor, use any contoured map of 3-inch scale, or over.

There are but four elements to map reading: Direction, Distance, Conventional Signs and Contours.

Starting with *direction,* the arrow on the map points to the north. On modern maps the north is at the top. The south is then at the bottom, the east at the right and the west at the left. Pick out a number of points on the map and determine their direction from any given point,—this as a matter of practice.

There is nothing else to learn about direction, except when you are using the map on the ground represented. It will then be necessary to understand the difference between true north and magnetic north and the symbol for each (Fig. 13), as explained under "Orientation" in Chapter IV of this text.

Next take up *distance.* You have learned that the map distance between any two points shown on the map, has a fixed and definite relation to the real distance between the real points on the ground, as 3 inches (map distance) equals one mile on the ground, etc. Conversely, if you are on the ground, to measure the distance between any two points, take the map distance between the points and multiply it by the proper ratio number (R. F.). Or, apply the scale which appears on the map and read off the ground distance in yards or miles.

Conventional signs and *abbreviations* are given in Chapter II. Learn what they stand for. Conventional signs can not be drawn to scale, except for very

large objects. If the exact dimensions are of importance, these dimensions will usually be written on the map; the dimensions of a bridge, for example.

Contours are but conventional signs to show the *height, shape* and *slope* of the ground.

The principles of contouring have been explained in Chapter V. Learn to distinguish between contour lines and the signs for roads and streams.

Usually a contour has its height labeled on it, which means the ground which it follows is that many feet above sea level (or other datum plane). Remember that all points on any contour are exactly the same height above sea level. If the height of a contour is not indicated on it, look for one that is numbered and count back. Knowing that on the same map all contours are the same vertical distance (V.I.) apart it is then a simple matter to determine the elevation of any particular contour.

Usually every fifth contour is drawn in heavy lines, indicating even hundreds on a 3-inch map, and fifties on a 6-inch map.

If there is a point through which no contour passes, this ground is not as low as the contour below, nor as high as the contour above. It is, obviously, the intermediate ground between two contours and its *exact* elevation can not be determined, though it is assumed that the ground between two contour lines slopes uniformly.

The highest point of a hill does not usually correspond with the highest contour, so that its exact elevation is sometimes indicated by figures, as 427. In this case the crest is 7 feet higher than the last contour (420) but not high enough to be indicated by the next contour.

Where contours lie closest the ground is steepest, and where they are further apart the ground is more nearly flat. You can find the degree of any slope by applying the slope scale (Fig. 27), or work it out for yourself by remembering that in a slope of 1 degree there is a rise of 1 foot in every 57.3 feet of horizontal distance.

To find the difference in elevation (if the contours are not numbered) between two points, count the contour spaces and multiply by their distance apart (V.I.). To find the *average* grade of a road, measure the ground distance in feet, and divide by the number of contour intervals. That will give you the average ground distance between contours. Then apply your table of slopes in Chapter V.

While contours on an ordinary map may seem much involved, it is only on account of their number, their many turns, and because many of them run off the map. Remember that a contour either closes on itself or runs off the map.

The water around an island in a lake is the same level. Suppose you mark around the water's edge with

a piece of chalk. You will then have a line, all points of which are of equal elevation, i. e., a contour. If the water level is then raised 20 feet (vertical distance), another mark around the water level would be somewhat less in circumference than the first mark, and its course would probably not have the same irregularities, but it would as surely close on itself and show the exact *shape* of the island at that particular level, and would also be a contour.

A closed contour indicates a hill (Fig. 34.) (A depression may be also represented by a closed contour, but this formation is seldom found unless the depression slopes to a body of water, and then, of course, the formation is easily recognized.) An open contour indicates a ridge or a valley. If valleys contain stream lines they are easily recognized, but when there is no stream line indicated you will sometimes not be able to tell at a glance whether the formation is a ridge or a valley.

Compare the appearance of the contours indicating valleys and ridges in Fig. 34. You will observe that the bends of the contours around the heads of the valleys are much sharper than the bends around a nose or ridge. In a typical formation the ridges are wider than the valleys. An exception to this rule is in the case of a "hogback"—a very sharp ridge.

Remember that in watersheds the contours bulge

towards the lower ground, and in water courses they bend sharply towards the higher ground.

The drainage system is the key to reading any map. First locate the streams. You will find that all other ground is higher and slopes towards the streams. The formation is always ridge, valley, (high, low) ridge, valley. There is never one without the other.

If contours are numbered, you have only to look at the numbers to be able to tell which is low, and which is high ground, but to read a map readily, you should be quite independent of these numbers.

Visibility

The problem of visibility is a stumbling block to the beginner in map reading. To him the subject is not of great practical value and he will find that it will be quite easily mastered when he has first become proficient in the other elements of map reading.

Visibility simply means if you were standing at a certain point would you be able to see some other point, or area? If you were standing on a certain hill, could you see troops, etc., at some other indicated point of the ground represented?

Problems in visibility can be accurately worked out by a system of "profiles." This method is explained in more advanced books on map reading. The following simple method gives results that are sufficiently accurate for all practical purposes.

(*a*) Assume that you are standing on Hill 920, four hundred yards west of J. Todd (Fig. 31). Can you tell from the map whether you could see Patton? Draw a straight line from your position on the map to Patton to represent your line of sight. Following this line you go down the hill to the stream at an elevation of 830. It is evident that to this point there is no ground to obstruct your view of Patton. Follow the line up the hill to Patton, which is at elevation 940. Patton is higher than your position, and as all the ground between the two points is lower it is apparent that there is no ground to obstruct your view, and that Patton is visible from Hill 920.

(*b*) Standing at the same point, can you see Stofa? Following the line of sight, you find that Stofa has the same elevation as your position, and that all intermediate ground is lower, therefore Stofa is visible.

(*c*) From the same point, can you see the $\frac{14 \times 12}{10}$ bridge at the S. E. corner of the map?

A straight line crosses the lower ground to the stream and then rises to an elevation of 940. The ground from 940 slopes to the bridge, which is at elevation 800. It is apparent that the ridge 940 obstructs your view and that the bridge is not visible from 920.

(*d*) Standing at Tomlin, can you see the R. R. bridge north of the Hill 920?

Tomlin is at Elevation 940, and as no ground as high or higher intervenes it is apparent that you can see to Hill 920. From Hill 920, the ground slopes down to the bridge, which is at elevation about 840.

From Tomlin to the crest of 920 hill is 800 yards. As your line of sight can not be lower than 920 at this point, it has fallen a maximum of 20 feet in a distance of 800 yards, and it would be necessary for the line of sight to fall 80 feet in the remaining 400 yards to be able to see the bridge.

As the line of sight falls 20 feet in a distance of 800 yards, or one foot elevation in 40 yards direction, it would, if continued the additional 400 yards, fall 10 feet more,—bring a straight line tangent to Hill 920. In order to be able to see the bridge it would have to be at an elevation of 10 feet less than 920, or 910 feet. As the bridge is at elevation 840, it is apparent that it can not be seen from Tomlin.

(*e*) Where would this same line of sight from Tomlin, just touching Hill 920, pierce the ground?

From Tomlin a line of sight tangent to Hill 920 has fallen 20 feet in 2¾ inches, or 7.4 feet in each inch, map distance. As the line of sight is straight, this proportion will be continued. Continue the line towards the top of the map, and measure off 1 inch from the Hill 920. Your line of sight will have further fallen 7.4 feet in this distance, and you would be able to see a point with an elevation of 912.6 feet.

As this point is over elevation 840 it is apparent that the line of sight continues. In one additional inch the fall will be to elevation 903.2. This point is over elevation about 840. An additional inch will bring the elevation down to 895.8 feet, and the end of the third inch is on Contour 910. Therefore the line of sight will pierce the ground *before reaching the elevation* 910, or between 840 and 910, i. e., within the last inch measured.

Within this last inch there has been a rise on the ground of 70 feet. A rise of only 55.8 feet (895-840) was necessary.

Assuming that the ground slopes equally we can find the exact distance by proportion.

$$55.8 : 70 :: \times : 1 = .8 \text{ inch.}$$

1 inch + 1 inch + .8 inch = 2.8 inches. This distance measured from Hill 920 brings the point to about Contour 900.

If trees intervene, assume their height as 40 feet.

Practice will show the way to short cuts in this method, but the principles remain the same.

CHAPTER IX

LANDSCAPE SKETCHING[1]

LANDSCAPE sketching is an elaboration on place sketching in which the details are shown by *perspective,* i. e., by actually drawing in the pictures of the objects so that they seem to lessen as they are more distant from the eye. It is the means, par excellence, for designation of targets in combat, and is of great military importance in illustrating a reconnaissance or in making outpost sketches. It also affords a ready means of identifying bridges, fords, road forks, and other landmarks, by small marginal drawings on road sketches.

A landscape sketch shows the terrain graphically and requires no knowledge of map reading to understand. The horizon is always of military importance. This is always shown, as well as intervening crests, woods, houses, fences, etc.

Drawing teaches one to judge ground rapidly and develops an accuracy of observation which mechanically notes the form and appearance of things. There

[1] Based on a study by the School of Musketry, Fort Sill, Oklahoma. By permission of Colonel R. M. Blatchford, Infantry, Commandant.

is no surer way or quicker method of educating the eye to estimate distances and to see military features of the terrain, than actual practice in sketching.

While landscape sketching is done from the terrain in perspective, it requires no special artistic ability and, when attacked in earnest, it will be found to be no more difficult and, to many, far easier and more interesting than topographical sketching.

The sketch is made while remaining in one spot, as in place sketching, and is usually executed while seated.

The positions of objects on the sketch are located by the angular deflection, measured in *mils* from the *Reference Point.*

A mil is an angle of 3 minutes, or one sixty-four-hundredth of a circle. These numbers are not absolutely accurate, but are used in mil measurements as a matter of convenience. In other words, the entire distance around the horizon is 6400 mils in terms of angular measurement.

The Reference Point selected must be clearly defined (school house in Fig. 44). It will seldom be exactly in the hostile position, or position to be sketched. It may be a peak 20 miles beyond, or a house or a tree nearer or more distant than the lines of enemy troops.

The paper used by a patrol leader will be his notebook or the back of a field message blank (Signal Corps, 207A). For practice a sheet of paper about 5

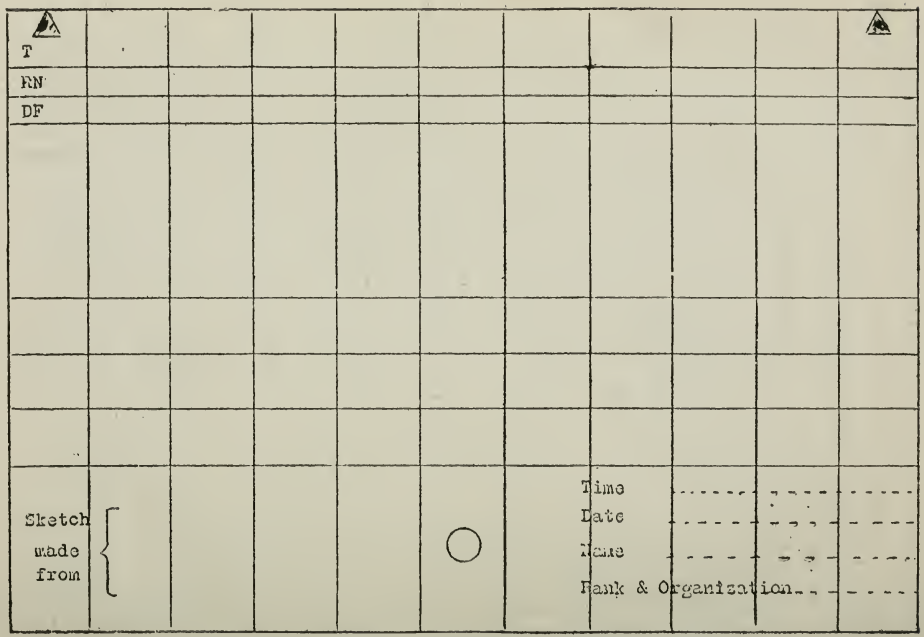
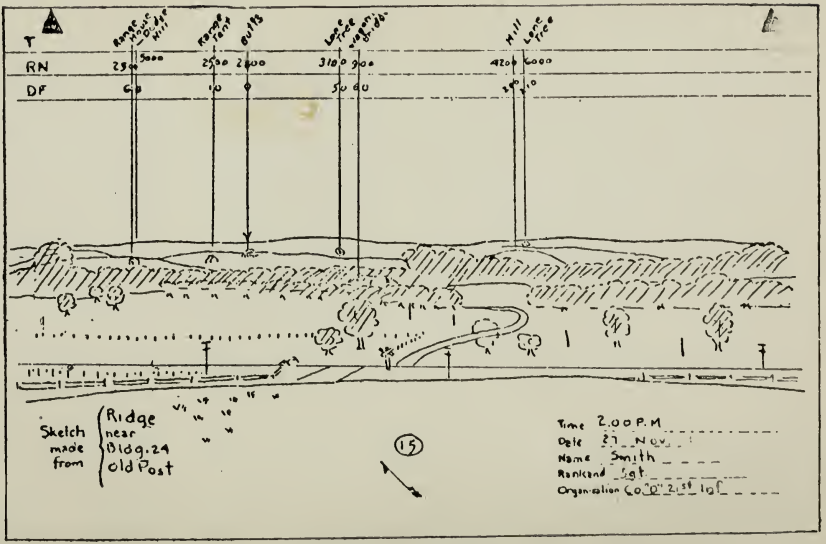


FIG. 35.—SCHOOL OF MUSKETRY SKETCHING PAD.

x 8 inches has been found very satisfactory. The length of the sketch (laterally) will seldom exceed 8 inches, which includes a visual angle of about 30 degrees (533 mils), or one-twelfth the entire distance around the horizon. A pad especially prepared is furnished for this work by the School of Musketry (Fig. 35). The sheets are 8½×5½ inches. Four horizontal lines in light blue and at half inch intervals are drawn just below the center of the sheet, the four enclosing a strip 1½ inches wide. This strip marks the *vertical* limits of the sketch. Ten vertical lines, also of light blue, cross the paper at equal distance apart. These lines are of value as guides in dropping the features of the landscape, located over the top of the paper, down to the sketch. An improvised pad can be readily constructed.

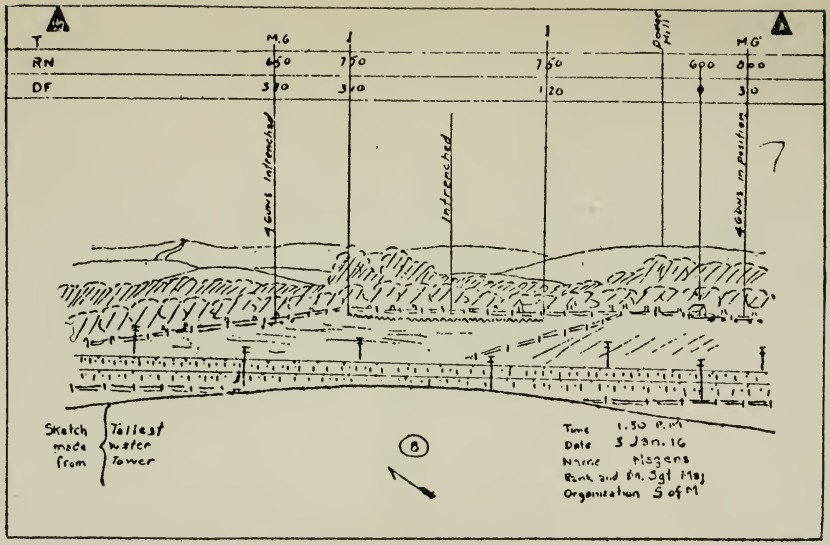
A cord run through an eyelet in the center of the backing of the pad near the top, and knotted at exactly 15 inches, is used to insure the paper being held at the same distance from the eye each time a sight is taken.

With this length of cord, the interval between lines subtends, or measures, a space of 50 mils. If an improvised pad is being used (as a matter of convenience) the vertical lines may be one-half inch apart. In this case, with a 10-inch string the interval between lines subtends 50 mils, and a 20-inch string, 25 mils.



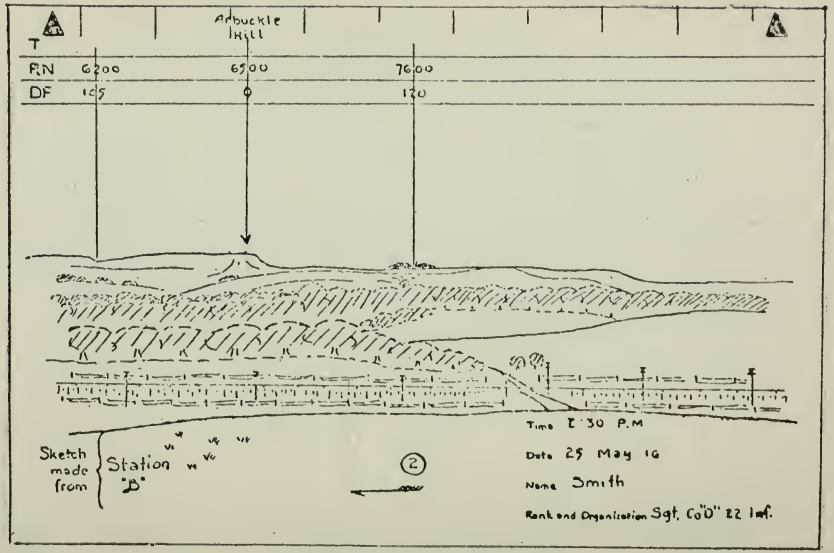
COMPLETED SKETCH.

FIG. 40.



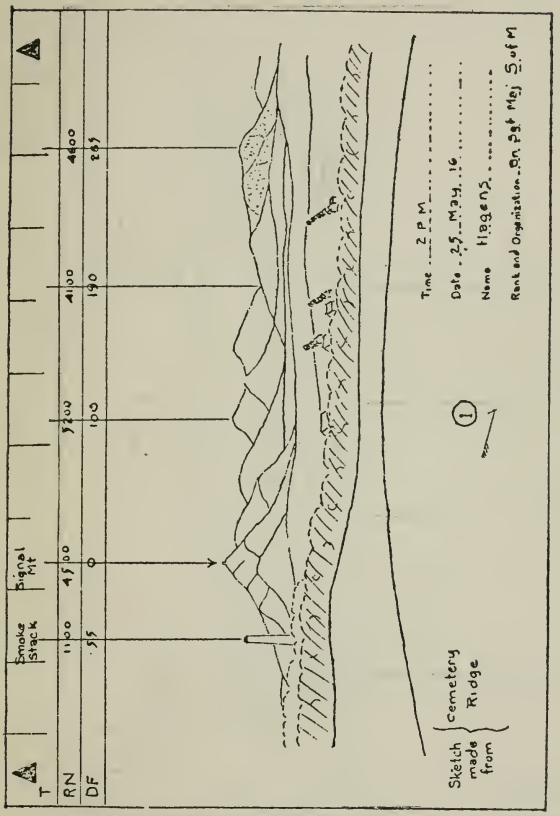
COMPLETED SKETCH.

FIG. 41.



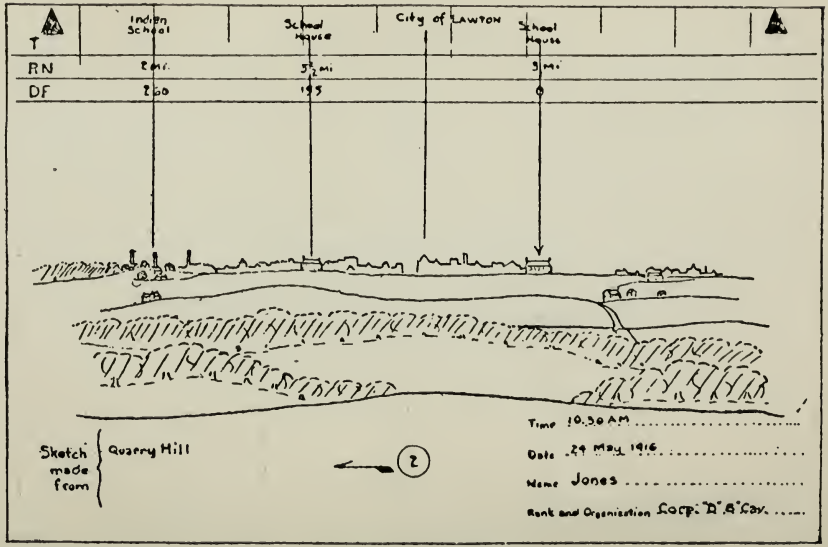
COMPLETED SKETCH.

FIG. 42.



COMPLETED SKETCH.

FIG. 43.



COMPLETED SKETCH.

FIG. 44.

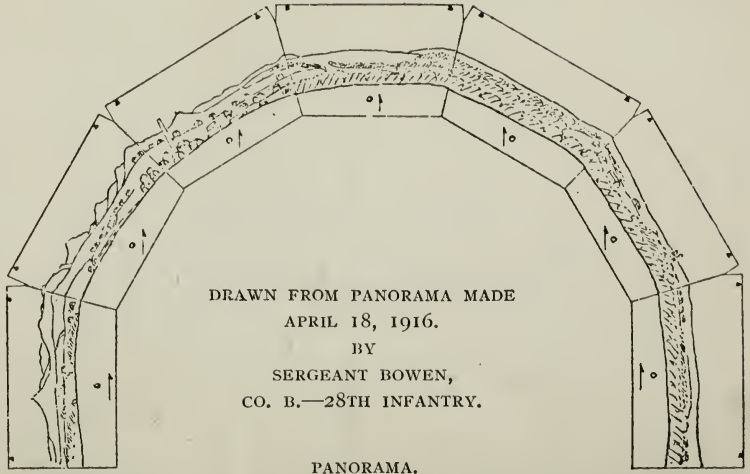
At the top of the paper are two heavy orientation marks (triangles) and three horizontal black lines. The orientation marks are placed to show the total width of the sector included in the sketch and the three lines define the divisions marked for Target (*T*), Range (*RN*), and Deflection (*DF*) (distance in mils to the right or left of the Reference Point).

On the left, below the picture, is a place for a description of the position from which the sketch was made (Figs. 40, 41, 42, 43 and 44). In the center is a circle to contain the number of the sketch and to indicate its position when a series of sketches, or panorama is made (Fig. 45). By the side of this circle, an arrowhead with one barb is drawn to show the magnetic north. On the right are spaces for time, date, name, rank and organization of the sketcher.

When landscape sketches are made on the back of a field message blank, if the blank is held 20 inches from the eye, each inch of the rule printed at the top of the sheet measures 50 mils; at 10 inches, 100 mils.

For years, the landscape sketch has been used by Field Artillery in target designation. Its value in connection with rifle fire has only recently been appreciated by Infantry.[2]

[2] In field artillery firing, deflections to the right or left are indicated in terms of mils. It is, no doubt, on this account, and because of its convenience as a unit of angular measure, that the mil is used in landscape sketching.



PANORAMA.

FIG. 45.

The *deflection,* or lateral distance of the target from the Reference Point is given in mils. This deflection and the range in yards are both entered along the upper margin of the paper together with any explanatory data. The error in deflection should never exceed 10 mils. Ranges will usually be determined by estimation. The manner of their determination—whether measured or estimated—should be noted on the sketch.

By means of landscape sketches, a patrol leader can render his report clear, brief and accurate. A few lines and explanatory remarks will convey much valuable information difficult to describe otherwise. A report locating the hostile dispositions with reference to easily recognized features, showing crest lines and possible firing positions, may be made from the concealment offered by some brush or rocks.

The position of the sketcher is indicated by a small circle and an arrowhead pointing in the direction illustrated.

Small marginal drawings of fords, bridges, landmarks, etc., add greatly to the value of any road sketch; with the map alone there is often difficulty in identifying such places. This difficulty is eliminated if a small sketch of the feature appears on the margin of the map (Fig. 46 and 47).

It is not necessary to be an artist to produce a useful military landscape sketch. The essential thing

is the rough indication of the military features. Effect and harmony are entirely secondary. The beginner will at first be confused with the mass of detail in the landscape before him. He must ignore all but the *outline* of the features sketched. Omit even prominent details in the foreground that are not of value to the sketch, such as telephone poles, trees, etc., and all unimportant details. Absolute accuracy in the detail of the appearance of houses, trees, etc., is not essential.

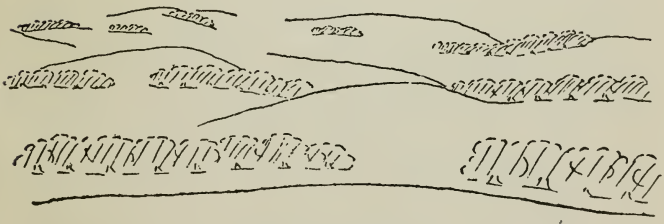
The sketcher first draws the outline of important military points (as sky line and crests), and then fills in other details *with fewest lines possible*; unnecessary shading tends to confuse and detracts from the clearness of the sketch.

The beginner will do well at first to copy other landscape drawings. By so doing, he will soon learn to handle his pencil, and will gain confidence in himself. Then make several sketches of the same country. A careful study of the ground before commencing to draw will assist greatly. Field glasses will define accidents and details of the terrain not plain to the eye.

The chief difficulty experienced by the beginner is in producing the receding effect in the picture—the *perspective*. To overcome this, note carefully the size of the objects; looking at the landscape, the further the objects are away, the smaller they look. *Make them so in the drawing.*

SKYLINE AND CRESTS.

WOODS BEHIND CRESTS.

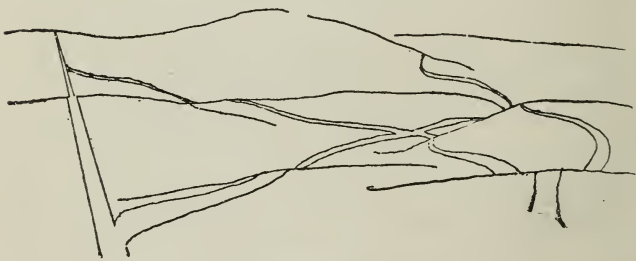


WOODS IN RELIEF.

FIG. 36.

SUCCESSIVE LINES OF WOODS.

LONE TREES.



ROADS.

FIG. 37.

The comparative size of objects near and distant may be noted by holding a pencil at arm's length before the eye and defining the limits of the object between the thumb and the end of the pencil. Heavy lines are used for objects in the foreground, medium lines for objects in the middle distance, and the background is sketched by fine lines with a hard pencil.

First draw the *sky line,* then work *towards the front,* and gradually thicken the strokes.

It may be advantageous for a beginner to use three pencils of varying hardness as an H for the foreground, 3H for middle distance and 5H for background. Commercial pencils, Nos. 2 and 3, pointed and used with care, produce the same results and are always available. Several pencils should be carried, pointed and ready for use.

To put in woods, sketch the outline of the tree tops with a succession of short curves, then draw a broken line to show the near edge of the woods, and fill the space between with diagonal shading. This is the only shading required in the entire landscape sketch, the result being that trees stand out prominently among the other details. A tree on a plain or slope, in full view, will show a portion of the trunk. Trees partially concealed by ridges, show only the rounded tops. Draw only the silhouette or outline of the tree—do not attempt detail of branches.

All roads are shown by two unbroken lines repre-

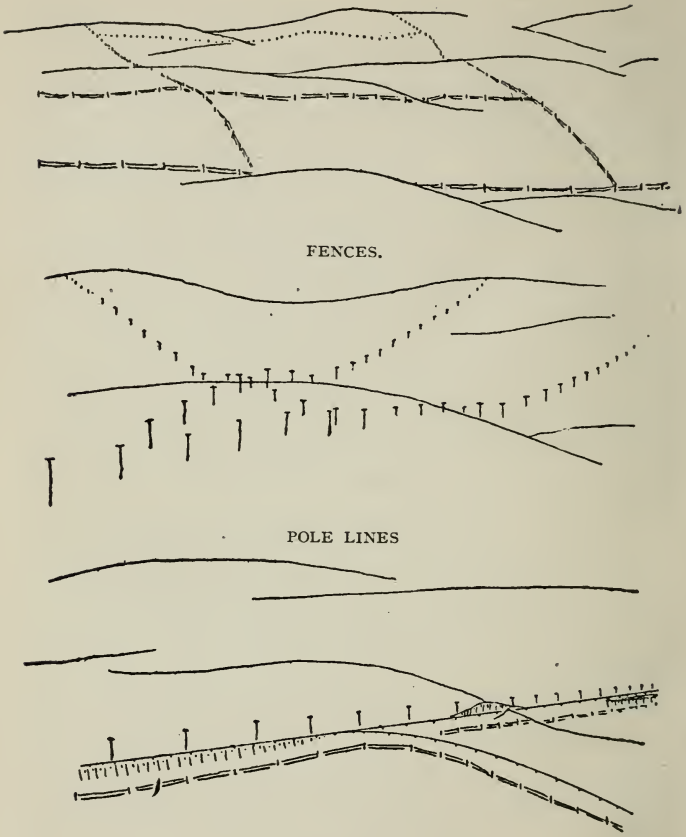
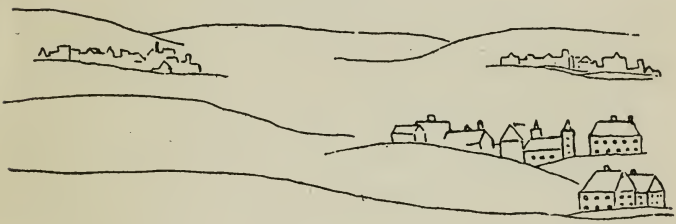


FIG. 38.

BUILDINGS.



VILLAGES.

BUILDINGS AND VILLAGE.

FIG. 39.

senting the edges, which get closer together as the road recedes, until they unite, forming one line. (Fig. 37).

Do not attempt to show unimproved roads and trails by dotted lines, as on contoured sketches—use solid lines and place any explanatory data in the *T*-section at the top of the paper.

Draw only the outline or silhouette of buildings. (Fig. 39).

Practice in Landscape Sketching

(*a*) A beginner in landscape sketching should first copy some typical sketches. He will thus learn how to handle his pencils, the relative weights of the lines in foreground and distance, and the extreme small size of the few conventional signs used to represent troops. He will also appreciate the importance of a sharp point to his pencils, and keep several always ready for use.

(*b*) The next step should be the drawing of imaginary landscapes. This is excellent practice. Skylines and intermediate crests can be drawn, and troops of all arms placed in position.

(*c*) Select a convenient section and sketch the same landscape at least once a day until the result is satisfactory.

(*d*) Select other landscapes for practice.

(*e*) Allow ten minutes for the completion of a sketch.

Making the Sketch

1. Hold the sketching pad in front of the eyes, facing the ground to be sketched, upper edge of paper horizontal, the cord knot in the teeth.

2. Close one eye, and move the paper laterally until the sector desired is included between the two orientation marks. The paper is now oriented.

3. With the paper thus oriented, the points or objects in the sector are visible along the upper edge, appearing in their proper relative positions, horizontal and vertical.

4. With a pencil, place a mark near the upper edge of the paper opposite the most prominent points or objects in the sector. Prominent features on the skyline should be located first, as they aid materially in placing other points in the drawing.

5. The lateral location of points on the skyline being thus determined, place the paper on the knee or other convenient support and transfer the marks from the upper edge to the "sketch section" of the paper. Commence with the mark opposite the highest point, which is placed *on* the first blue line. This determines the highest part of the sketch. The marks locating other features are transposed in their relative vertical and horizontal positions.

6. Draw the skyline, lightly, by connecting the transposed marks. This will give the horizon in profile.

7. Other points, crests, targets, etc., are now entered in the same manner, reorienting the paper when necessary. With practice, the other features of the landscape may be drawn in without reorientation, once the skyline has been located on the sketch.

8. The immediate foreground is indicated by a very heavy line above the circle. This may be made by using the side of the pencil point.

By this method, the lateral proportions of the sketch will be fairly accurate. The vertical should be slightly exaggerated. No effort need be made to effect this, since most sketchers will do so unconsciously.

In addition to the skyline, important crest lines and other features should be sketched in. The position of fences, roads, walls, and woods of possible military value must be included. Features of the foreground are omitted unless of military importance.

No effort should be made to obtain purely artistic effect.

Avoid detail. Show buildings, woods, trees, and other features only in the outline of the silhouette.

The only shading is used in showing woods.

Military Data

The Reference Point selected must be an object easily recognized by another person using the sketch.

It is indicated on the sketch by a vertical line drawn from near the top of the paper, stopping just above the point or object. (Fig. 43.) An arrowhead is drawn at the lower end of this line and a zero (o), is bisected in the deflection (*DF*) section.

A *reference point is always designated.*

2. In the *T*-section at the top of the sketch, is entered the name or description of the Reference Point and all other objects identified, including the letter denoting the nature of the target (Enemy).

(I., infantry; C., cavalry; A., artillery; M.G., machine guns).

3. Targets are accurately indicated on the sheet by the use of conventional signs. None but the authorized conventional signs should be used.

In addition to these conventional signs, the location is emphasized by a perpendicular dropped from the *T* line. At the top of this perpendicular, the abbreviation I., C., A., or M.G., further indicates the nature of the target.

In case the target or position shown has considerable linear dimensions, as infantry deployed, a perpendicular is dropped to each end of the line occupied. (Fig. 41.)

4. Information concerning the target (and nothing else) is written vertically upon the sketch along the perpendiculars in the broad space between the sketch and the *DF* line.

For example on perpendiculars headed

I.

4 Plat. col. advancing.
Entrenched.
Column, moving east.

C.

Led horses.
Moving north.

A.

4 guns in positions.
Limbered.

M.G.

4 guns in positions.

Moving west.

5. The range, estimated or measured, is entered in the *RN* space, across the perpendicular, indicating the target or object. The method of determining the range is written after *RN*—"Estimated" or "Measured."

When the terrain is so extensive that more than one sketch is required to cover it, sketches are numbered serially within the circle at the bottom of the pad. The location and direction illustrated on each sketch are identified by the corresponding number in a circle with an arrow pointing towards it.

7. The compass bearing is shown by an arrow with one barb, drawn beside the circle. To determine its direction, orient the sketch in a horizontal position with the "vertical" line marking the Reference Point pointing *toward the Reference Point.* Then draw the arrow parallel to the compass needle, barb toward the north.

8. The time, date and signature entered in the right-hand lower corner completes the sketch.

Joining Sketches

Several sketches will often be made from one position for the purpose of showing more terrain than can be included on one sketch.

Whenever two sketches are to be joined, the same terrain feature must appear on each—near the left edge of one and the right edge of the other. When given a terrain too wide to be included in one sketch, the procedure is as follows:

Make a complete sketch, including the terrain from the left, for example, as far as the paper

will permit toward the right, noting an object approximately beneath the right orientation mark and preferably on the skyline. The next sketch will commence with its left orientation mark over the feature noted on the right of the preceding sketch—this feature appearing on both sketches. This repeating of a fea- on two adjacent sketches is continued until the required sector of terrain is covered—up to a complete panorama of 360°. (Fig. 45.)

A series of seven sketches may be made, for example, from one position, giving a panorama of 180°. If this panorama extends from the east through the north to the west, the arrow on the first sketch indicating the magnetic bearing will lie parallel to the bottom of the paper pointing to the observer's right, the arrow on the fourth sketch (looking north) will lie at right angles to the lower edge of the paper pointing toward the top, and the arrow on the last sketch (looking west) will lie parallel to the lower edge of the paper, pointing to the observer's left. The arrows of the second and third sketches will occupy intermediate positions with reference to the lower edge of the paper between those of the first and fourth sketches, and the arrows of the fifth and sixth sketches intermediate positions between the fourth and seventh.

In assembling to form a panorama, the sketches are placed in order on a flat surface with all the arrows

parallel. In the above example, a panorama extending through 180°, the sketches form a semicircle. (Fig. 45.)

In "joining" two adjacent sketches, the corner of the right sketch, for example, is folded under and in a line through the center of the common feature. (The fold usually strikes the lower edge of the paper about an inch from the corner, and the right edge about ½ inch from the top.) Place the folded sketch over the other, so that half the common feature will be visible on each sketch, and with this common feature as a pivot, turn the right sketch until the arrows of both sketches are parallel. The crests and other features of the two sketches should meet approximately along the edge of the fold. The position of the right sketch folded under will depict the identical terrain it covers on the left sketch.

As landscape sketches are made rapidly and with a free hand, some adjustment of data will usually be necessary to secure unbroken lines where the sketches meet. The joining should be checked on the ground and corrections made without hesitation.

When several joined sketches are necessary, each sketch should be complete in itself with reference points, deflections etc.

The sketches will be joined as chords of a circle, and not arcs. This is because the successive sketches are drawn on flat surfaces, and between straight hori-

zontal lines. A panorama will therefore consist of a series of sketches joined by slight angles. This will be found to interfere little with the accurate representation of the terrain.

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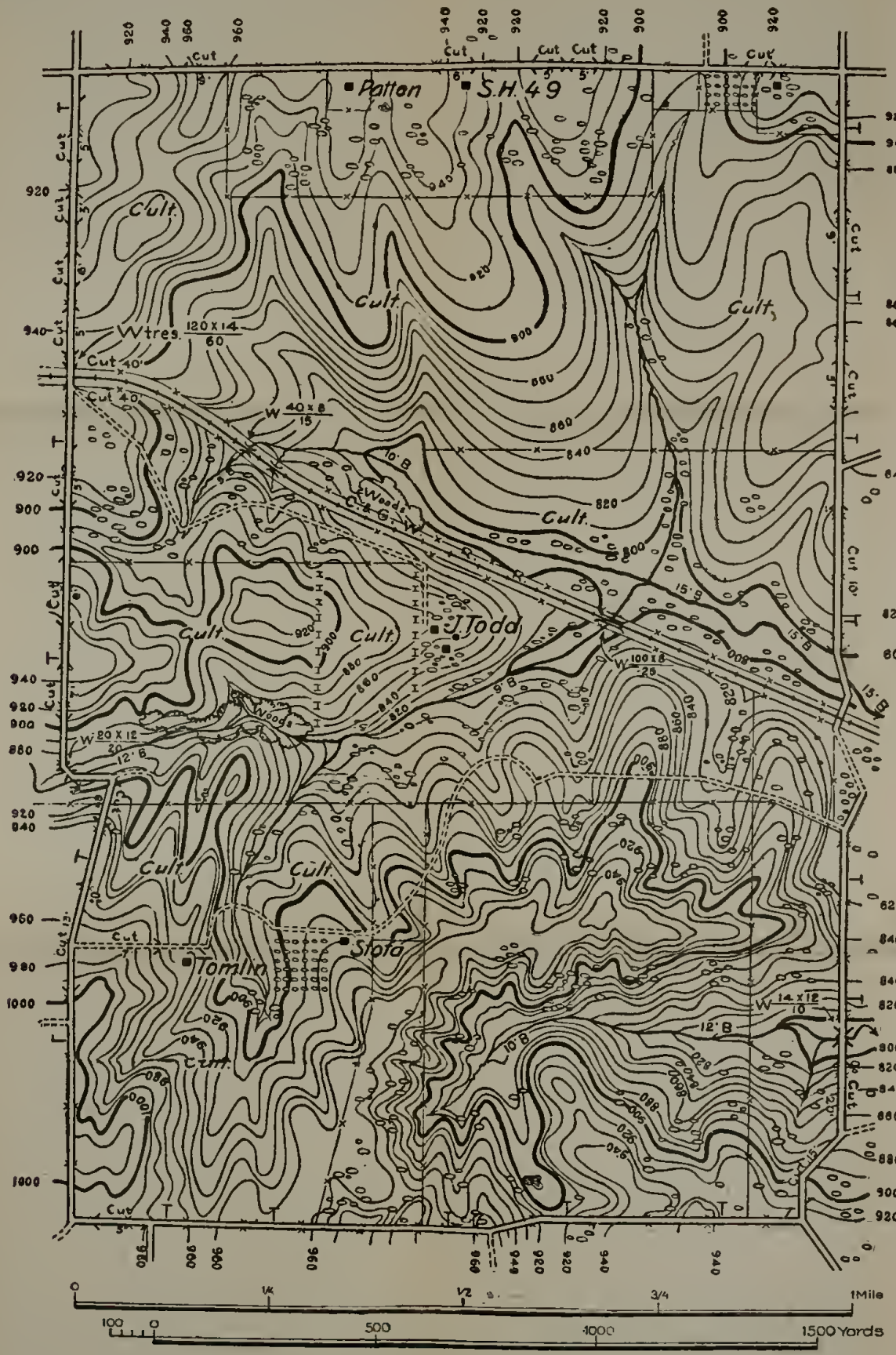

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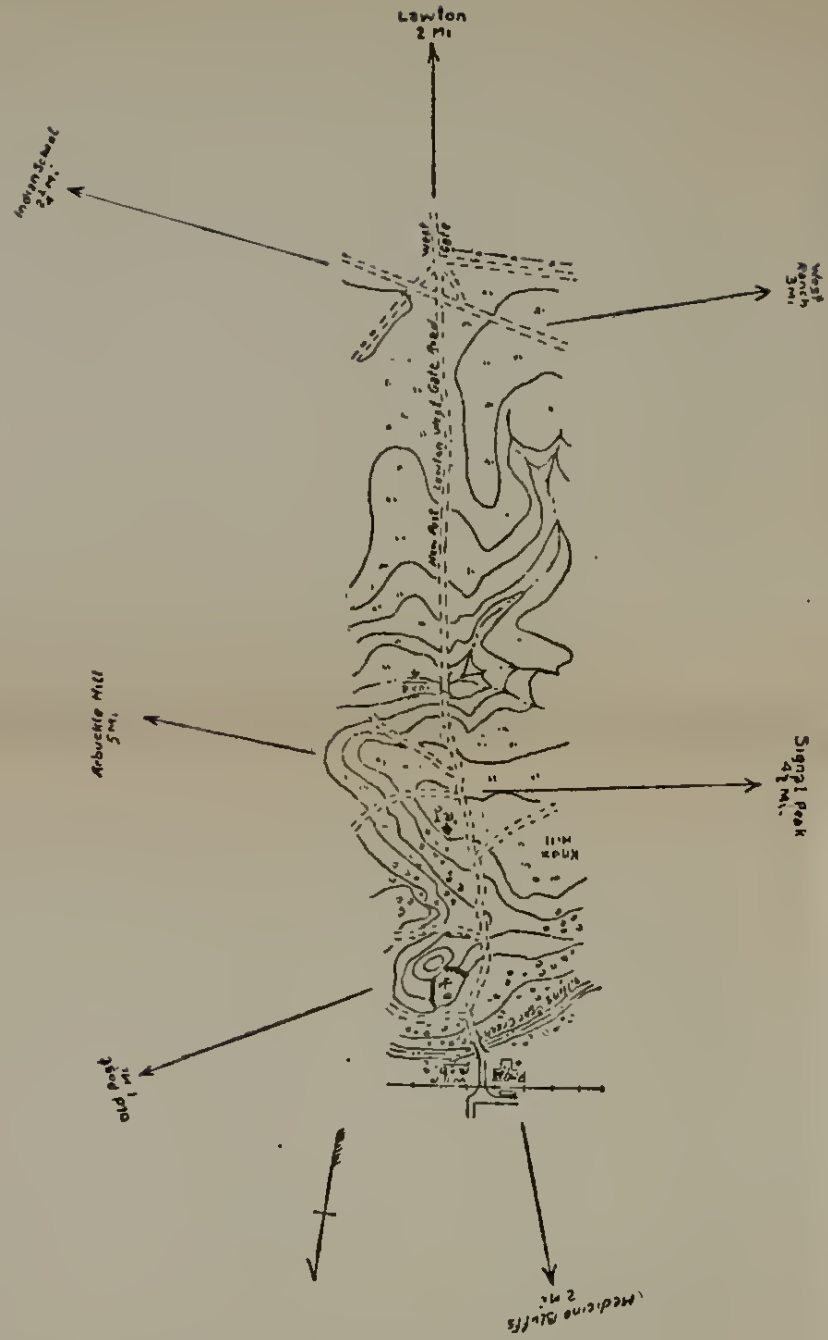

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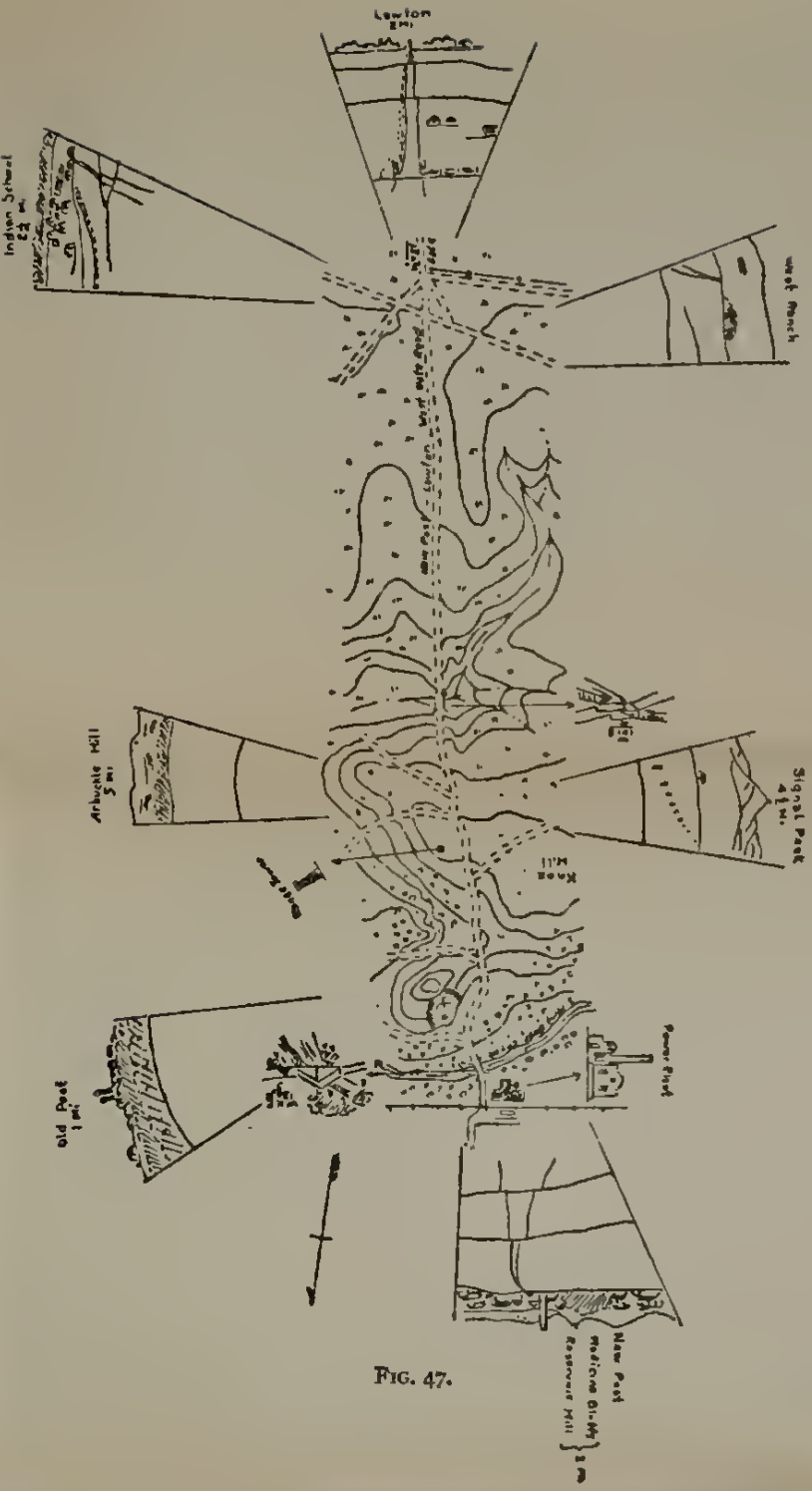

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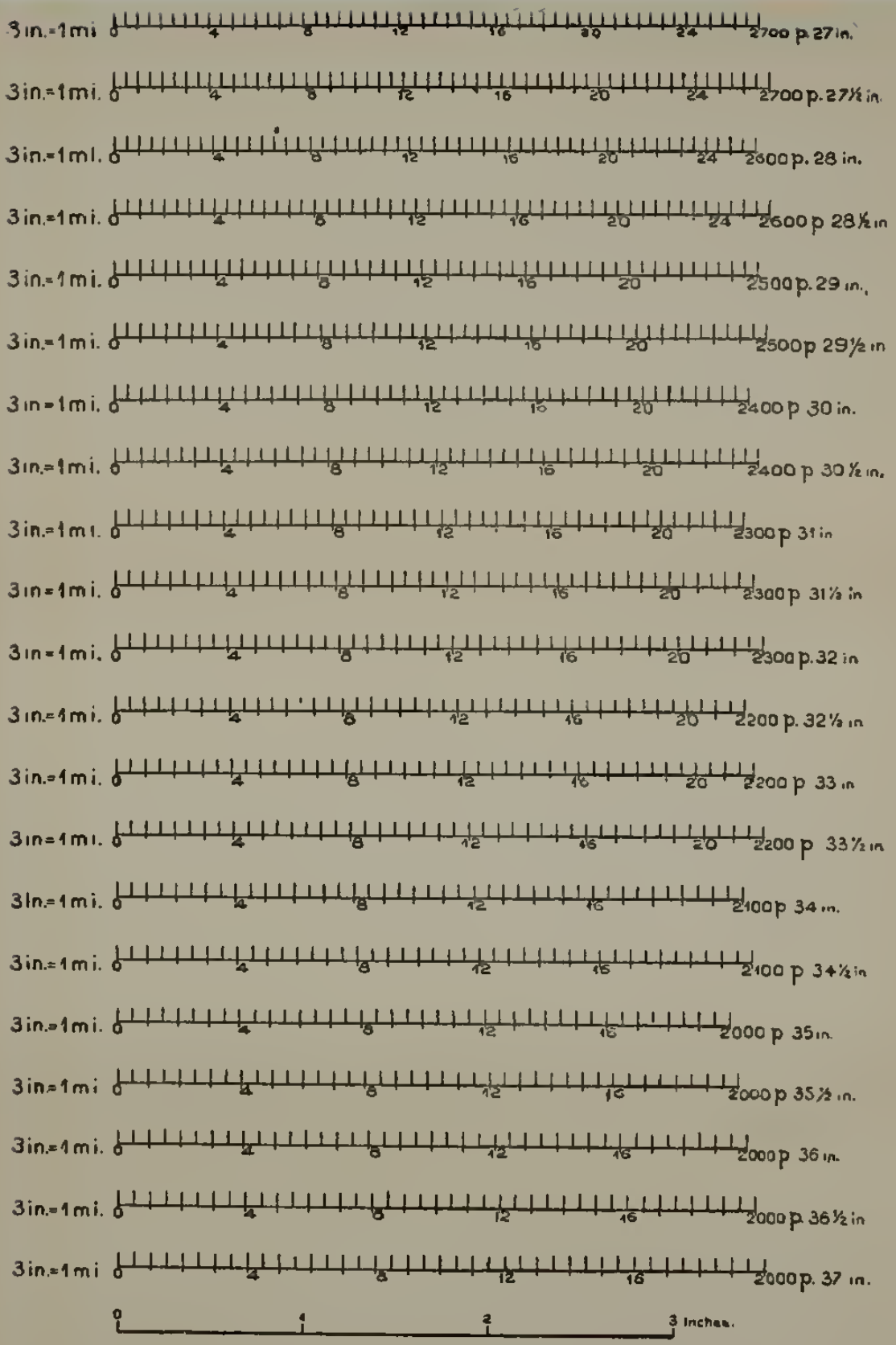

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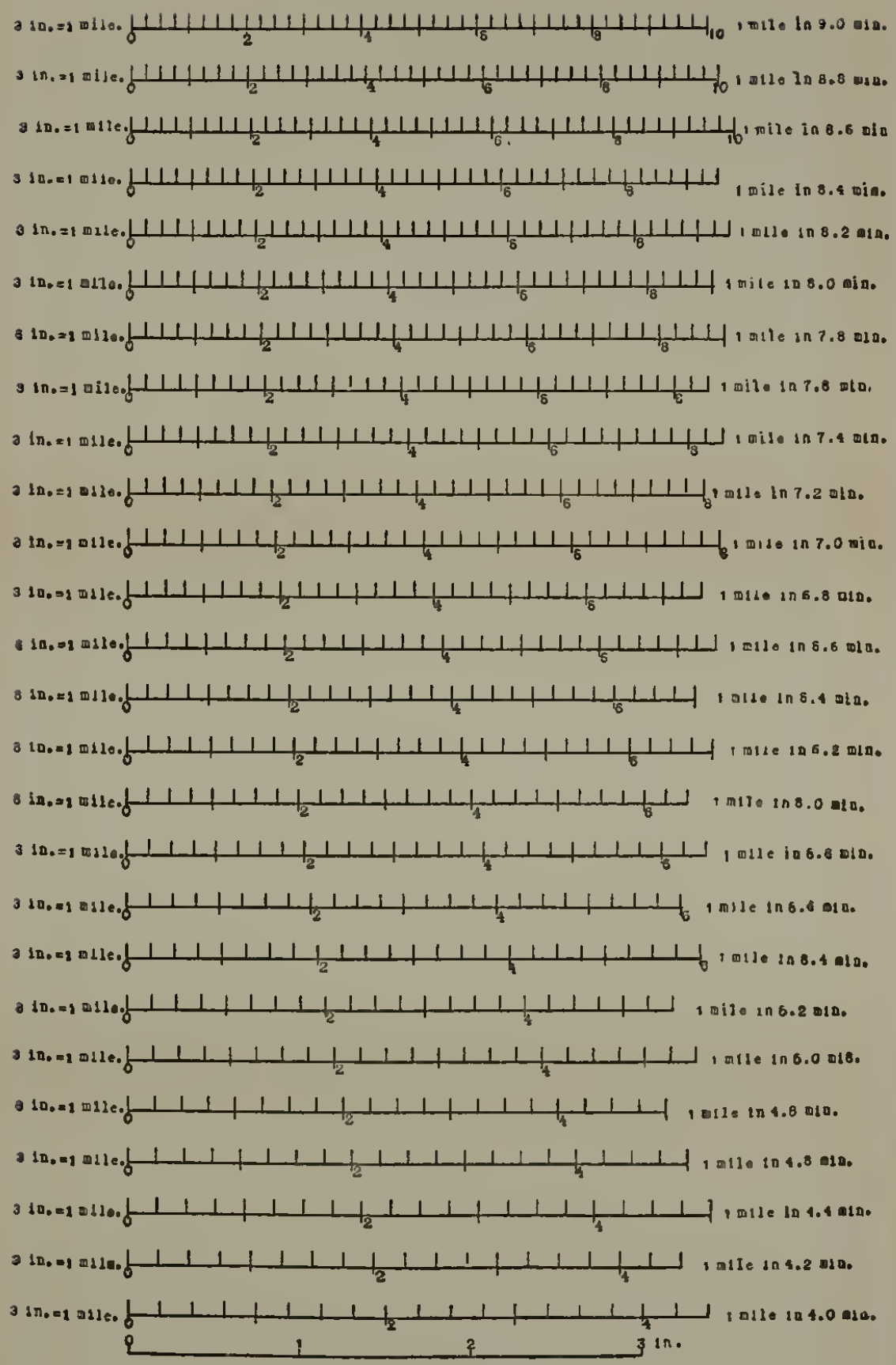

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FIG. 2D.

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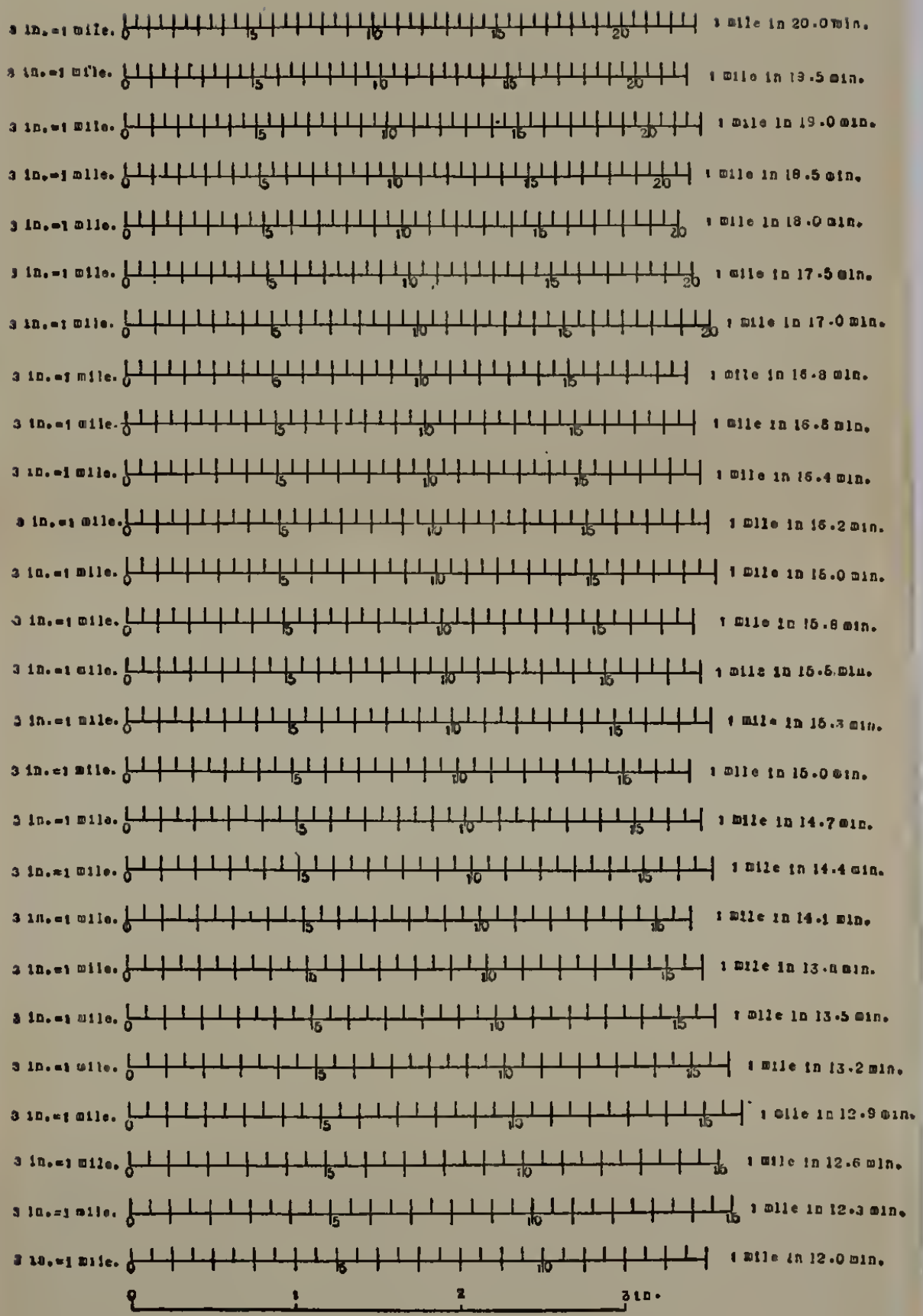

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