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43-H

ACADEMIC DEPARTMENT

ARMY AIR FORCES PREFLIGHT SCHOOL (PILOT)

SAN ANTONIO AVIATION CADET CENTER

Also S-2 Intelligence Dept
U.S. Air Force



SAN ANTONIO, TEXAS

MAPS, CHARTS, AND AERIAL PHOTOGRAPHS

JANUARY 1, 1943

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MAPS, CHARTS, AND AERIAL PHOTOGRAPHS

The purpose of this course is to present to you information which will be of use during your entire military career. The subject of Maps, Charts, and Aerial Photographs is one which vitally concerns pilots as well as navigators and bombardiers. You will at once appreciate the importance of military personnel being where they are supposed to be when they are supposed to be there. Precise timing is very important, particularly in the combat zone. Often success or failure of a mission may depend upon the perfect coordination of all units participating. In order to make and put into execution the intricate plans necessary in aerial warfare, particularly the plans of flights, it is absolutely necessary to understand both the fundamentals and details concerning maps and charts. Because in the zone of operations many of the latest maps are in the form of aerial photographs, it is essential that the flyer understand the full meaning and interpretation of these vast sources of valuable information.

The information given in this course will serve as a nucleus around which the cadet can build a working knowledge of the subject, for during his work at primary, basic, and advanced schools he will obtain through training and experience other data which will be essential in successfully completing missions assigned to him.

PLAN OF COURSE

The course is planned so that the fundamentals of the construction and interpretation of maps are given first consideration. Later in the course more details are given regarding the construction and uses of specific types of maps and charts. The final subject discussed in the course, namely the use and interpretation of aerial photographs, is one which deserves emphasis for all those planning to be flyers.

For your convenience this workbook has been prepared to enable you to follow the instructor's lectures and at the same time organize your notes in an orderly and useful manner. The figures given in this workbook have been reproduced in order that you may have a more accurate record of the drawings given by the instructor than could be obtained by sketches made from any illustration that he might use. Frequently the exact angles in drawings are significant and if the drawings are inaccurate, the value of the drawing will be lost.

The outlines of the lectures are incorporated in the workbook in order that you may have a complete record of the main topics discussed during the lecture hours. By following the outline in taking notes you will have a well organized set of notes for reference.

The exercises in the workbook are to be completed outside of class time. The cadet should be reminded that only by doing this work independently will he obtain the full benefits from this course.

In order to be able to recognize land features from the air, it is necessary to be able to read maps accurately and quickly while aloft. The importance of interpreting maps correctly cannot be over-emphasized, for it is imperative that the correct identification of objectives and other features be made. It is therefore without any apology whatsoever that the cadet is required to learn certain of the more common conventional signs and symbols used on maps and aeronautical charts. The indication of signs and symbols on maps and charts is a matter of mathematical exactness and correctness, and the interpretation of signs and symbols by the flyer must be equally exact. Detailed information regarding conventional signs and symbols is an important part of this workbook.

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MAPS, CHARTS, AND AERIAL PHOTOGRAPHS

List of Lectures

LECTURE

- I. General Consideration of Maps and Charts.
- II. Azimuths, Bearings, Distances, and Coordinates.
- III. Elevation, Relief, and Contour Maps.
- IV. Map Problems.
- V. Latitude, Longitude, and Time.
- VI. Map Projections: Mercator and Lambert Projections.
- VII. Polyconic and Gnomonic Projections.
- VIII. Map Problems and Charts.
- IX. Charts.
- X. Aerial Photographs.
- XI. Aerial Photographs and Review.
- XII. Final Examination.

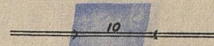
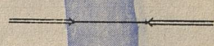
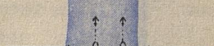
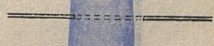
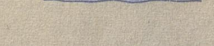
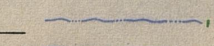
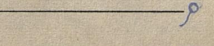
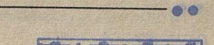
CONVENTIONAL SIGNS AND MILITARY SYMBOLS

The conventional signs and military symbols shown on pages 2 to 6, inclusive, will be studied outside the classroom.

Quizzes will be given during the first five minutes of class periods as announced by your instructor. The quiz for any particular day will cover that day's assignment and any previous assignment.

CONVENTIONAL SIGNS AND MILITARY SYMBOLS

Roads	{	Good motor	_____	=====
		Poor motor or private	_____	=====
		On small-scale maps	_____	-----
		<i>Routes usually traveled may be further classified by red overprinting as follows:</i>		
		Hard impervious surfaces	_____	=====
		Other surface improvements	_____	=====
		Good pack trail	_____	-----
		Poor pack trail or footpath	_____	-----
Railroads	{	Railroad of any kind, small scale	_____	-----
		Railroad single track, large-scale maps		
		Railroad crossing	_____	-----
		grade--rr above--rr beneath	_____	
Tunnel	{	railroad	_____	-----
		road	_____	=====
		Railroad station of any kind	_____	-----
		Telegraph and telephone lines	{ On ground or poles	-----
		Electric power transmission line		
		Buildings in general	_____	{ 
		Church	_____	
		Hospital	_____	
		Schoolhouse	_____	 or 
		Triangulation point or primary traverse station	_____	
		Permanent bench mark (and elevation)	_____	
		Cemetery	_____	 or 
		Mine or quarry of any kind (or open cut)	_____	

Bridges	{	General symbol (capacity in tons indicated by figures)	{	road	
				railroad	
		Foot			
		Ponton			
Ferries					
Fords	{	General symbol (for vehicles)	{		
		Equestrian			
Dam					
Streams in general					
Intermittent streams					
Spring					
Wells and water tanks					
Marsh in general (interior salt marshes and coastal fresh marshes are to be indicated as such)					
Woodland (or as shown below)					
Woodland (or broad-leaved trees)					
Orchard					
Fences	{	Stone			
		Worm			
		Wire	barbed		
		Wire	smooth		
Hedge					
Depression contours					
Fills					
Cuts					

To indicate purpose or character of activity

Military post or station—command post or headquarters 
(Lower end of staff or symbol will terminate at point of establishment represented.)

Troop unit 
(On large scale maps where troop units can be shown to scale, this symbol may be modified so as to show area occupied by units in column or line, thus:

Line 

Column 

Observation Post 

Depot (supply point) 

Temporary depot in combat zone 

Supply train or transportation unit 

To indicate arm or service or activity of arm or service.--These symbols will be placed generally within the symbols shown above.

Air Corps 

Airdrome 

Airport 

Armored Force 

Artillery 

Cavalry { Horse 
Mechanized 

Chemical Warfare Service 

Engineers 

Infantry (except military police) 

Military police 

Medical Department 

Ordnance Department 

Ammunition only 

Prisoners of war 

Quartermaster Corps 

Class I supplies 

Gasoline and oil only 

Signal Corps 

Signal Corps (aviation) 

Transportation Service 

To indicate size of units.--These symbols will be placed above the symbols indicating purpose of character of activity, or used for indicating boundaries as shown below.

Squad 

Section 

Platoon 

Company, troop, battery, or Air Corps flight 

Battalion, cavalry squadron, or Air Corps squadron 

Regiment or Air Corps group 

Brigade or Air Corps wing 

Division 

Corps 

Army 

General headquarters 

Air Force Combat Command  CC

To indicate boundaries

Squad 

Section 

Platoon 

Company or similar unit 

Battalion or similar unit 

Regiment or similar unit 

Brigade 

Division 

Front line 

Limit of wheeled traffic by day 

Limit of wheeled traffic by night 

Miscellaneous

Message Center 

Tank trap 

Traffic:

One-way 

Two-way 

Trench for one squad 
(For each additional squad add one traverse.)

GN MN
10°30'

- Area gassed, to be avoided 
- Automatic rifle 
- (Dotted when emplacement is not occupied) 
- Machine gun 
- (Arrow to point in principal direction of fire. When used alone it indicates Machine gun, water-cooled, cal. .30)
- Machine-gun symbol under symbol of unit of any arm indicates machine-gun unit of that arm.
- Caliber .50 (antitank) 
- Machine gun (single gun) 
- (arrows to indicate sectors of fire, shaded portion to show danger space when fire is placed in final protective line.)
- Machine-gun section (two guns) 
- Gun 
- Gun battery 
- Howitzer or mortar 
- 37-mm gun 
- (AT or AA to be added where applicable.)
- 81-mm mortar 

- Light Machine-Gun Section, Company A, 2d Infantry 
- 1st Platoon, Company B, 2d Infantry 
- Machine-Gun Platoon, Caliber .50, Company H, 29th Infantry 
- Headquarters Company, 3d Infantry 
- Company D, 20th Infantry 
- Command Post, 3d Battalion, 4th Infantry 
- Observation Post, 6th Infantry Regiment 

SYMBOLS FOR AIR NAVIGATION MAPS AND CHARTS

- Army, Navy, or Marine Corps field 
- Commercial or municipal field 
- Department of Commerce intermediate field 
- Marked auxiliary field 
- Airplane landing field, marked or emergency (where not shown in plan nor by symbol indicating characteristics) 
- Mooring mast 
- Night lighting facilities 
- Seaplane base with ramp, beach, and handling facilities 
- Anchorage with refueling and usual harbor facilities 
- Protected anchorage with limited facilities 
- Airway light beacon (arrows indicate course lights) 
- Auxiliary airway light beacon, flashing 

- APPLICATION OF SPECIAL SYMBOLS**
- Light Machine-Gun Platoon, Troop A, 2d Cavalry 
- Machine-Gun Troop, Caliber .50, 2d Cavalry 
- Troop F, 2d Cavalry 
- Company A, 2d Engineers (combat) 
- Battery F, 2d Field Artillery 
- One Squad, Company A, 4th Infantry 

Airport light beacon with code light 
(within airport symbol)

Airport light beacon without code light 
(within airport symbol)

Landmark light beacon with bearing projector (arrow indicates fixed beam pointing to airport) 

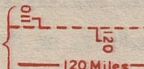
Landmark light beacon without bearing projector 

Radio station with call  or  RS (WUF 1830)
letters and frequency

Radio direction-finder station with call letters and frequency (radio-compass station)  RC (NDW 3010)

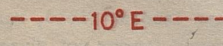
Radio beacon with call letters  RBn (WRO)

Radio range beacon  RR Bn

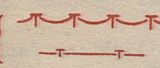
Air routes, optional symbols 
120 Miles

Radio marker beacon 
344°

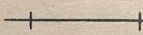
Fan marker beacon 
ARCOLA

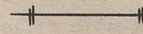
Lines of equal magnetic variation 
10° E

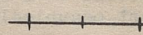
Prohibited area 

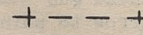
Prominent transmission line 

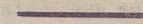
Railroads

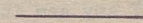
Single track, 
crosstie spacing 5 miles

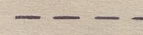
Two or more tracks, 
crosstie spacing 5 miles

Electric, 
crosstie spacing 2½ miles

Abandoned 

Highway, prominent 

Highway, less prominent 

Road or trail, prominence uncertain 

Oil well derrick 

Obstruction (numerals indicate height above ground in feet) 
257

Prominent elevation (numerals indicate height in feet) 
862

Coast Guard station 

Look-out tower 

High explosive area

Marked 
HIOX #77

Unmarked 

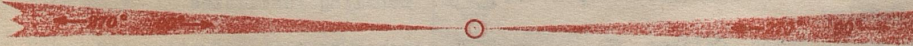
Cities and towns

Less than 1000 

1000 to 5000 

more than 5000, actual shape 

Race track 

Radio range 
170°

Bearings are magnetic at the station

Gradient of elevations

0 to	1000	2000	3000	5000	7000	9000	Maximum
Green	Light green	Pale brown	Light brown	Medium brown	Deep brown	Dark brown	

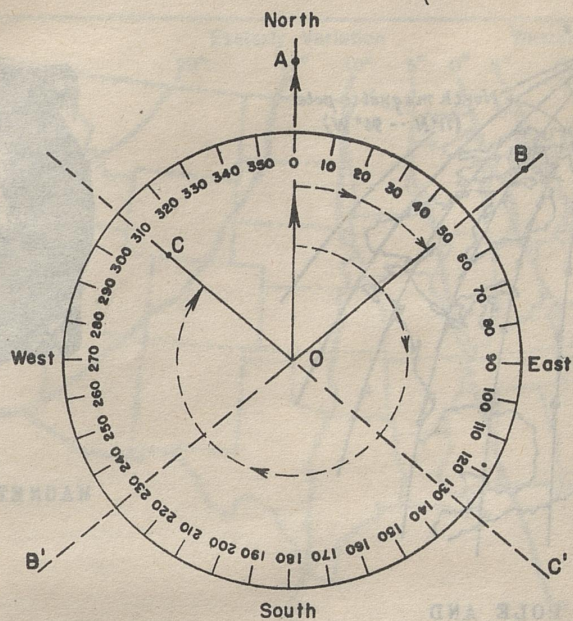


Fig. 1. AZIMUTH CIRCLE IN DEGREES

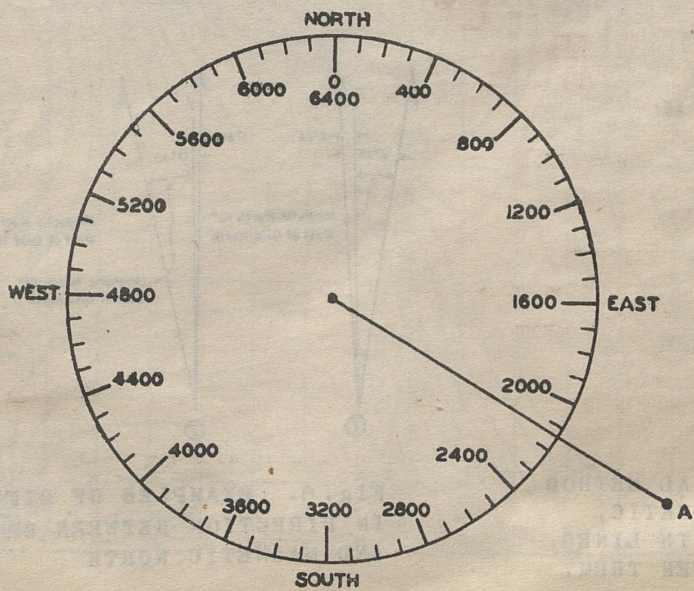


Fig. 2. AZIMUTH CIRCLE IN MILS

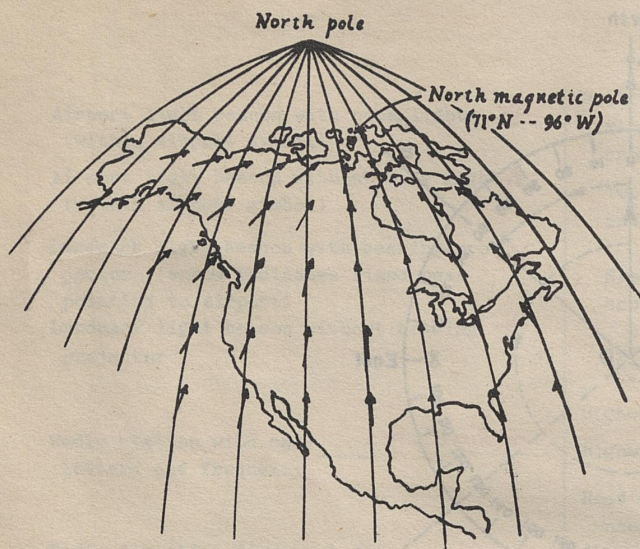


Fig. 3. THE MAGNETIC POLE AND MAGNETIC VARIATION

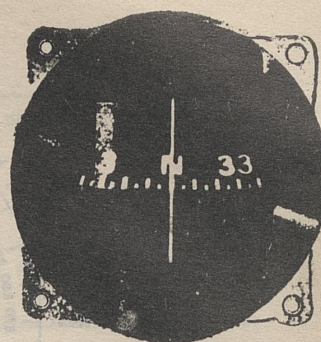


Fig. 4
MAGNETIC COMPASS

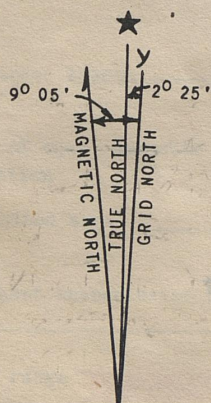


Fig. 5. CONVENTIONAL METHOD OF INDICATING MAGNETIC, TRUE AND GRID NORTH LINES. ANGLES VARY BETWEEN THEM.

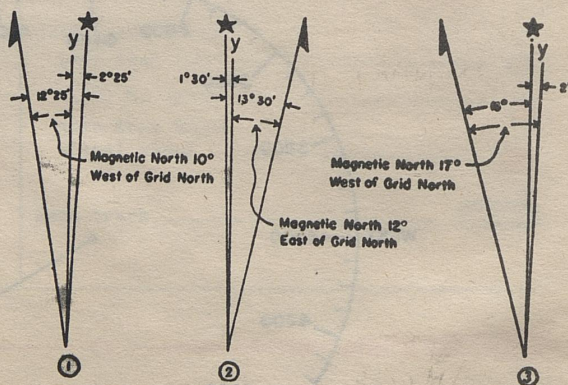
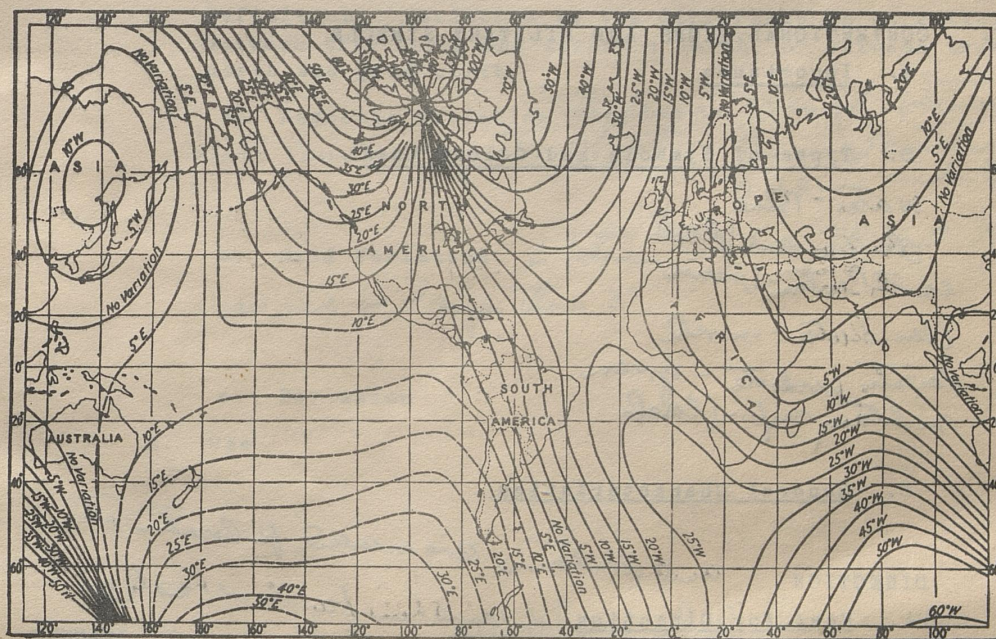
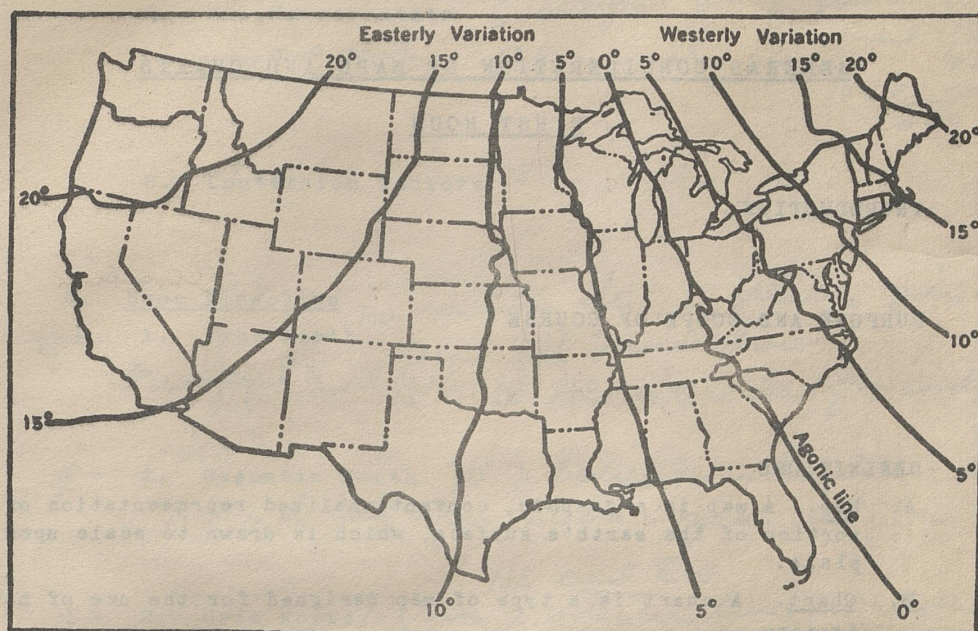


Fig. 6. EXAMPLES OF DIFFERENCE IN DIRECTION BETWEEN GRID AND MAGNETIC NORTH



GENERAL CONSIDERATION OF MAPS AND CHARTS

FIRST HOUR

I. INTRODUCTION

II. PURPOSE AND SCOPE OF COURSE

III. DEFINITIONS

- A. Map. A map is a graphic, conventionalized representation of a portion of the earth's surface, which is drawn to scale upon a plane.
- B. Chart. A chart is a type of map designed for the use of navigators.
- C. Aerial Photograph. An aerial photograph is a picture, with either a vertical or an oblique viewpoint, taken from an aircraft.

IV. CONVENTIONAL SIGNS AND MILITARY SYMBOLS

A. Importance

B. Types of Symbols and Colors Used

Water - Blue
Contours are black
earth Contour - brown
Cen. data - in red
Vegetation woodlots - green
military info - black

C. General Characteristics

V. DIRECTION

A. Need for Direction

and distance are needed for location etc
to find how far the road has to go

B. Unit of Angular Measurement

1. Degree Measurements

means a compass by °
and bear sure a distance or point lies in that direction
no mark distance away

2. Mil Measurements

6400 equal pts $\perp$ between each line
 $1760' = 1 \text{ mil}$

$1 \text{ mil} = \frac{3600}{6400}$
 $10 = \frac{6400}{360}$

3. Conversion Factors

C. Base Direction

★ 1. True North

$\perp$ military dir. $\perp$ between given dir. +
 some pt based line
 Geographical North Pole. An object to is dist of meridians

7 = 2. ^{MN} Magnetic North

$70^\circ \text{ N. latitude } 96^\circ \text{ W longitude}$
 M.N. is the way your needle is pulled away from T.N.

7 = 3. Grid North

N.S. and E.W.
 (series of intersecting lines) Military maps.
 are based on charts M.N.

D. Variation or Declination

1. Definition. Variation is the difference in direction between true north and magnetic north, or between true north and grid north.

a. Magnetic Variation

difference given pt between true north and magnetic North. E or W variations add. sub. E

b. Grid Variation

$\perp$ between true north and grid north will never be larger than 3°

c. Deviation

2. Use

VI. SUMMARY

azimuth line - pts along which there is no magnetic variation

GENERAL CONSIDERATION OF MAPS AND CHARTS

1. What are the important differences, to pilots, between maps and charts?
2. What two facts are of importance in locating one point on the map in respect to another? (1) Distance (2) Direction.
3. If a battery of artillery were laid at 623 miles and a pilot wished to fly toward the target from the point of fire, what would be his direction in degrees? 35°.
4. What is the relationship between grid north and true north?
5. When is the direction of true north the same as that of magnetic north? At 0°.
6. What is the angle between grid north and magnetic north, assuming grid variation to be $1^{\circ}57'$ east and magnetic variation to be $9^{\circ}45'$ west? 11.02°.
7. List the types of features which the pilot would expect to find on the ground as indicated by the following colors on a map:
 1. Black Buildings
 2. Brown Contours
 3. Green Woods
 4. Red Highways
 5. Blue Water
8. Of what importance is deviation to a pilot? must know the deviation or the pilot will lose course
9. On military maps:
 - A straight line ending in half an arrow-head indicates M. north.
 - A straight line ending at a star indicates True north.
 - A straight line ending at a letter 'y' indicates Grid north.
10. In converting true courses to magnetic courses, are easterly variations added or subtracted? Sub. Why?

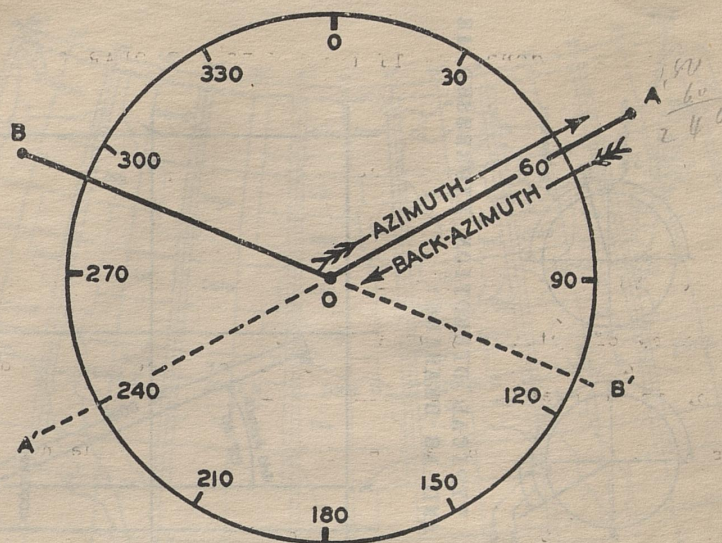


Fig. 9 BACK AZIMUTHS

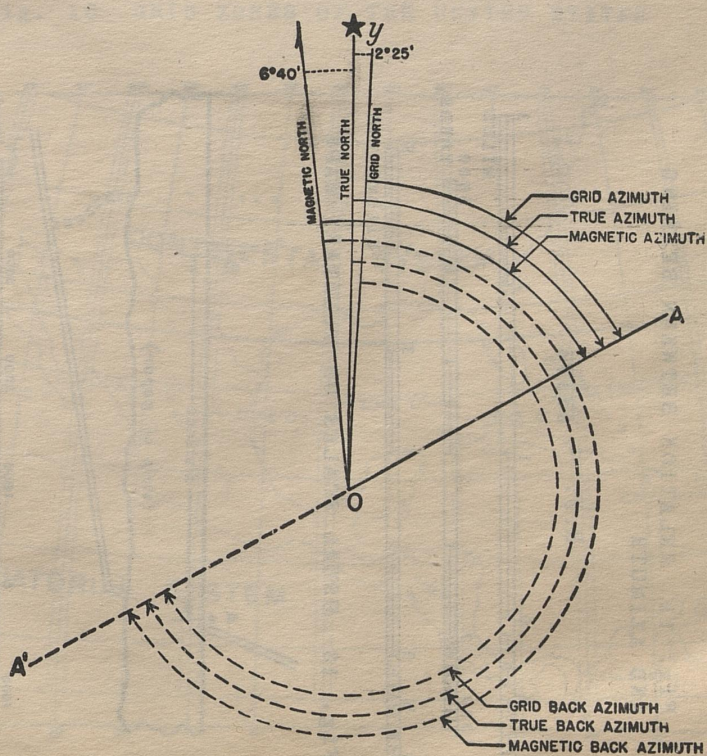


FIG.10 EXAMPLE OF RELATIONSHIP BETWEEN THREE BASE DIRECTIONS ON A MAP, SHOWING CORRESPONDING AZIMUTHS AND BACK AZIMUTHS OF LINE OA.

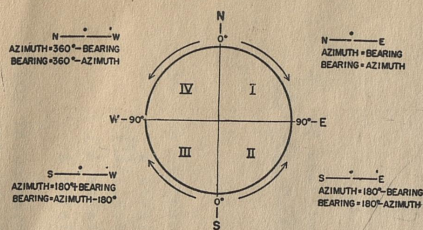


Fig. 11 RELATION BETWEEN BEARING AND AZIMUTH

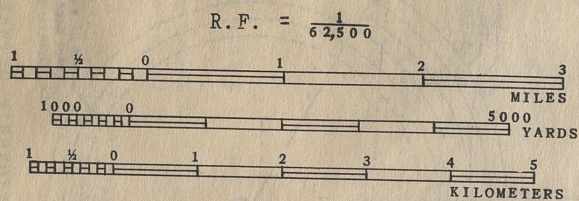


Fig. 13 USUAL SCALES ON MILITARY MAPS

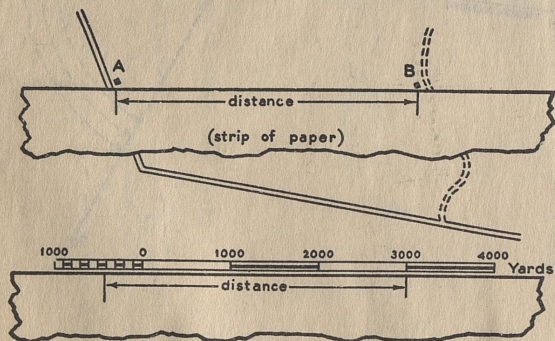


Fig. 14 MEASURING DISTANCE ON A MAP BY USE OF GRAPHIC SCALE

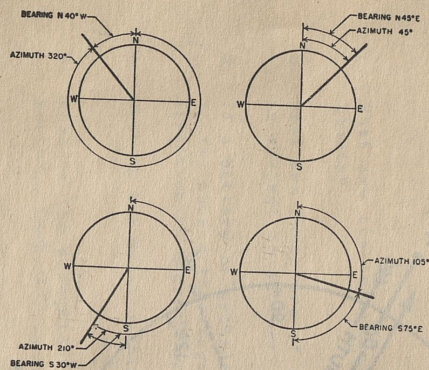


Fig. 12 TYPICAL DIRECTION EXPRESSED AS AZIMUTH AND AS BEARING

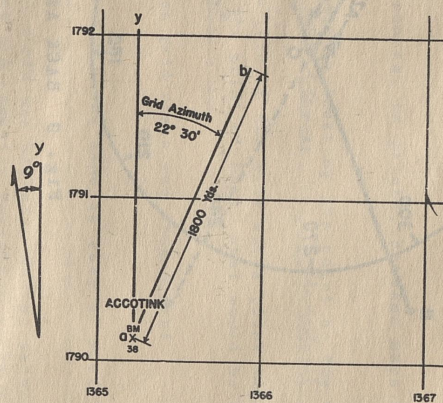


Fig. 15 POLAR COORDINATES

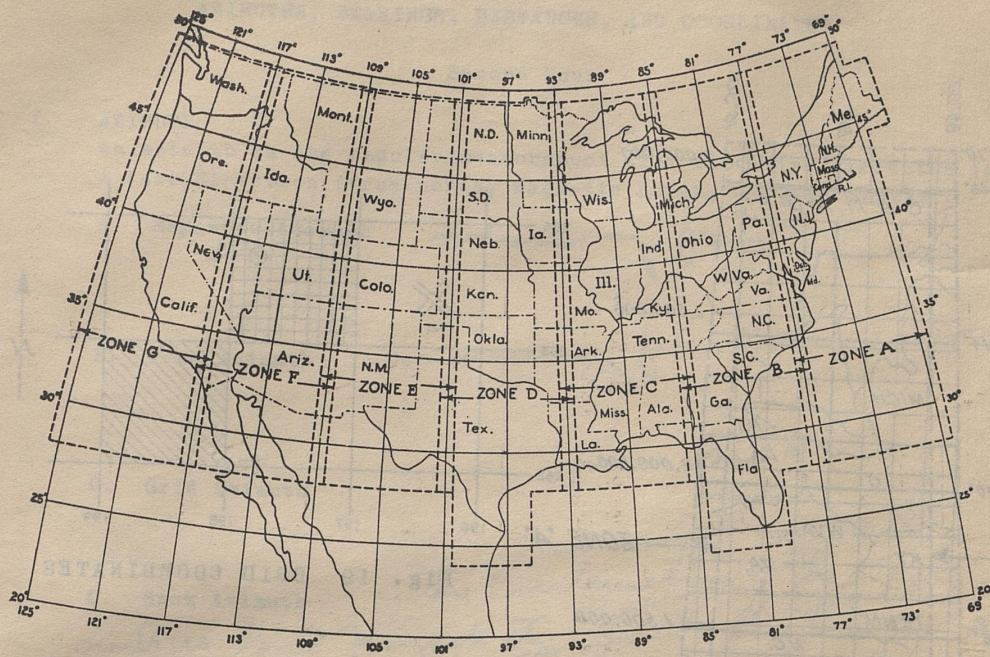


Fig. 16 GRID ZONES OF THE UNITED STATES

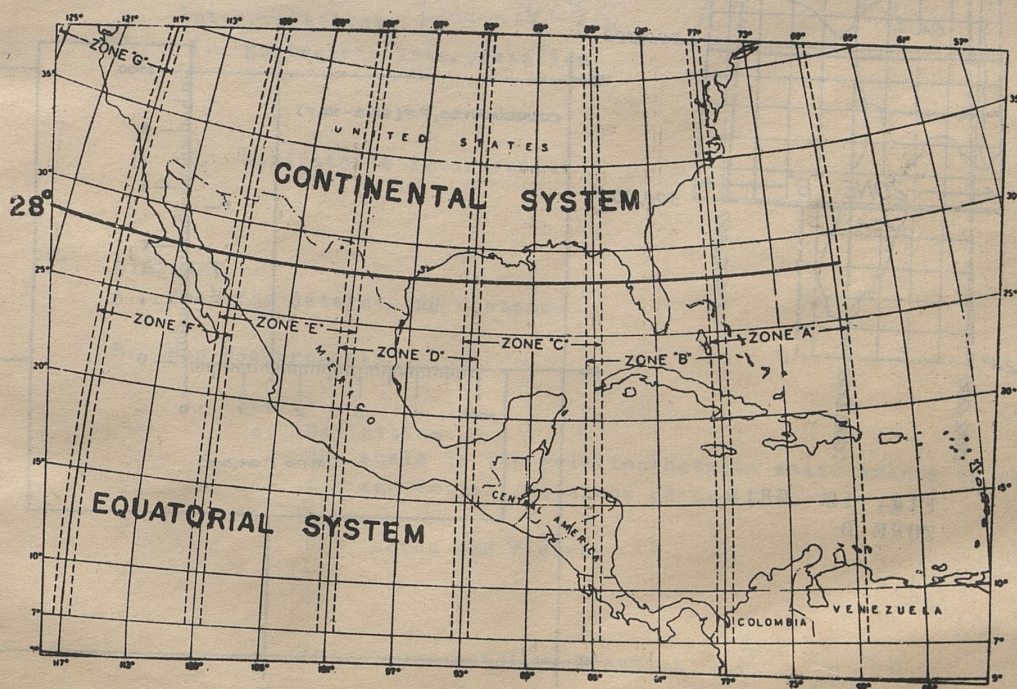


Fig. 17 EQUATORIAL GRID SYSTEM

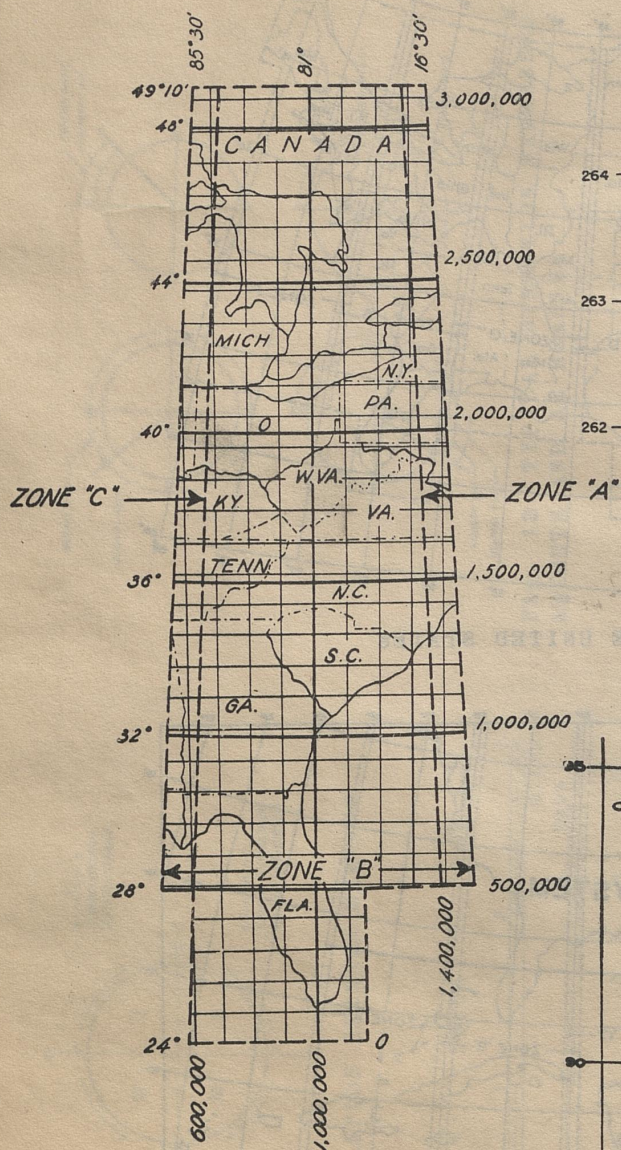


Fig. 18 GRID
ZONE B

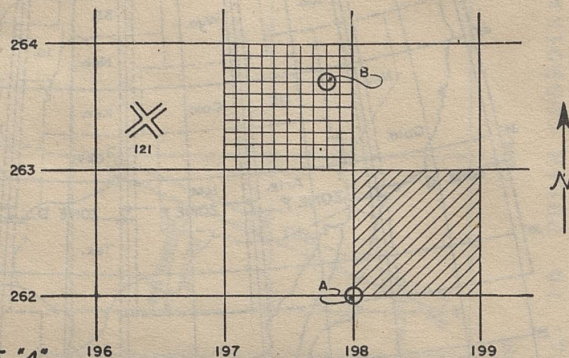


Fig. 19 GRID COORDINATES

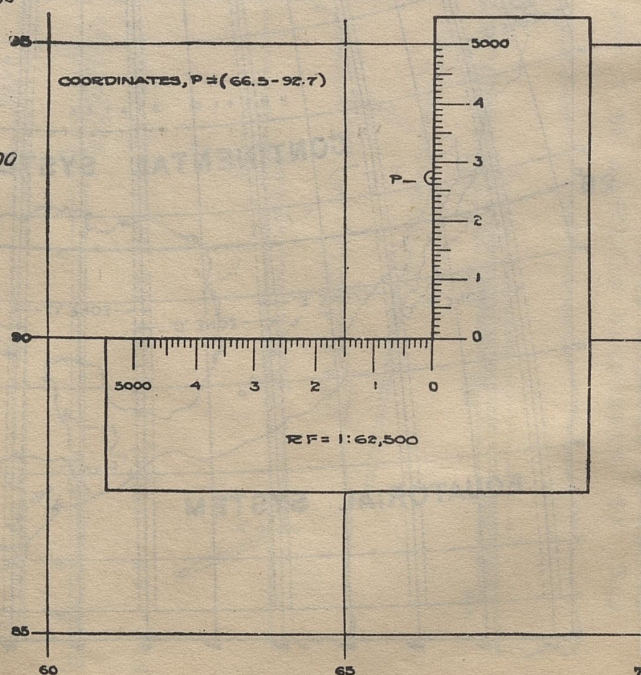


Fig. 20 COORDINATE SCALE

AZIMUTHS, BEARINGS, DISTANCES, AND COORDINATES

Second Hour

I. AZIMUTH

An azimuth is the angular measurement in a clockwise direction from a base direction (true north, magnetic north, or grid north).

A. Magnetic Azimuth

measuring from M.N.

B. True Azimuth

measuring from T.N.

} forward

C. Grid Azimuth

from Grid N

D. Back Azimuth

- is the continuation of the North line makes Grid Magnetic etc. total is less than 360° add to your forward but if less than

+ (or) - 180°

II. BEARINGS

= N 45° E etc. azimuth if found by one of bearing from 180° etc

A. Interpretations

1. Engineer's Interpretation

2. Navigator's Interpretation

III. DISTANCE

A. Need for determining distance

B. Map Measurements

1. Scales

a. Definition

The scale is the relation between measurements on the map and actual distances on the ground.

b. Types

(1) Words and Figures

(2) Representative Fraction = $\frac{R}{F} = \frac{1}{62,500}$

(3) Graphic Scales

scale on map

such as marked off on a

*(3280) in miles
63,360 in miles*

B. Distance Determination

C. Conversion of Distance to Time

10 = 60 minutes

IV. LOCATION BY COORDINATES

A. General Considerations

1. Necessity for Reference Points

B. Polar Coordinates

1. Definition

The polar coordinate system is one in which a point is located by giving its distance and direction from another known and given point.

2. Use

on maps where there are no grid lines

C. Military Grid

1. General Considerations

a. Description of Grid System

*U.S. divided into 7 grid sections each has 90
longitude. Center line is on true North*

b. Scales

Large scale 1000 yds apart 500 yds smaller

2. Location by Grid Coordinates and use of Coordinate Scale

See fig 19 Aug 16

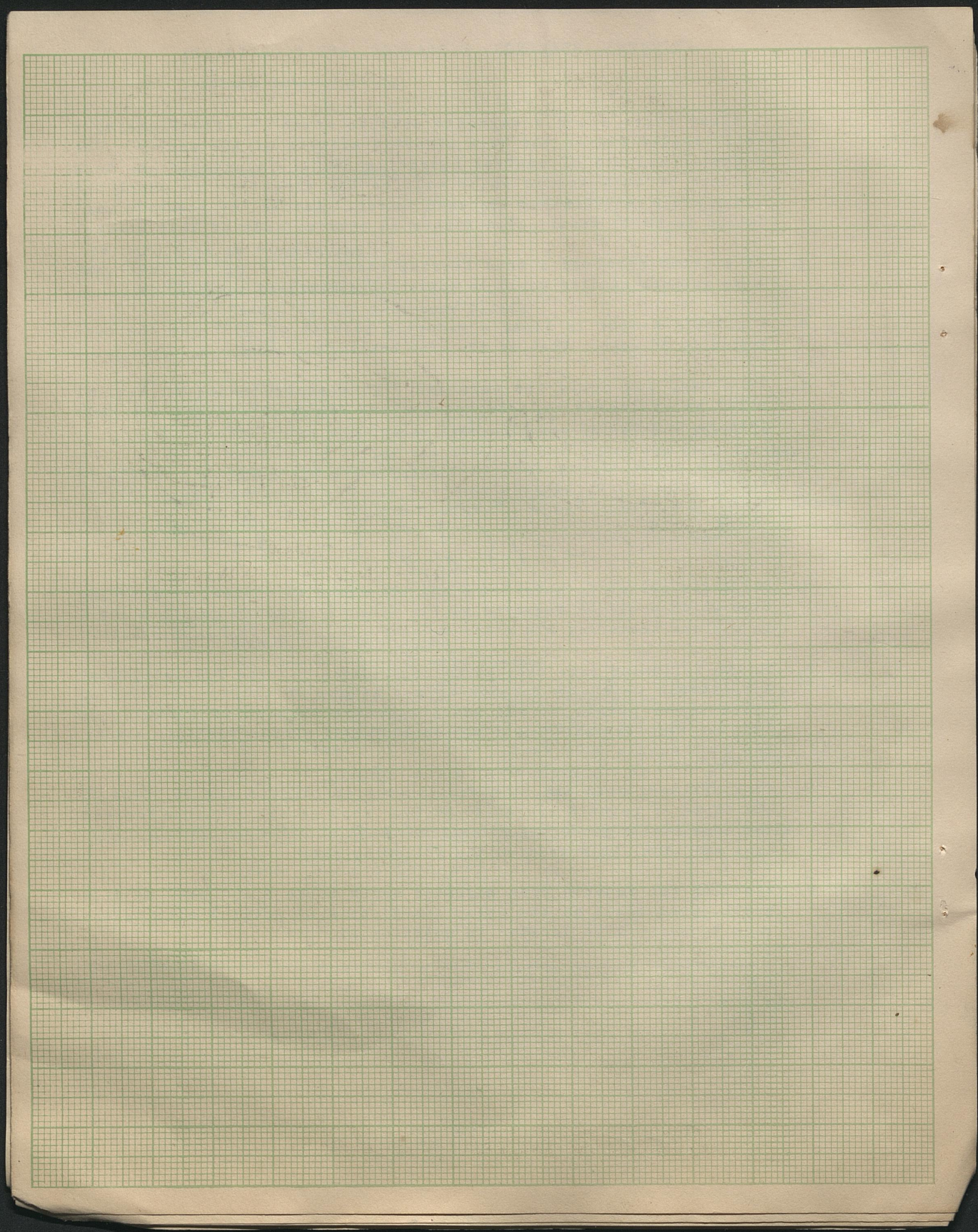
V. SUMMARY

AZIMUTHS, BEARINGS, DISTANCES, AND COORDINATES

1. A plane flies along a magnetic azimuth of 46° . Illustrate by a well-labeled figure the back magnetic azimuth of the course. The magnetic azimuth of another course is 342° . Illustrate the back azimuth of this course which will be the direction in which the plane would return along the same course. Assume the magnetic variation to be 5° west. (Put figure on reverse side of this sheet.)
2. If a pilot received a true bearing reading of S 31° W, into what true azimuth reading would he convert the bearing? 211°
3. A pilot's course is along a magnetic azimuth of 233° and the variation is 3° west. What is the true bearing? 236°
4. On a map, how could the word and figure scale "one inch equals 1 mile" be expressed as a representative fraction? (There are 5280 feet in one mile.) $1/62360$
5. Using a scale of one inch equals 2 miles, determine the length of the stream, below, between points A and B. Distance $1\frac{1}{2}$ miles.

6. Using the sketch in question 5 and the scale as stated, compute the time which would be required to fly directly between points A and B in a plane traveling 275 miles an hour. $3\frac{1}{2}$ miles.
7. On the following page plot polar coordinates for the following data: A strategic point is located at a distance of 4200 yards from an observation point, O, and has a magnetic azimuth of $43^{\circ}20'$. On this map magnetic north is $6^{\circ}45'$ east of grid north. Use this scale, one inch equals 2000 feet.
8. On a military grid map, the coordinates of point A are 36.75-84.20 and those of point B are 38.40-86.70. What is the distance between these points in yards? _____
Plot and label this grid on the following page.
9. Assuming the azimuth from magnetic north to be $3^{\circ}30'$ west of grid north, what would be the polar coordinates of point B with reference to point A as located in question 8?

5280
10560
5280
63460



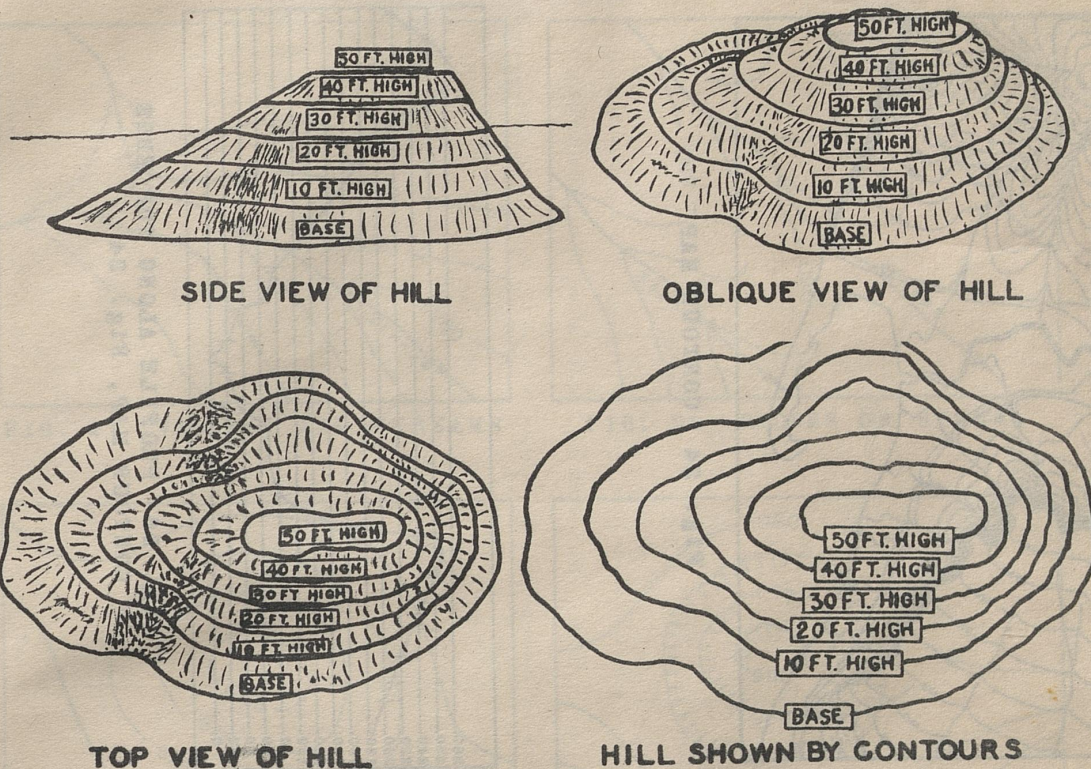


Fig. 21 CONTOURED HILL

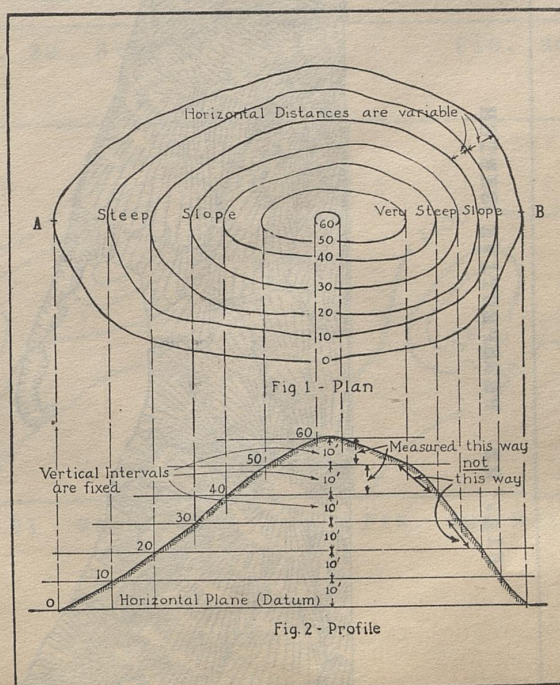


Fig. 22 PLAN AND PROFILE OF A HILL

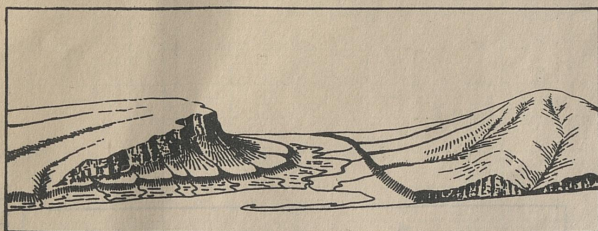


Fig. 23 PERSPECTIVE SKETCH



Fig. 24 CONTOUR MAP



Fig. 25 HACHURE MAP

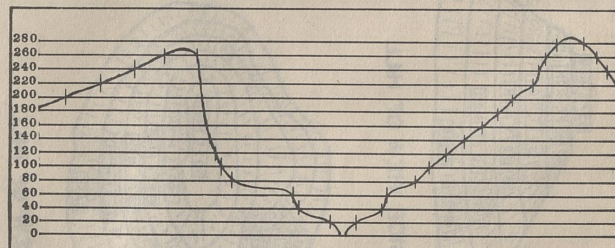


Fig. 26 PROFILE ALONG TOP EDGE
OF CONTOUR MAP, Fig. 24

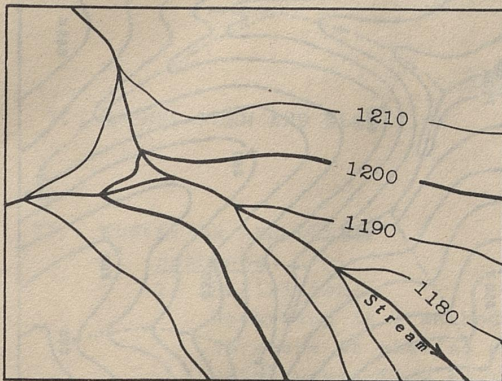


FIG. 27 VALLEYS AND STREAMS

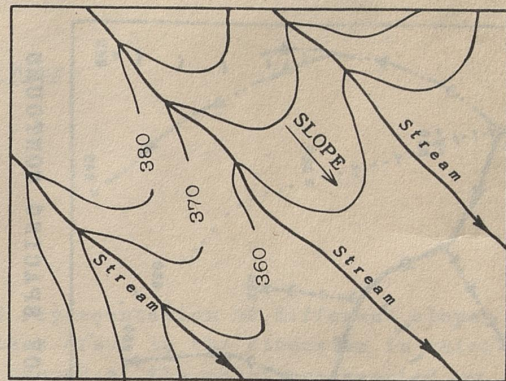


FIG. 28 RIDGES OR SPURS

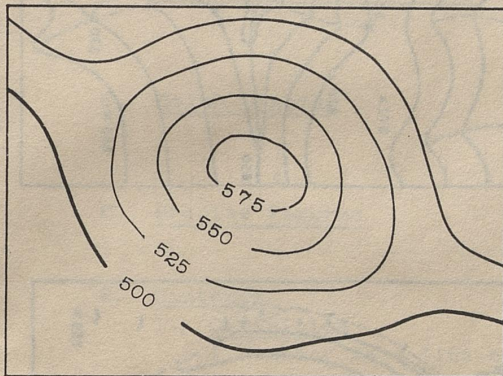


FIG. 29 HILL

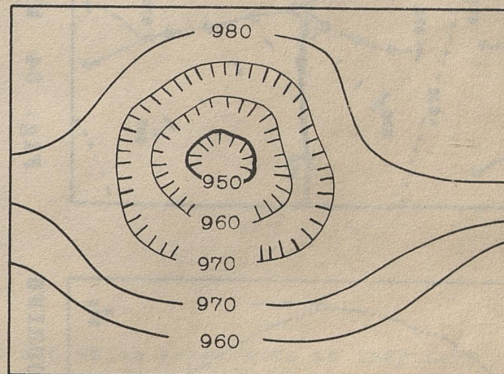


FIG. 30 DEPRESSION

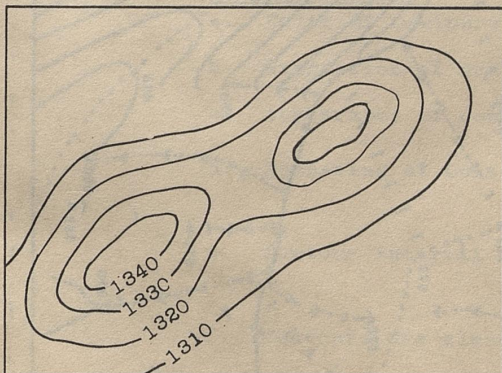


FIG. 31 SADDLE

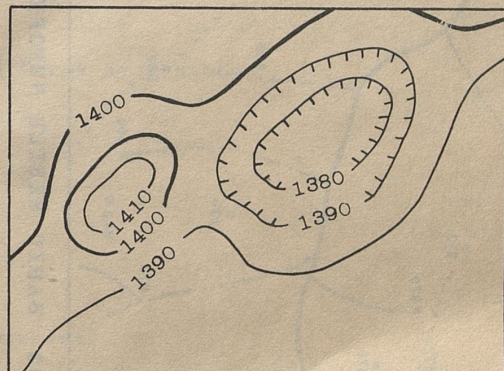


FIG. 32 HILL AND DEPRESSION

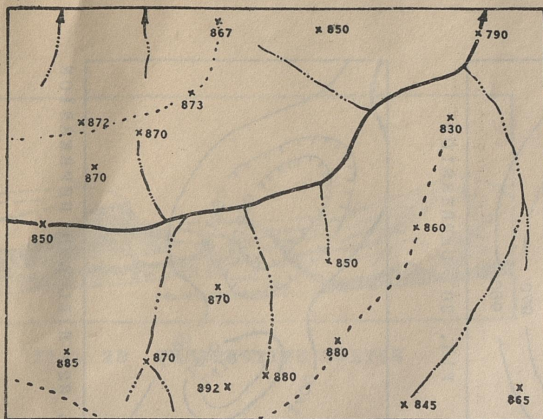


Fig. 33 BASIC SKETCH BEFORE CONTOURING

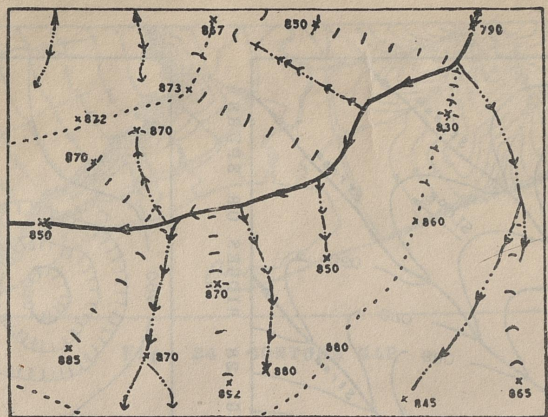


Fig. 34 METHOD OF SPACING CONTOURS

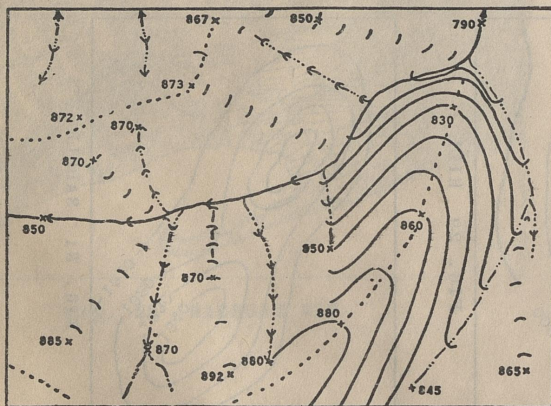


Fig. 35 DRAWING THE CONTOURS

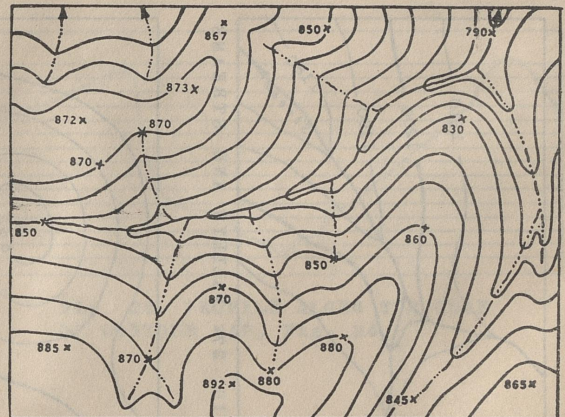


Fig. 36 COMPLETED CONTOUR SKETCH

ELEVATION, RELIEF, AND CONTOUR MAPS

Third Hour

I. GROUND FORM AND ELEVATION

II. ELEVATION AND RELIEF

A. Hachures

1. Definition.

Hachuring is a method of representation of different slopes by means of shading strokes drawn in the direction in which water would flow on the ground at the point represented on the map.

B. Hill and Valley Shading

C. Color Tinting

D. Precise Figures

E. Contours

1. Definition

A contour is a line on a map which represents an imaginary line on the ground all points of which are at the same elevation.

2. Characteristics

a. Color of Contours

b. Expression of ground forms by contours

c. Appearance of contours

d. Numbering of Contours

e. Contour interval

f. Contours are closed curves.

g. Contours never cross

h. Spacing of contours

- i. Distant spacing of contours

Summit is pretty flat

- j. Regular spacing of contours

- k. Regular closed contours

- l. Depression contours

- m. Crossing of streams by contours

- n. Ridges or spurs

- o. Configuration of contours at junction of streams

- p. Saddles

III. Drill on Contour Maps

IV. Summary.

CONTOUR THE MAP BELOW USING A CONTOUR INTERVAL OF 20 FEET. CONTOUR LINES, THE VALUES OF WHICH ARE MULTIPLES OF 100, SHOULD BE HEAVIER THAN OTHERS AND SHOULD BE NUMBERED.

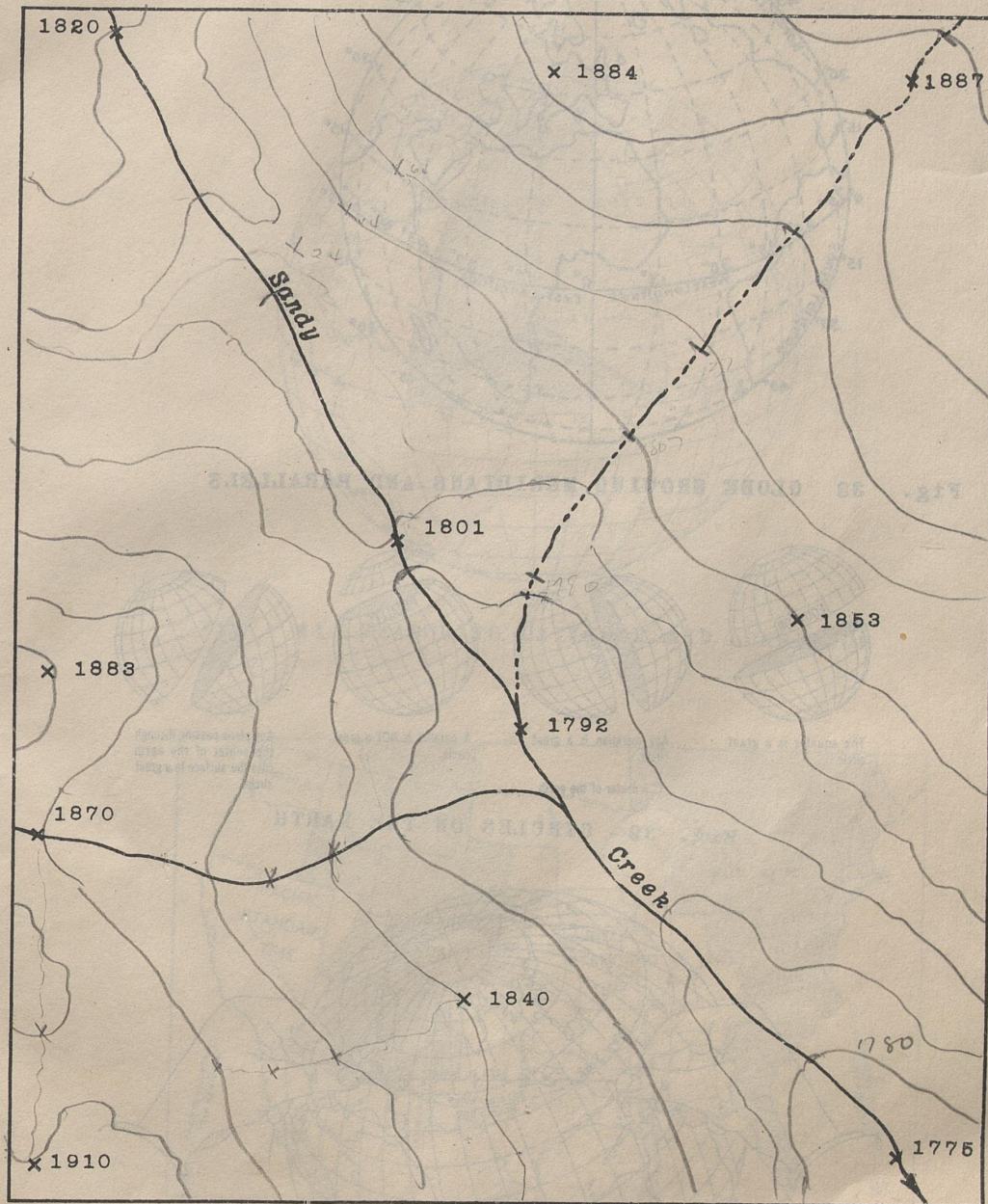
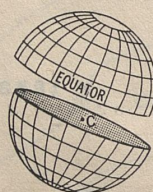


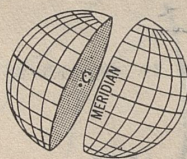
FIG. 37 CONTOUR MAP.



Fig. 38 GLOBE SHOWING MERIDIANS AND PARALLELS

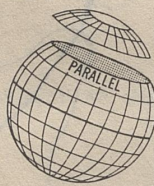


The equator is a great circle.

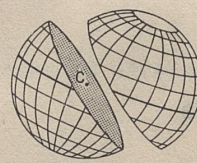


Any meridian is a great circle.

C = center of the earth



A parallel is NOT a great circle.



Any plane passing through the center of the earth cuts the surface in a great circle.

Fig. 39 CIRCLES ON THE EARTH

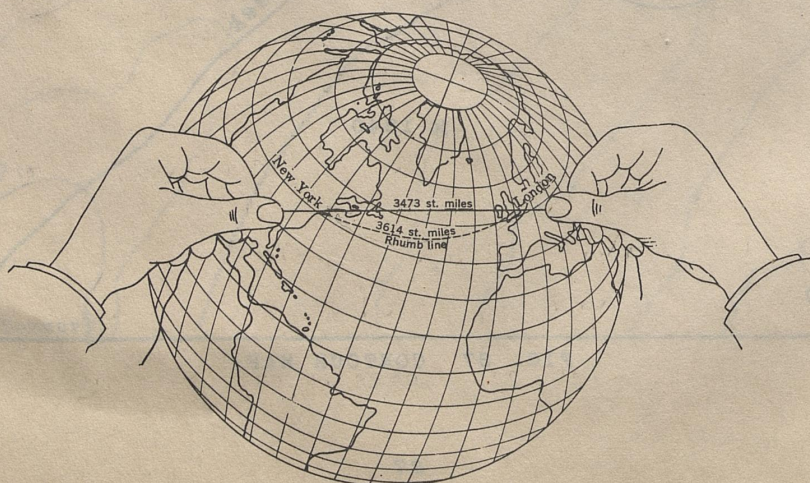


Fig. 40 GREAT CIRCLE AND RHUMB LINE

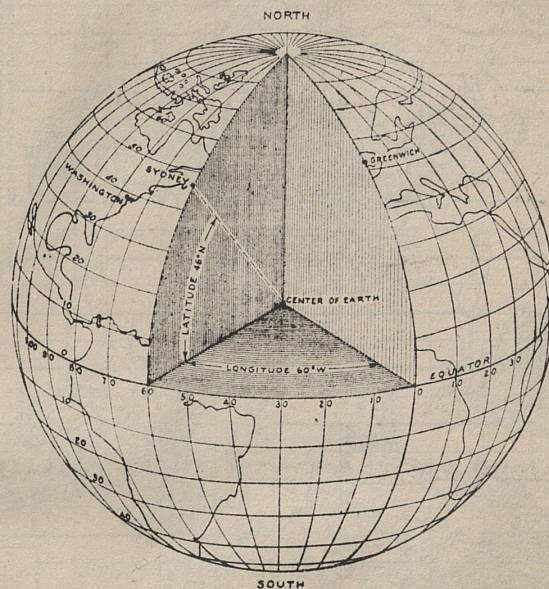


Fig. 41 MEASURING LATITUDE AND LONGITUDE

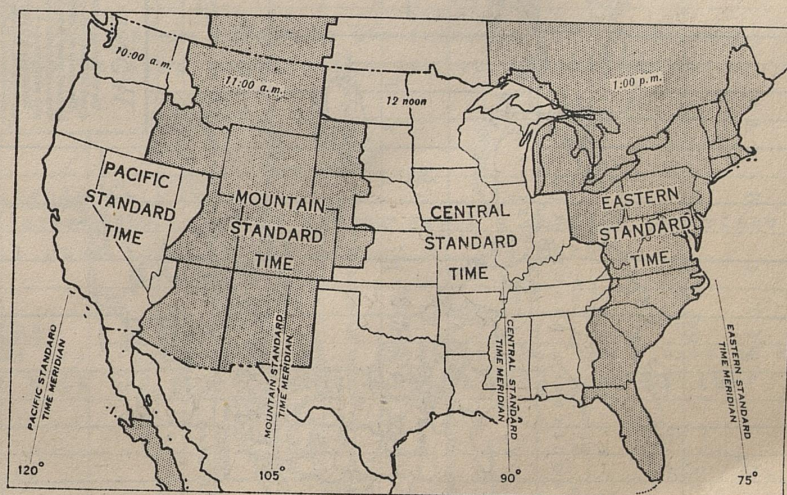


Fig. 42 TIME ZONES IN UNITED STATES

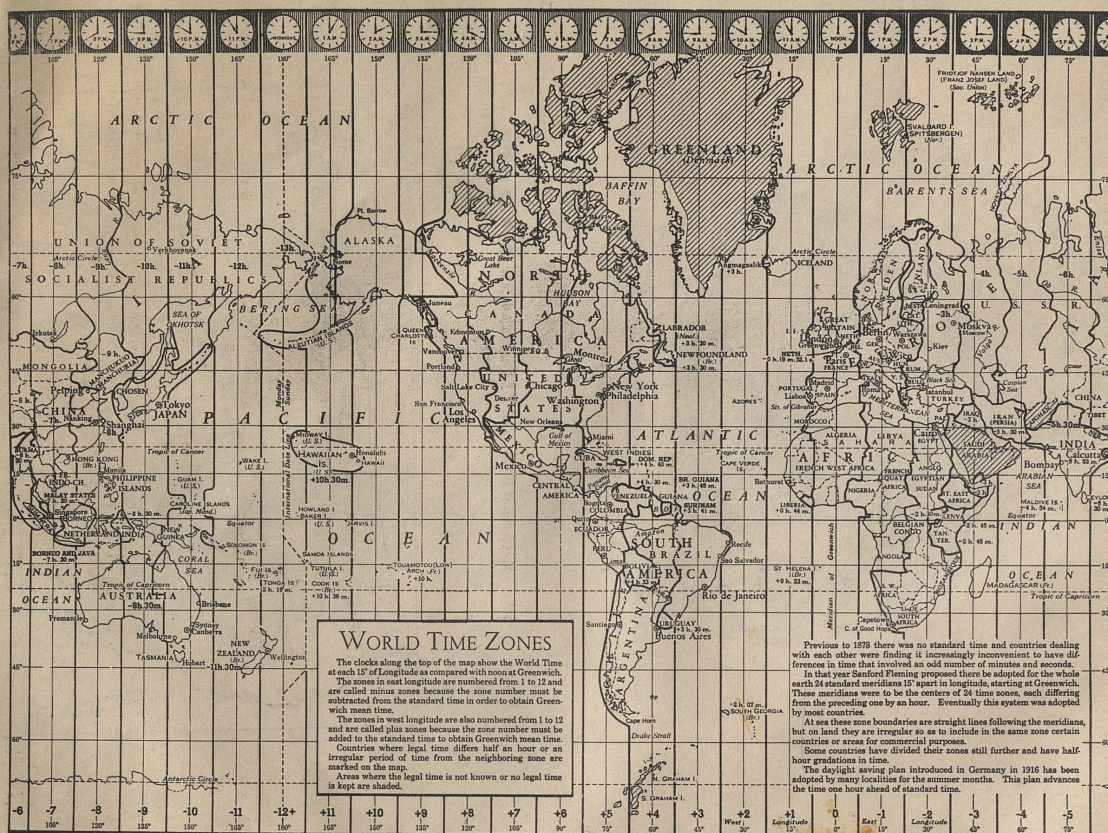


Fig. 43 TIME ZONE MAP OF THE WORLD

LATITUDE, LONGITUDE, AND TIME

Fifth Hour

1 hour = 15° longitude

I. MAP MAKING

II. TERMINOLOGY

A. Sphere

A sphere is a body bounded by a surface all points of which are equidistant from a point called the center.

B. Geographic Poles

These are the points at which the axis, around which the earth rotates, intersects the surface of the earth.

C. Equator

With the north and south poles as starting points, the earth is conceived to be divided into two equal parts or hemispheres by a plane perpendicular to the axis of the earth at its center. The circle formed by the intersection of this plane and the surface of the earth is the Equator.

D. Great Circle

A great circle is one formed by the intersection on the earth's surface of a plane passing through the center of the earth.

E. Small Circle

A small circle is a circle on the earth's surface the plane of which does not pass through the center of the earth.

F. Meridians

Meridians are lines representing great circles the planes of which intersect both the north and the south geographic poles.

G. Parallels

Small circles the planes of which are parallel to the equator are called parallels of latitude.

H. Rhumb Line

A rhumb line is one which crosses all meridians at the same angle.

Any two pts on earth can be connected
Loxodromic curve is formed by a line drawn on a sphere

I. Prime Meridian

To furnish a starting point from which meridians could be numbered, the meridian passing through Greenwich, England, was arbitrarily chosen as the zero meridian. This is called the prime meridian.

J. Degree *360 round surface of earth*

K. Minute *60 min. = 1°*

L. Second *60 sec. = 1 min*

III. LATITUDE AND LONGITUDE

A. Latitude

Definition

Latitude is the angular distance north and south of the Equator, as subtended at the center of the earth and measured from the Equator as a plane of origin.

B. Longitude

Definition

Longitude is the angular distance, as subtended at the center of the earth, between the plane of a meridian and the plane of the prime meridian at Greenwich, England, measured eastward and westward.

C. Use of Meridians and Parallels

1. Location of points

use the Coast and Geodetic Survey map

2. Measurement by latitude and longitude

Nautical mile

1 minute of latitude is equal to 1 nautical mile or 6080 ft
1 mi longitude is = to 1 nautical mile only on the equator

IV. TIME AND TIME CONVERSIONS

A. General Considerations

B. Need for Standardization

C. Time Zones T2

D. Greenwich Civil Time (G.C.T.) C.T.

E. Numbering of Time Zones

1 hr. = 15° longitude

F. Zone Descriptions

G. Rules for Conversions of Time

V. SUMMARY

LATITUDE, LONGITUDE, AND TIME

1. On the map, how does a great circle differ from a small circle?
2. On aeronautical charts, what is the circle of reference for latitude?
@ Equator
3. On aeronautical charts, what is the circle of reference for longitude?
Greenwich Prime meridian
4. In flying directly toward the north or south pole, what is the relationship between nautical miles and degrees of latitude?
5. A bomber flies from San Antonio to London over the great circle route, 7100 miles, at the rate of 200 miles per hour. If the plane leaves San Antonio at 0600 on Monday, at what San Antonio time will it arrive in London?
17:30 Tues
What will be the London time? 23:30 Tuesday
6. A bomber flies from San Diego to Tokyo over the great circle route of 8100 miles at the rate of 250 miles per hour. If the plane leaves San Diego at 0300, Monday, when, by San Diego time will it arrive over Tokyo?
11:24 Tuesday
What will be the Tokyo time? 04:24 Wed
7. At 1500, Sunday, in San Antonio, what is the time in the Solomon Islands?
0800 Monday
8. What is the angular distance, in minutes, between the equator and the North Pole?
5400
9. How many feet are there in one nautical mile?
6080 ft
10. How many statute miles are there in 1251 nautical miles?
1438.65
11. Express 681 statute miles in terms of nautical miles.
592.17
12. Where does one minute of longitude equal one nautical mile?
Equator
13. Describe the way in which military grid coordinates are read.

1251
1.15
62.55
12.51
1438.65

1.15 681
1.15

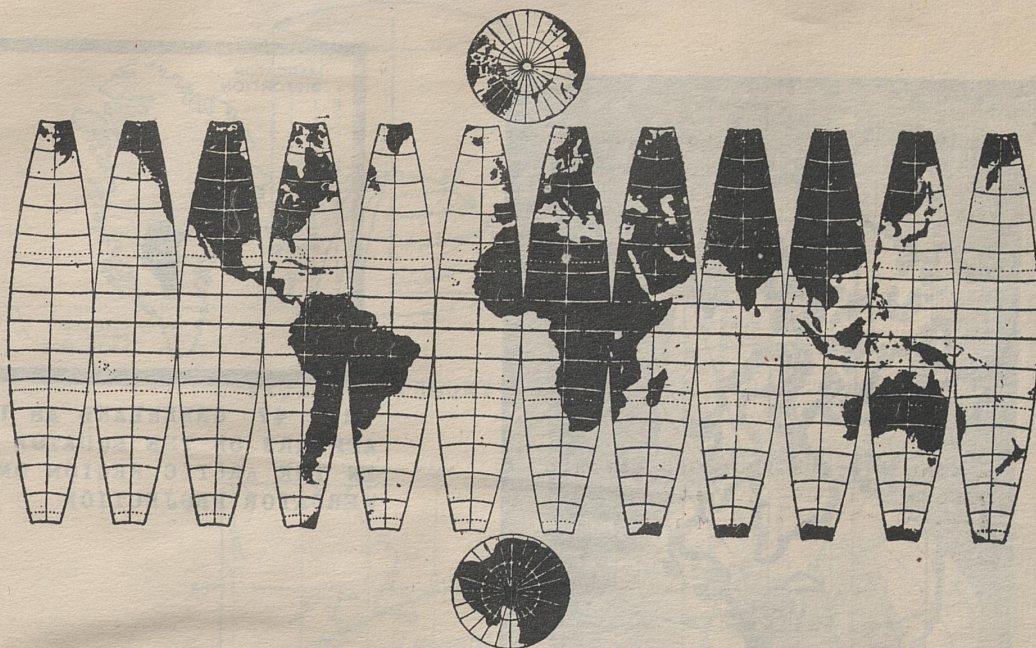


Fig. 44 COVERING FOR A GLOBE AS IT APPEARS ON A PLANE

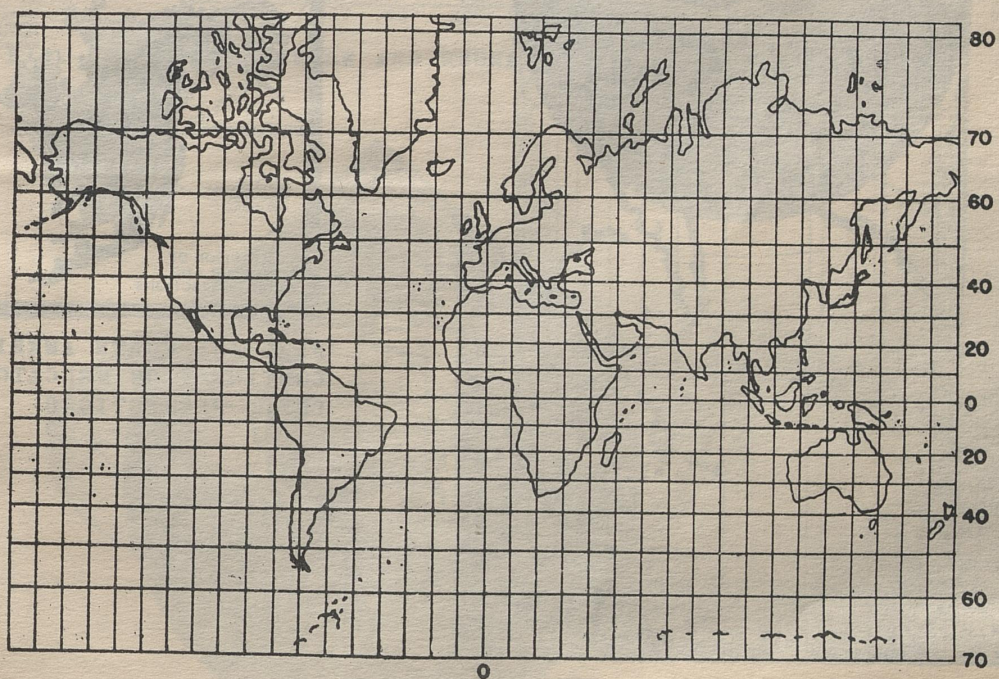


Fig. 45 WORLD ON A MERCATOR PROJECTION



Fig. 46 GLOBE ENCLOSED IN A CYLINDER

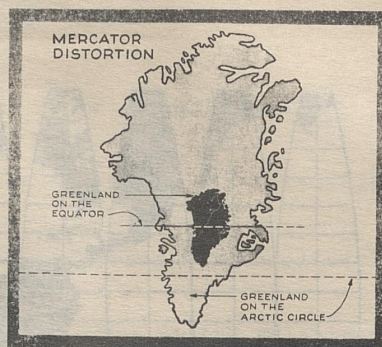


Fig. 47 GREENLAND AS IT APPEARS ON THE EQUATOR AND IN THE ARCTIC REGION ON A MERCATOR PROJECTION

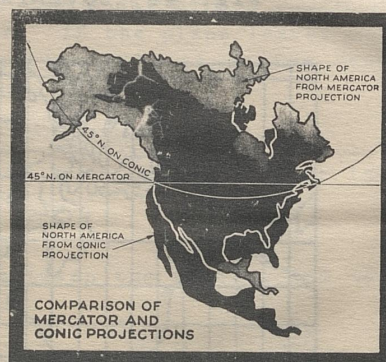


Fig. 48 NORTH AMERICAN CONTINENT ON MERCATOR AND CONIC PROJECTIONS

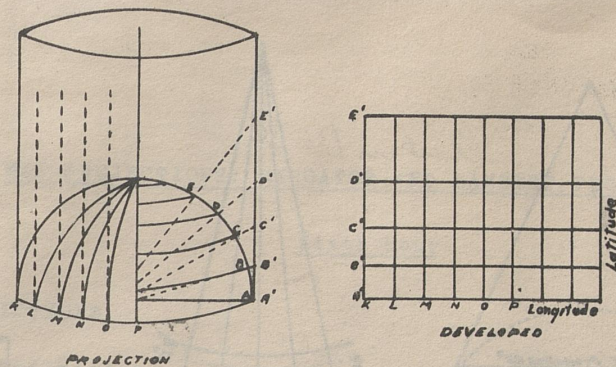


Fig. 49 THEORY OF MERCATOR PROJECTION

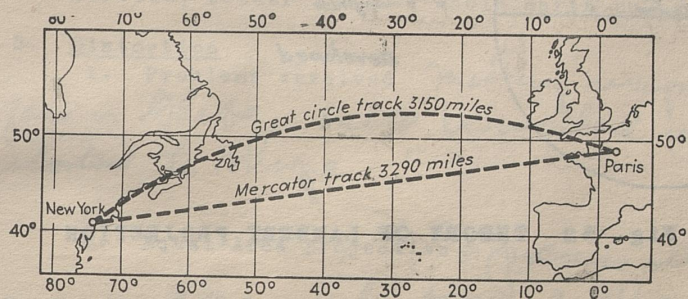


Fig. 50 GREAT CIRCLE AND RHUMB LINE ON MERCATOR CHART



Fig. 51 CONE APPLIED ON A GLOBE

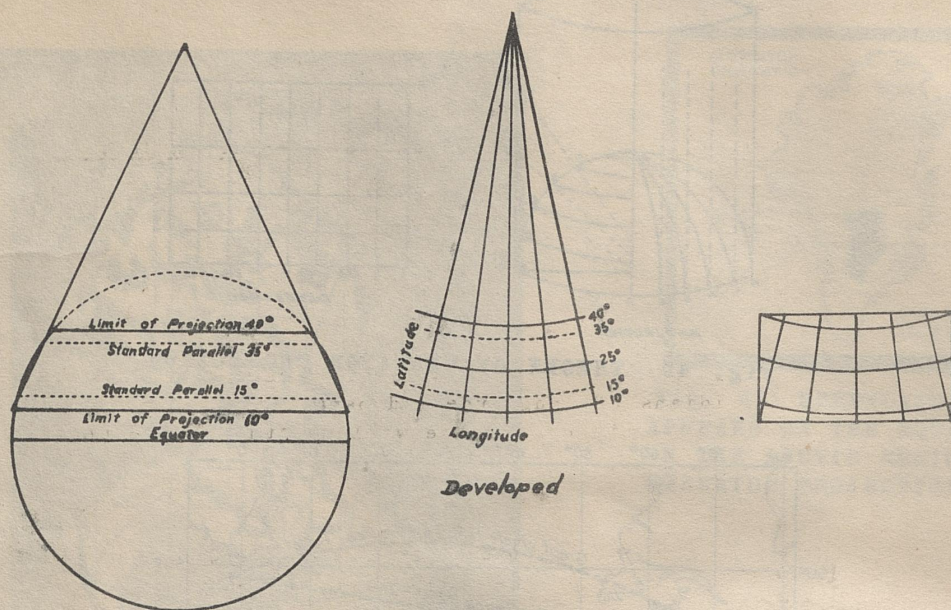


Fig. 52 THEORY OF LAMBERT PROJECTION

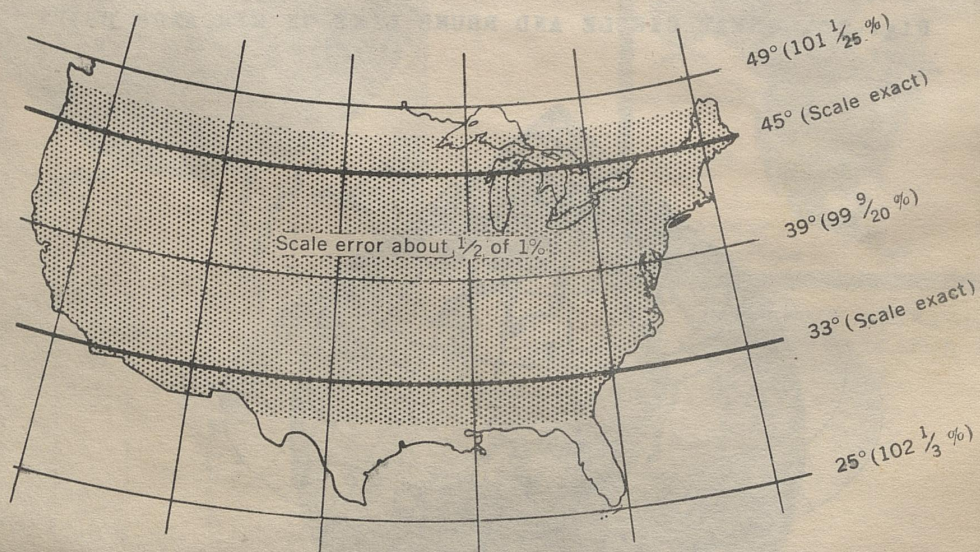


Fig. 53 UNITED STATES ON LAMBERT PROJECTION

MAP PROJECTIONS: MERCATOR AND LAMBERT PROJECTIONS

Sixth Hour

I. PROJECTIONS

A. Definition

A map projection is a systematic drawing of lines representing meridians of longitude and parallels of latitude on a plane surface, either for the whole earth or some portion of it.

B. Distortion

1. Problems involved making maps from earth surface or globe. Will be marked in streets distorted to shape

2. Equal-Area projection = preserves relations in the plane area onto ground, shapes will be

3. Conformal projection - has same scale in all directions from pt but different scale from pt to pt. Preserves shape locally even

C. Functions of Map Projections

Functions of Map Projections

Many keep	size constant	of any shape
" "	shape "	" " " size

D. Types of Map Projections

1. Mercator
2. Lambert Conformal
3. Polyconic
4. Gnomonic

Cincio

II. MERCATOR PROJECTION

A. History

used in 16th century name came from man who published it

B. Definition

The Mercator projection is a conformal projection upon a cylinder tangent to the earth at the equator.

C. Description

Meridians are parallel and equal spaced parallels of latitudes

D. Uses

*Rhumb line is a straight line
used in plotting charts
use by Mariner's & Admiral navigators*

E. Advantages and Disadvantages

1. Advantages

- Rhumb line is shown as a straight line.
- Meridians are straight and parallel. Positions plotted easily.
- Course line may be plotted directly or easily transferred without error.
- All charts similar, and if of same scale will join exactly.
- Areas within any narrow latitude belt are represented by true shapes.
- Projection is readily constructed.

2. Disadvantages

- Distortion: physical features out of proportion, bad if latitudes above 60° .
- Scale not constant, varies with latitude.
- Great circles not straight lines.

III. LAMBERT CONFORMAL PROJECTION

A. History

B. Definition

A Lambert Conformal Projection is one which is based on a right circular cone which has its apex on the axis of the

earth produced and which cuts the earth on two parallels of latitude known as the upper and lower standard parallels.

C. Description

alone with top directly over N pole
and rest of line tangent to earth's surface
rhumb line will not be at true course great circle
will almost be so line ^{parallel} meridians will differ as
latitudes

D. Uses

charts

uses in going E to W at convenient

E. Advantages and Disadvantages

1. Advantages

- a. One scale suffices for entire map. Eliminates errors because of this.
- b. Distortion through projection is very slight.
- c. A straight line approximates a great circle.

2. Disadvantages

- a. Plane flying a rhumb line will not fly over points through which line on map drawn from point of departure to destination would indicate.
- b. Course line on chart makes different angle with every meridian.
- c. Because of curvature of the parallels and the convergence of the meridians, positions are plotted less easily by latitude and longitude.

IV. SUMMARY

MAP PROJECTIONS

GRAPHIC CONSTRUCTION OF MERCATOR PROJECTION

General

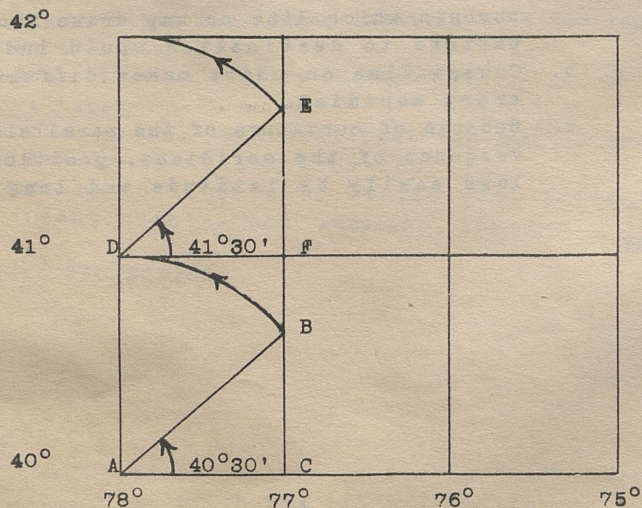
The graphical construction of a mercator chart is based on the assumption that the earth is a true sphere, in which case the meridians are true circles. While this assumption is not true, the resulting error for a small area is negligible.

2. Problem

Required a small area mercator chart from latitude 40°N , to 43°N , and from longitude 75°W . to 78°W ., on a scale of 1 inch to 1° of longitude.

3. Solution

- Draw a straight line 3 inches in length parallel to the lower edge of sheet. This will represent the base parallel of latitude 40°N . From the ends of this line and at 1 inch intervals along it carefully erect perpendicular lines, which from right to left will be the meridians 75°W ., 76°W ., 77°W ., and 78°W .
- Lay off a line A B so that the angle BAC equals the mean latitude between the parallel 40° and 41° , or $40^{\circ} 30'$.
- Measuring upward along the meridians from the base parallel 40° , lay off the distance AD equal to AB, and through these points draw the latitude 41° .
- In the same manner, determine the parallel 42° by laying off the line DE so that angle DEF equals $41^{\circ} 30'$, and the parallel 43° by laying off the line so that the angle equals $42^{\circ} 30'$.



CONSTRUCTION OF A MERCATOR CHART FROM TABLES OF MERIDIONAL PARTS

1. Procedure

If the chart for which the projection is to be made includes the Equator, the values to be measured off are given directly by the tables of meridional parts. If the Equator is not to be shown on the chart, then the parallels of latitude to be laid down should be referred to a principal parallel, preferably the lowest parallel to be drawn on the chart. The distance of any other parallel of latitude from the principal parallel is then the difference of the meridional parts for the two taken from the table and reduced to the scale of the chart.

2. Problem

Let it be required to construct a mercator chart between the parallels of latitude $32^{\circ}00'$ N. and $35^{\circ}00'$ N. and between longitudes 116° W. and 120° W., on a scale of 1° longitude equals 2 inches. Integral degrees of latitude and longitude are to be shown.

3. Solution

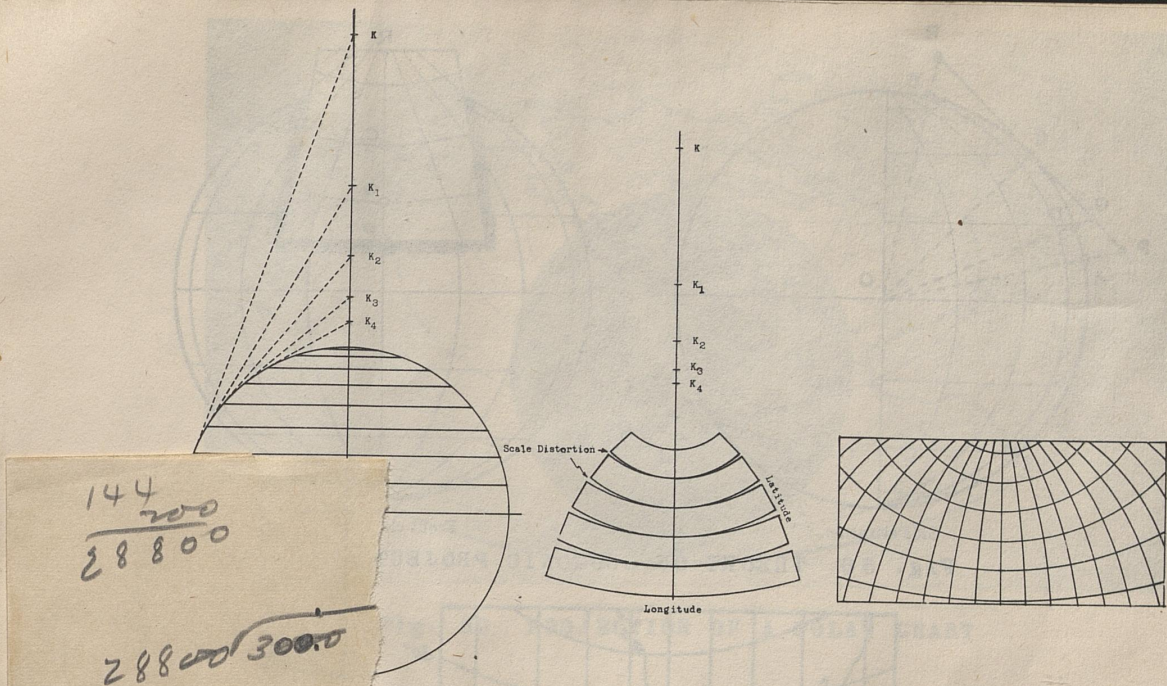
- a. Draw a straight line 8 inches in length parallel to the lower edge of the sheet. This line will represent the principal parallel of latitude $32^{\circ}00'$ N.
- b. At intervals of 2 inches along the principal parallel erect perpendiculars. These lines from right to left will be the meridians 116° W., 117° W., 118° W., 119° W., and 120° W.
- c. Since the scale of the chart is 1° of longitude equals 2 inches, the unit of measurement (one meridional part) will be $1/60 \times 2 = 1/30$ inch.
- d. From the tables of meridional parts find for latitude 32° the value 2016 and for latitude 33° the value 2087. The difference is shown between the two numbers, namely 71, the number of meridional parts between the parallels 32° and 33° . Then the distance on the chart between these parallels will be $1/30 \times 71 = 2.36$ inches.
- e. On two of the meridians already constructed lay off the distance 2.36 inches, and through the points thus obtained draw a straight line which will be parallel $33^{\circ}00'$.
- f. Proceed in the same manner to lay down all of the parallels.
- g. The whole degrees of latitude and longitude may be subdivided as minutely as required.

Lat. <i>L</i>	Meridional parts <i>M</i>	Length of 1° of		Lat. <i>L</i>	Meridional parts <i>M</i>	Length of 1° of	
		Long.	Lat.			Long.	Lat.
0	0 60	60.1	59.7	40	2608 78	46.1	59.9
1	60 59	60.1	59.7	41	2686 80	45.4	59.9
2	119 60	60.0	59.7	42	2766 81	44.7	59.9
3	179 60	60.0	59.7	43	2847 83	44.0	59.9
4	239 59	59.9	59.7	44	2930 83	43.3	60.0
5	298 60	59.8	59.7	45	3013 86	42.5	60.0
6	358 60	59.7	59.7	46	3099 87	41.8	60.0
7	418 60	59.6	59.7	47	3186 88	41.0	60.0
8	478 61	59.5	59.7	48	3274 90	40.3	60.0
9	539 60	59.3	59.7	49	3364 93	39.5	60.0
10	599 61	59.2	59.7	50	3457 94	38.7	60.0
11	660 61	59.0	59.7	51	3551 96	37.9	60.0
12	721 61	58.8	59.7	52	3647 98	37.1	60.0
13	782 61	58.5	59.7	53	3745 101	36.2	60.1
14	843 61	58.3	59.7	54	3846 103	35.4	60.1
15	904 62	58.0	59.7	55	3949 106	34.5	60.1
16	966 63	57.8	59.7	56	4055 108	33.7	60.1
17	1029 62	57.5	59.7	57	4163 111	32.8	60.1
18	1091 63	57.1	59.7	58	4274 115	31.9	60.1
19	1154 63	56.8	59.7	59	4389 118	31.0	60.1
20	1217 64	56.5	59.7	60	4507 122	30.1	60.1
21	1281 64	56.1	59.7	61	4629 125	29.2	60.1
22	1345 65	55.7	59.7	62	4754 130	28.3	60.1
23	1410 65	55.3	59.8	63	4884 134	27.3	60.1
24	1475 65	54.9	59.8	64	5018 140	26.4	60.2
25	1540 66	54.5	59.8	65	5158 144	25.5	60.2
26	1606 67	54.0	59.8	66	5302 150	24.5	60.2
27	1673 67	53.6	59.8	67	5452 157	23.5	60.2
28	1740 68	53.1	59.8	68	5609 164	22.6	60.2
29	1808 69	52.6	59.8	69	5773 171	21.6	60.2
30	1877 69	52.1	59.8	70	5944 180	20.6	60.2
31	1946 70	51.5	59.8	71	6124 189	19.6	60.2
32	2016 71	51.0	59.8	72	6313 199	18.6	60.2
33	2087 71	50.4	59.8	73	6512 211	17.6	60.2
34	2158 73	49.9	59.9	74	6723 225	16.6	60.2
35	2231 73	49.3	59.9	75	6948 239	15.6	60.2
36	2304 75	48.7	59.9	76	7187 257	14.6	60.2
37	2379 75	48.0	59.9	77	7444 278	13.6	60.2
38	2454 76	47.4	59.9	78	7722 301	12.5	60.2
39	2530 78	46.7	59.9	79	8023 329	11.5	60.3
40	2608	46.1	59.9	80	8352	10.5	60.3

TABLE OF MERIDIONAL PARTS

MAP PROJECTIONS (MERCATOR AND LAMBERT)

1. Under what conditions would a pilot prefer to fly a rhumb line rather than a great circle route?
2. What type of projection would you choose if you wish a rhumb line to appear as a straight line? Mercator.
3. If you were flying from Washington, D.C. to Los Angeles, which type of projection would you probably use? Lambert Why?
4. In flying over oceans, what type of projection is usually used? Mercator.
5. On what type of projection are geographic coordinates (latitude and longitude) most easily plotted? Mercator.
6. On Lambert projections do great circles appear as absolutely straight lines? No.
7. Explain principle involved in constructing Lambert projections.
8. Using the Mercator projection, construct a map covering the area between $30^{\circ}00'$ and $33^{\circ}00'$ north latitude and $105^{\circ}00'$ and $108^{\circ}00'$ west longitude. Use a scale of 1 inch to 1° of arc at the Equator. This projection is to be constructed graphically. Show by a dashed line how a rhumb line would appear between $30^{\circ}00'$ N. Lat. - $108^{\circ}00'$ W. Long. and $32^{\circ}00'$ N. Lat. - $105^{\circ}00'$ W. Long. Put projection on following page.
9. Using meridional parts table, construct a Mercator projection covering the area between $40^{\circ}00'$ and $43^{\circ}00'$ north latitude, and $105^{\circ}00'$ and $108^{\circ}00'$ west longitude. Use a scale of 1 inch to 1° of arc at the equator. Put projection on following page.



54 THEORY OF POLYCONIC PROJECTION

33
28800 2 0.0.00
288
1200
1152
48

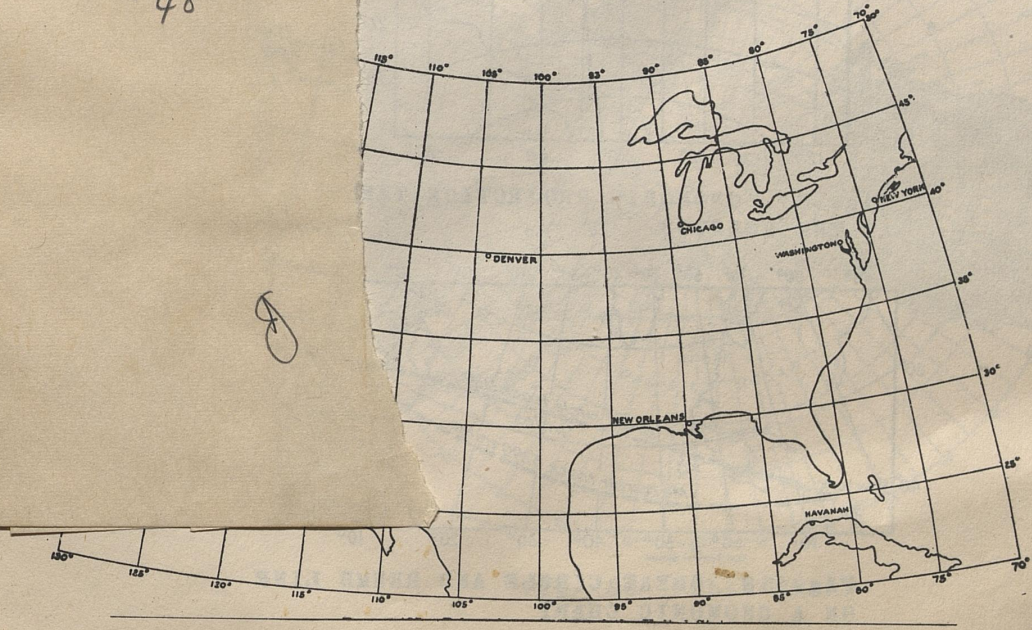


Fig. 55 UNITED STATES ON POLYCONIC PROJECTION

$$\begin{array}{r} 33 \\ 28800 \\ \hline 288 \\ 1200 \\ \hline 1152 \\ 48 \end{array}$$

288003000



Loose Item

SQD / F LIGHT C 43-H
BOFINGER J. 19082372
STICKER ON WINDOW 1 DEM.

Loose Item

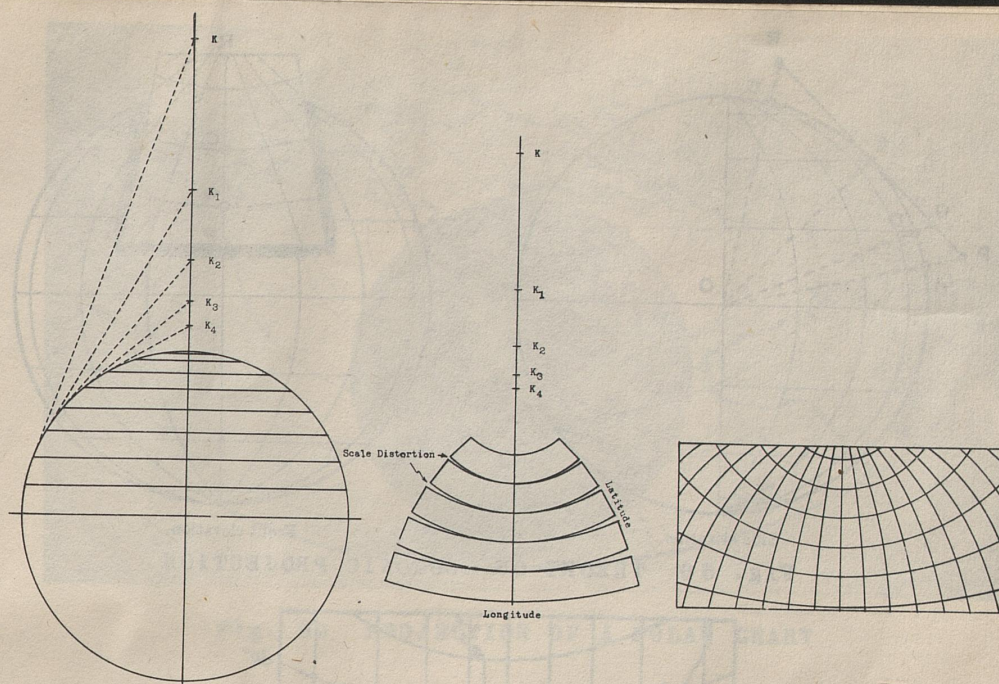
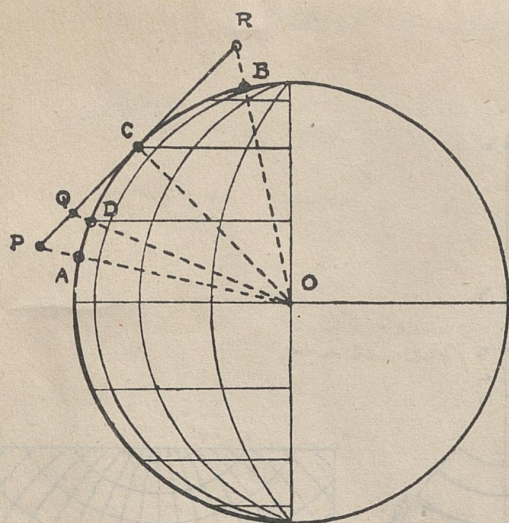


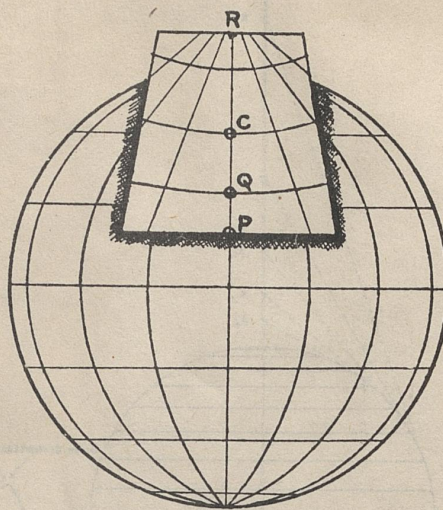
Fig. 54 THEORY OF POLYCONIC PROJECTION



Fig. 55 UNITED STATES ON POLYCONIC PROJECTION



Side elevation.



Front elevation.

Fig. 56 THEORY OF GNOMONIC PROJECTION

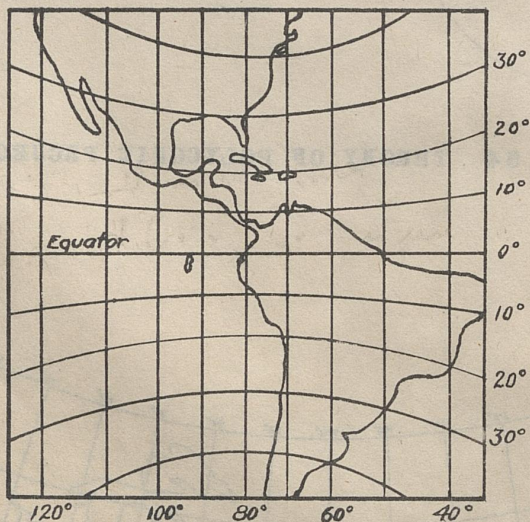


Fig. 57 GNOMONIC PROJECTION TANGENT AT THE EQUATOR

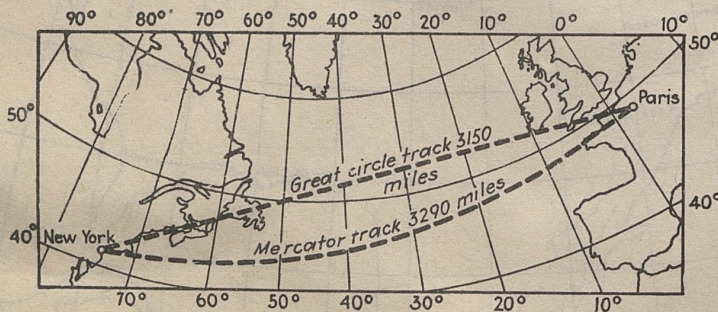


Fig. 58 GREAT CIRCLE AND RHUMB LINE ON A GNOMONIC CHART



Fig. 59 PROJECTION OF A POLAR CHART

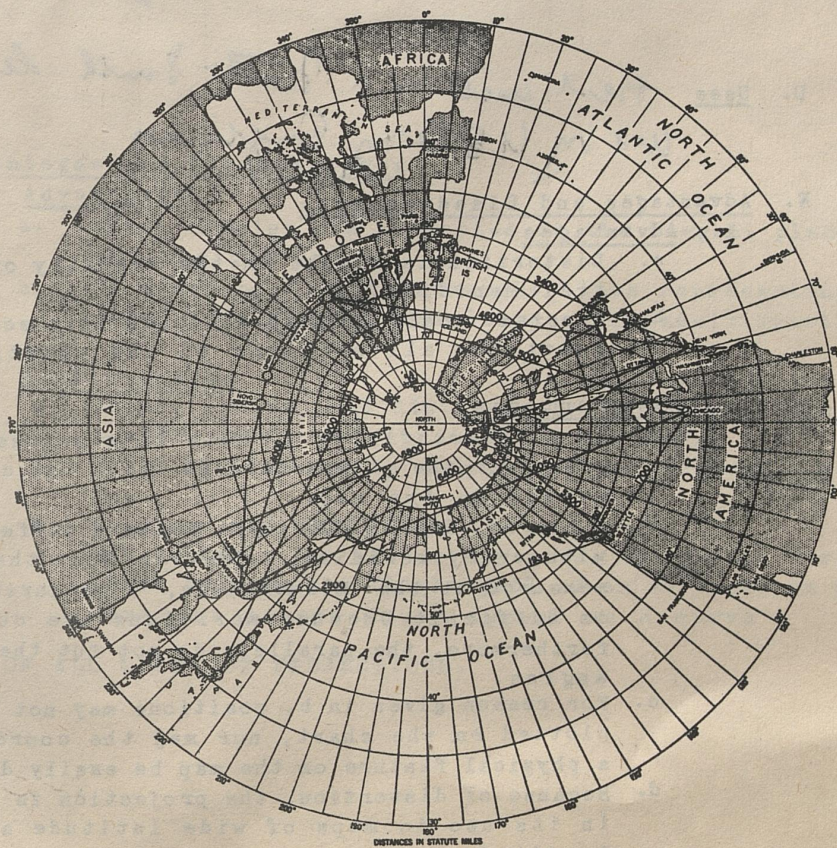


Fig. 60 POLAR CHART

POLYCONIC AND GNOMONIC PROJECTIONS

Seventh Hour

I. POLYCONIC PROJECTION

A. History

B. Definition

A polyconic projection is a development of the earth's surface upon a series of cones each one tangent to and having a common axis with the earth.

C. Description

D. Uses

*Best used in a North-South direction
use by U.S. Army Engineers*

E. Advantages and Disadvantages

1. Advantages

- a. Distortion is slight in the vicinity of the central meridian.
- b. Constant scale is used although this scale is not exact for all sections of the chart.

2. Disadvantages

- a. An airplane flying a rhumb line course will not pass over the points through which the course line passes on the map.
- b. A course line on the chart makes a different angle with every meridian. Courses must therefore be measured at the midmeridian, a measurement which is difficult because meridians are curved and, furthermore, the parallels do not cut them at right angles.
- c. For reason given in b, positions may not be readily plotted on the chart, nor may the coordinates of a physical feature on the map be easily determined.
- d. Because of distortion, the projection is restricted in its use to maps of wide latitude and narrow longitude.

II. GNOMONIC PROJECTIONS

A. Definition

A gnomonic projection is a perspective projection upon a plane tangent to a sphere with the point from which the projecting lines are drawn situated at the center of the sphere.

B. Description

*Parallels will be circles
Meridians will be straight lines (circles)
only one straight line will be
just circles etc*

C. Uses

*B Polar Charts + Azimuthal
Planning Charts*

D. Advantages and Disadvantages

1. Advantages

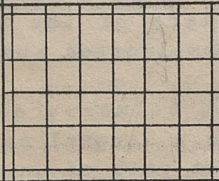
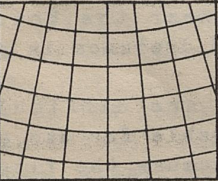
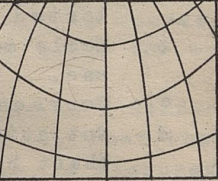
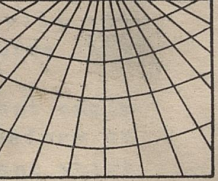
- Great circles are projected on the tangent plane as straight lines.
- In planning flights straight lines representing great circle route are drawn on gnomonic chart.

2. Disadvantages

- Areas, shapes, and distances become greatly distorted near the boundary of the map.
- Scale of distance is complicated and difficult to use.
- Courses are difficult to measure.
- Not suitable for use as a general navigation work chart because the flight path of an aircraft on a constant course would appear as a curve

III. SUMMARY OF ALL TYPES OF PROJECTIONS.

SUMMARY OF PROJECTIONS

	MERCATOR	LAMBERT	POLYCONIC	GNOMONIC
PLAN OF CONSTRUCTION	Sphere and cylinder.	Sphere and cone.	Sphere and series of cones.	Sphere and plane.
RELATIONSHIP OF MERIDIANS	Parallel, straight and equidistant. Right angles with parallel.	Converging and straight. Right angles with parallels.	Central meridian straight, all others curved.	Converging and straight.
RELATIONSHIP OF PARALLELS	Parallel and straight. Non-equidistant.	Equidistant, concentric circles. Right angles with meridians.	Portions of non-parallel curves.	Curved; non-equidistant.
GREAT CIRCLES	Curved line.	Approximates a straight line.	Approximates a straight line.	Straight line.
RHUMB LINE	Straight.	Curved.	Curved.	Curved.
SHAPES	Shapes true for small area. Continents distorted.	Only slight distortion.	Shape distorted except near central meridian.	Shape true only near center of map.
AREAS	Areas greatly distorted in high latitudes.	Only slight distortion.	Area distorted except near central meridian.	Area true only near center of map.
USES	Precise aerial and marine navigation.	Aeronautical charts. Areas elongated east-west.	Used by U.S. Army Engineers. Only available maps sometimes on this projection.	Aeronautical planning charts. Polar Charts.
TYPICAL DIAGRAM				

1. What type of projection would you prefer in determining the shortest possible route between London, England and Capetown, South Africa?
Gnomonic
2. What type of projection would you prefer in determining the shortest route between San Francisco and Berlin?
Lambert
3. In actually flying from Natal, Brazil to Dakar, Senegal, what type of projection would you use?
Lambert

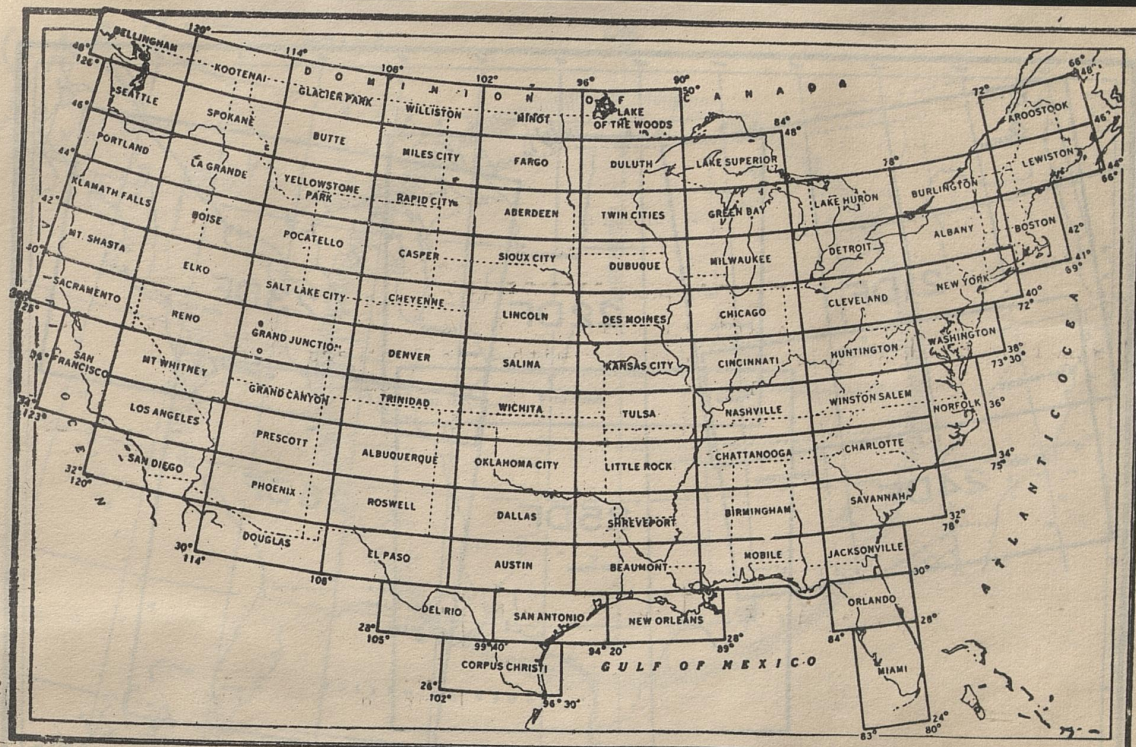


Fig. 61 INDEX OF SECTIONAL AERONAUTICAL CHARTS

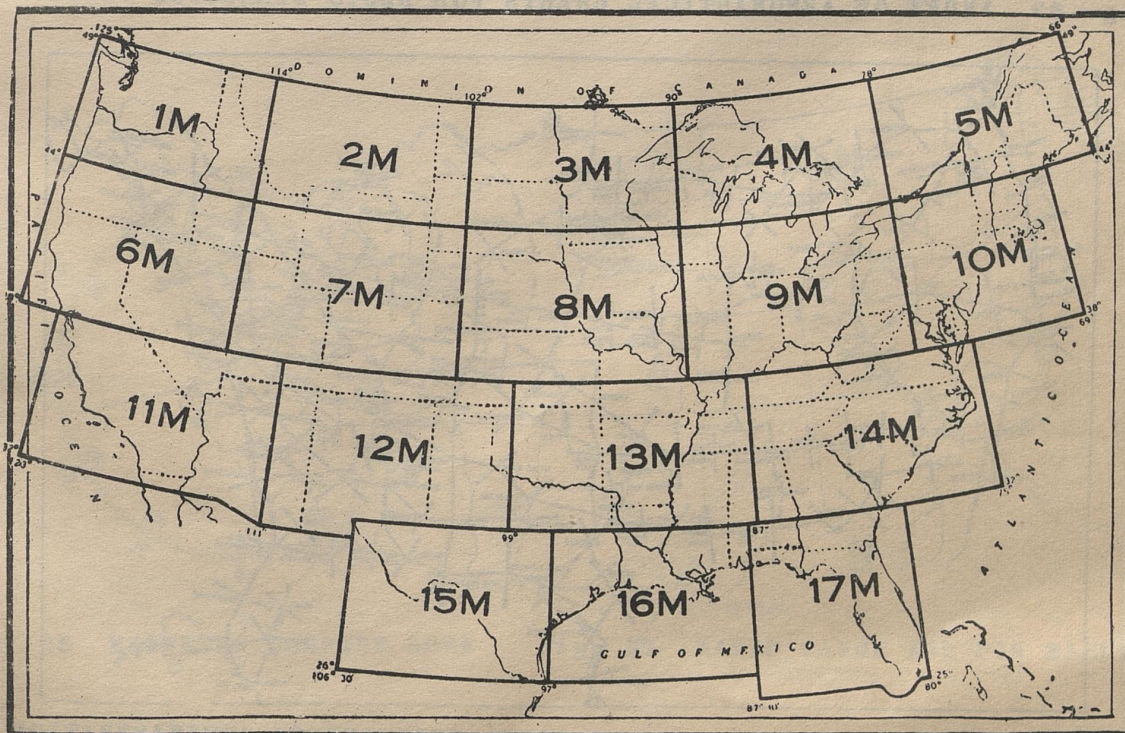


Fig. 62 INDEX OF REGIONAL AERONAUTICAL CHARTS

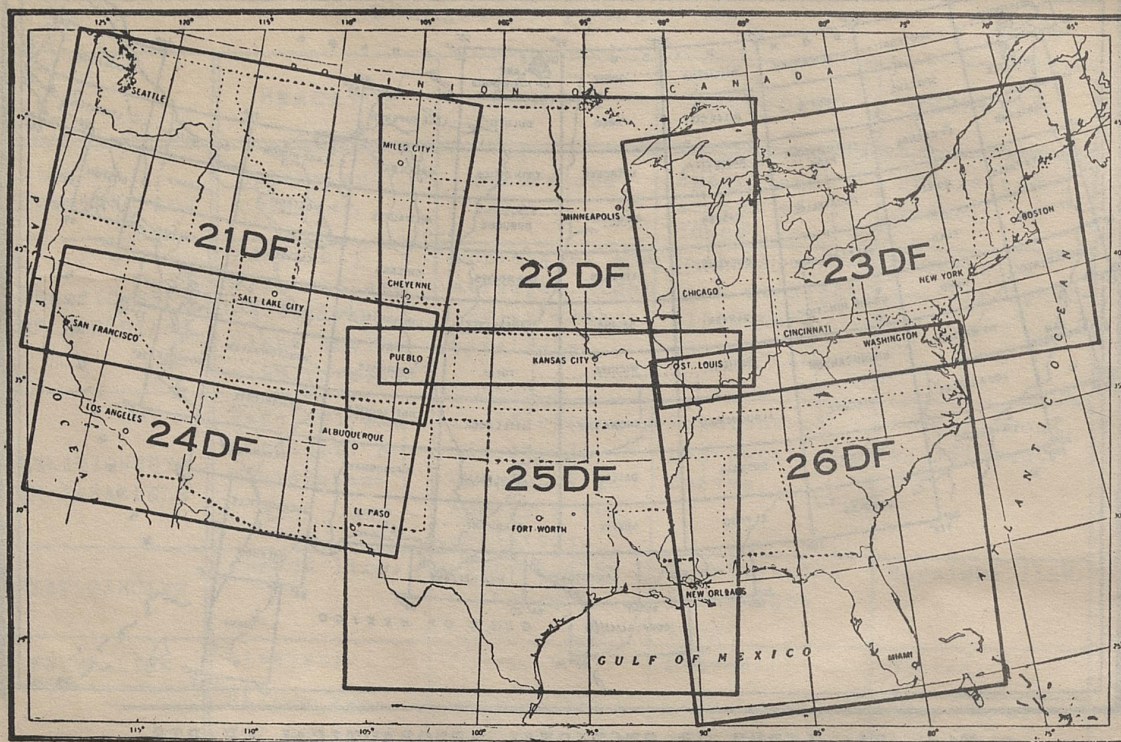


Fig. 63 INDEX OF AERONAUTICAL CHARTS FOR RADIO DIRECTION FINDING

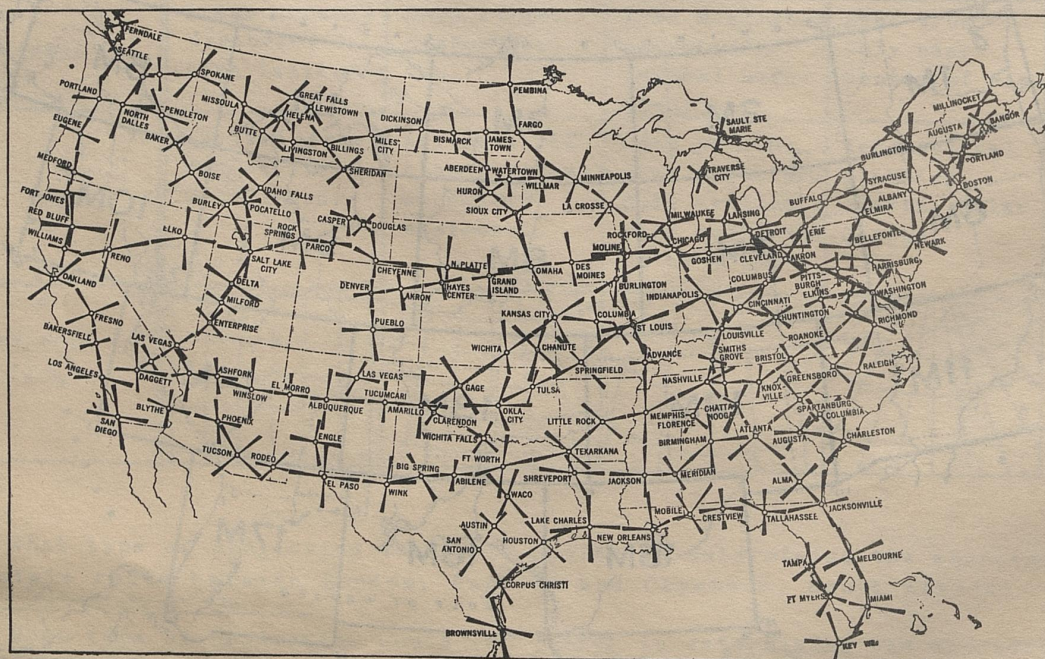


Fig. 64 RADIO RANGE SYSTEM OF CIVIL AERONAUTICS ADMINISTRATION

NORTH	Ground	Trophy	is	old	Duracore
East	"	"	"	"	"
West	"	"	"	"	"
SOUTH	"	"	"	"	"



CHARTS

I. DEFINITION

A chart is a type of map designed for the use by navigators.

II. KINDS OF AERONAUTICAL CHARTS

A. Sectional

Entire U. S. covered by 87 sectional charts.

Scale of charts is 1:500,000 or 1 inch equals approximately 8 miles

Lambert projection used.

B. Regional

Entire U. S. covered by 17 regional charts.

Scale of charts is 1:1,000,000 or 1 inch equals approximately 16 miles.

Lambert projection used.

C. Radio Direction Finding

Entire U. S. covered by 6 charts.

Scale of charts is 1:2,000,000 or 1 inch equals approximately 32 miles.

Lambert projection used.

D. Aeronautical Planning Chart of U.S.

Entire U. S. covered by one chart.

Scale of charts is 1:5,000,000 or 1 inch equals approximately 80 miles.

Lambert projection used.

E. Great Circle Chart of U.S.

Entire U. S. covered by one chart.

Scale of chart is 1:5,000,000 or 1 inch equals approximately 80 miles.

Gnomonic projection used.

F. Magnetic or Isogonic Chart of U.S.

Entire U. S. covered by one chart.

Scale of chart is 1:7,500,000 or 1 inch equals approximately 115 miles.

Type of projection used not significant.

G. Night Flying Charts.

Scale of chart is 1:1,000,000 at latitude 40°.

Mercator projection used.

H. Universal Plotting Chart.

Scale of chart is 1 inch equals 16 nautical miles.

Partially constructed Mercator chart.

I. Pilot Charts.

Small scale charts of the upper air, showing prevailing winds, percentage of foggy days, and other data of interest to aviator. Exact scale and projection used not significant.

J. Flight Charts.

Courses of flights may be plotted directly on one of the charts listed above. Commonly sectional, regional or universal plotting charts used as bases

III. REVISION OF CHARTS.

IV. INTERPRETATION OF AERONAUTICAL CHARTS.

A. Colors.

Shades of green and brown indicate elevations or relief.

0-1000	Green
1000-2000	Light green
2000-3000	Pale brown
3000-5000	Light brown
5000-7000	Medium brown
7000-9000	Deep brown
9000-up	Dark brown

C. Cultural Features.

D. Relief

E. Aeronautical Information

1. Features shown in red

2. Kind of Airport

3. Elevations of Airports

4. Lighting Facilities

5. Beacons

6. Reserved Areas

7. Danger Zones

8. High Explosive Areas

9. Marked Areas

10. Radio Data

a. Radio Stations

b. Radio Range

11. Isogonic Lines

12. True Compass Rose

13. Magnetic Compass Rose

14. Airways

V. SUMMARY

CHARTS

1. Assume that you are making a flight from Kelly Field to the Houston Airport. Use San Antonio Sectional Chart in answering questions.
 - a. What is the magnetic bearing or azimuth from Kelly to Houston?

 - b. What is the airline distance? _____ statute miles.
 - c. What is the average magnetic variation along the course?

 - d. What is the elevation of Kelly Field? _____ . Of Houston Airport? _____
 - e. If direct course were flown, how many railroads would be crossed?

 - f. List in order the 'check points' (features used in checking position along course) which could be used in making a 'contact' flight (one in which landmarks are used for reference rather than by instruments) of the course outlines above.

 - g. What kind of projection is used on this chart? _____
 - h. In flying this course, would you be flying a great circle route? _____ A rhumb line route? _____
 - i. If radio ranges were used entirely, what would the distance be? _____ statute miles.
 - j. What are the identification letters of the San Antonio Radio Range station? _____
2. Determine as precisely as you can the difference in latitude and longitude between the San Antonio Radio Range Station and Houston Airport. Difference in latitude: _____ Difference in longitude: _____
3. What is the significance to a pilot of the two dashes at Losoya fan marker on the intersection of the Amber and Red Airways south of San Antonio?
4. According to the color tinting on the San Antonio Sectional chart, what is the highest possible elevation in the area covered by the chart? _____ feet.
5. Why do pilots need true compass roses on sectional charts?
6. What is the approximate population of Yoakum, Texas, (Near radio range station on Red Airway)? _____

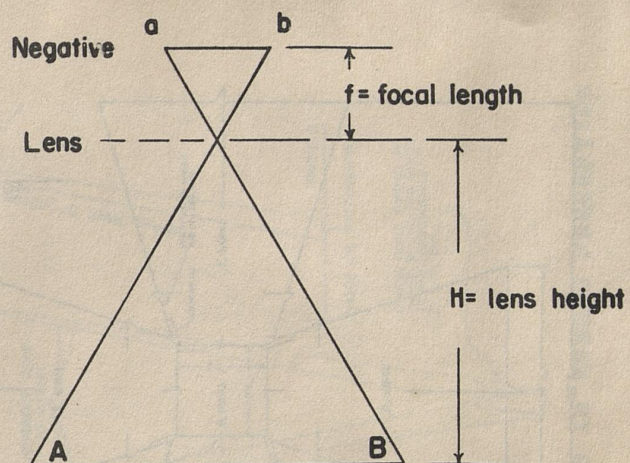


Fig. 68 COMPARISON OF FOCAL LENGTH AND CAMERA HEIGHT

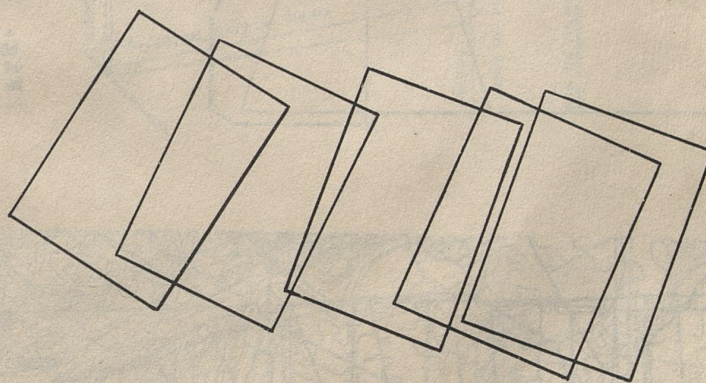


DIAGRAM OF PHOTO ARRANGEMENT

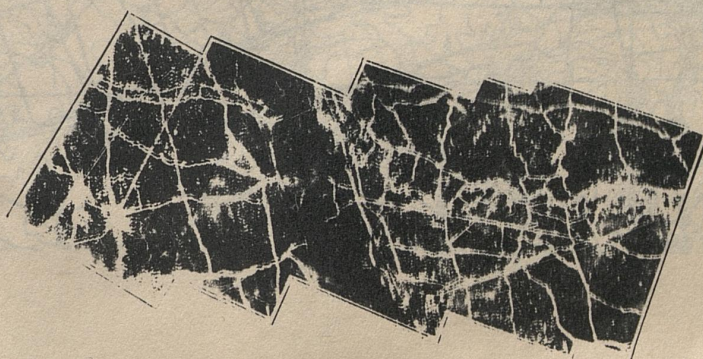
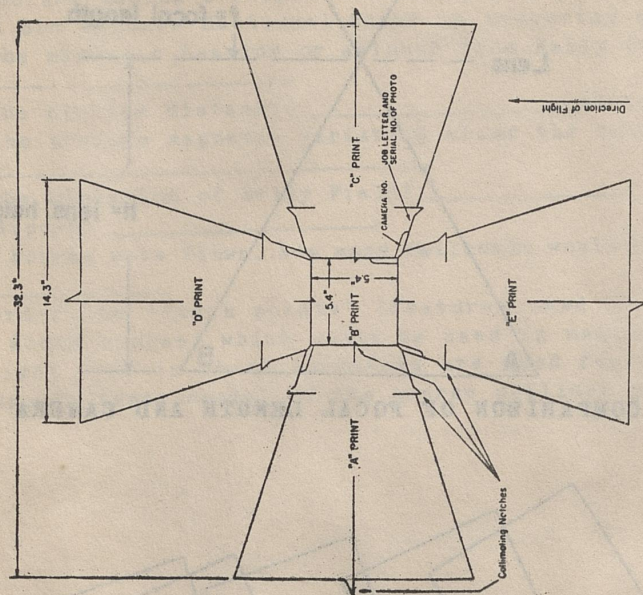


Fig. 69 AERIAL PHOTO STRIP



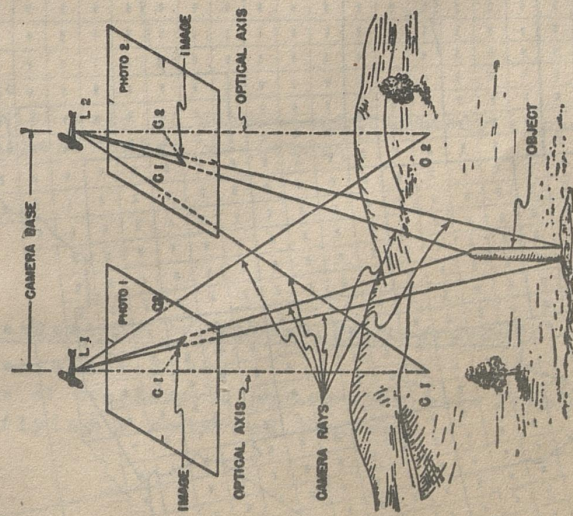


FIG. 72 POSITIONS IN TAKING
STEREO-PAIR PHOTOGRAPHS

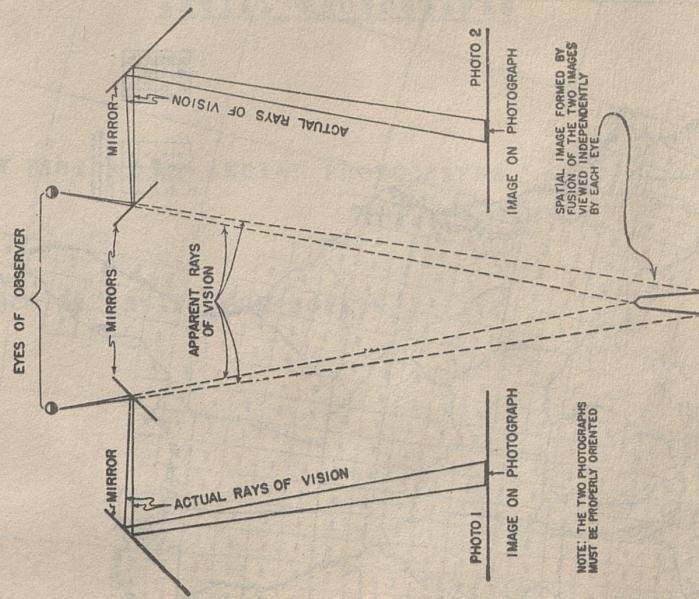


FIG. 73 METHOD IN STEREO PERCEPTION

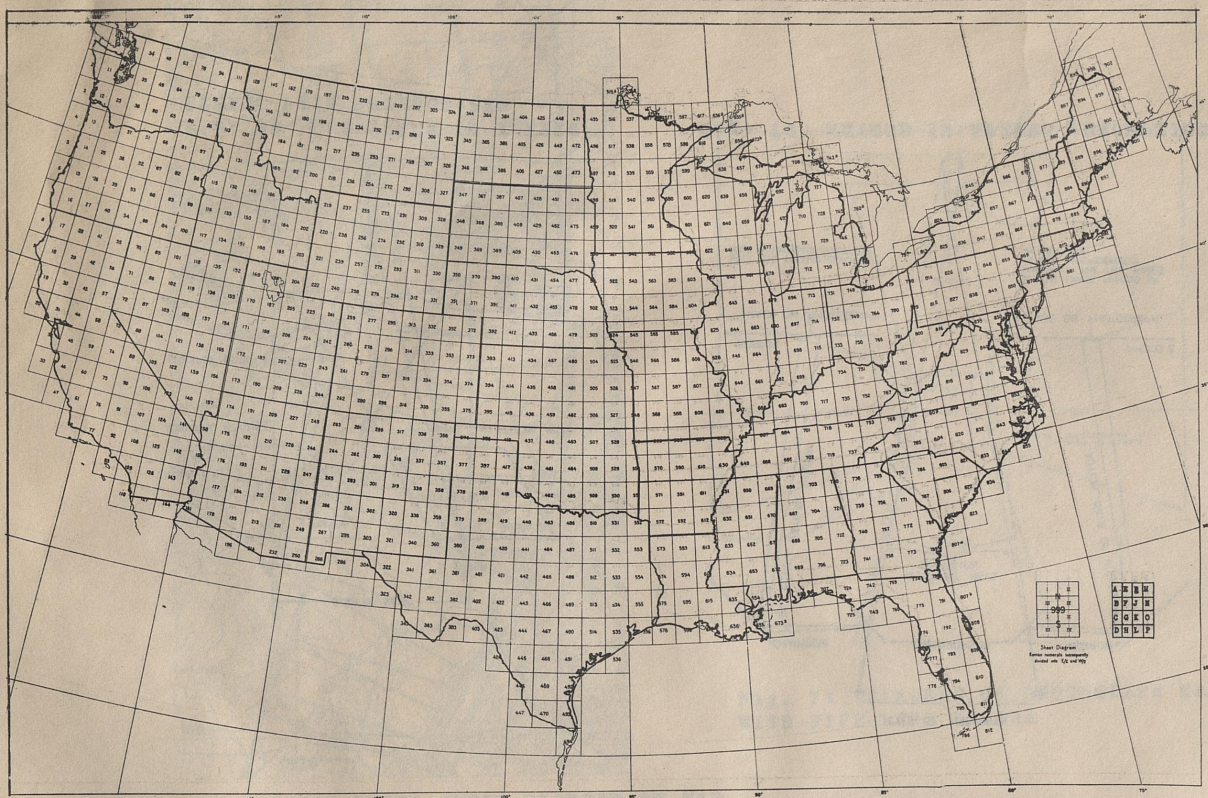


Fig. 74 PHOTO GRID SYSTEM OF U.S.

AERIAL PHOTOGRAPHS

I. MILITARY HISTORY OF AERIAL PHOTOGRAPHS

II. IMPORTANCE OF AERIAL PHOTOGRAPHS

III. TYPES

A. Basic Types

1. Vertical

Taken from bottom of plane with axis of camera perpendicular to the earth.

2. Oblique

Taken with axis of camera deliberately tipped from the perpendicular position.

B. Special Arrangements of Aerial Photographs

1. Reconnaissance Strip

A series of overlapping photographs made from an aircraft flying a selected course.

2. Mosaic

Made by joining photographs taken at different camera positions.

3. Composite

Made with camera having one principal lens and two or more adjacent oblique lenses.

4. Photomap

A single photograph, composite, or mosaic, which is reproduced usually by lithography after the addition of marginal data, scales, and other desired data.

5. Stereo-pair

Two vertical photographs taken from same altitude, but from two different camera positions, with overlap of 60% to 75%.

6. Pinpoint

Photograph taken for the purpose of studying a particular object which is centered in the photograph.

IV. MARGINAL DATA

A. Purpose

B. Location

C. Style

D. Interpretation of Data

V. ORIENTATION OF PHOTOGRAPHS

VI. SCALE

VII. INTERPRETATION OF AERIAL PHOTOGRAPHS

A. How to Hold Aerial Photographs

Rule 1: Always hold a vertical photograph so that the shadows are toward you.

Rule 2: Always hold an oblique photograph in normal position (as camera viewed it).

B. Identification of Features

C. Difficulty of Interpretation

VIII. EXAMINATION OF AERIAL PHOTOGRAPHS

IX. SUMMARY

AERIAL PHOTOGRAPHS

1. How are photomaps distinguished from other maps?

Plate I

2. What is the airline distance between the center of the water tower and the center of the street intersection on the northwest corner of the main parade ground? _____ feet.
3. What criterion is used in distinguishing the hospital area from other building areas?

Plate II

4. How are cultivated fields distinguished?

Give location of one cultivated field on this map.

5. List the reasons proving that there is a lowland to the east of the building area.

Plate III

6. What is the diameter of the circle indicating the presence of the landing field? _____ feet.
7. What is the length of the runway at the landing field? _____ feet.
8. What point on the photograph represents the highest elevation of the ground?

Plate IV

9. Along what margin (north, east, south, west) of the photograph are the houses located? _____. What did you use as a basis of this determination?

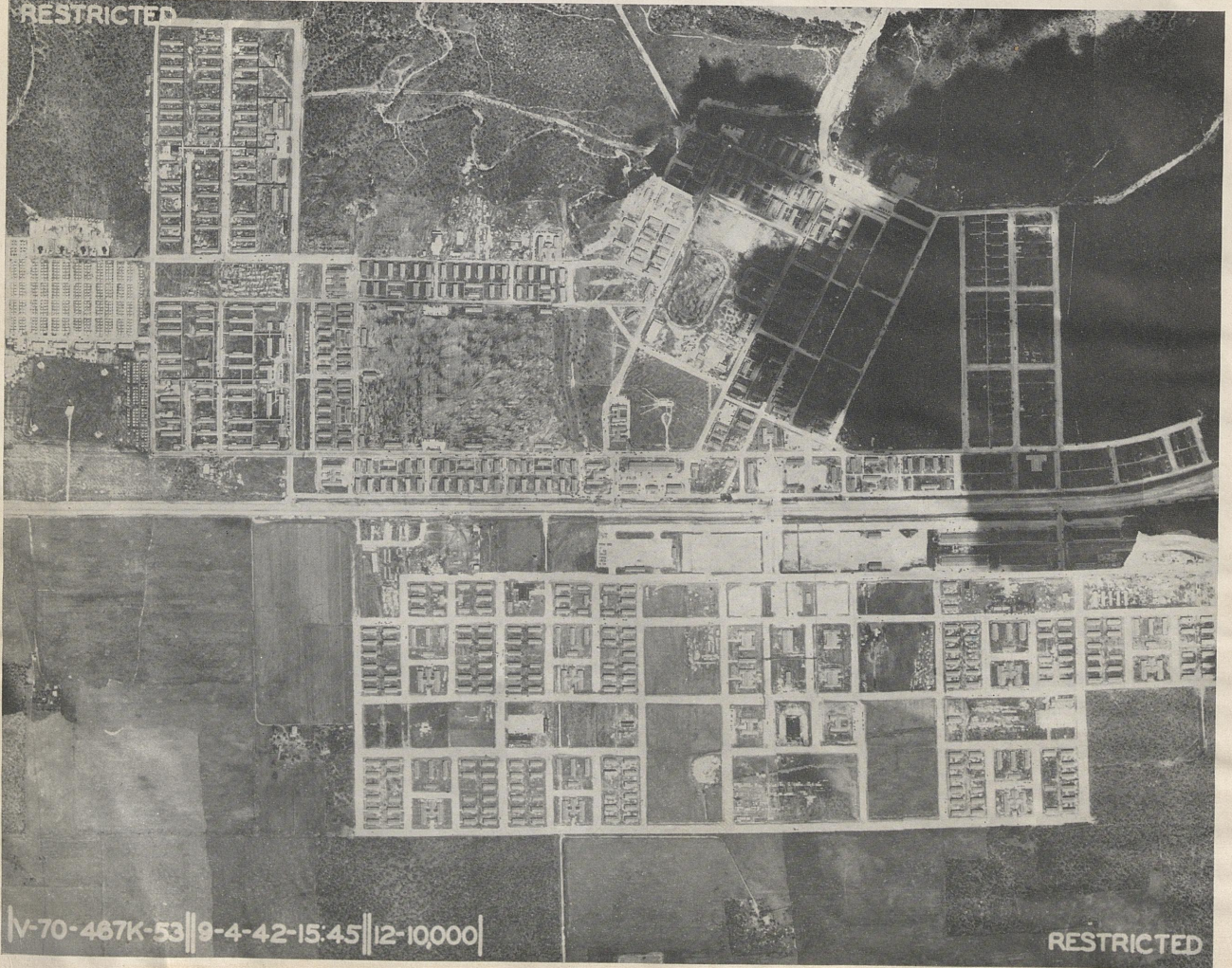
Plate V

10. Would this picture be designated as a high or low oblique? _____. Why?
11. What proof do you have as to the identity of the winding wooded areas on this photograph?

Plate VI

12. What is the diameter of the southernmost of the two tanks in the west central part of the photograph? _____ feet.
13. Give an estimate of the number of square feet in the building south of the east-west paved highway. _____ square feet.
14. What is the width of the east-west paved highway just mentioned? _____ feet.

RESTRICTED



V-70-467K-53||9-4-42-15:45||12-10,000|

RESTRICTED

PLATE I

**PAGE(S)
DAMAGED**

PLATE VI

V-157-304E-1) (2-22-29-100P)(5600-12)



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS
JOHN W. BEAL, COMMISSIONER
(Belchertown)

ATHOL 29 MI.
BELCHERTOWN 2 MI.
MASSACHUSETTS
LUDLOW QUADRANGLE



Scale 1:62,500
1 inch = 1 mile
1 centimeter = 1000 feet
Contour interval 10 feet
Datum is mean sea level
Approximate mean declination 1938
Routes usually traveled
Hard impervious surfaces
Other surface improvements
1940
U. S. Route
State Route
LUDLOW, MASS.
N 4207.5-W 7222.5/7.5

60y + final exam

① Signs symbols ② lecture + specimens

(1) ① 2nd hour (Jan 26) ② 5th hour (Jan 29) ③ 7th hour (Jan 31)

④ 9th hour (Feb 2nd)

(2) ① 4th hour (Jan 28th) ② 8th hour (Feb 1st)

in large lecture features or may attached with notes

$$1260/360 - x: 40$$

$$360x = 50400$$

$$4\overline{)36} \frac{9}{}$$

$$\begin{array}{r} 90 \\ 60 \\ \hline 54 \end{array} \frac{00}{} \quad \frac{4}{}$$

$$\begin{array}{r} 137 \\ 360 \overline{)50400} \\ \underline{360} \\ 1340 \\ \underline{1080} \\ 2600 \\ \underline{2520} \end{array}$$

$$\begin{array}{r} 840 \\ 60 \overline{)50400} \\ \underline{480} \\ 240 \\ \underline{240} \end{array}$$

$$\frac{840}{360} = \frac{14}{6} = 2\frac{1}{3} = 2\frac{40}{120}$$

$$= 99\frac{1}{3}$$

