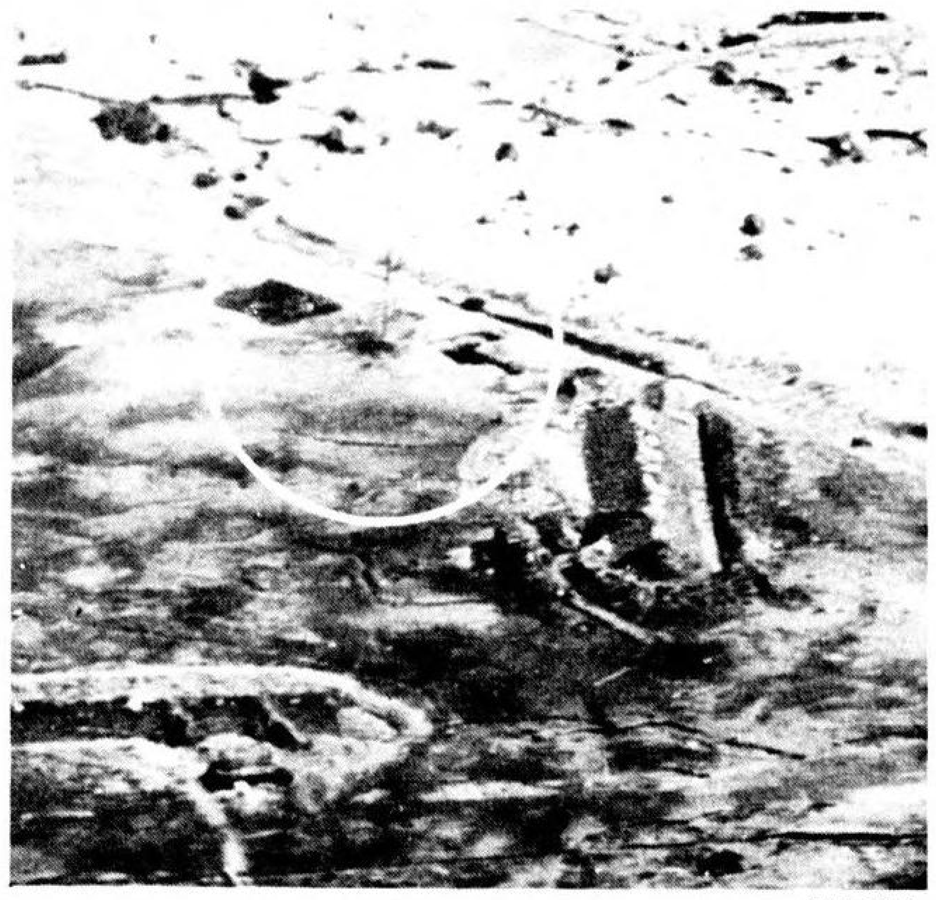
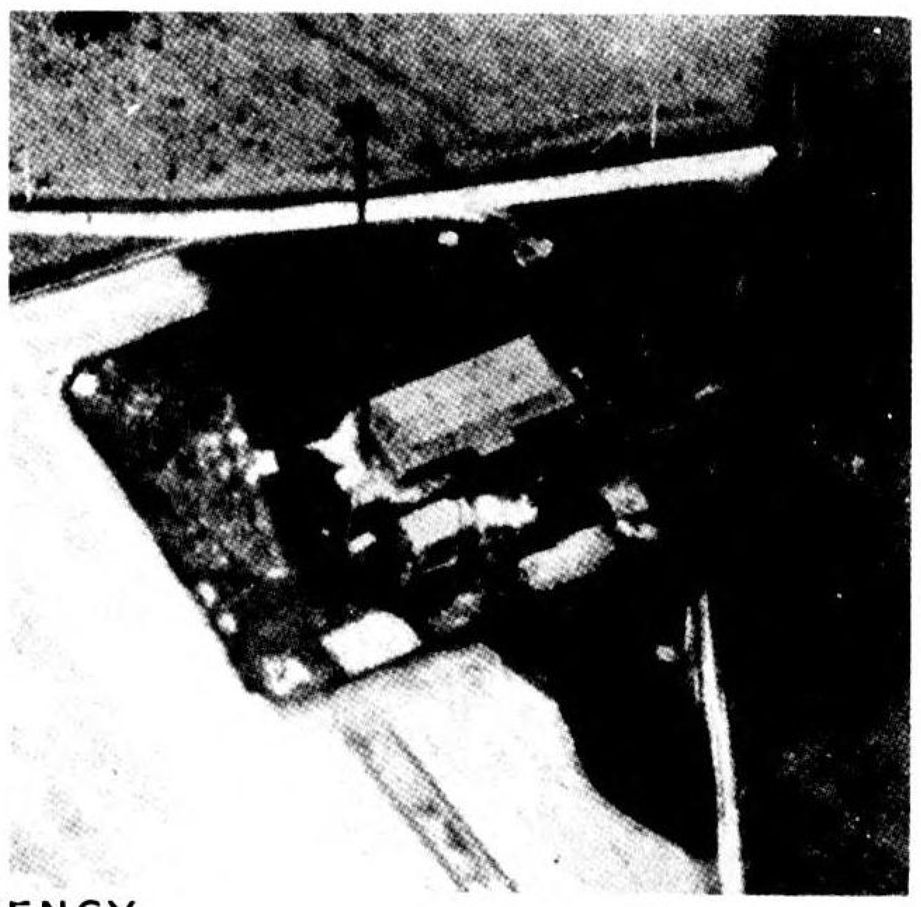
RADIO

LOW FREQUENCY	30 to 300 Kcs.	2 or more masts or towers*
MEDIUM FREQUENCY	0.3 to 3 Mcs.	
HIGH FREQUENCY	3 to 30 Mcs.	One mast or tower
VERY HIGH FREQUENCY	30 to 300 Mcs.	

In General: LOW FREQUENCY = long range
HIGH FREQUENCY = short range

*2 or 3 masts of towers more than 300 feet in height will probably carry low frequency antennae.

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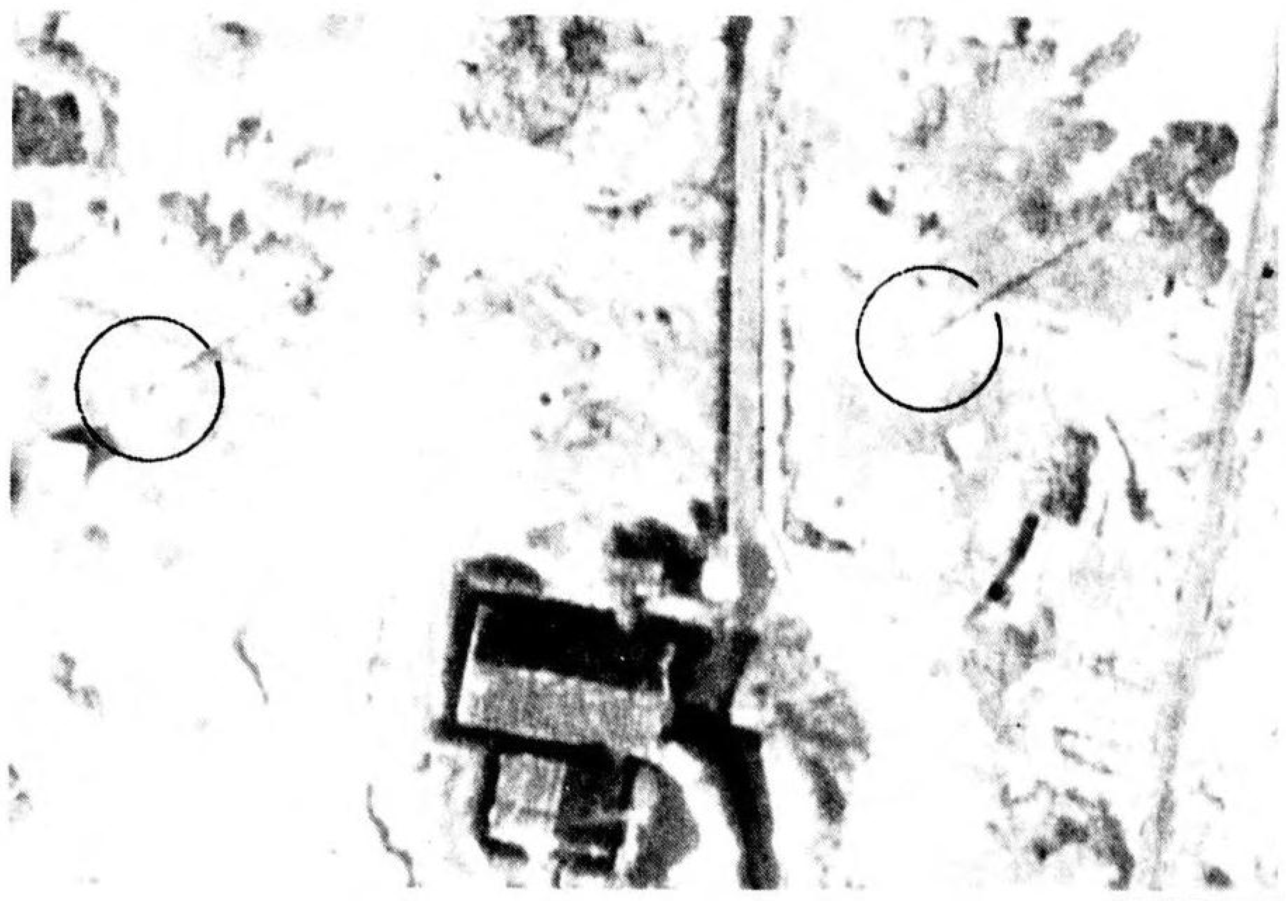
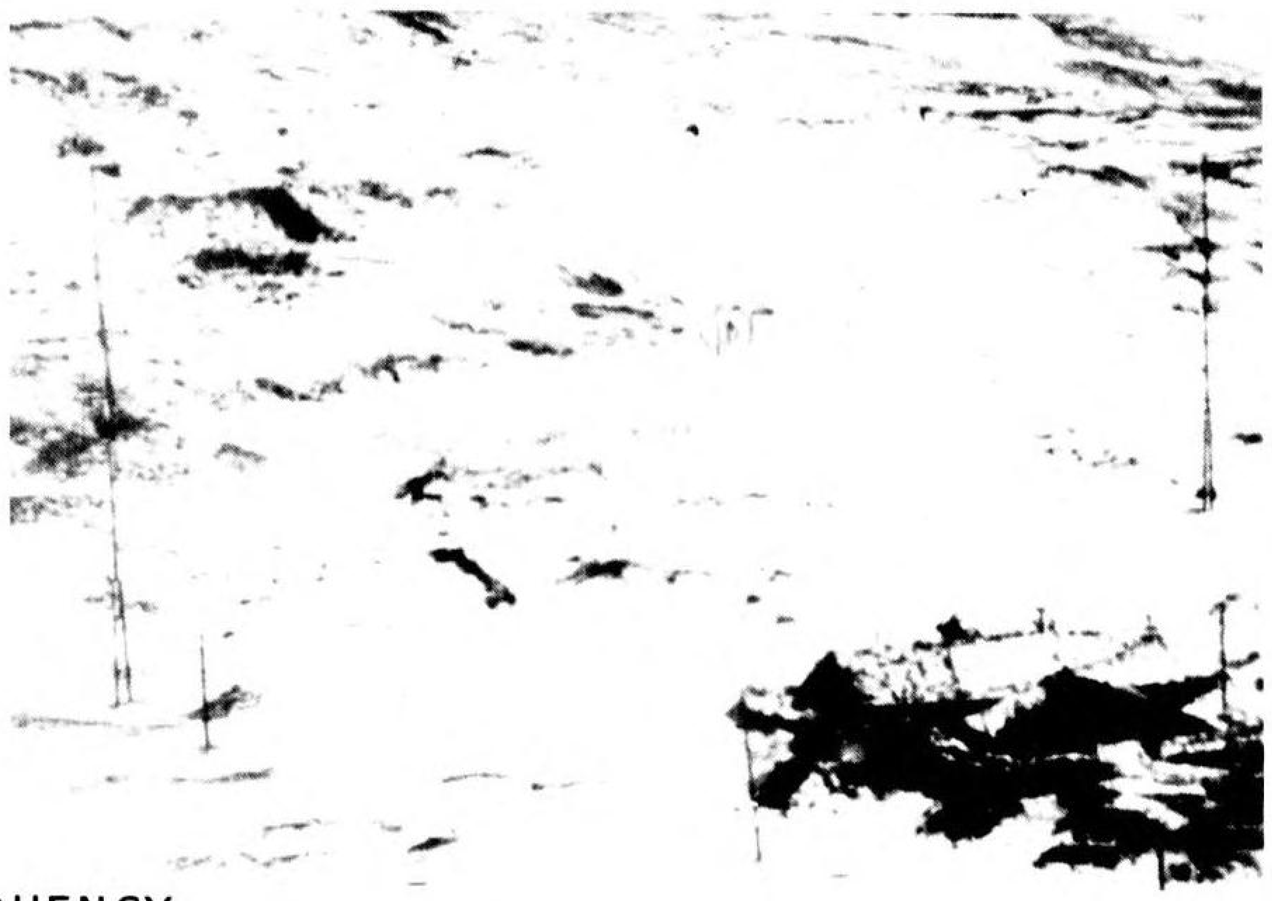

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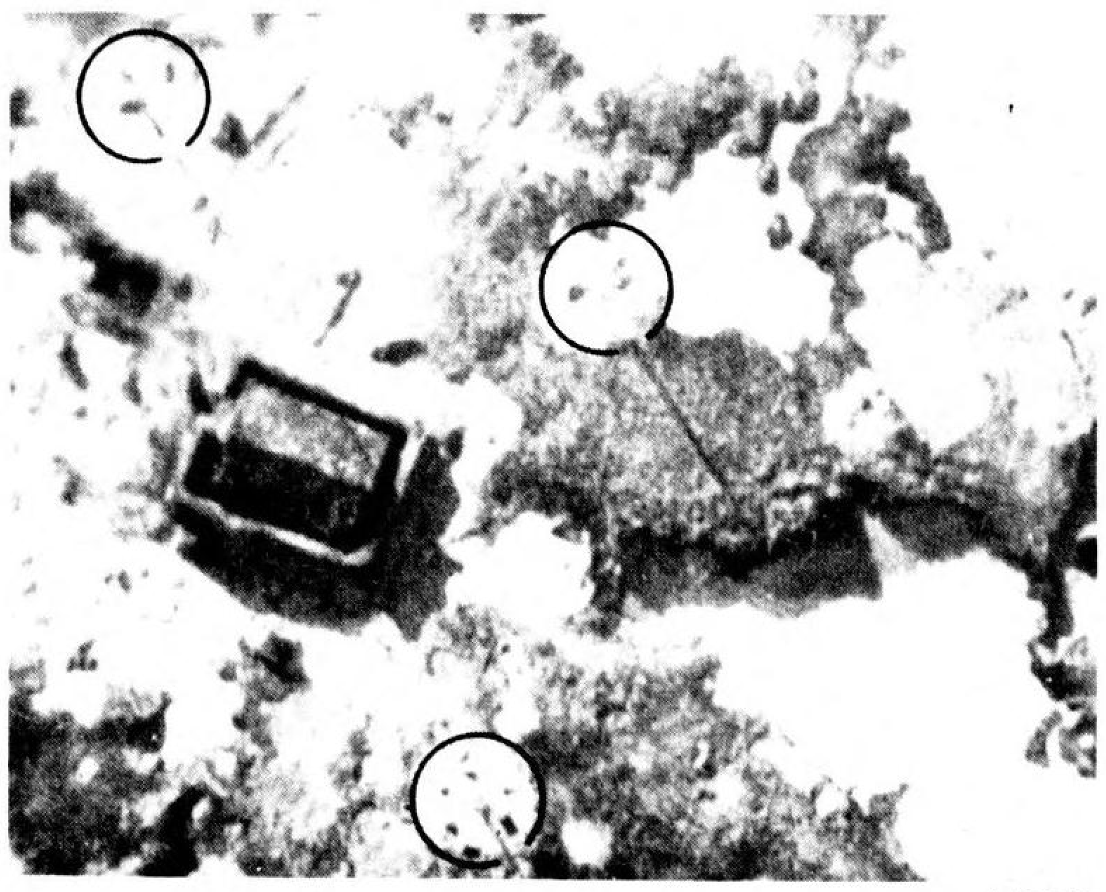
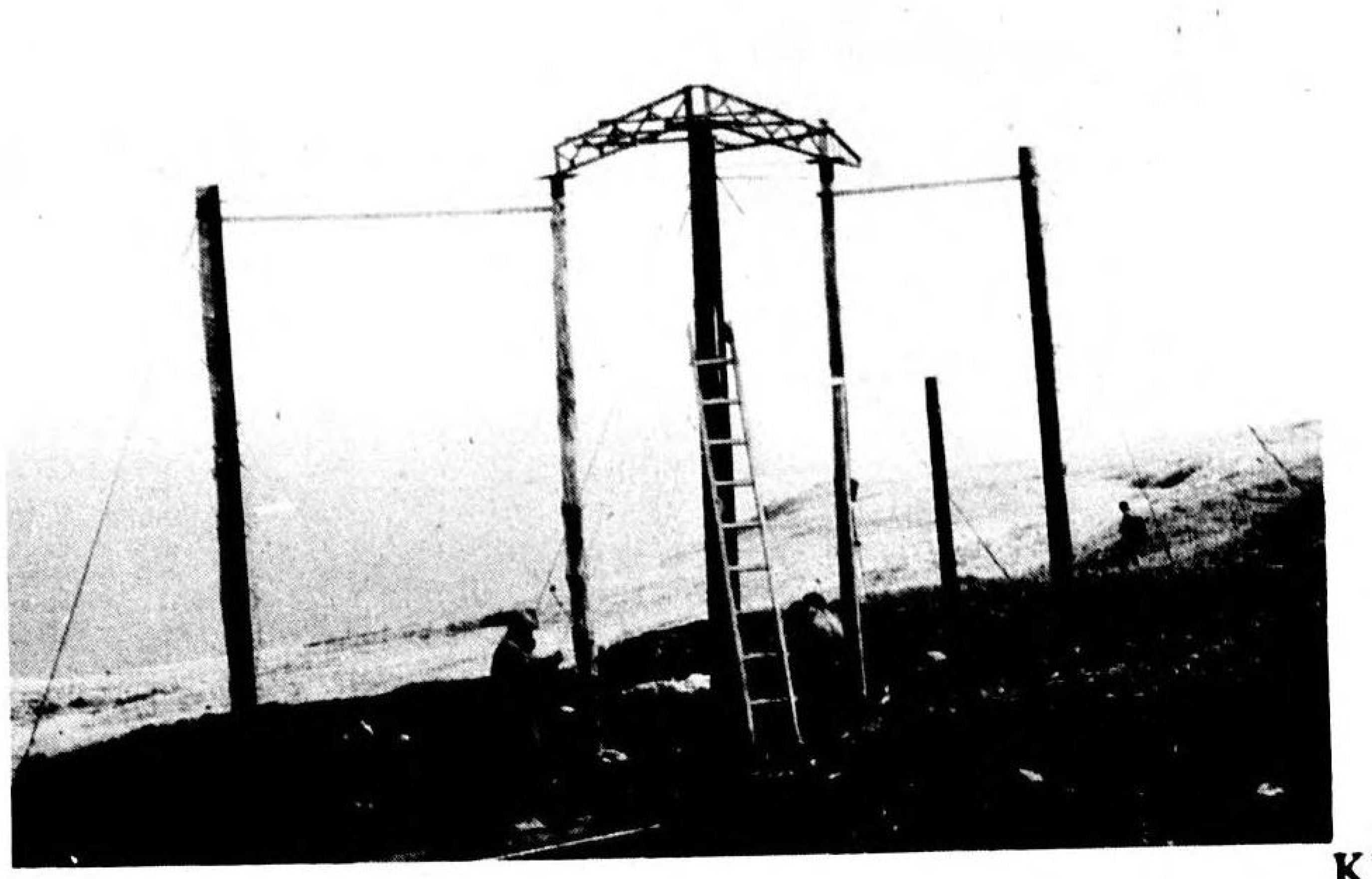



LOW FREQUENCY

TECHNICAL STUDIES
ELECTRONICS (CONT.)

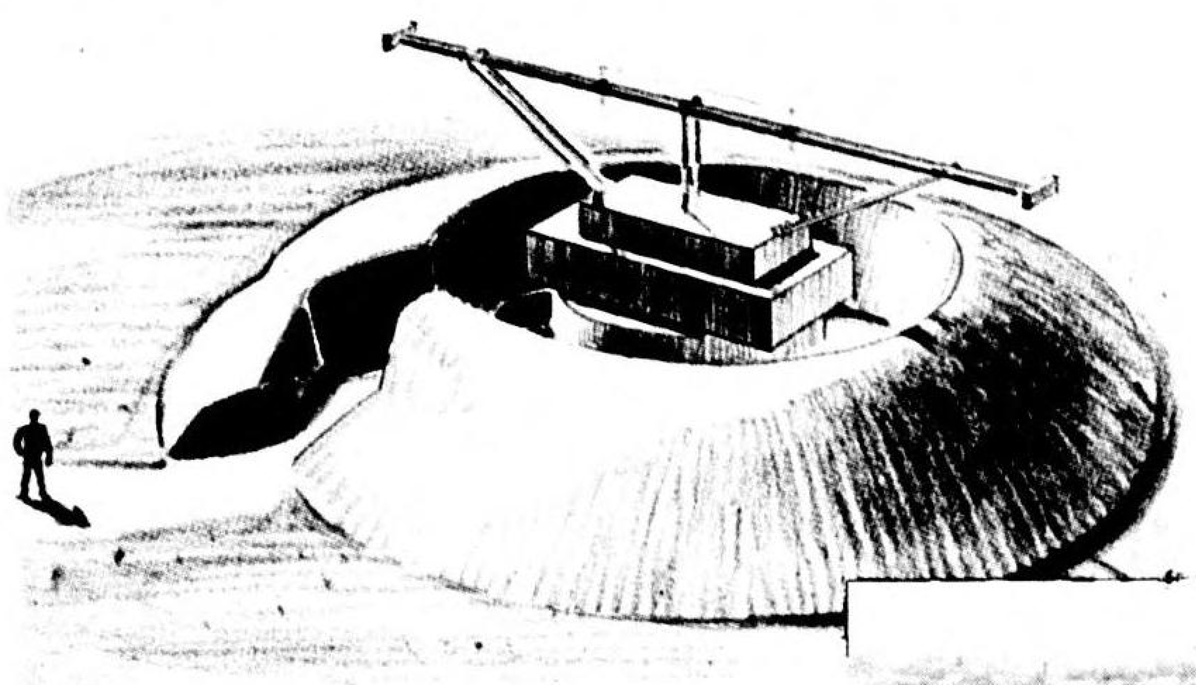
True navigation aids operate as transmitters. Radio range and radio beacons fall in this category. The German navigation aids were developed to aid bombers in locating targets in addition to guiding them back to their airdromes.

NAVIGATION AIDS - JAPANESE

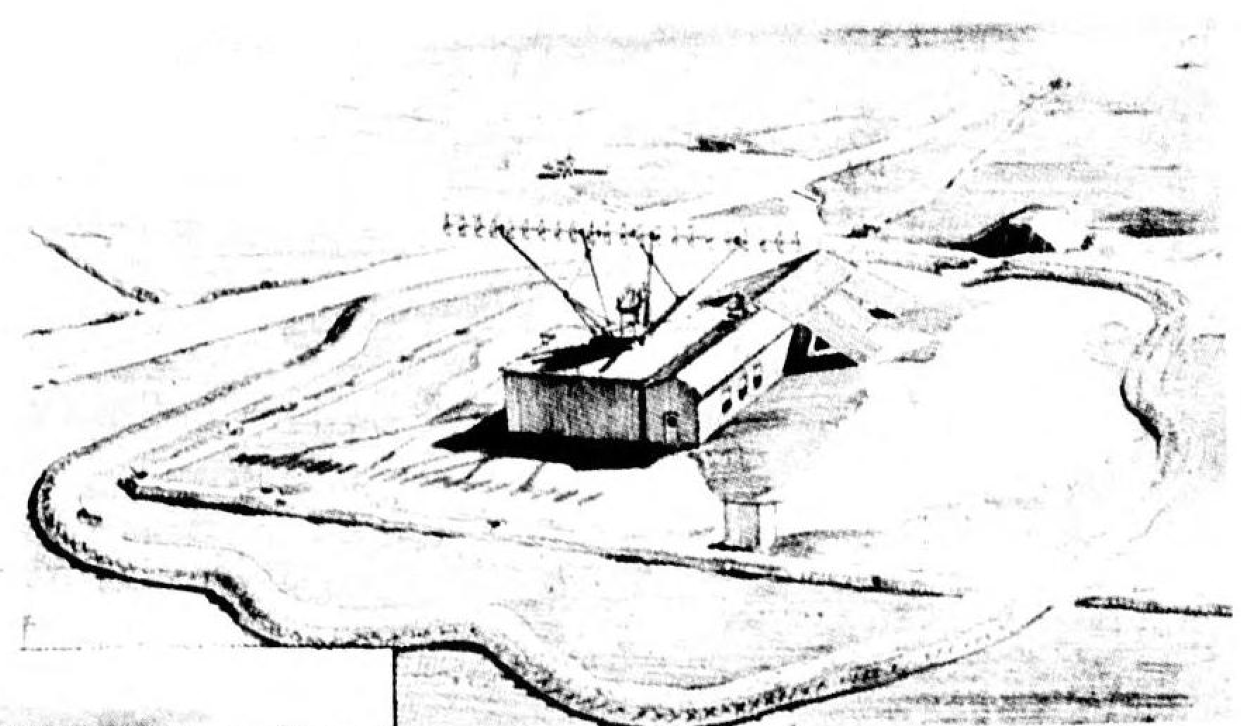


KISKA

NAVIGATION AIDS - GERMAN



RUFFIAN



BENITO

KNICKEBEIN

ELECTRA (not shown)

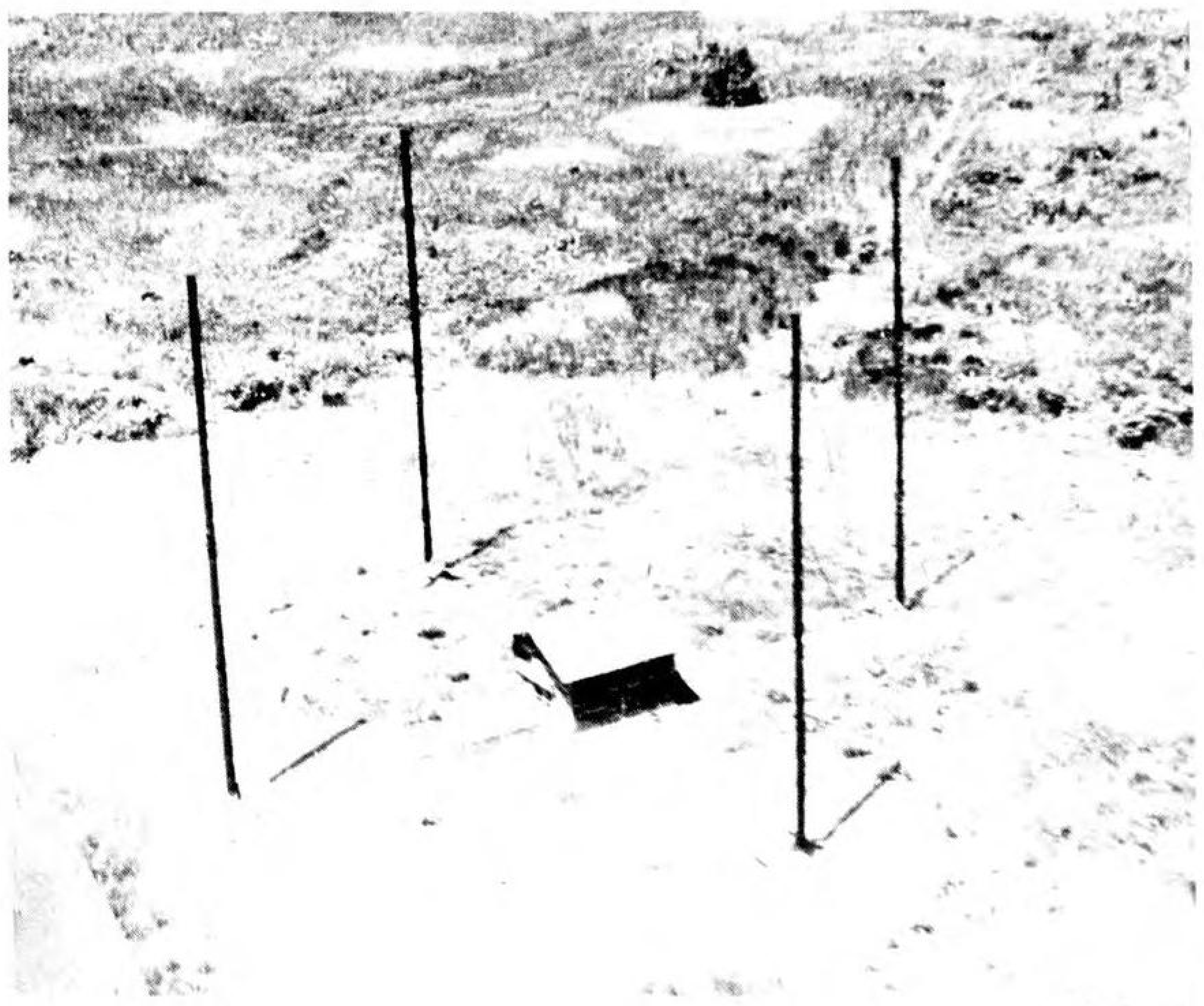
A long distance directional beam on the long wave beam. These beams are fanned out over the target area.

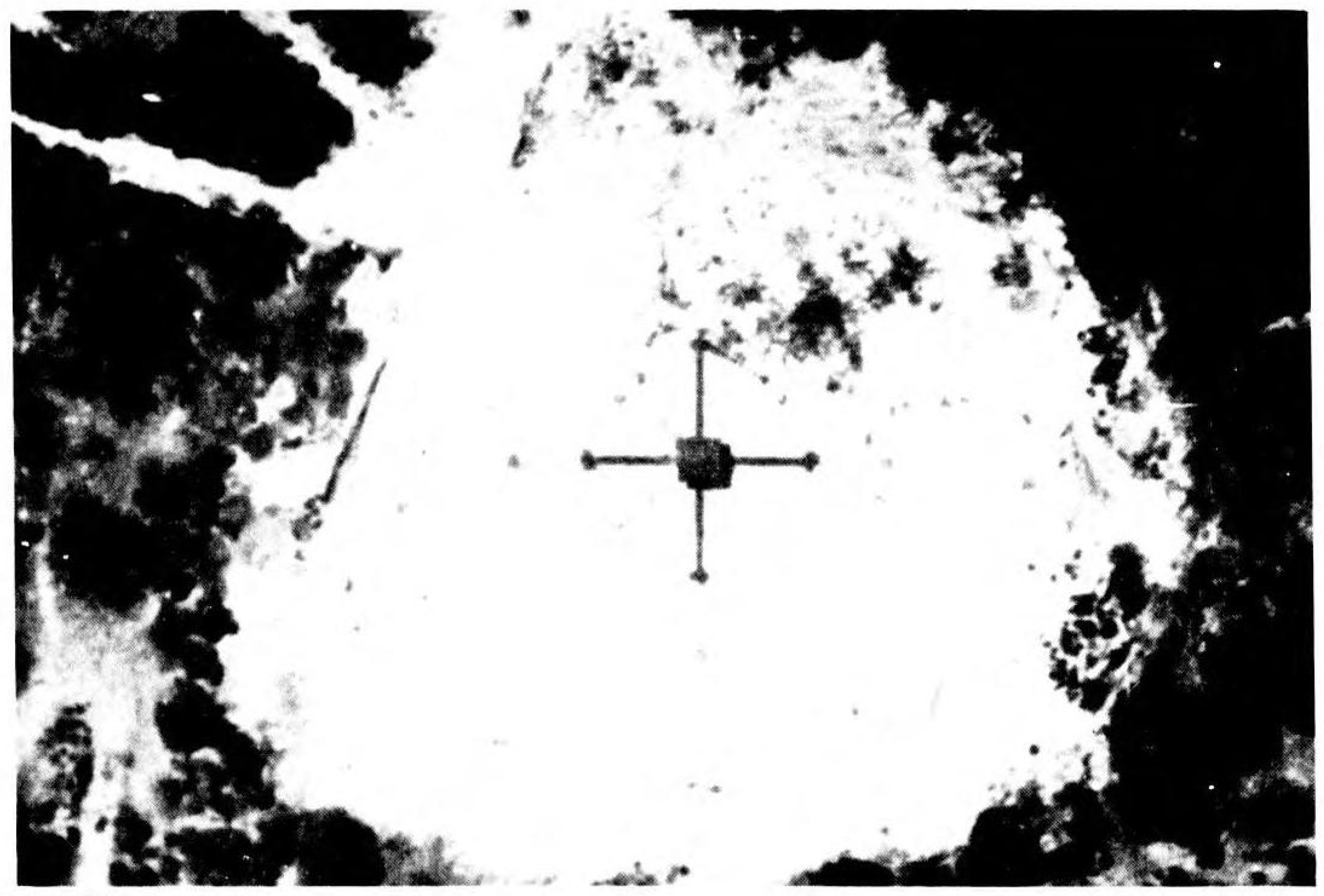
Two types (a) Consists of 2 complimentary installations, each with a simple tall mast and transmitter huts, about 2 miles apart.

(b) Consists of special aerial arrangements in what appears to be a multi-mast communications center.

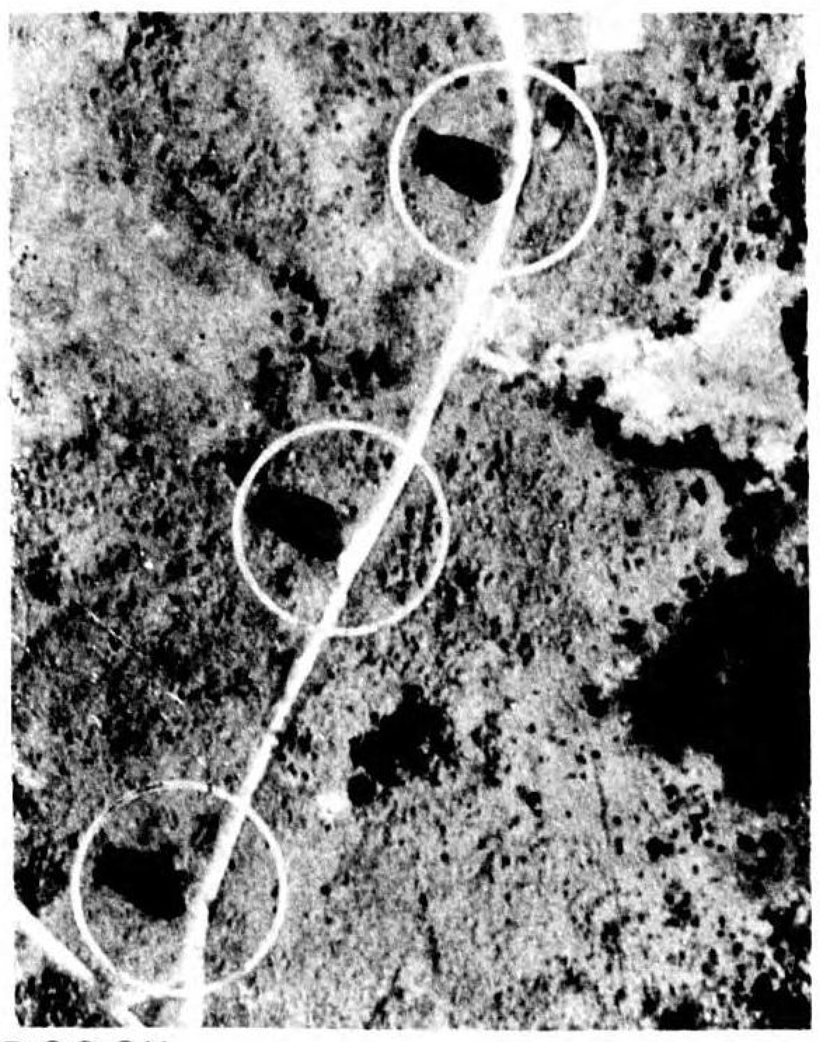
DIRECTION FINDERS - JAPANESE

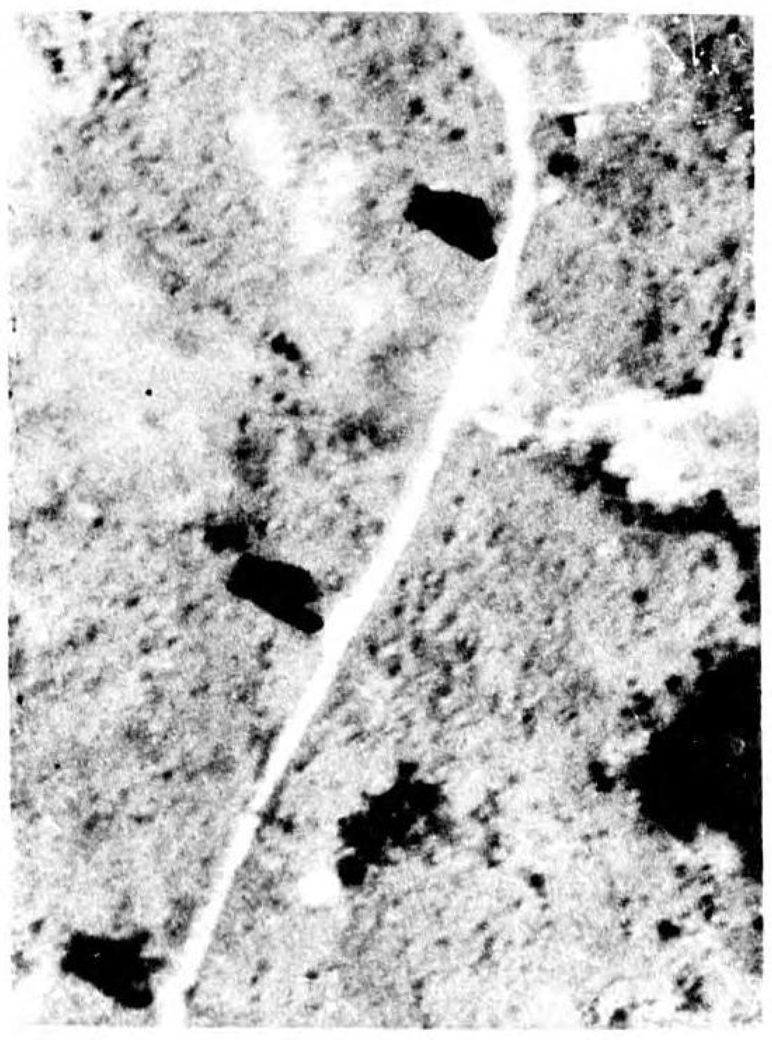
True direction finder equipment acts as a receiver of radio impulses - giving direction and distance to the source of such impulses. Diagonal distance between unipoles will indicate frequency. (EXAMPLE: 90 feet would be suitable for medium frequency up to 2 Mcs.; 25-30 feet, high frequency up to 10 Mcs., etc.) Direction finders may be used as aids to navigation.





OPEN ADCOCK





HOUSED ADCOCK

DIRECTION FINDERS - GERMAN

Adcock types shown above are used by both Germany and Japan.

BELLINI TOSI

SECTION 9
HEIGHT PARALLAX

9.01 —— 9.99

USE OF INSTRUMENTS IN DETERMINING HEIGHT OF OBJECTS FROM PARALLAX MEASURENTS

Determining the height of objects in vertical aerial photographs by measurement of differential parallax involves the use of such instruments as a stereocomparagraph, height or contour finder, interpretometer, or a parallax bar. In measuring directly with the scale or parallax bar, care must be taken to measure only the component of displacement in the direction of flight. This is done for both prints and the two figures subtracted if displacement is in the same direction, or added if in opposite directions.

The contour finder accomplishes the measurement by means of two small dots on the bottom surfaces of glass plates carried by the stereoscope. These dots are practically in the plane of the picture, one remains in a fixed position beneath the left eye piece of the stereoscope while the other may be moved back and forth in the line of flight beneath the right eye piece. Measurement is accomplished essentially by placing the left dot on one of the two points between which the difference in elevation is desired. The other dot is moved to exactly the same point on the right photograph or to such a position that it appears to fuze with the left dot and the fuzed image appears to be at the same level as the point. A reading of the micrometer dial of the stereocomparagraph, or of the position of the sliding wedge of the interpretometer is then made, which records the position of the right dot. The stereoscope assembly is then moved, remaining parallel to the line of flight, so that the left dot is on the second point. Again, the right dot is moved so that it occupies the same point on the right photograph or visually coincides with the left and the fuzed dot appears to be at the level of the second point. A second reading is taken of the position of the right dot and the difference between the two readings is a measure of the differential parallax, the unit of measure depending, of course, on the calibration of the instrument. If calibrated in millimeters or decimal parts of inches, the reading should be converted to decimal parts of feet for use in the formula so that the calculated height of the object will be in feet.

The procedure requires much practice in fuzing the dots at just the proper elevation and a good eye in appreciating relative depth. The surfaces or objects must have photographic tone and detail in order that a comparison of elevation may be made. White surfaces, for example, do not give an impression of position or depth. Moreover, actual manipulation of the dial, in the case of the stereocomparagraph, for relatively accurate readings requires that the right dot approach the left for fusion in the same direction at each point so as to eliminate play in the dial mechanism.

PROCEDURE IN DETERMINING HEIGHT OF OBJECTS IN AERIAL PHOTOGRAPHS BY MEANS OF PARALLAX MEASUREMENT

The following procedure presupposes the use of one of the various devices for measuring parallax, such as height or contour finders, preferably calibrated to read decimal parts of feet. The parallax factor used herein is the displacement, in line of flight, of the top of the object relative to its base, as measured on a stereo pair. Direct utilization of formula No. 1 requires that the prints are contact and that the following data pertaining to the photographs are known:

1. Scale of photographs
2. Focal length of camera lens

The formula is as follows: (1) $ho = \dfrac{f \times P}{RF(W + P)}$

Where:

ho = Height of object in feet

P = Parallax distance as measured on photographs by means of height finder, etc., in decimal parts of feet.

f = Focal length of camera lens in feet. (If given in inches, divide by 12)

W = Distance between centers of photos in feet. This factor is determined by plotting center of one photo on the other and measuring photo distance between centers in decimal parts of feet.

RF = Scale of photographs

The RF should be calculated as accurately as possible by whatever means are available. This may be determined by measuring on the photo objects of known size and using the formula: RF = Photo Measurement divided by ground measurement in the same units. RF may be determined by comparison with maps of known scale:

$$\text{RF of photo} = \frac{\text{Distance on photo} \times \text{RF of map}}{\text{Distance on map.}}$$

The RF may be calculated by using the formula: $RF = \dfrac{f}{H}$, where H is elevation of aircraft above ground, or elevation of aircraft above sea level minus elevation of ground above sea level. Altitude of aircraft given in marginal information is generally an approximation and results obtained by using this figure will correspondingly be approximate. However, when H is known (in feet) the formula may be used in the following form:

$$(2) \quad ho = \frac{H \times P}{W + P}$$

Once the height of an object on the photographs is determined and its parallax has been measured, the height of other objects on the photos can be determined by direct proportion as follows:

$$(3) \quad \frac{ho}{P} = \frac{ho'}{P'} \quad \text{or} \quad ho' = \frac{ho \times P'}{P}$$

Where ho' and P' are height and parallax respectively of second object.

EXAMPLE:

It is desired to determine the height of a structure on a stereo pair. The parallax as measured by the height finder is .00155 feet. The marginal information on the prints indicates that the focal length of the camera lens is 6"(.5 feet).

The RF is determined by comparison with a map of the area. The distance between two intersections on the photograph is 2.6 inches. On the map, having a scale of 1:20,000, the same two intersections are 1.3 inches apart.

$$RF = \frac{2.6}{1.3} \times \frac{1}{20,000} = \frac{1}{10,000} \quad \text{for the photographs}$$

The center of one of the stereo pairs was plotted on the other and it is found that they are .25 feet apart on the print.

P = .00155 feet
f = .5 feet
W = .25 feet
RF = 1/10,000

$$ho = \frac{f \times P}{RF(W+P)} = \frac{(.5)(.00155)}{\frac{1}{10000}(.25 + .00155)} = \frac{(.000775)(10000)}{.25155} = 30.8 \text{ ft.}$$

ENLARGEMENTS:- In the event that the photos used are not contact prints, the marginal information will lead to erroneous results unless properly interpreted. The effect of enlarging a print is similar to that of using a camera with a longer focal length, but with the same height of aircraft or camera. In measuring parallax on blow-ups it is essential that the height of the aircraft remain the constant factor and that 'f' be considered as varying with the scale or amount of enlargement. If the height of the aircraft above ground is known with reasonable accuracy, the formula for height of object may be used in the following form:

$$(2) \qquad ho = \frac{H \times P}{W + P}$$

Here again, the height of aircraft given in the marginal information of the photo is probably inaccurate, and if 'f' for the blow-up can be calculated from the amount of enlargement(i.e. if the enlargement is 3 times then 'f' for the enlargement will be 3 times that for the contact print), then the height of the object in the photo can be determined by the formula:

$$(1) \qquad ho = \frac{f \times P}{RF(W + P)}$$

where RF of the enlargement has been determined by scaling objects of known size or by comparison with maps.

HEIGHT PARALLAX

GRAPHIC METHOD

GRAPHIC SOLUTION OF FORMULA FOR DETERMINING HEIGHTS OF OBJECTS FROM PARALLAX MEASUREMENT

The accompanying graph for determining heights of objects on stereo pairs of vertical photographs from a measurement of parallax solves the formula:

$$ho = \frac{H \times P}{W}$$

Where: ho = height of object
H = height of aircraft
P = parallax measurement
W = distance between centers of photographs

The above formula is a simplification of the form:

$$ho = \frac{H \times P}{W + P}$$

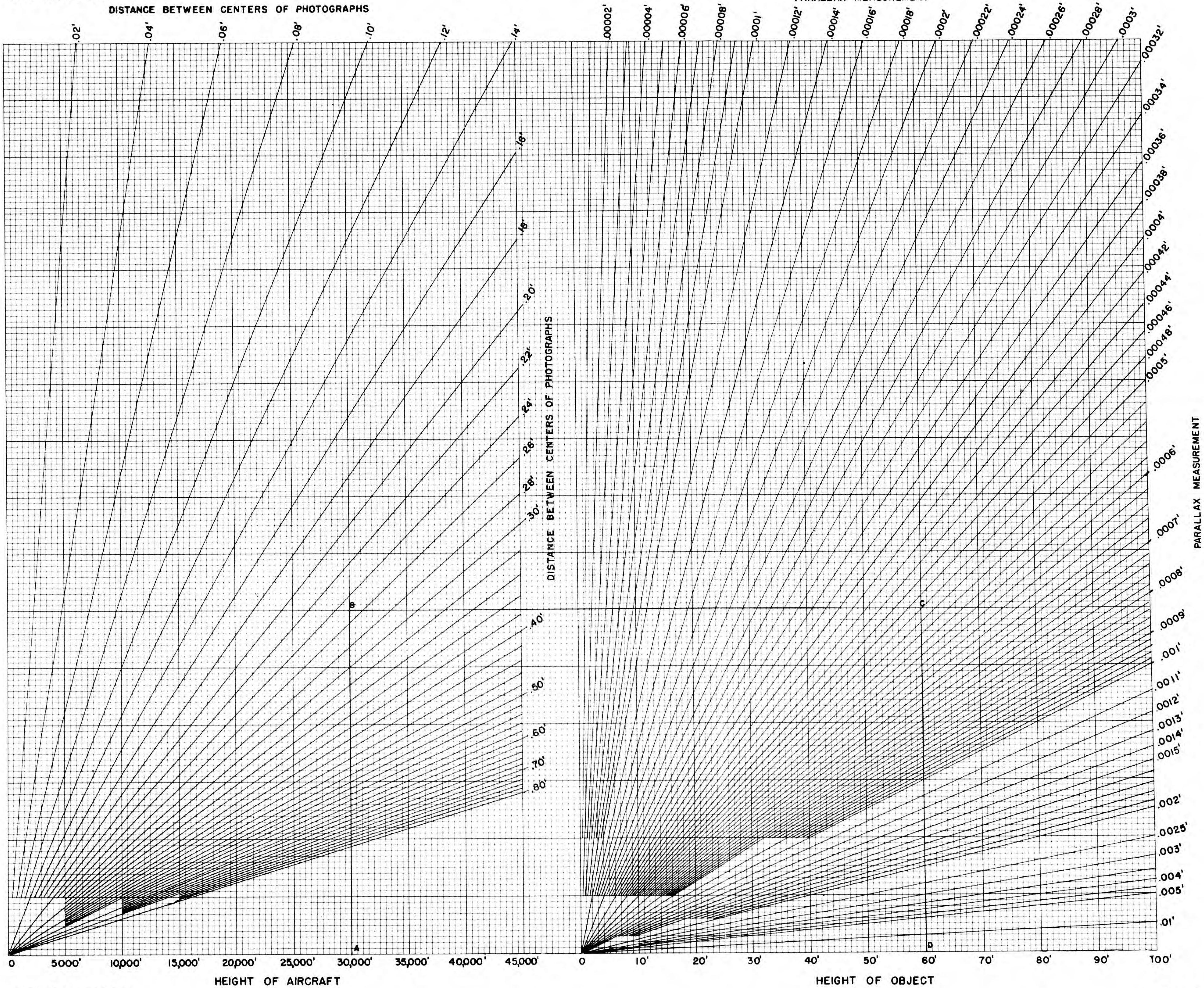
where the value of P is small with respect to W, a condition true in all but very large scale photos of objects or terrain of marked relief.

The graph is designed for use where all measurements are in feet, however, it will work equally well with other units of measure provided all measurements in a particular problem are in the same units.

EXAMPLE:- On aerial photographs taken from an altitude of 30,000 feet the parallax due to the height of a chimney was found by measurement to be .0005 feet. The center of one photograph was plotted on the other and the distance between the two centers was found to be .25 feet. The height of chimney may be determined as follows:

From a position "A", representing 30,000 feet on the scale for aircraft heights along the left half of the lower margin of the graph, follow a vertical line to the position "B", an interpolated point between oblique lines .24 feet and .26 feet for distance between centers of photos. From position "B" follow horizontal line to position "C" on oblique line .0005 feet representing the parallax measurement. From position "C" follow vertical line to position "D" at bottom of graph where height of object is found to be 60 feet.

Note:- The decimal point in any of the factors involved in the graph may be moved, provided it is moved properly in the answer. For example, if it is desired to move the decimal point one position on the scale for height of aircraft, or for the indicated parallax, it will be moved one position in the same direction in the answer. If, however, the decimal point in the indicated value of the distance between centers of photographs is moved one position, the decimal point in the value of the height of the object will be moved one position in the opposite direction.


DISTANCE BETWEEN CENTERS OF PHOTOGRAPHS
.02'
.04'
.06'
.08'
.10'
.12'
.14'
.16'
.18'
.20'
.22'
.24'
.26'
.28'
.30'
.40'
.50'
.60'
.70'
.80'
PARALLAX MEASUREMENT
.00002'
.00004'
.00006'
.00008'
.0001'
.00012'
.00014'
.00016'
.00018'
.0002'
.00022'
.00024'
.00026'
.00028'
.0003'
.00032'
.00034'
.00036'
.00038'
.0004'
.00042'
.00044'
.00046'
.00048'
.0005'
.0006'
.0007'
.0008'
.0009'
.001'
.0011'
.0012'
.0013'
.0014'
.0015'
.002'
.0025'
.003'
.004'
.005'
.01'
B
C
A
D
0
5000'
10,000'
15,000'
20,000'
25,000'
30,000'
35,000'
40,000'
45,000'
HEIGHT OF AIRCRAFT
0
10'
20'
30'
40'
50'
60'
70'
80'
90'
100'
HEIGHT OF OBJECT

DEPTH MEASUREMENT BY PARALLAX USING SONNE STRIP PHOTOGRAPHS

The Sonne camera photographs a continuous strip of terrain by allowing the negative to move continuously over a fixed slit at the focal plane of the camera. The speed with which the film moves is adjusted to the height and speed of the aircraft. The Sonne camera has been modified to permit stereo coverage by using two lenses and partitioning the camera cone so that two strips are photographed side by side on the negative. Parallax is obtained by causing the lens assembly to be rotated in a horizontal plane so that one lens is in advance of the other. As a consequence, a different portion of terrain image is directed toward the slit on each side of the partition at any one time, and an appreciable time interval elapses between exposures of the same detail on each side of the negative. The angle which the lens assembly is rotated from a neutral position - that in which neither lens is in advance of the other - determines the amount of parallax which can be measured for any particular height or depth. A rotation which permits about 5° between the rays directed to the slit, where the focal length of the lenses is 100 mm., is considered most satisfactory.

Sonne strip photography is especially adapted to low altitude flying and permits much more accurate determination of height and depth, provided the speed of the film is correctly maintained so as to eliminate distortion in line of flight. At 200' altitude the plane travels about 21 feet from the position where a particular point is recorded by the forward lens to where the same detail is recorded by the aft lens. The relatively short interval of time between exposures of the same point at high plane speeds is of particular value in depth of water determinations, where the bottom of the water can be discerned, in that the top surface of the water is photographed stereoscopically in a nearly static condition, producing a stereoscopically visible base or datum level from which to make depth measurements.

Determining height of objects or depth of water by parallax measurement on parallel strip photographs is essentially similar to the procdeure involved in using ordinary stereo pairs. Prints from equivalent parts of the two strips may be cut and arranged under the height finder in the same way as an ordinary stereo pair, orienting each print so that measurement will be made in the direction of flight. Parallax may also be measured by a stereoscopic viewer having a parallax attachment which is so designed as to permit examination and measurement of the parallel strips without the necessity of cutting and arranging photos under an ordinary height finder.

In determining depth of water, the "floating dot" of the height finder is adjusted at the same elevation as a point on the water surface on the upper part of the stereo pair. The dot is then moved to the lower part of the picture. Using the first point as a center, one picture is rotated until the second surface point appears at the same elevation as the dot.

If all surface points on the stereo pair are not at the same elevation, allowing for differences due to waves, such a condition may have resulted from change of plane direction during photography, or to forward and back tip of the plane in line of flight. Tilt across the line of flight does not affect vertical measurements. The water surface will appear to change elevation only along the line of flight if the photos are carefully rotated as described above. To avoid the effects of distortion, measurements should be made of depths occurring along a line across the direction of flight. Photos should be reoriented for each such line across the pictures.

For best results the following conditions should exist:.

1. The lens assembly should be rotated for about 5° between rays.
2. Plane altitude should be constant and less than 300'
3. Speed of film should be carefully coordinated with heighth and speed of plane. Improper coordination will result in a distorted parallax measurement.
4. The sun should be at such an angle that the bottom is well lighted and that occasional ripples show on the surface.
5. Photographic plane runs should be straight lines.
6. The bottom should not be obscured by surface disturbance, silt, etc.

The condition of the tide at the time of photography should be taken into consideration so that depths may be determined at future times.

The formulae which may be used to determine heights of objects and depths of water are as follows:

$$\text{height} = \frac{H \cdot P}{2 \cdot f \cdot \tan \frac{1}{2}a}$$

$$\text{depth} = \frac{H \cdot P}{2 \cdot f \cdot \sin \frac{1}{2}a}\sqrt{n^2 - \sin^2 \frac{1}{2}a}$$

The depth formula, however, may be simplified to

$$\text{depth} = \frac{1.34\, H \cdot P}{2 \cdot f \cdot \sin \frac{1}{2}a} \quad \text{for practical purposes.}$$

Where:
- H = height of aircraft
- P = parallax measurement
- f = focal length of camera lens
- a = angle between light rays directed to camera slit, read directly on calibrated scale from amount of rotation of lens assembly
- n = 1.34 = index of refraction of water
- All linear measurements in same units.

With a focal length for the camera lens of 100 mm. or .328 feet, and an angle of 5° the formulae may be simplified to the following:

Where P is measured in millimeters and H in feet:

$$\text{height} = \frac{H \cdot P}{(2)(100)(.0437)} = \frac{H \cdot P}{8.73} \text{ feet}$$

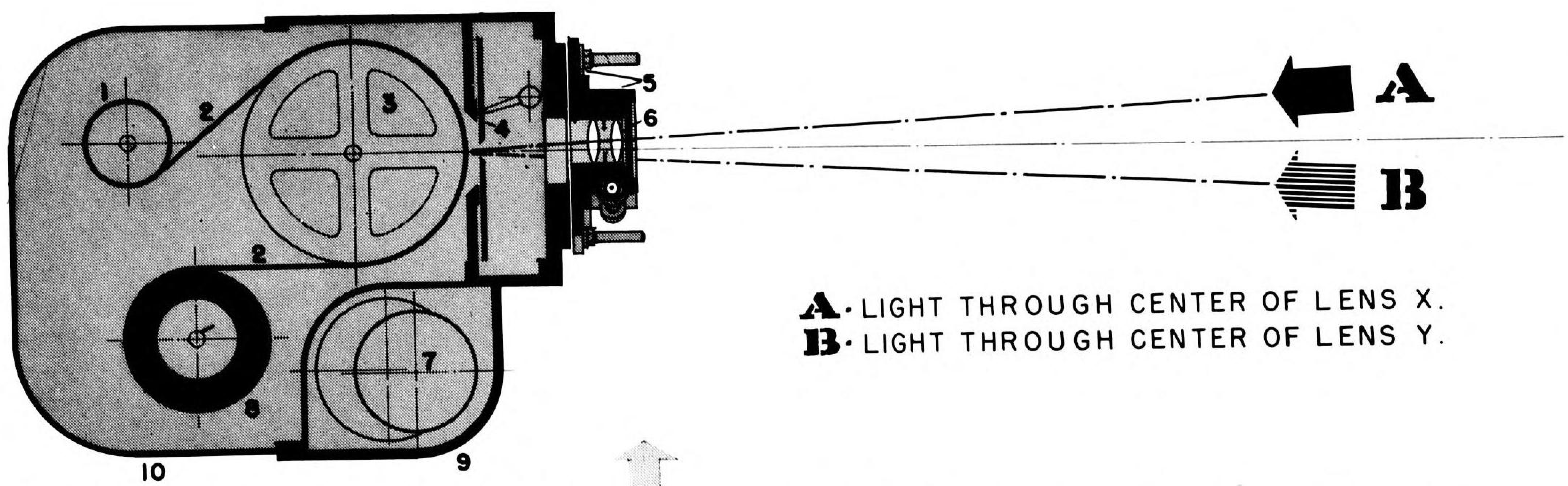
$$\text{depth} = \frac{1.34\, H \cdot P}{(2)(100)(.0436)} = \frac{H \cdot P}{6.51} \text{ feet}$$

HEIGHT PARALLAX
SONNE STRIP (CONT.)

Where P is measured in decimal parts of feet and H in feet:

$$\text{height} = \frac{(12)(25.4)\ H \cdot P}{8.73} = 34.9\ H \cdot P \text{ feet}$$

$$\text{depth} = \frac{(12)(25.4)\ H \cdot P}{6.51} = 46.8\ H \cdot P \text{ feet}$$

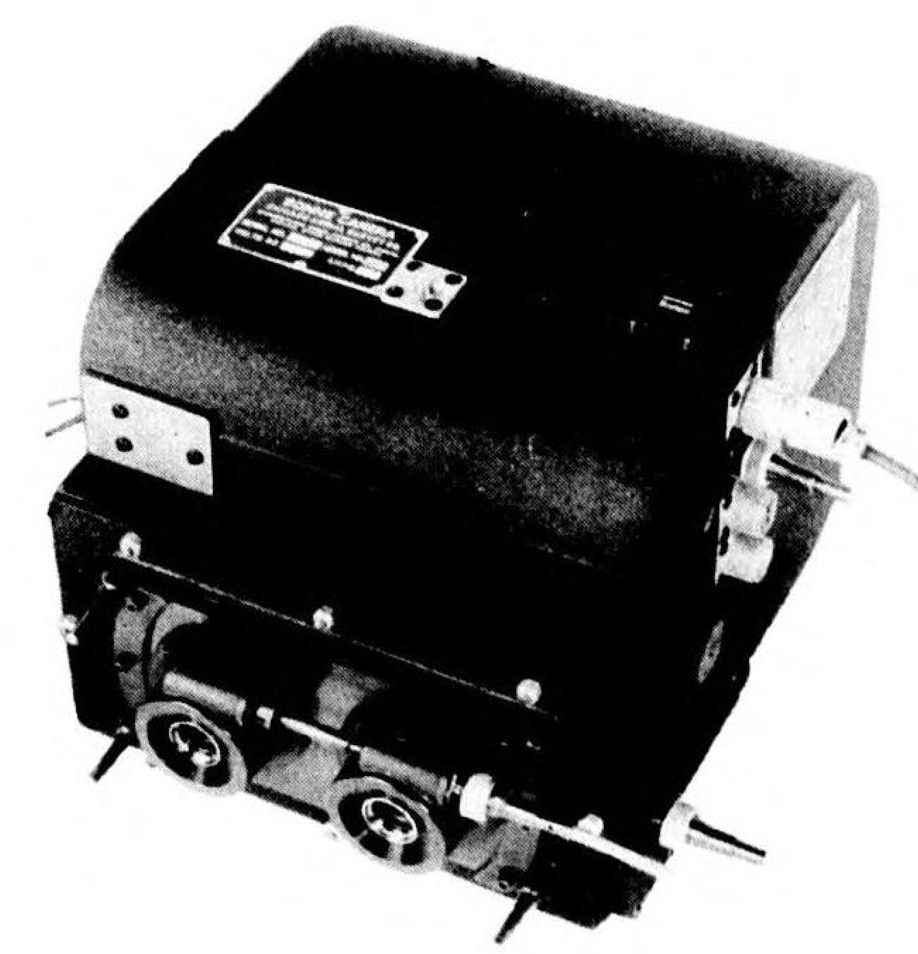


A - LIGHT THROUGH CENTER OF LENS X.
B - LIGHT THROUGH CENTER OF LENS Y.

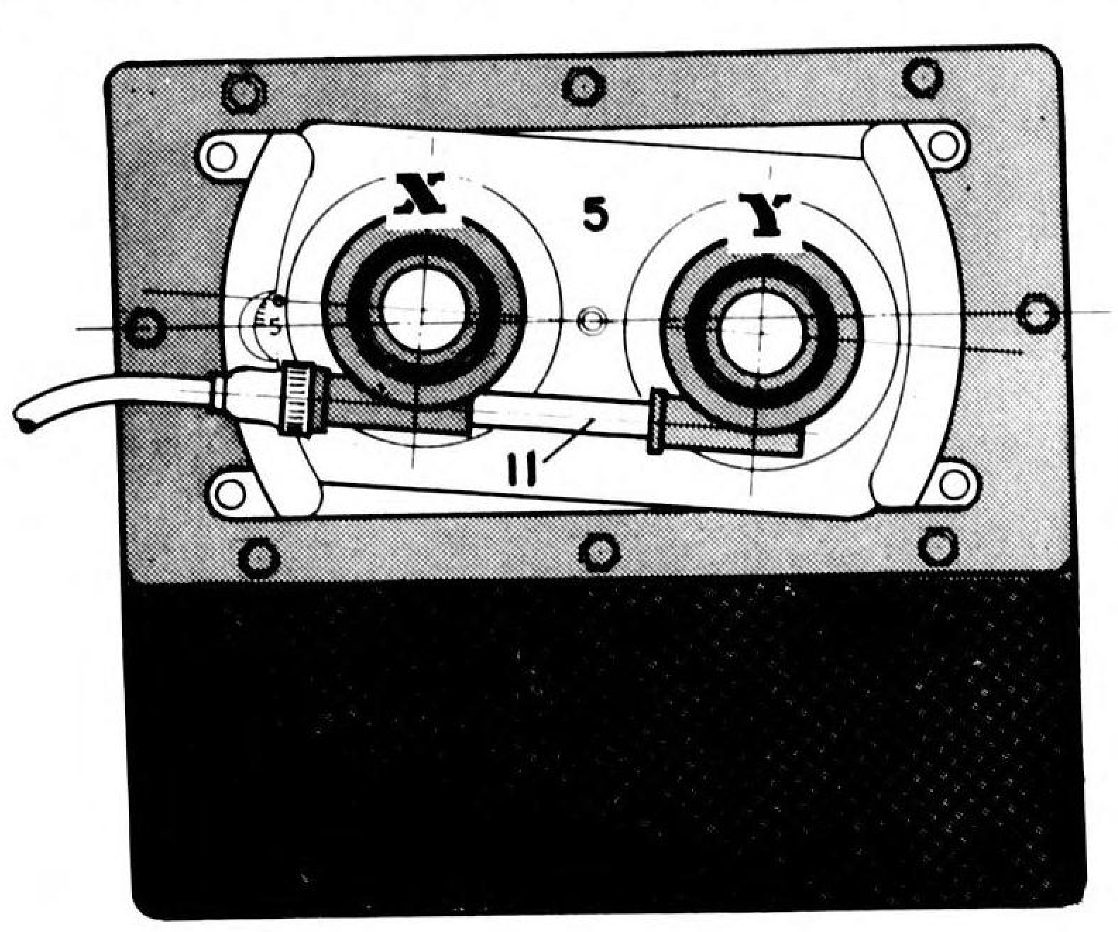
S E C T I O N

SONNE CAMERA

1. FILM TAKE UP SPOOL
2. FILM
3. FOCAL ROLLER
4. ADJUSTABLE APERTURE
5. ADJUSTABLE LENS TURRET
6. LENS
7. MOTOR AND VARIABLE SPEED TRANSMISSION
8. UNEXPOSED FILM SPOOL
9. CAMERA BODY
10. CAMERA COVER
11. DIAPHRAM CONTROL



VIEW SHOWING LENS TURRET IN ROTATED POSITION



STEREO-VIEWER SHOWN IN OPEN POSITION

SECTION 10
HEIGHT SHADOW

10.01 —— 10.99

PROCEDURE IN DETERMINING HEIGHT OF OBJECTS FROM SHADOW LENGTHS ON AERIAL PHOTOGRAPHS

For all practical purposes this procedure makes but two simple assumptions; (a), that the shadow falls on level ground and that (b), the earth is a sphere.

To apply the formula for height from shadow length, the following information is needed:

1. The date and time of photography.
2. The latitude and longitude of photography.

From this information we may calculate and list the following factors utilized in the formula:

a = Sun's declination or latitude. This may be determined from graph (curve 1) or Solar Ephemeris for the date of photography.

b = Latitude of photography (known).

c = Difference in longitude between position of sun and position of photography. This may be calculated as follows:

1. From time of photography (and referring to a time zone map) determine G.C.T. (Greenwich Civil Time).
2. From G.C.T. determine interval of time between G.C.T. and Greenwich noon.
3. Multiply this interval by 15 (remembering that minutes are not decimal parts of hours), giving the longitude of the sun at the time of photography. (The sun's longitude will be East if G.C.T. is A.M. and West if G.C.T. is P.M.).
4. A correction should be applied to the above calculated longitude of the sun for relatively accurate measurements, This correction involves adding or subtracting (as indicated) the small angle derived from graph (curve 2), if the longitude of the sun is West. If the longitude of the sun is East, the signs indicated in graph (curve 2) are reversed.
5. From the calculated longitude of the sun and the known longitude of the photography determine the difference in longitude between these two positions. = c.

From Tables of Natural Functions substitute the sine and cosine values in the following formula:

$$\sin x = (\cos a)(\cos b)(\cos c) \pm (\sin a)(\sin b)$$

The sign between the two parts of this equation will be plus if the sun and photography are the same side of the Equator. If they are on opposite sides the sign will be minus.

From the value of 'sin x' calculated above determine from Tables of Natural Functions the value of 'tan x'. Height in the photograph will be shadow length multiplied by 'tan x'.

EXAMPLE:

It is desired to determine the height of a radio tower in Dakar which casts a shadow 77 feet long. The photograph was taken at 9 A.M. on the 4th of August. The latitude of Dakar is $14^{o}40'$ North and the longitude is $17^{o}20'$ West.

a = Sun's declination (or latitude) from graph (curve 1, page 10.03) = $17^{o}20'$ N
cos $17^{o}20'$ = .9546   sin $17^{o}20'$ = .2979

b = Latitude of photograph = $14^\circ 40'$
    $\cos 14^\circ 40' = .9674$ $\sin 14^\circ 40' = .2532$

c = Difference in longitude between sun and photograph

1. From time zone map Dakar is seen to be 1 hour west of Greenwich. therefore G.C.T. = 10 A.M.
2. Interval between G.C.T. and Greenwich noon = 2 hours.
3. 2 x 15 = 30 or 30° East is longitude of sun.
4. Correction from Table I on August 4th is seen to be $-1^\circ 31'$, but longitude of sun is East, so sign is changed to $+1^\circ 31'$ making corrected longitude of sun $31^\circ 31'$ East.
5. Longitude of photograph = $17^\circ 20'$ West. Difference in longitude between sur and photograph = c = $48^\circ 51'$ $\cos 48^\circ 51' = .6581$.

$$\sin x = (\cos a)(\cos b)(\cos c) \pm (\sin a)(\sin b)$$

$$\sin x = (.9546)(.9674)(.6581) \pm (.2979)(.2532)$$

The sign in the equation is plus because sun and photograph are on same side of Equator.

$$\sin x = .6080 + .0754 = .6834$$
$$x = 43^\circ 7'$$
$$\tan x = .9347$$

Length of shadow = 77 feet.
    $.9347 \times 77 = 72$ feet, height of radio tower.

In the foregoing procedure it is assumed that the time of day for the photography is known. If this information is lacking, the angle of elevation of the sun may still be determined if the direction of true north on the photograph is known. The accuracy of this method depends largely on the accuracy with which the angle between the direction of the shadow and true north may be measured on the photograph.

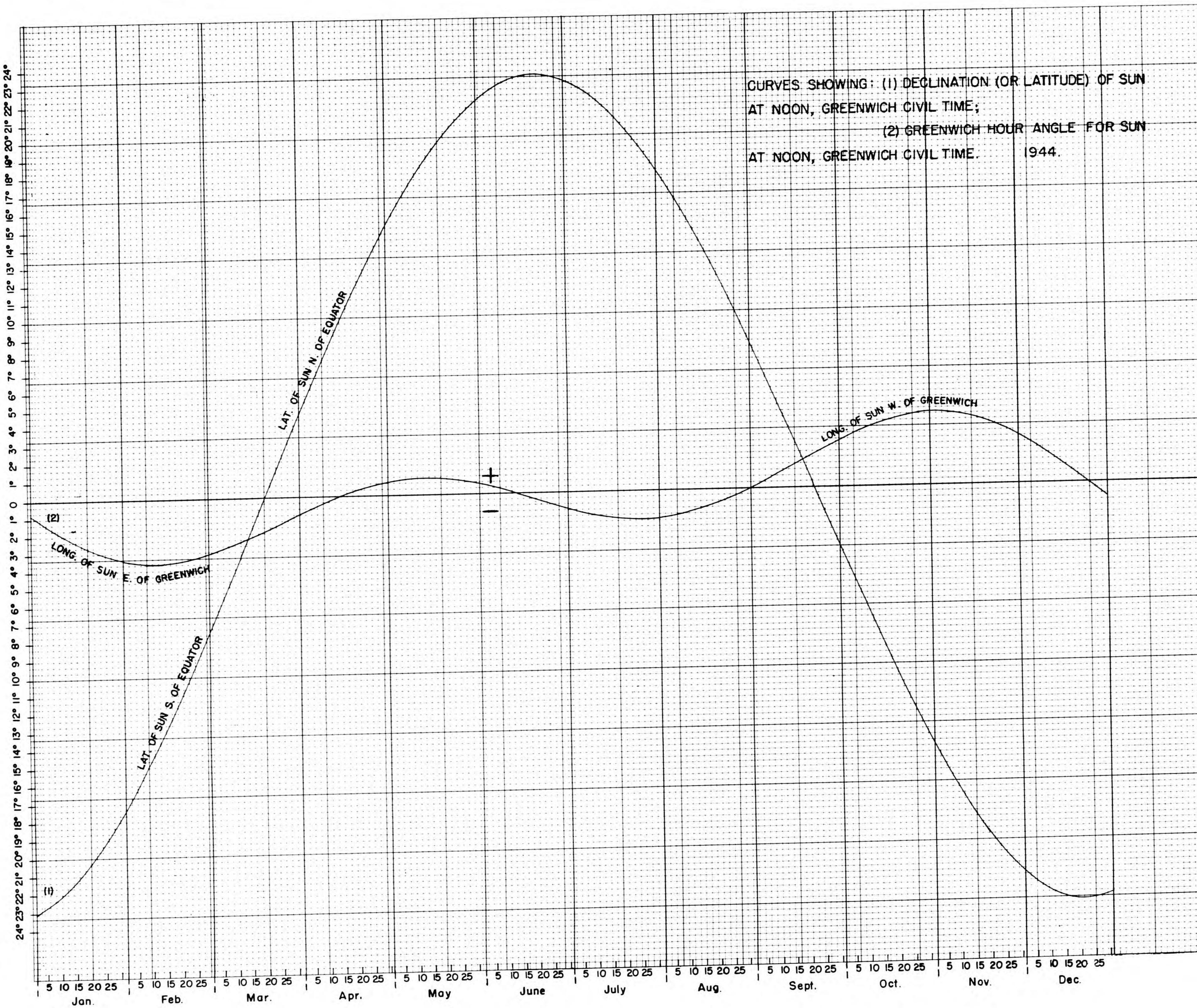
The following formula applies (substituting values from tables of natural functions):

$$\sin x = \frac{(\cos b)(\cos N)\ \sqrt{(\cos^2 a) - (\cos^2 b)(\sin^2 N)} \pm (\sin a)(\sin b)}{1 - (\cos^2 b)(\sin^2 N)}$$

The sign in this equation is plus if the latitude of the sun and of the photography are on the same side of the equator. The sign is minus if they are on opposite sides.

a = Latitude of sun (as before)
b = Latitude of photography (as before)
x = Angle of elevation of sun (as before)
N = Angle between direction of shadow and true north measured on photograph.

Height of object = length of shadow multiplied by 'tan x', (converting sin x to tan x by tables of Natural Functions).



1630880

RESTRICTED

HEIGHT SHADOW

MATHEMATICAL METHOD (CONT.)

GRAPHIC METHOD OF DETERMINING HEIGHT OF OBJECTS FROM SHADOW LENGTHS ON AERIAL PHOTOGRAPHS

The following procedure requires that the date and time of photography are known as well as the geographic coordinates. The sun's longitude is determined in graph I from the time of day and time zone involved, and a small correction derived from graph II. Graphs III to V solve the relation: $\sin x = \cos a \cdot \cos b \cdot \cos c \pm \sin a \cdot \sin b$, without the use of trigonometric tables or calculations. Graph VI gives the height of the object from the shadow length and the numerical value ($\sin x$) obtained from Graphs III to V. The various steps in the procedure are outlined below:

1. Referring to graph I showing relationship between time of day and longitude of sun, select point along lower margin of graph corresponding to indicated time of photography. Follow vertical line corresponding to time to proper oblique line representing zone to which indicated time is referred. From point of intersection follow horizontal line to right margin for longitude of sun.

2. Apply small correction to sun's longitude for the particular day of the year as indicated in Graph II. This correction is to added or subtracted as indicated by the graph if the longitude of the sun is west. If the longitude of the sun is east, the signs indicated for addition or subtraction are reversed.

3. Difference in longitude between sun and locality photographed may be determined by subtracting one from the other if both are west or if both are east. The two longitudes are added if one is east and the other west. If the result of this addition is greater than 360°, subtract 360°.

4. From date of photography indicated on left half of lower margin, below Graph V, follow vertical line for day concerned to curve in Graph III representing latitude of locality photographed. From this point in Graph III follow horizontal line into Graph IV to oblique line representing difference in longitude as determined in above paragraph. From point of contact in Graph IV follow vertical line down to lower margin of Graph IV to determine value of "Y".

5. Again, from left lower margin indicating date of photography follow same vertical line to curve in Graph V which represents latitude of locality photographed. From point of contact in Graph V follow horizontal line to right margin of Graph V to determine value of "Z".

6. The values of "Y" and "Z" are added together if the sun's latitude (or declination) and that of the photograph are on the same side of the equator. If they are on opposite sides of the equator, "Z" is subtracted from "Y". Note: Sun is north of the equator from Mar. 21 to Sept. 21.

7. In Graph VI select point along lower margin representing length of shadow. Follow vertical line for value of shadow length to oblique line representing the value of Y + Z or Y-Z as determined in paragraph above.

From point of intersection of vertical and oblique lines, or interpolated position, follow horizontal line to left margin for height of object. Once the height of an object casting a shadow has been determined, the height of other objects on the same photograph or strip can be determined from their shadow lengths by direct proportion,

EXAMPLE: A radio tower at Okayama, Formosa, casts a shadow 82½ feet long in an aerial photograph taken at 1115 hours on November 7th. The latitude and longitude of Okayama are 22°48' N and 120°15' E.

1 Select point representing 1115 along lower margin of the graph (I) showing relation between time and longitude of sun. Follow vertical line representing 1115 to oblique line representing 7th zone east, assuming time given on photo is the local time of an air base in China which is 7 hours earlier than Greenwich. From point of intersection follow horizontal line to right margin where longitude of sun is found to be 116°.

2. From Graph II it is seen that the sun is about 4° west of Greenwich at noon Nov. 7th and since Formosa has an east longitude this amount is subtracted from 116°, leaving 112° as the corrected longitude for the sun

3. The difference in longitude between sun and locality is 120°15' — 112° or 8° to the nearest degree.

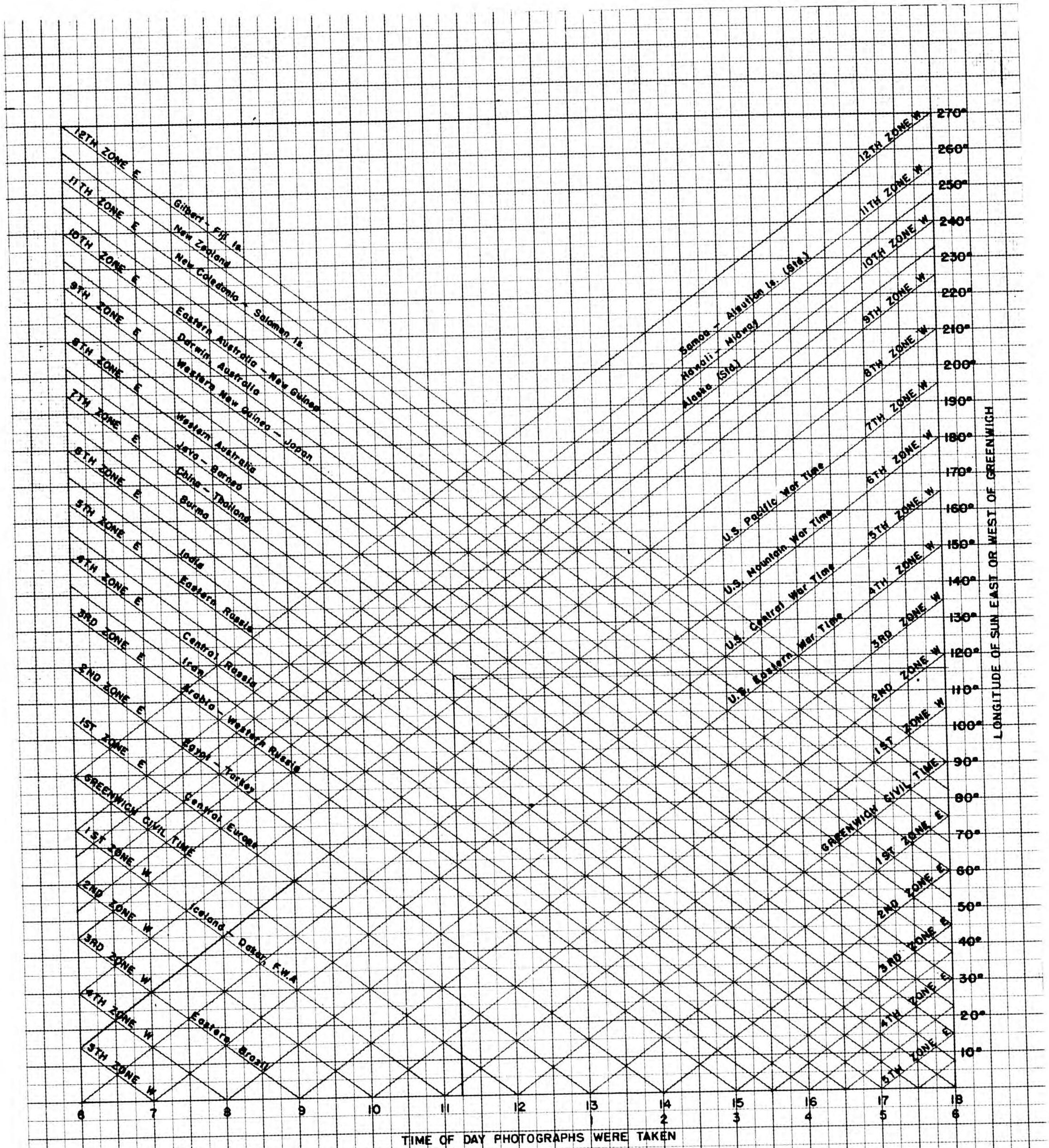
4. The vertical line A - B representing Nov. 7th in the left lower margin is followed to point B in Graph III representing latitude 22°48' for Okayama. From point B a horizontal direction is followed to point C representing 8° difference in longitude in Graph IV. From point C a vertical line is followed to point D at lower margin of Graph IV, giving a value of .875 for "Y".

5. Returning to line A - B representing November 7th, point E on the date line represents a position in Graph V corresponding to the latitude of Okayama. From point E a horizontal direction is followed to the right margin of Graph V where the value of "Z" is found to be .108

6. "Z" is subtracted from "Y" inasmuch as the sun and locality are not on same side of equator. .875 minus .108 equals .767.

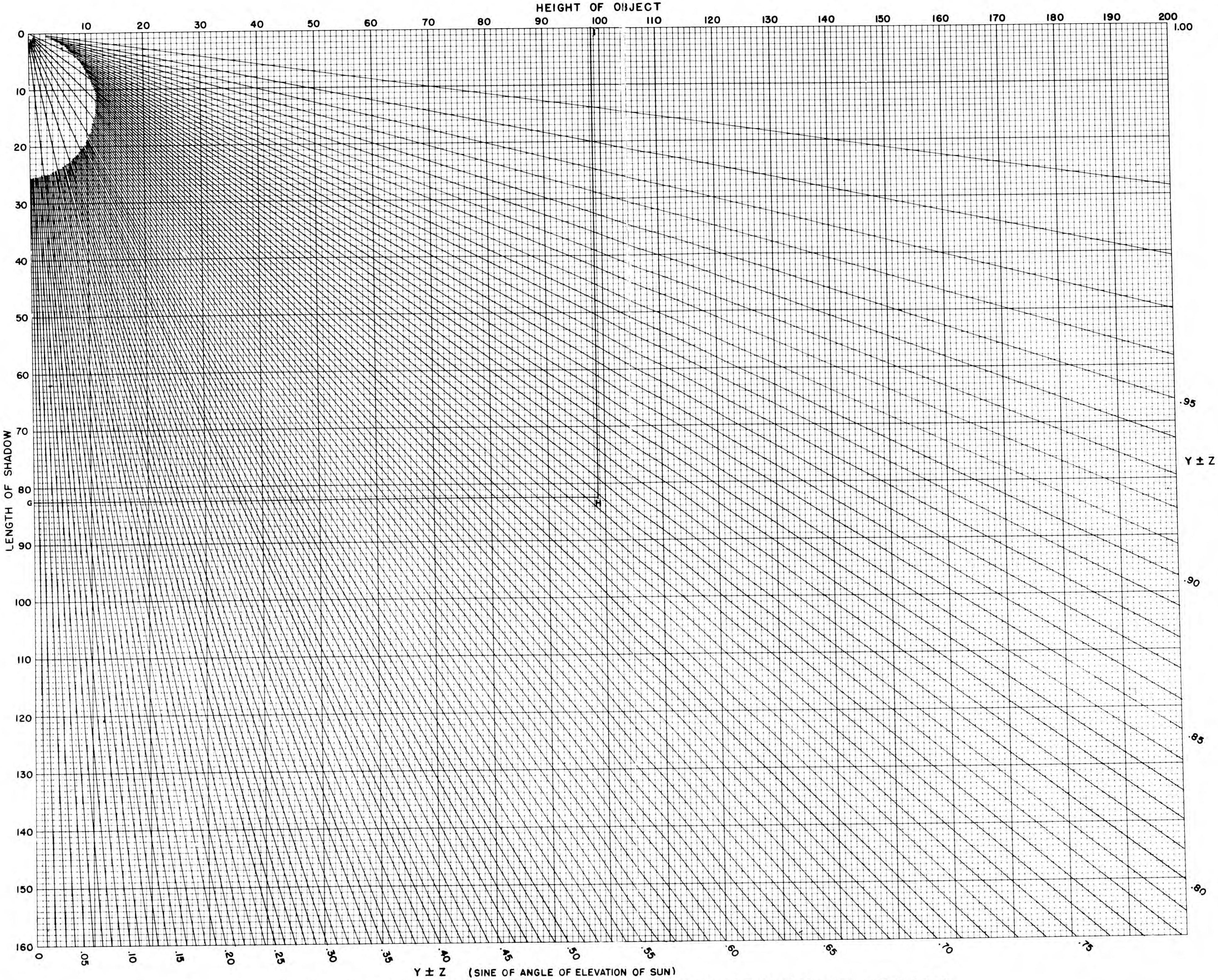
7. Referring to lower margin of Graph VI locate point G representing 82½ feet for shadow length. Follow horizontal line representing 82.5 to position H between oblique lines .76 and .77, representing .767. A vertical line from point H to point I at top margin shows height of radio tower to be 98½ feet high.

HEIGHT SHADOW
GRAPHIC METHOD (CONT.)



GRAPH SHOWING LONGITUDE OF SUN FOR TIME OF DAY IN VARIOUS TIME ZONES EAST AND WEST OF GREENWICH

GRAPH NO. I



GRAPH VI TO BE USED IN DETERMINING HEIGHT OF OBJECTS FROM LENGTH OF SHADOW ON AERIAL PHOTOGRAPHS

GRAPH NO. II
LONGITUDE OF SUN AT NOON, GREENWICH CIVIL TIME
LONGITUDE
WEST EAST
GRAPH NO. III
LATITUDE OF LOCALITY
DIFFERENCE IN LONGITUDE BETWEEN SUN AND LOCALITY PHOTOGRAPHED (HOUR ANGLE)
GRAPH NO. IV
VALUE OF "Y"
VALUE OF "Z"
GRAPH NO. V
"Y" AND "Z" ARE ADDED IF SUN AND LOCALITY ARE ON SAME SIDE OF EQUATOR.
"Z" IS SUBTRACTED FROM "Y" IF SUN AND LOCALITY ARE ON OPPOSITE SIDES OF EQUATOR.
THE RESULT IS USE IN GRAPH V.
GRAPHS I TO IV TO BE USED IN DETERMINING HEIGHT OF OBJECTS FROM LENGTH OF SHADOW ON AERIAL PHOTOGRAPHS
(GRAPHIC SOLUTION OF EQUATION: SIN X = COS A · COS B · COS C ± SIN A · SIN B)
OFFICE OF THE A.C./A.S., INTELLIGENCE WASHINGTON, D.C.

GRAPHIC METHOD OF DETERMINING DIRECTION OF NORTH FROM DIRECTION OF SHADOWS ON AERIAL PHOTOGRAPHS

The following procedure requires, as in determining height of objects from shadow length, that the date and time of photography are known, as well as the geographic coordinates. The graphs prepared specifically for determining the angle between a north-south direction and shadow direction are a solution of the equation: $\sin N = \cos a \cdot \sin c \div \cos x$. The procedure involves use of the curves designed to give height of objects from shadow length so far as obtaining the value of $Y \pm Z$ (sine of the angle of elevation of the sun). The various steps in the procedure are outlined below:

Obtain value of $Y \pm Z$ from graphic method of determining height of objects from shadow length; paragraphs 1 to 6 inclusive in outline of procedure.

2. On graph VII showing angle between north (or south) and shadow direction, select point along left half of lower margin representing value of $Y \pm Z$ and follow vertical line to the curve representing difference in longitude between sun and locality as indicated along left margin. From point of intersection with proper curve, or interpolated position, follow horizontal line to curve or position between curves on right representing date of photography. Note: The curves shown represent the 21st day of the month indicated and approximate positions for intervening dates will be found by interpolation. From point where horizontal line intersects date of photography follow vertical line to lower margin of graph to read angle between shadow and a north-south line. At this point the interpreter is required to visualize the approximate direction of the shadow in order to determine in which quadrant the shadow falls, and hence in which direction from the shadow that the angle determined above is to be plotted.

EXAMPLE: Same data as in height vs. shadow length problem: Photos taken at 1115 hours, Nov. 7th. Latitude and Longitude: $22^{\circ}48'$ N. and $120^{\circ}15'$ E.

1. From curves I to V, $Y \pm Z$ is .767.

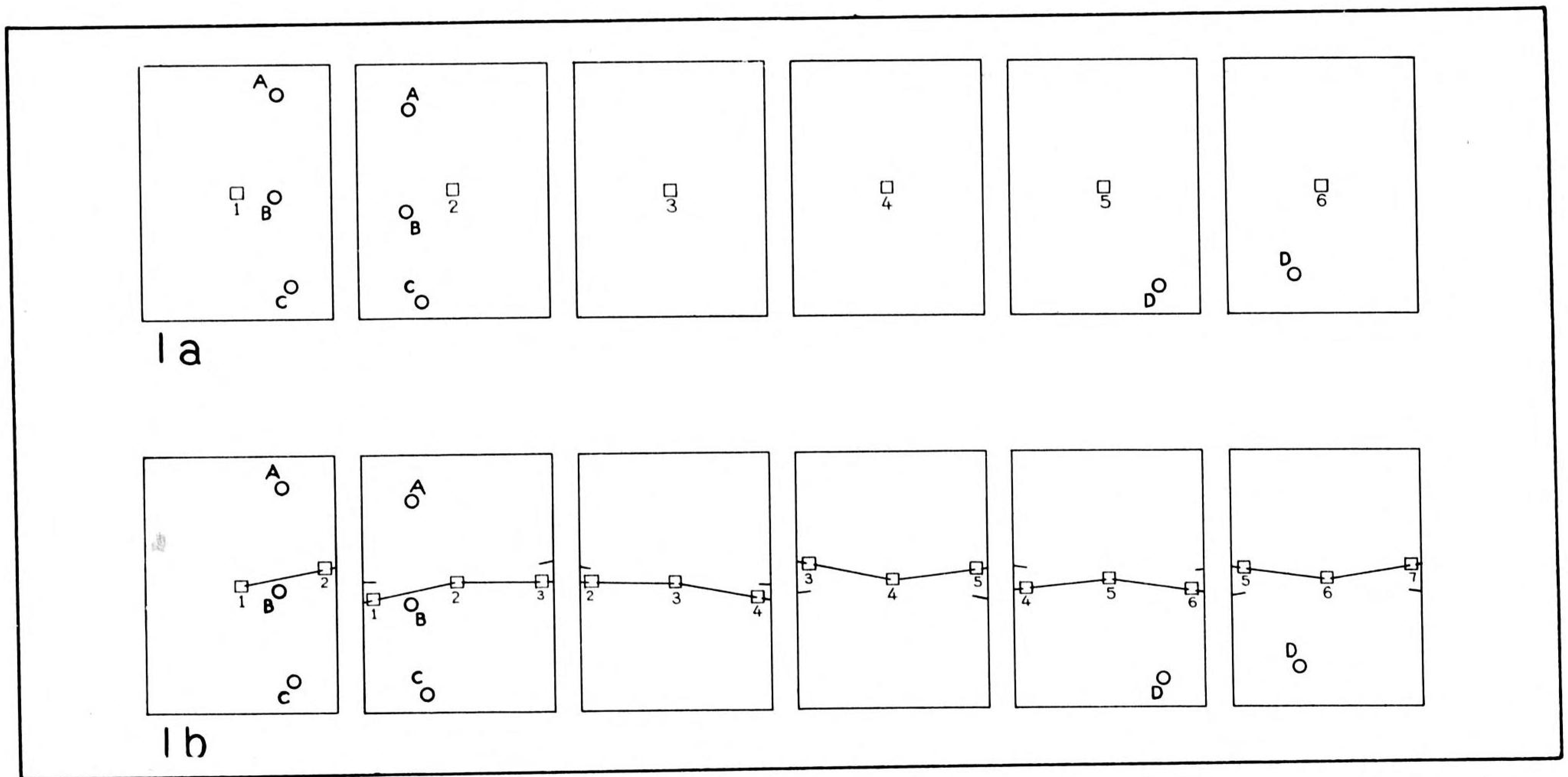
2. Selecting point .767 on left half of lower margin of graph VII follow vertical line to curve representing 8° difference in longitude. From point of intersection follow horizontal line to interpolated position for Nov. 7th in curves representing dates of photography to right. From latter point of intersection follow vertical line to lower margin to find angle from north to be 12°. Since time of photography was 1115 hours, presumably referred to an air base in China at least an hour earlier than sun time in Formosa, it is actually early afternoon in Formosa, hence the shadow is directed to the northeast and the angle of 12° would be plotted counter clockwise from the shadow in the photograph for the direction of north.

GRAPHS FOR DETERMINING ANGLE BETWEEN SHADOW DIRECTION AND NORTH FROM VALUE OF "Y"±"Z" (SINE OF ANGLE OF ELEVATION OF SUN), DIFFERENCE IN LONGITUDE BETWEEN SUN AND LOCALITY, AND DATE OF PHOTOGRAPHY.

OFFICE OF THE A.C./A.S., INTELLIGENCE
WASHINGTON, D.C.

SECTION 11
PLOTTING

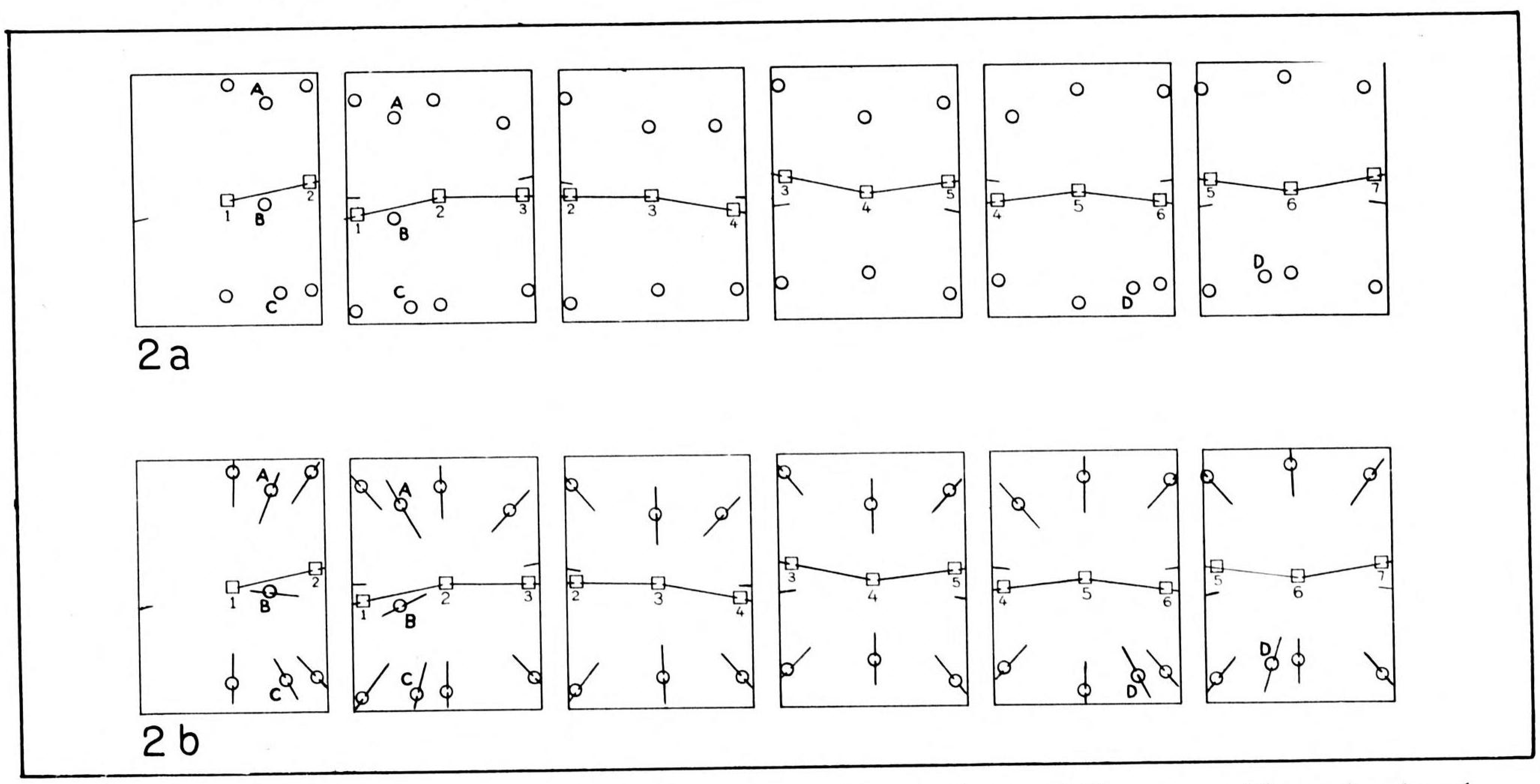
11.01 —— 11.99



Six photographs selected, with control points (A-B-C-D) as located in the field. The control points are transferred to all photographs on which they fall, and are marked with a green circle (about ¼ inch diameter), using green India ink.

1a. Locate the PRINCIPAL POINT on all photographs. Mark them with a small square, using either red pencil or India ink.

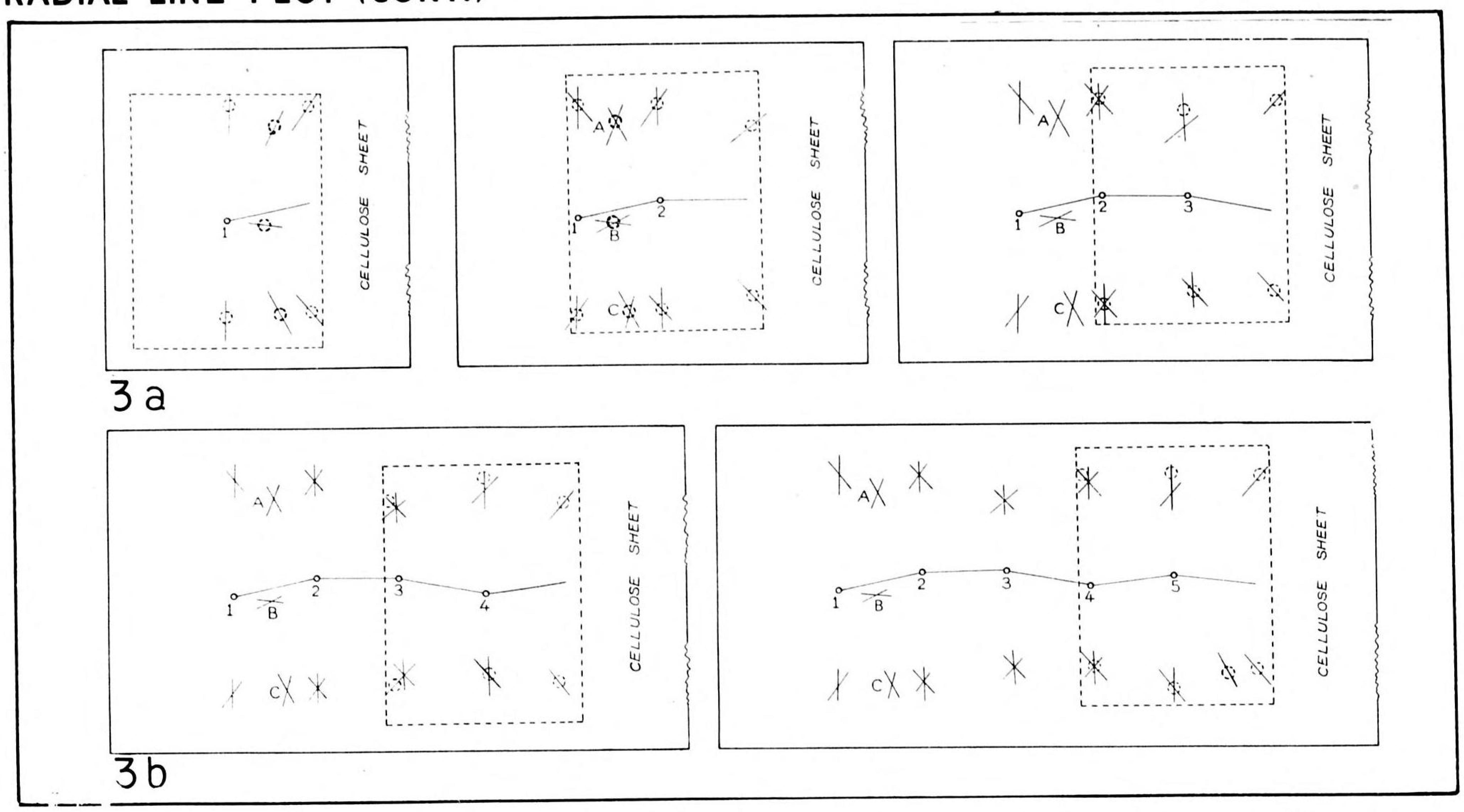
1b. Transfer the principal point to the succeeding and preceding prints, marking them as described in 1a. Draw lines (in blue ink or water color), connecting these points with the principal point of the print itself, and extend through to each side of the print (THE PRINCIPAL BASE).



2a. Select PICTURE CONTROL POINTS, marking them with a small red circle (about ¼ inch diameter), using red India ink.

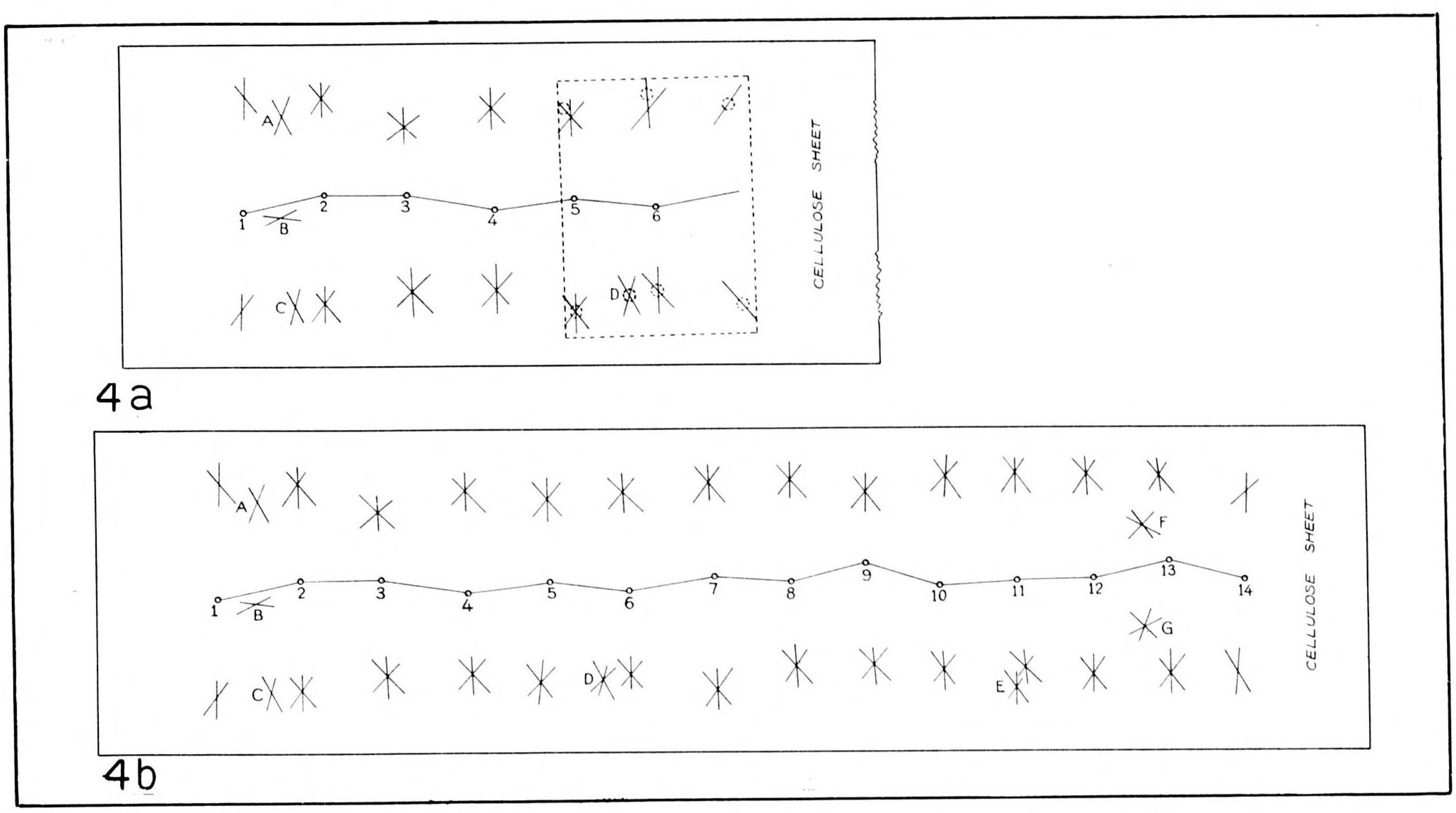
2b. Draw radial lines (in blue India ink, or blue water color) through all control points, from principal point.

RADIAL LINE PLOT (CONT.)



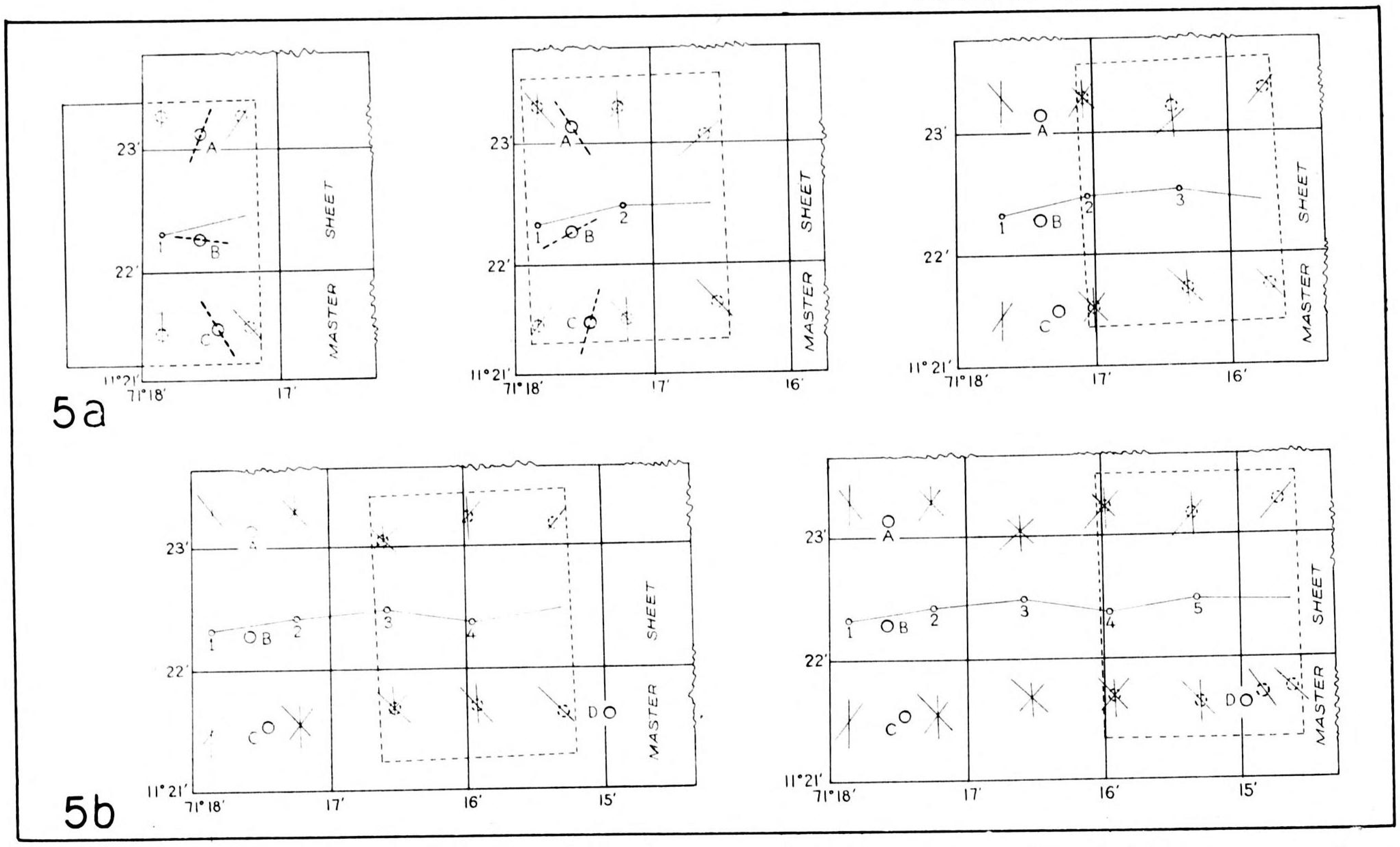
3a. Begin the preliminary radial plot. (All lines shown in 3a, 3b, 4a, 4b, to be drawn on the cellulose sheet in red, using a pencil).

3b. Preliminary radial plot extended.



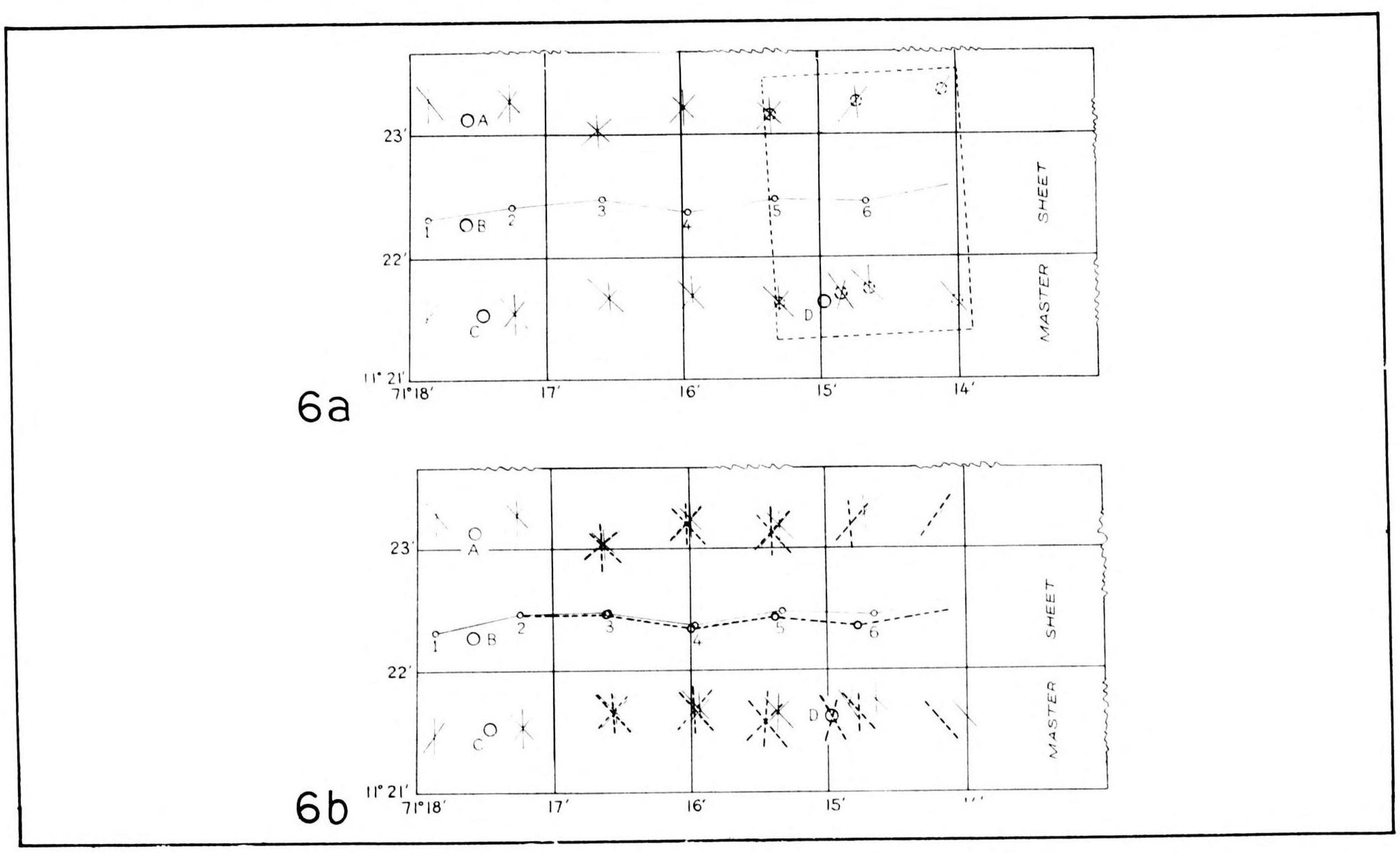
4a. Preliminary radial plot extended.

4b. Preliminary radial plot concluded. Now draw polyconic projection to the average scale of the flight. (The projection lines and the scale to be left in pencil, see Plate 7.) All ground control signals are plotted and marked with a small red circle (about ¼ inch diameter), using red cellulose ink. (This sheet is the MASTER SHEET.)



5a. Start the controlled plot. Extend the picture control between, and adjacent, to the located ground control.

5b. Picture control plot extended.

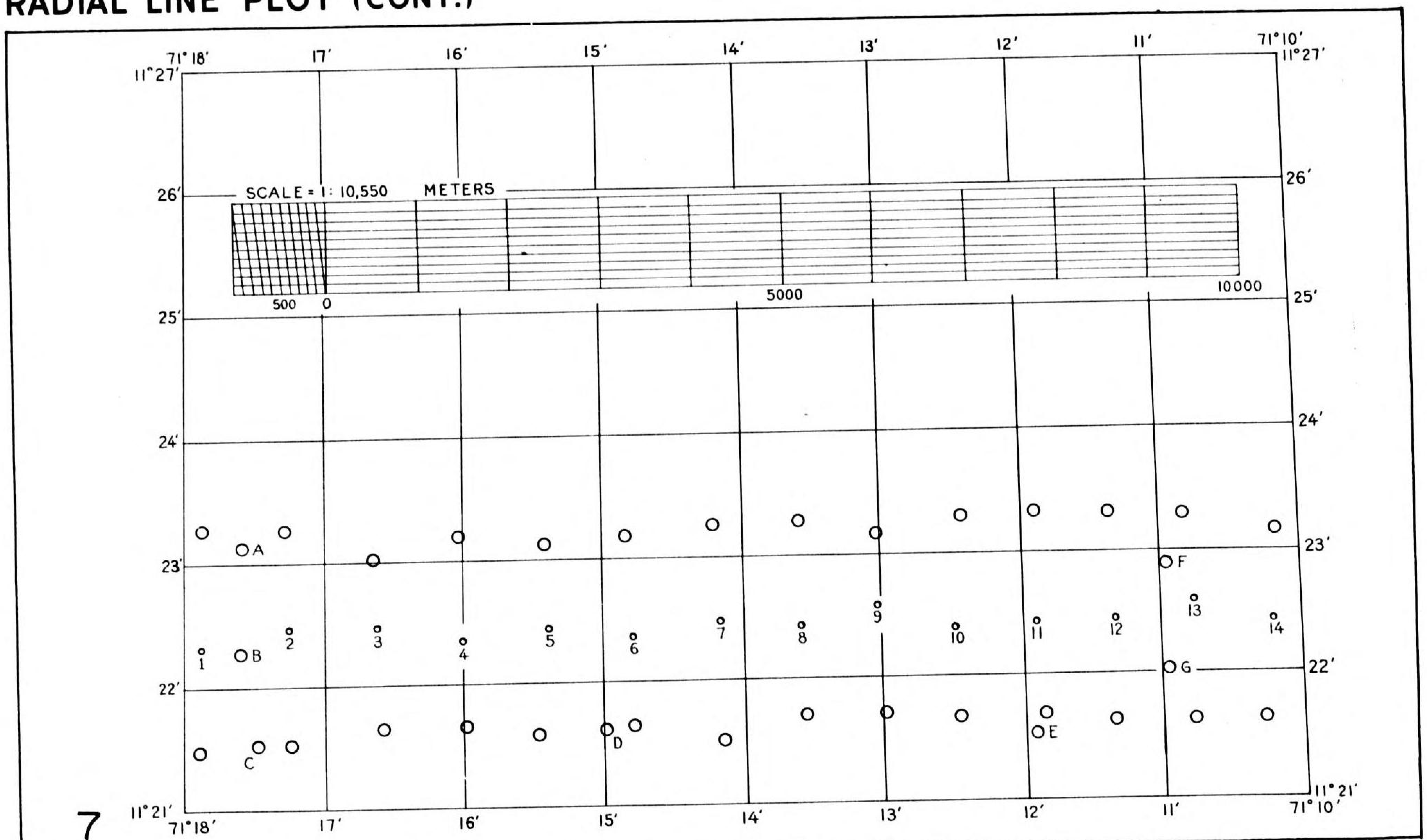


6a. Picture control plot extended to the nearest ground control point. (All lines shown in 5a, 5b, 6a are drawn on the master sheet in red, using a pencil.)

6b. Adjustment of the picture control plot.

PLOTTING

RADIAL LINE PLOT (CONT.)



7. The completed control plot. The radial intersections are marked with a small blue circle (about ¼ inch diameter), using blue cellulose ink, the principal points of all photographs are marked with a small red circle (about 1/16 inch diameter), using red cellulose ink. All points marked on reverse side of master sheet. The projection lines on the master sheet are inked (black cellulose ink) and the scale is inked (red cellulose ink).

TRACING DETAIL FROM PHOTOS TO WORK SHEET

PROCEDURE:

1. Select additional points to control planimetric detail (detail points). Such points may be along shore line, outlying rocks, drainage lines, buildings and other critical points necessary for tracing detail.
2. Transfer these detail points to each succeeding and preceding print. (¼ green circles)
3. Place photo under work sheet and orient it according to center point and intersections of picture control points on work sheet. Then get radial intersection of detail points by same method as picture control intersections were obtained. (¼ green circles)
4. Place each pair of photographs under stereoscope and outline ground detail desired by drawing on photographs.
5. Place photograph under work sheet in its proper orientation.
6. When tracing detail, move detail point of intersection on sheet exactly over the corresponding detail point on the photograph, keeping in line with the principal point. Then trace the detail around this detail point and gradually move the work sheet so that when tracing arrives at the next detail point, the detail point on the work sheet is exactly over the same detail point on the photograph. This movement from point to point, should be from the principal point, in or out, as the case may be.

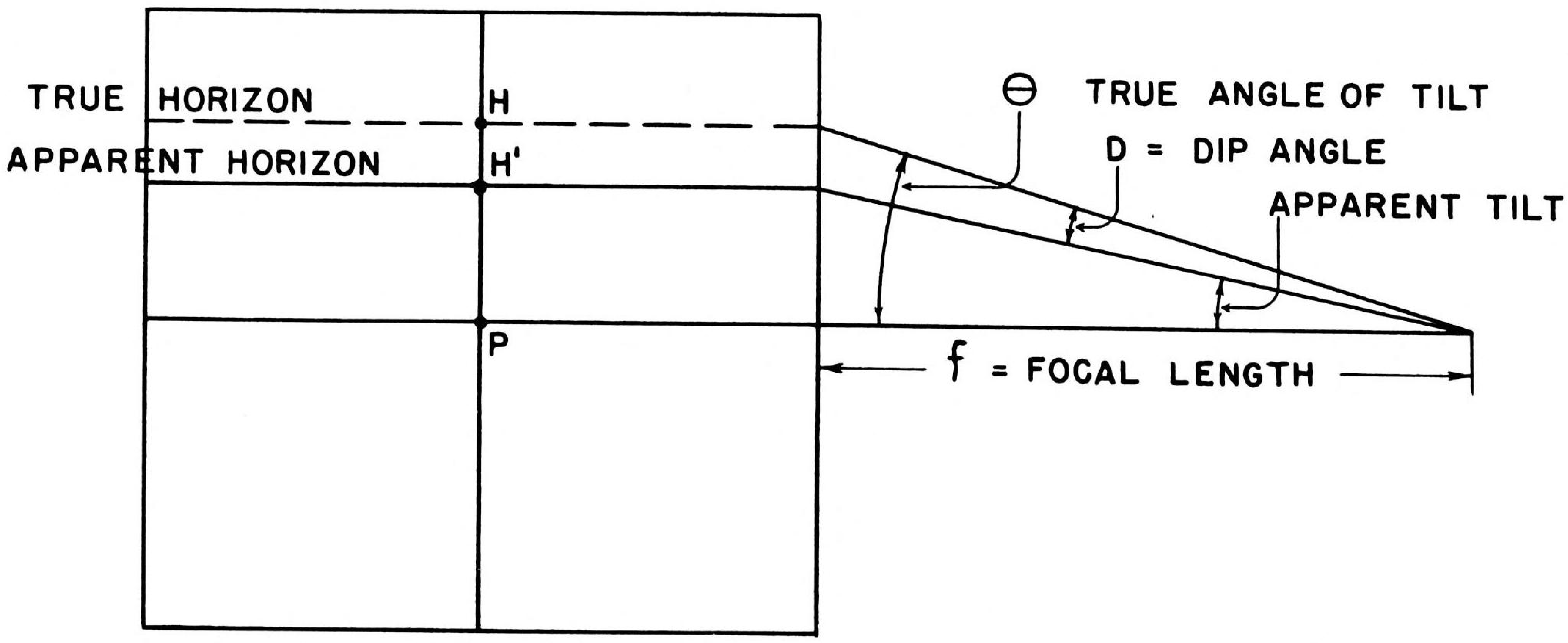
CONSTRUCTION OF CANADIAN GRID

Three conditions are required:

1. Precise focal length
2. Flying height
3. Visible horizon

PROCEDURE:

I Establish true horizon.



P - principal point
A - altitude
Θ - True angle of tilt (+apparent tilt + dip angle)

H1 - Apparent horizon
H - True horizon
D - Dip angle

$$\text{tan of apparent tilt} = \frac{\text{PH1 measured on photo in inches}}{\text{focal length in inches}}$$

Dip angle in minutes = .98 altitude in feet

Distance PH is found from formula

$$PH = f \tan \Theta$$

Line PH is perpendicular to the apparent horizon.

Draw a line thru H parallel to the apparent horizon.

II Erect a construction line AA' parallel to the true horizon thru point G. (Diagram on following page).

$$\text{HG in inches} = \frac{\text{Altitude}}{\cos \Theta} \times \text{Scale}$$

Scale Scale of grid

Example: Scale - 1" on grid = 660' on ground
Altitude - 5,000
Tilt - 30°

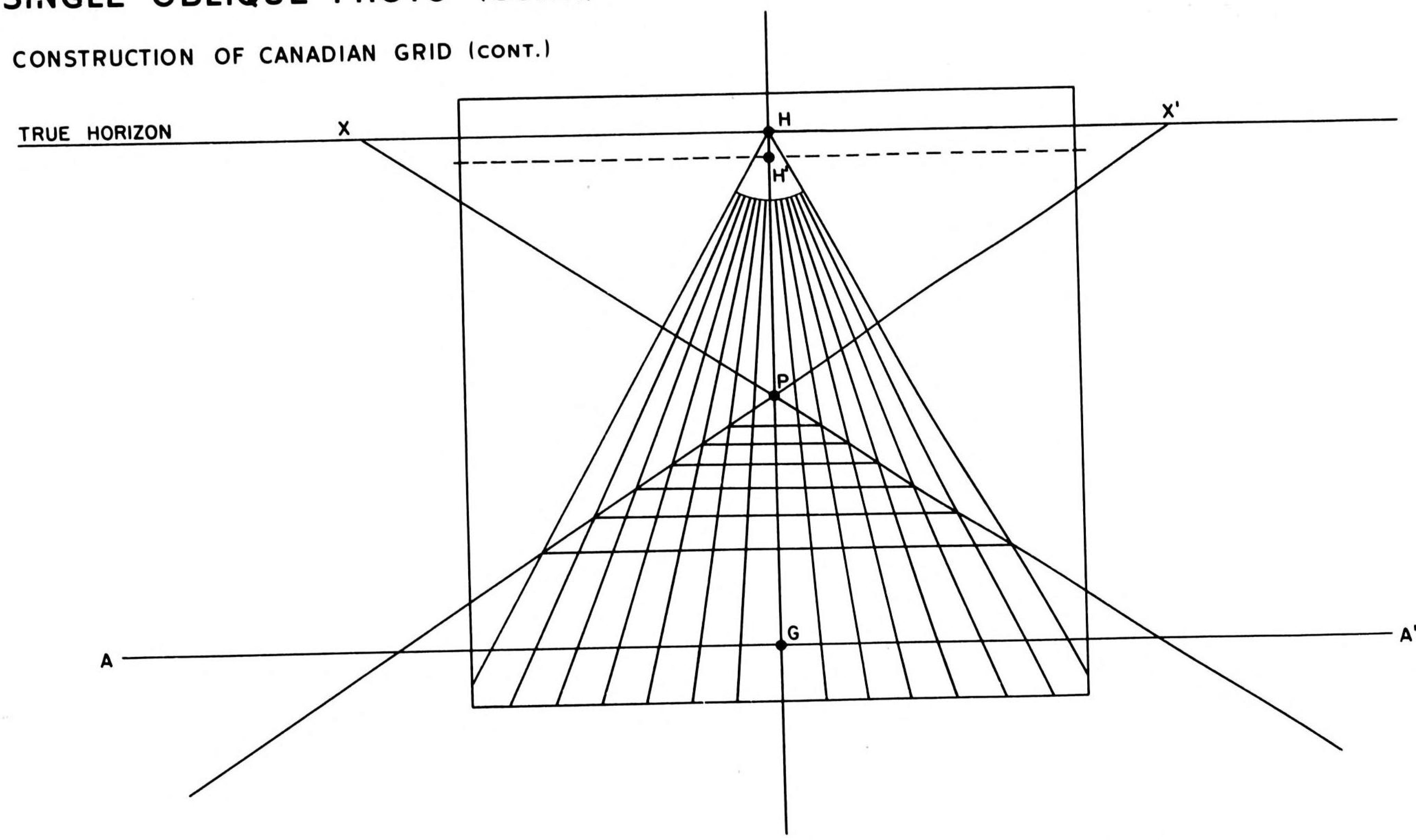
$$HG = \frac{5000}{866} \times \frac{1''}{660'} = 9.99''$$

Point G is plotted along a line thru P. The construction line AA' parallel to the true horizon is drawn thru G.

PLOTTING

SINGLE OBLIQUE PHOTO (CONT.)

CONSTRUCTION OF CANADIAN GRID (CONT.)



III Lay off along AA' equal space units(previously determined as the scale of the grid)originating spaces at point G. Draw meridians connecting these points and point H.

IV The vanishing points for a system of parallel lines that make an angle of 45° on the ground with the meridian lines is located on the true horizon at a distance HX or HX^1 from point H.

$$HX \text{ or } HX^1 = \frac{f}{\cos\theta}$$

Plot X and X^1 and draw lines thru P from X and X^1 cutting across the meridian lines.

V The points where the diagonals cross the meridian lines will give the proper spacing for the horizontal lines.

METHOD OF MAKING BASE MAP FROM AN OBLIQUE

Four conditions are required:

1. Precise focal length
2. Flying heighth
3. Visible horizon
4. Comparatively flat terrain

I Establish true horizon.

θ = Apparent tilt + dip angle
(Same as Canadian grid)

RESTRICTED

SUPPLEMENT NO. 7

PHOTOGRAPHIC INTERPRETATION HANDBOOK — UNITED STATES FORCES

PLOTTING

15 MAY, 1945

PHOTOGRAPHIC INTELLIGENCE CENTER,
DIVISION OF NAVAL INTELLIGENCE, NAVY DEPARTMENT

RESTRICTED

METHOD OF MAKING BASE MAP FROM AN OBLIQUE (CONT.)

II Draw perpendicular (principal line) from true horizon passing through principal point.

III From scale desired on base map HG should be determined (as with Canadian grid) and a construction or ground line drawn through point G parallel to the true horizon.

NOTE:
Procedure involved in first three steps is the same as that for Canadian grid.

IV Determine isocenter:

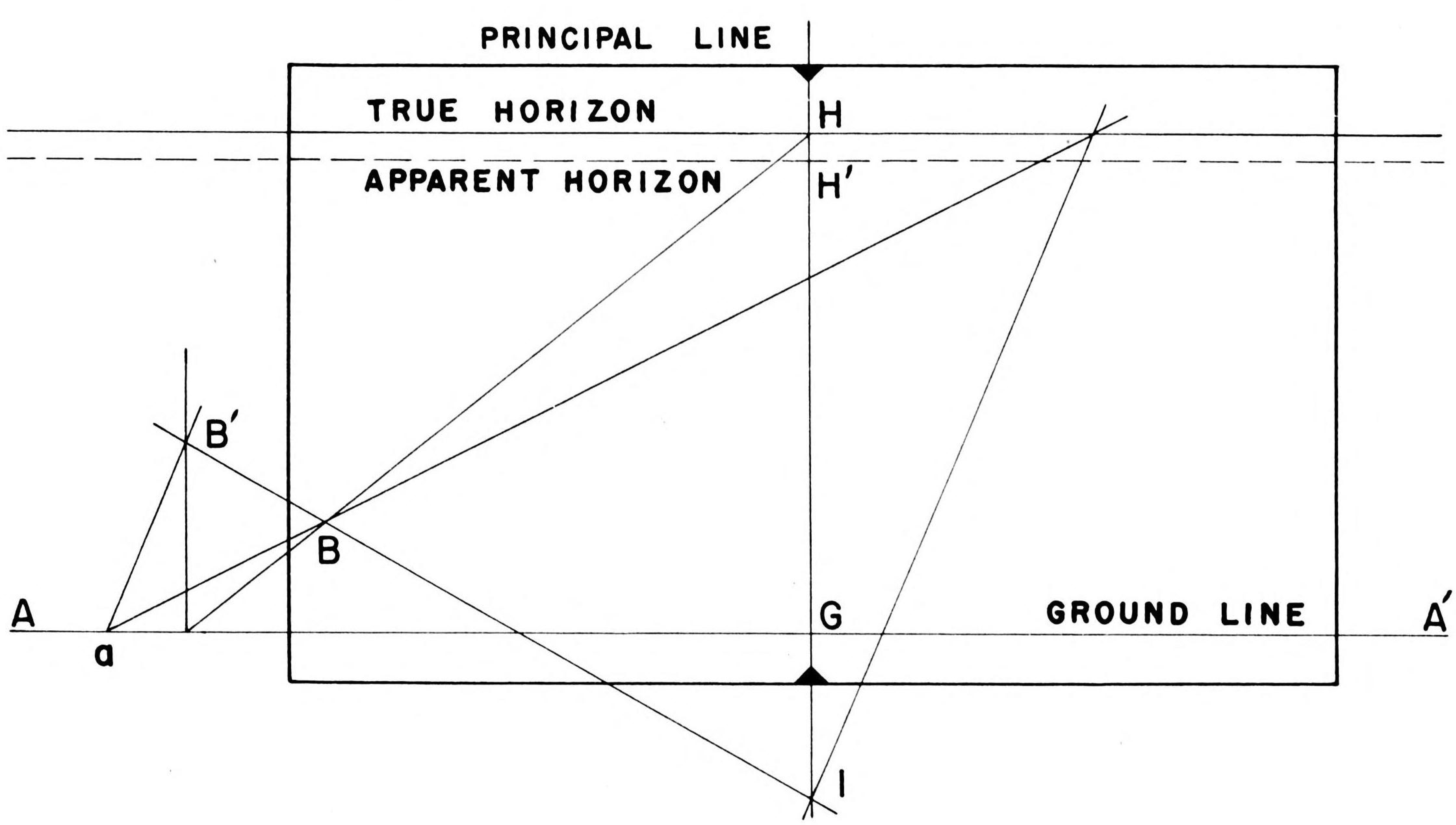
$$\text{Distance HI} = \frac{\text{Focal length in inches}}{\cos \theta}$$

V Draw a ray from the perspective center H through the selected image point B and extend to the ground line AA′. From this intersection with the ground line erect a line parallel to the principal line.

VI From the isocenter draw ray through the image point and extend to intersect the parallel erected in step V. This intersection locates the rectified position of the point in a horizontal plane.

VII To strengthen and check the rectified position draw an arbitrary line from any point 'a' on the ground line through the image point to the horizon. From this intersection with the horizon line draw a line to the isocenter which when paralleled thru point 'a' will intersect the rectified position.

VIII After all selected control points are rectified in this manner detail may be transferred to the base map by inspection or by using a mechanical oblique sketching instrument.



BASE MAP OF IRREGULAR TERRAIN FROM OBLIQUES

Control points at sea level or at approximately equal elevation are located on a base map from a single oblique exactly as described in the foregoing article. Points on uneven terrain are then located as follows using two or more adjacent obliques.

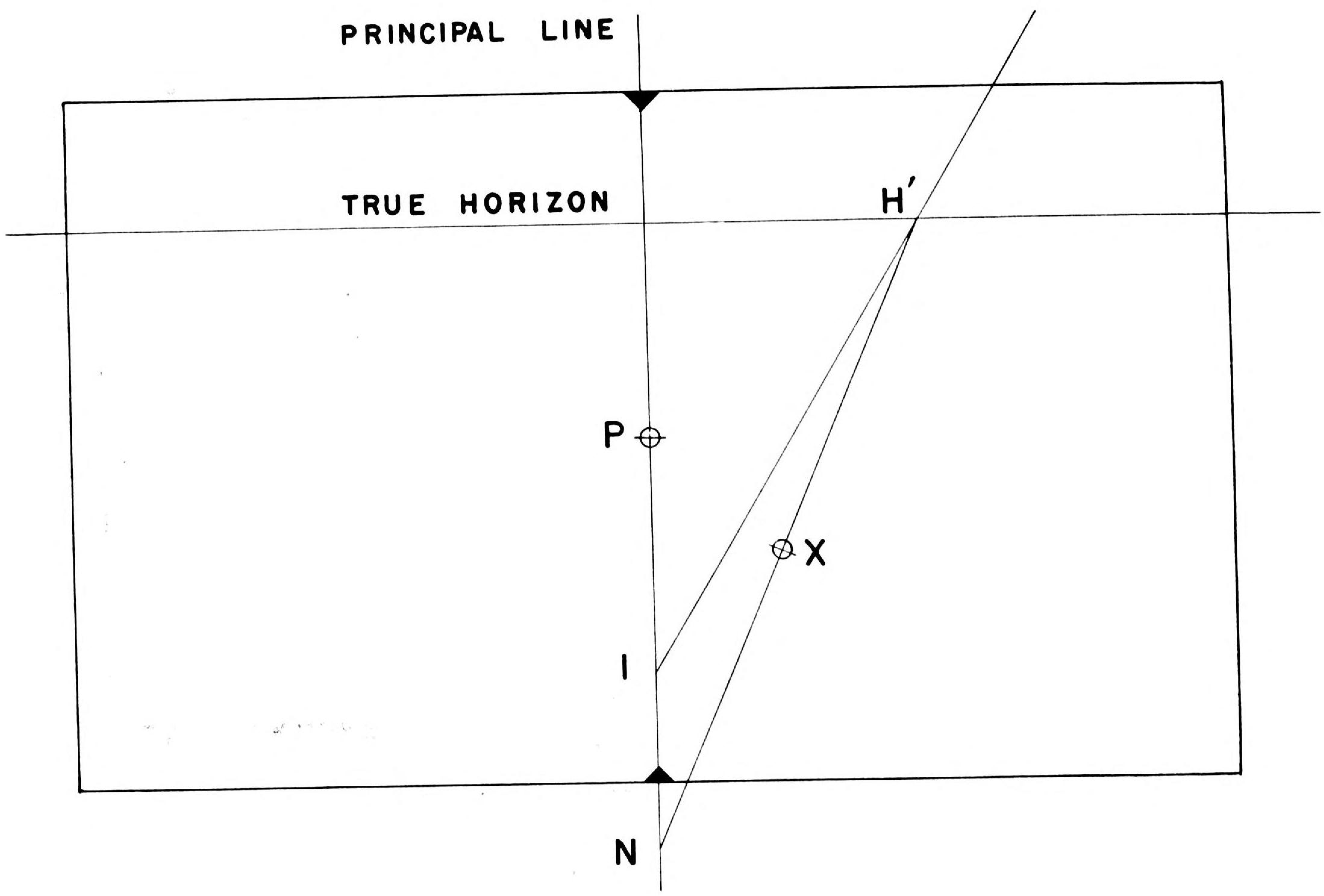
I. Prepare base map as in previous article leaving photo fastened to base map with principal line and true horizon extended beyond photo. It should be noted that points above the datum plane will be displaced outward from their true position.

II. Prepare tracing paper templet of sufficient size to include all points located on base map. Fasten templet over photo and trace the true horizon and the principal line.

III. Locate the Nadir point along the principal line from $PN = \frac{\text{focal length}}{\tan\theta}$ (Where θ is true depression angle).

IV. Referring to the diagram below if the picture plane is rotated to a horizontal plane, the isocenter will coincide with the Nadir point and all rays from I will form true ground angles from the Nadir point. Therefore, any point X appearing in an oblique plane along NH' if rectified into a horizontal plane will fall along IH'. Locate H' for all control points and draw rays from I through H' extending beyond the horizon line.

V. A similar templet should be prepared for at least one adjacent photo (preferably two or more) for all points which can be transferred between photos.



BASE MAP OF IRREGULAR TERRAIN FROM OBLIQUES

VI. Secure the planimetric base map over a light table and superimpose the templet from the corresponding photo so that templet rays of all sea level or level terrain points pass through corresponding points on base map. (Principal lines will coincide; isocenters will not coincide if scale of base map was not established along isoline).

VII. Secure templet to table and superimpose second templet so that level terrain rays pass through corresponding map positions as before.

VIII. The intersection of corresponding rays will define the true position of points not at sea level or the datum plane used for the original base map. If additional adjacent obliques are available any number of templets may be superimposed in this manner.

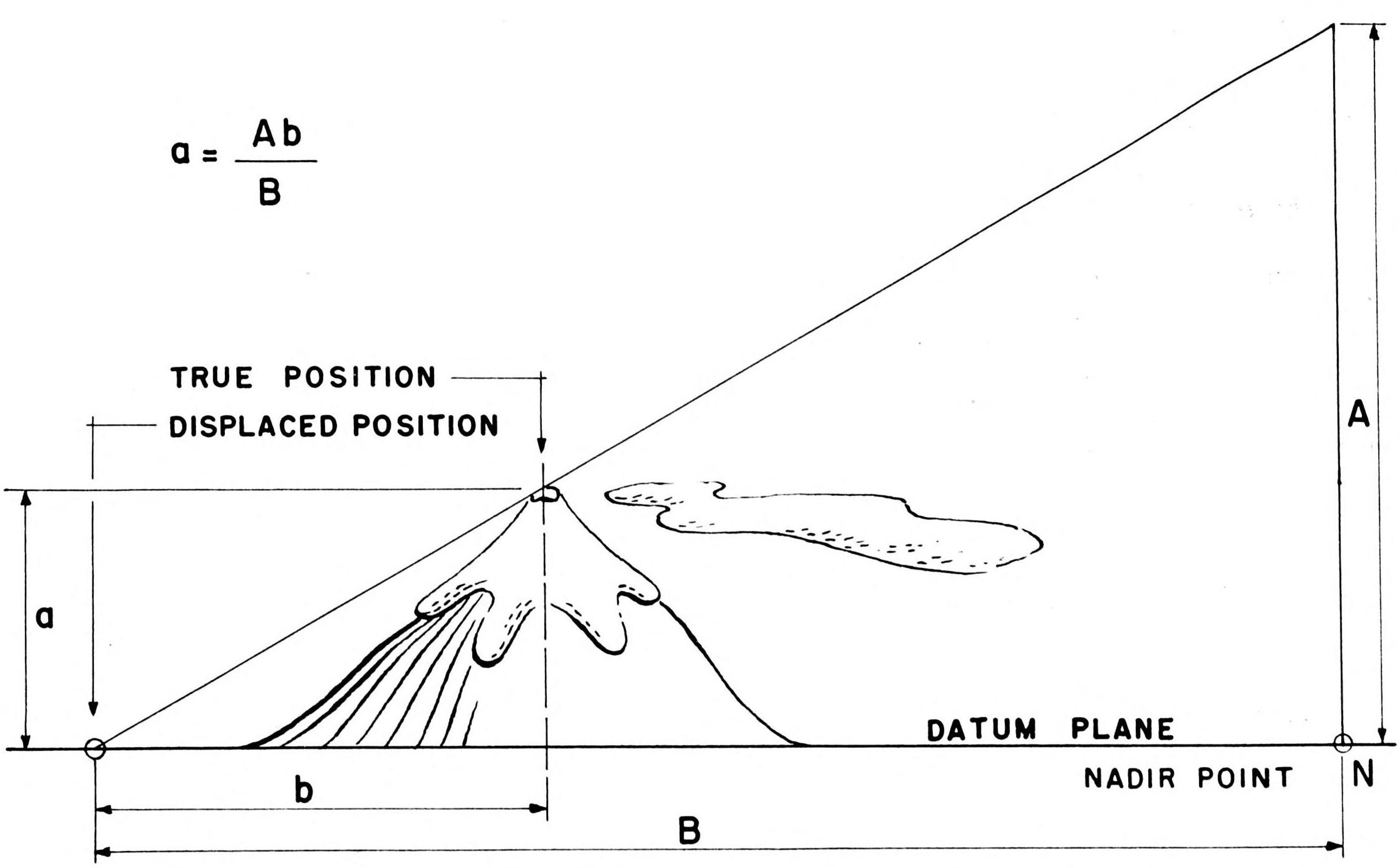
IX. Elevations of points above the selected datum plane on the base map may be solved as follows:

a = Elevation of hill in ft. A = Altitude in ft.
b = Distance in inches point is moved to corrected position.
B = Distance from N on base map to displaced position in inches.

NOTE:

Nadir point N is located on the base map by pricking through the isocenter of the first templet after it is secured over the map.

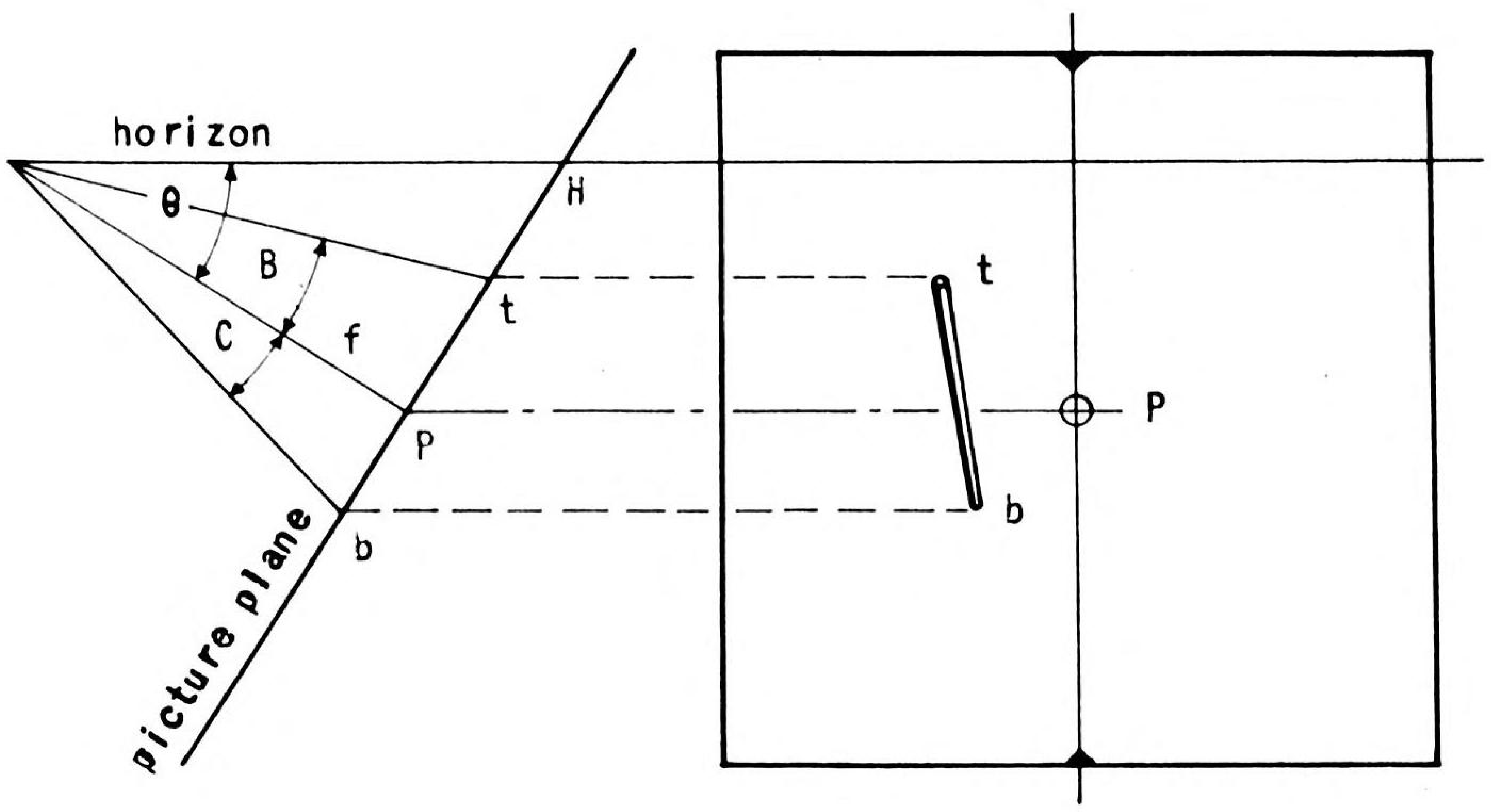
$$a = \frac{Ab}{B}$$



PLOTTING
ELEVATIONS FROM OBLIQUES — TRI-METROGON

ELEVATIONS FROM SINGLE OBLIQUES

(Vertical objects with visible base, e.g. smoke stacks, buildings etc.)



A = Altitude of plane

h = Height of object

f = Focal length

t = Top of object

b = Bottom of object

P = Principal point

θ = True depression angle

$\tan \theta = \frac{PH}{f}$ $\tan B = \frac{Pt}{f}$ $\tan C = \frac{bP}{f}$

When:

Top and bottom straddle P: $h = A \frac{\tan(90-\theta+B) - \tan(90-\theta-C)}{\tan(90-\theta+B)}$

Top and bottom below P: $h = A \frac{\tan(90-\theta-B) - \tan(90-\theta-C)}{\tan(90-\theta-B)}$

Top and bottom above P: $h = A \frac{\tan(90-\theta+B) - \tan(90-\theta+C)}{\tan(90-\theta+B)}$

TRI-METROGON PHOTOGRAPHY & MAPPING

In tri-metrogon photography an assembly of three cameras is used. One camera is directed vertically downward and two are mounted at an angle of 30° from horizontal and perpendicular to the line of flight. The two oblique cameras are so placed that they photograph both the horizon and a small area covered by the vertical camera. All cameras are exposed simultaneously, so that the area from horizon to horizon, perpendicular to the line of flight, is covered by three photographs.

For mapping large areas at a small scale (1:1,000,000 to 1:250,000) tri-metrogon photography has the following advantages:

1. The distance between flight lines can be much greater than in single lens photography (about 25 miles apart at 20,000 feet.)

2. Flight lines need not be flown as accurately as in single lens photography.

3. Less ground control needed.

4. More economical for mapping large areas (less film, fewer flying hours).

SECTION 12
INDUSTRY

12.01 — 12.99

CONFIDENTIAL

SUPPLEMENT NO. 6

PHOTOGRAPHIC INTERPRETATION HANDBOOK — UNITED STATES FORCES

THE COKE, IRON & STEEL INDUSTRY

15 MAY, 1945

PHOTOGRAPHIC INTELLIGENCE CENTER,
DIVISION OF NAVAL INTELLIGENCE, NAVY DEPARTMENT

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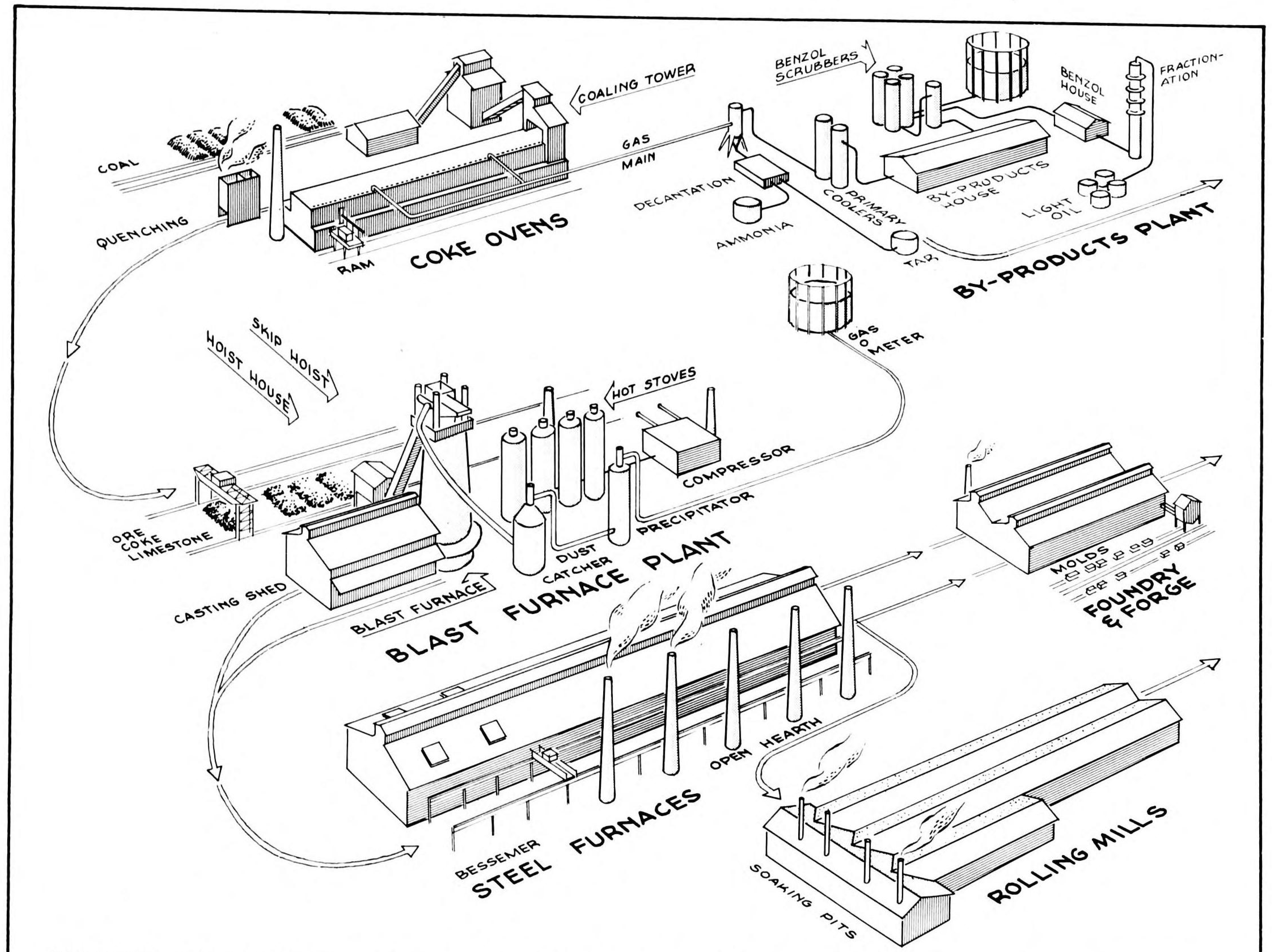
The following sources, used in compiling this digest, should be consulted for more detailed information:

(1) THE COKE, IRON AND STEEL INDUSTRIES, Photo Industrial Study No. 3, prepared by AC/AS Intelligence, USAAF, and P.I.C., Division of Naval Intelligence, Navy Department. September 1944.

(2) THE COKE, IRON AND STEEL INDUSTRY an Air Target System Folder prepared by the Joint Target Group, Washington, D.C. 5 February 1945.

(3) FUNCTIONAL ANALYSIS REPORTS Nos. F/A 8, 9, 19, 20, 30, 46, 47, 49 and 60, prepared by AC/AS Intelligence, USAAF.

THE COKE, IRON AND STEEL INDUSTRY



FLOW DIAGRAM OF THE COKE, IRON AND STEEL INDUSTRY

Present Japanese steel production is at the rate of 5,000,000 tons annually, compared with U.S. production of 65,000,000 tons. In 1944, 24% of the Jap total was allocated to naval construction, ordnance and repair, 16% to the Army, 9% to the Air Force, 11% to general military use (fuel drums, fortifications, etc.) and 40% to indirect military use (merchant vessels, railroad, etc.)

The inadequacy of this production has resulted in suspension of production of mountain guns, tanks and other non-priority ordnance, and in a 57% decrease in steel for ammunition.

The present stringency in steel exists because:

1. The best coal and iron ore are found on the Asiatic Mainland.
2. 84% of steel ingot production capacity is on Japan Proper, and
3. Shipping cannot be allocated to carry the raw materials or pig iron to Japan.

Because of existing stockpiles and the rate at which present construction and steel use progresses, further reduction in steel production caused by our bombing will be felt in the overall military situation after a 6 to 12 months' time lag. Moreover, the wars progress should continually present new problems and additional uses for steel:

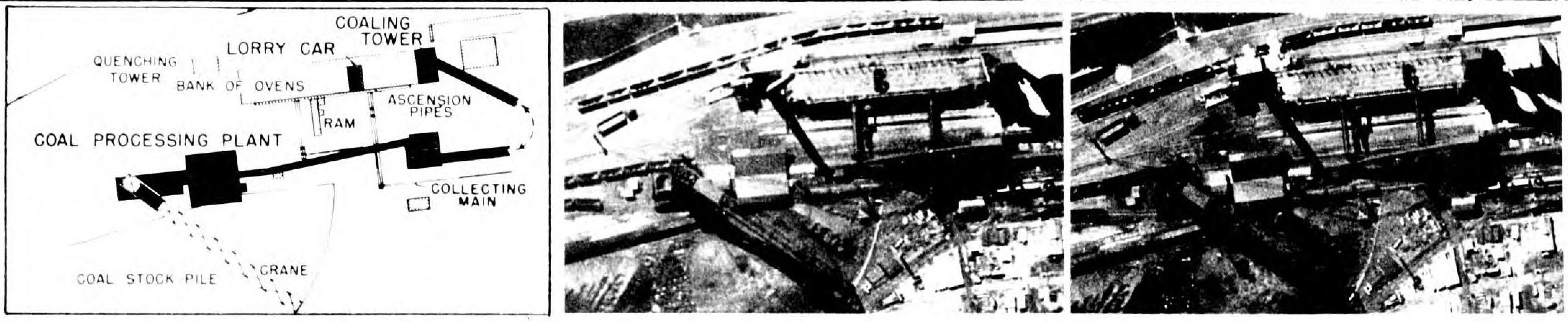
1. Loss of oil import will necessitate construction of synthetic oil plants.
2. Aluminum shale plants must be constructed to replace loss of bauxite imports.
3. Coal and ore in Japan proper must be increasingly exploited.
4. The need for anti-invasion defenses on Japan proper grows greater.

"Thus an attack on steel is essentially insurance against a long war".

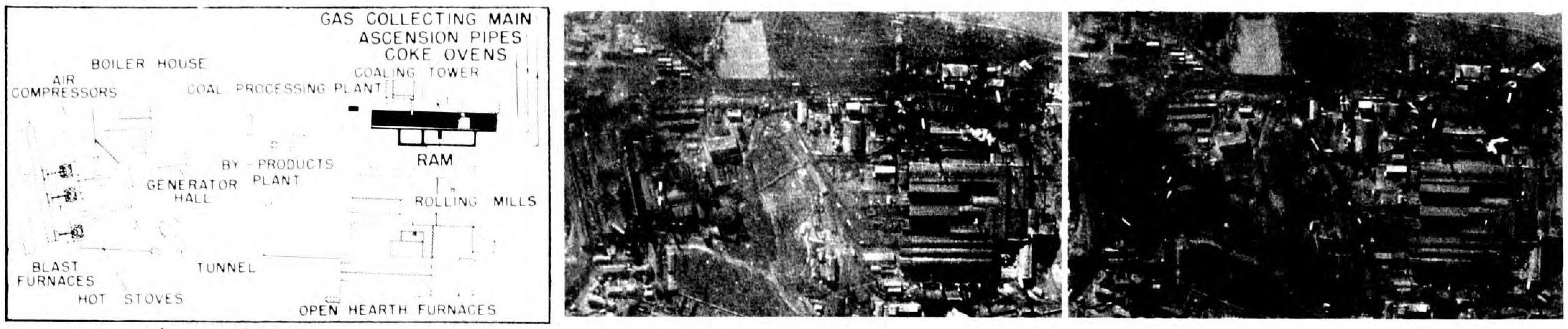
ANALYSIS OF THE COKE, IRON AND STEEL INDUSTRY

INDUSTRIAL PROCESS	CHARACTERISTIC BUILDING	POSSIBLE VARIATIONS
Coal is moved from storage yard by conveyors to coal processing plant, thence to coaling towers, and from coaling towers is distributed by lorry car to coke ovens.	Coal processing plant consists of one or more sheds located between the storage yard and the coaling tower. Coaling tower straddles battery of ovens, and loads coal into lorry car.	Coke oven battery may contain 25 to 60 ovens. Single oven averages 3–6′ wide, 37′ to 43′ long.
Coke ovens are heated by fuel and blast furnace gases. Baked coal, or coke, releases gas which is processed in the by-products plant When withdrawn from oven, coke is ignited on contact with air, and must be quenched with water to prevent complete burning.	An ascension pipe projecting upward from each oven carries coal gas to collecting main. Coke is pushed out of oven by a ram, into car which takes it to quenching tower.	Older beehive ovens are simpler; batteries are narrower, and have no gas collecting equipment.
Coke, ore, and limestone are conveyed to blast furnace, into which they are charged at top in alternate layers. Furnace operates continuously, receiving raw materials at top, molten ore and slag drawn off at bottom. Operation of furnace is about 3 or 4 years, until complete repairs become necessary.	Ore and limestone stockpiles are usually located near furnaces. Skip hoists convey materials to furnace top. In hoist house are indicators showing interior conditions of furnace.	Skip hoist may be inclined or vertical. Hoist house may be located beneath hoist, at side, on platform, or at top of vertical hoist. Electrically heated blast furnaces, said to be used in Japan, use only 1/3 normal coke wt.
Burning of coke in furnaces, accelerated by blast of preheated air from the hot stoves, melts the charge, releasing combustible gas and reducing the ore. Gas is carried to dust catchers and precipitators to be cleaned, sent on to hot stoves to heat air blast, or to coke ovens.	Hot stoves heat the air received under pressure from compressors. Compressor or blower house is located near hot stoves and powerhouse. Its air intake pipe should be visible. Gas cleaning devices, situated next to blast furnace, are characterized by large gas mains seen entering and leaving.	Four hot stoves usual for each furnace. Three said to be normal for Asia. Each set of stoves may have a stack, or each stove a stack. Blower-house air intake pipe may be horizontal or vertical. If vertical, will probably be square in plan.
Molten iron is drawn off at the bottom of furnace. Slag, which floats on the molten liquid is drawn off slightly above and usually on the opposite side.	In casting shed, located at base of blast furnace, molten iron is tapped into a ladle. Slag is tapped into smaller ladles and conveyed to a large dump.	Iron ladles may be open or closed. If closed, they carry large amounts of iron held to relatively constant temperature.
Molten iron may be cast, forming pigs, or if steel plant is adjacent, conveyed molten to the mixer. Iron is kept molten in mixer until used in steel furnaces.	Pig casting buildings will be near the blast furnaces and are characterized by the moving mold belt, usually seen in open. The mixer is a huge ladle with a capacity of 150 to 1,300 tons of metal.	Mixer may be located in a separate building between the blast and steel furnaces, or may be in the steel furnace building.

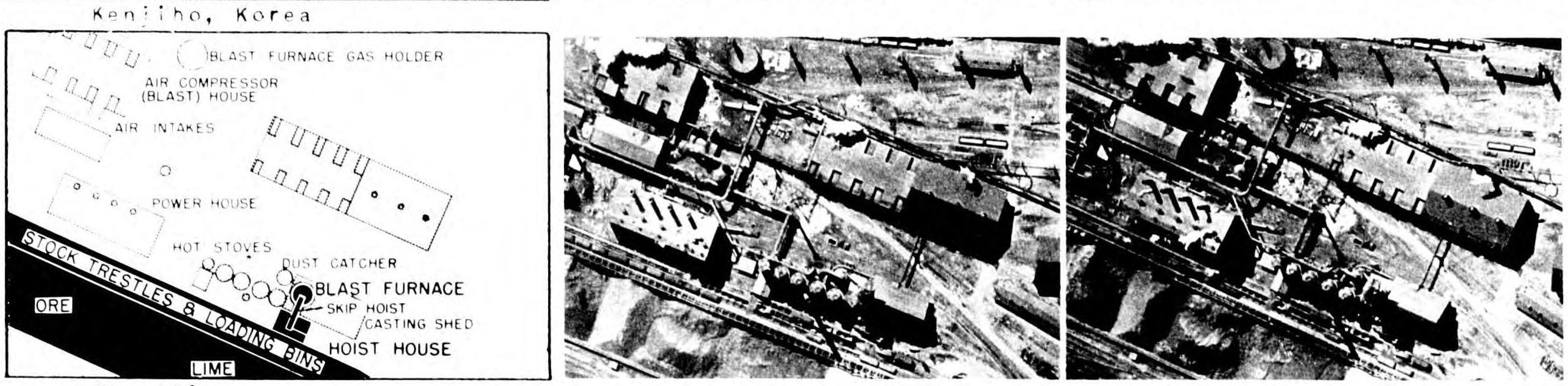
ANALYSIS OF THE COKE, IRON AND STEEL INDUSTRY



Domestic



Kenjiho, Korea



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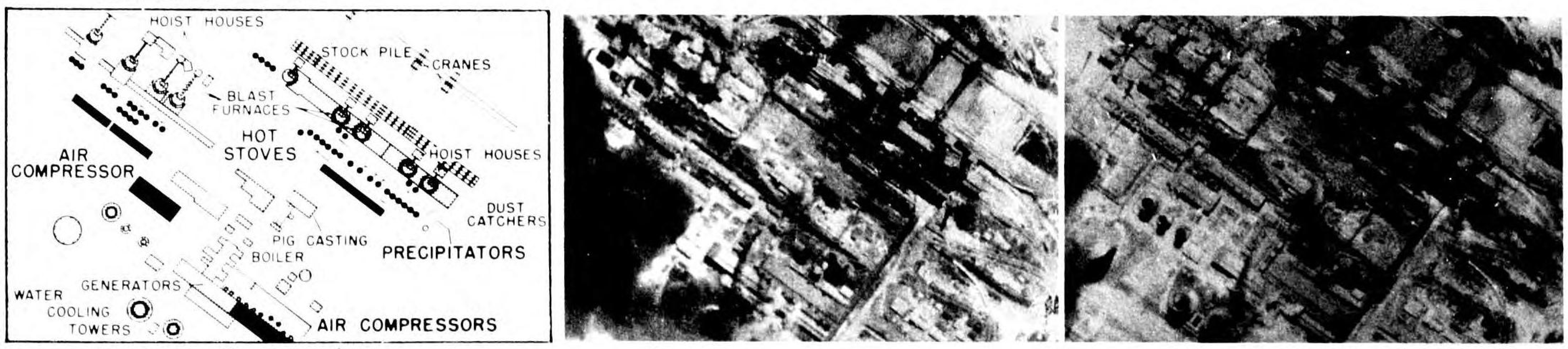
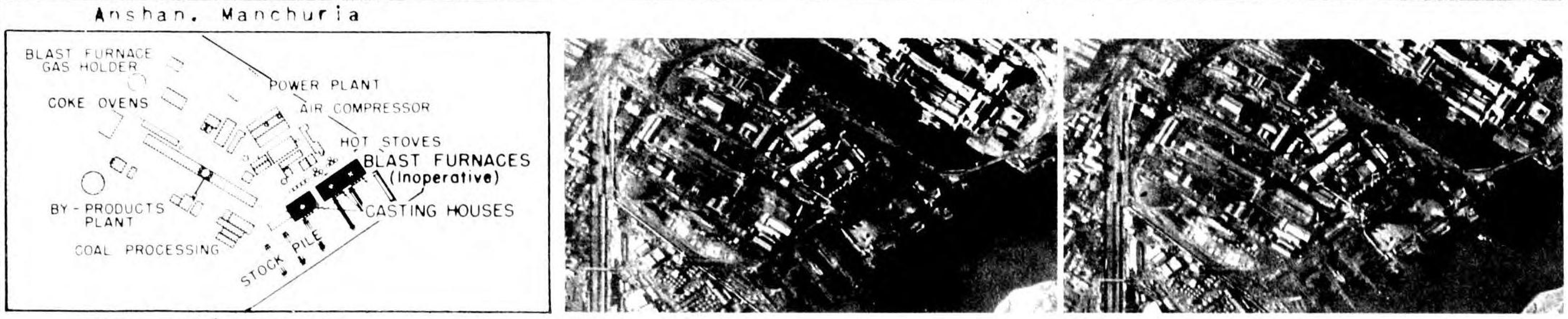
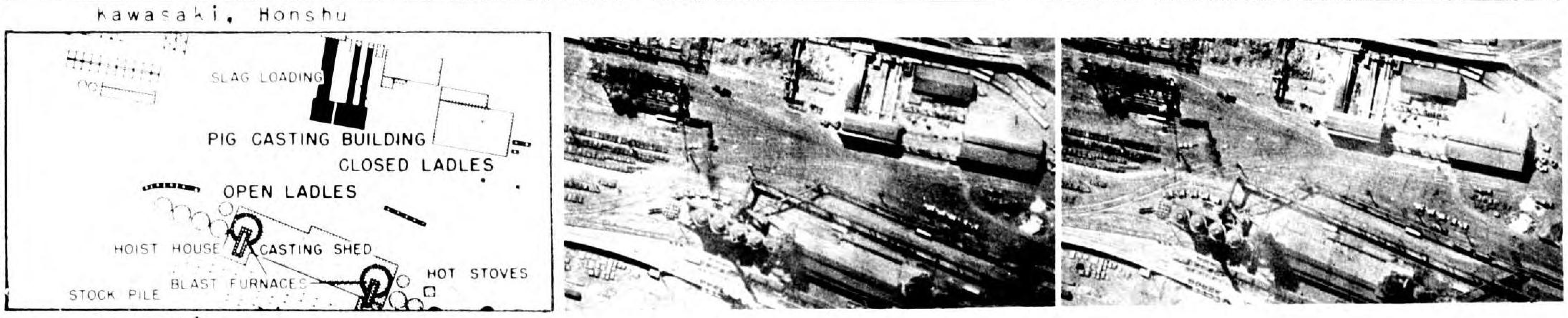


Anshan, Manchuria



Kawasaki, Honshu

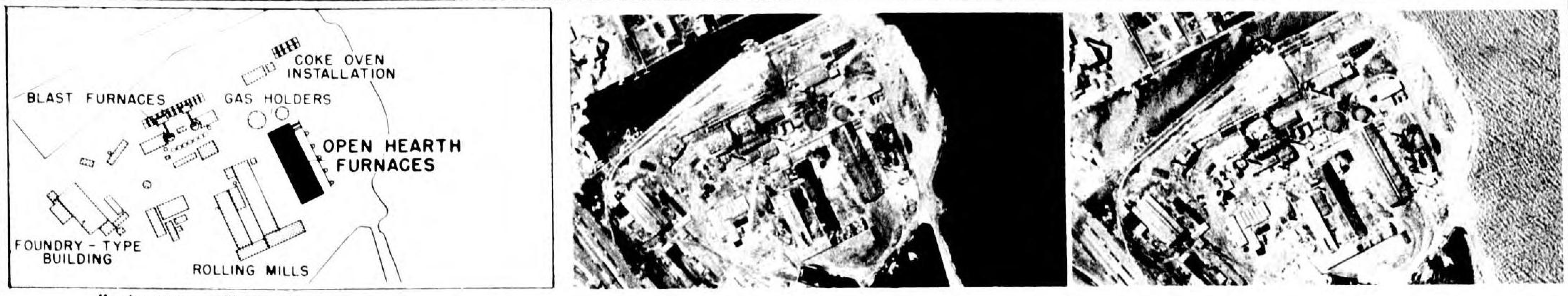


Domestic

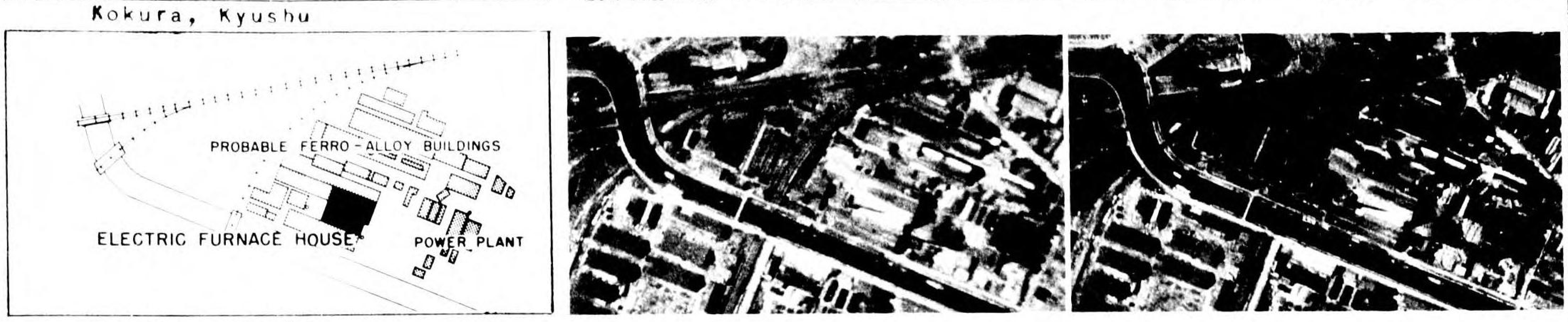
ANALYSIS OF THE COKE, IRON AND STEEL INDUSTRY

INDUSTRIAL PROCESS	CHARACTERISTIC BUILDING	POSSIBLE VARIATIONS
To molten iron are added scrap, limestone flux and heat, resulting in the production of steel. Addition of other metals produces alloys. By the open-hearth process the molten iron and added materials (the charge), are subjected to a preheated mixture of air and gas which ignites at high temperature in the presence of the charge.	Steel plants are frequently located near blast furnaces. In the open-hearth process, hearths are arranged in a row under a single long roof; each hearth has a tall stack.	In Japan at present, operating steel plants may be seen next to closed-down blast furnaces, while on the Asiatic Mainland the situation may be reversed. Stacks may be at edge of building, or may be in a row a few feet from the building.
By the electric process, heat is generated by (1) an electric arc created in the charge, or (2) by induction of a high frequency current in the charge.	Electric furnaces can be in any shed-type structure, and will have no stacks. Transformers will be present.	Transformers can be next to electric furnace building, or may be within the building.
By the Bessemer Process, air under pressure is forced through the charge, combustion of which materially raises the temperature.	Bessemer converters are open-topped cylinders; compressed air enters through jets in the bottom, blowing column of smoke and flame. Roofs of buildings will have open sections to accommodate flame.	Since a large percentage of Bessemer Steel is used to prime open hearth furnaces, converters may be located in or near open hearth building.
Steel is cast into ingots in the furnace building, and then, if to be rolled, transported to soaking pits. Here the ingot is brought to a uniform consistency and temperature.	Soaking pit buildings show a row of stacks on roof, are usually located at the steel furnace end of the rolling mill.	Stacks are smaller and closer together than Open-hearth stacks, building may be at right angles to and connected with rolling mill, or may be a short distance away.
The steel ingot is shaped either by rolling in a mill, hammering or pressing in a forge, or the molten metal may be cast in a foundry. If rolled, ingots are passed through successive pairs of rollers until the desired shape has been imparted to the steel.	Rolling mills are usually near steel furnaces, have a soaking pit at one end, and are long in plan. Roof shows no stack. Smaller finishing mills are usually found in connection. Railroad loading sheds and rail connections may be seen.	Many combinations in arrangement of the many types of mill buildings and their soaking pits will be seen.
The forges themselves are the furnaces in which the steel is heated preparatory to being worked. Presses and hammers are powered by steam or electricity. In the foundry, metal is received molten or is melted in a small blast or cupola furnace found in the building. Steel is then poured into sand molds to be formed.	Forge and foundry buildings are taller and more square in plan than mill buildings; vents and stacks are seen in the roof. Lumber, molds and sand reclaiming devices may be seen near the foundry.	In foundry work, preparation of molds, heat treatment and finishing may take place in separate buildings. Conveyors, hoppers and/or elevators are characteristic of sand reclaiming installations.

ANALYSIS OF THE COKE, IRON AND STEEL INDUSTRY



Kokura, Kyushu

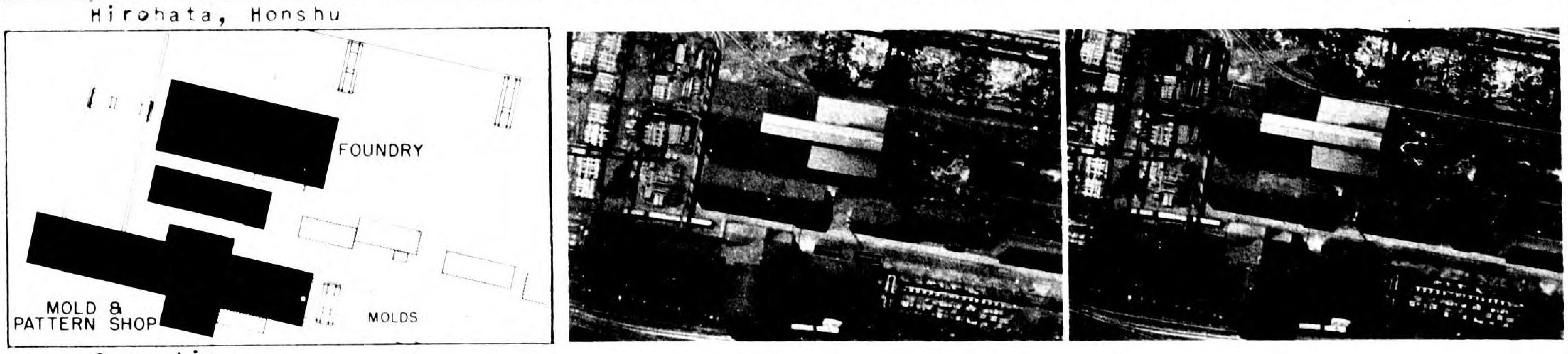


Nagoya, Honshu

Yawata, Kyushu

Kobe, Honshu

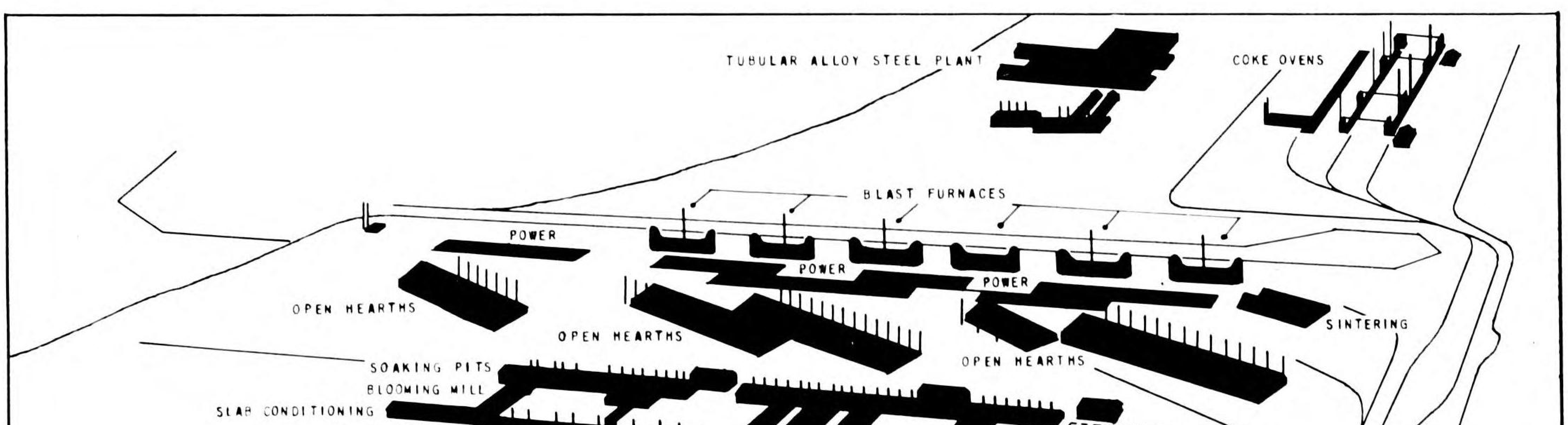
Hirohata, Honshu



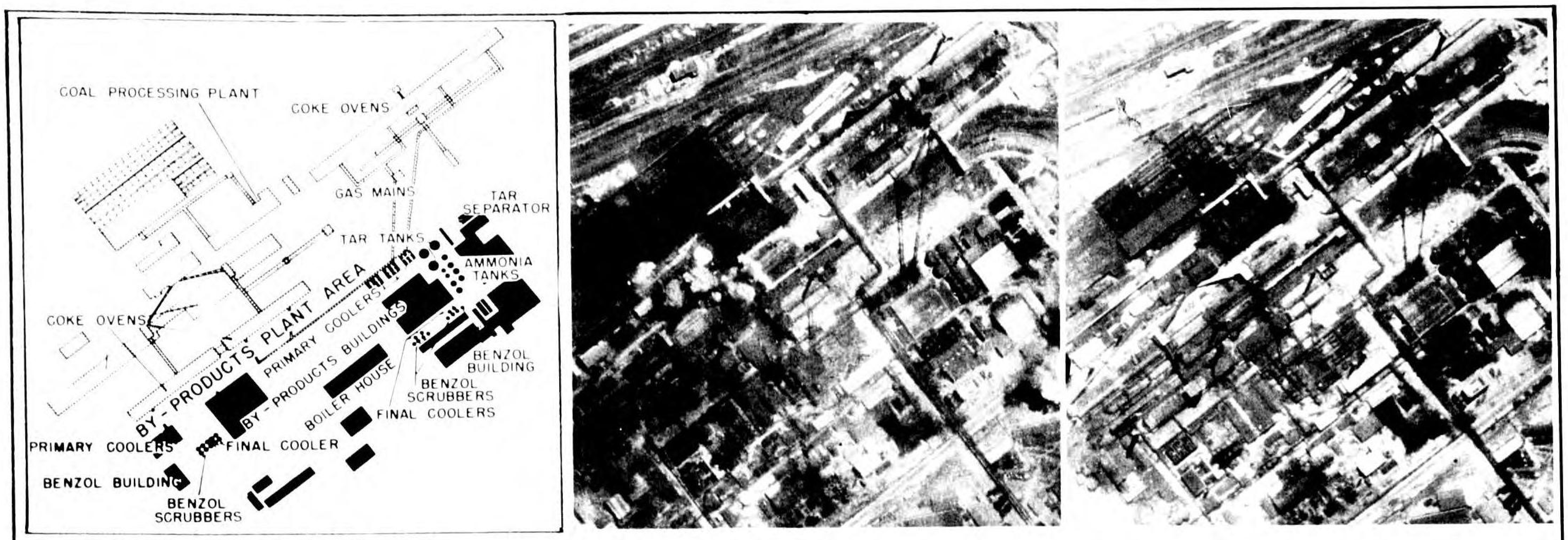
Domestic

ANALYSIS OF THE COKE, IRON AND STEEL INDUSTRY

INDUSTRIAL PROCESS	CHARACTERISTIC BUILDING	POSSIBLE VARIATIONS
BY-PRODUCTS PLANT—At the by-products plant the gas and tar recovered from the coke ovens are subjected to separatory processes (decantation, scrubbing, and distillation). Separation is only carried out to the point where are recovered: 1. Combustible gas to be used as fuel at the blast furnaces and coke ovens. 2. Specific raw materials for use at chemical processing plants.	The by-products plant is near the coke ovens, and connected with them by gas mains. These units should be seen in processual sequence: 1. Primary coolers (large gas mains enter, small pipes exit). 2. Tar separator (decantation) tanks. 3. By-products house, controls circulation of gas and tar. 4. Benzol scrubbers. 5. Fractionization. Tower for destructive distilation of light oils. 6. Gasometer.	1. Primary coolers can be cylindrical or rectangular. 2. Decantation tanks usually rectangular, squat. Mechanical or electrical tar-separators, if present will appear as small building with 15′ x 30′ high cylinders standing on roof. 3. Usually first bldg. after gas leaves primary coolers, is vital to operation of by-products plant. 4. Bank of 2 to 4 tall cylinders, 1 pipe leads to gasometer, second carries benzol to benzol bldg. 5. Fractionization tower may be in benzol bldg. or near it.
WATER SUPPLY—Millions of gallons of water are used each day for cooling (7,000,000 gallons to cool each blast furnace), quenching, for boilers, fire protection, etc. STEAM—Steam may be used. 1. To drive air blast compressors, and by-products plant exhausters and pumps. 2. To heat steam-jacketed mains and tanks, and by-products distillation tower. 3. To drive generators. (see below)	The pump house is usually a small building of no characteristic design. When the natural water supply is inadequate, water-cooling towers, pools and additional pumps will be seen. Boiler house is rectangular, high building with number of stacks.	If water supply is lake, river or reservoir, pump house is usually on the shore. If water supply is distant, scar of cross-country pipeline will lead to pump house. If coal is used for fuel, coal handling equipment, conveyors etc. will be seen. However, coke oven or blast furnaces gases, or oil can be used to heat boilers.
POWER—Electricity generators at the plants are usually driven by steam turbines. In Japan most plants also receive electricity from outside sources.	Power house consists of the boiler house, generator hall and electrical gallery or control room. As steam has many uses, the presence of a boiler house does not necessarily indicate presence of a power house.	These units may be seen as one building, or may be in separate bldgs. If in one building, will have a characteristic stepped appearance, boiler house being the tallest unit. Large power house boilers are usually heated by coal.



ANALYSIS OF THE COKE, IRON AND STEEL INDUSTRY



Anshan, Manchuria

Penhsihu, Manchuria

Hirohata, Honshu

Domestic

ANALYSIS OF THE COKE, IRON AND STEEL INDUSTRY

VULNERABILITY

Because of the great heat generated within many of the installations in the course of their normal operation, air attack will cause not only direct but also indirect damage to coke, iron and steel plants. Crater and shock action will cause direct damage to those objectives which are hit. Should this direct damage result in sudden reduction or cessation of the plant's water supply, electrical power, or fuel gas distribution, those installations depending on these sources to control and maintain working temperature will be damaged by excessive heat or uncontrolled cooling.

Maximum damage to the iron and steel industry will be caused by stopping the production of pig iron at the blast furnace plant. While the blast furnaces themselves make small targets and are difficult to damage except by a direct hit, they are highly vulnerable to indirect damage. If the air blast is stopped the charge will freeze in the furnace, requiring much labor over a long period to chip it loose. If the water supply is interrupted the uncontrolled heat will burn out the blast furnace lining and cause other damage. However, hot-stoves and gas-cleaning equipment are easily repaired.

Coke ovens are the most vulnerable installations. Carefully constructed of silica refractory brick, oven walls can be easily misaligned, rendering the ovens useless and subjecting neighboring ovens to damage through rapid cooling. Rate of repair depends on the available supply of refractory brick and skilled labor. Both are thought to be plentiful on the Asiatic mainland, while they are probably more difficult to find on Japan proper.

Because existing Japanese steel-furnace capacity is triple the present production, steel furnaces are not the best targets. They are susceptible to both direct and indirect damage. Destruction of units in operation, necessitating use of substitute plants, will increase the strain of shipping.

Rolling mill equipment is heavy and probably difficult to damage. However, electric motive power units and an intricate network of mill controls are dispersed over the entire mill area and are more susceptible.

Water pumps are vital to operations, but probably would be seriously damaged only by a direct hit.

Boiler installations are heavy but may be damaged through flue and control equipment. The power plant is usually supplemented by outside power sources.

Damage to the transformer equipment would be highly effective.

REPORTING THE COKE, IRON AND STEEL INDUSTRY

The check-off list for Industrial Reports which appears in Section 2 of this Handbook should be used as a guide in organizing these reports.

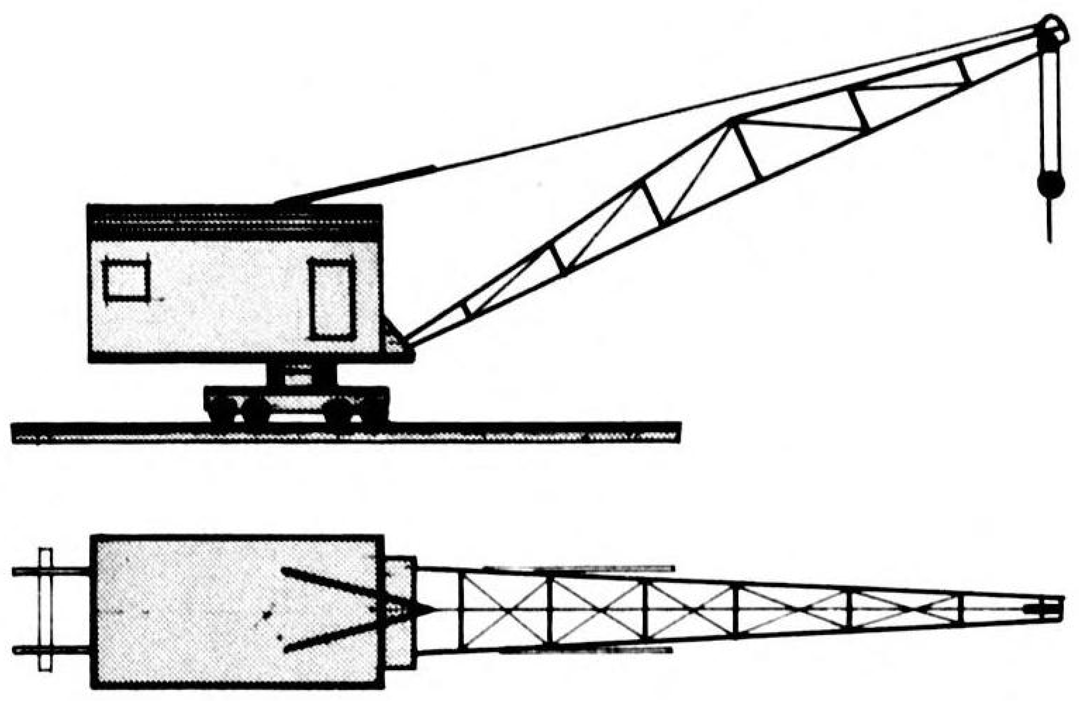
An important problem pertaining to the Japanese coke, iron and steel industries arises from our need for constant reassessment of total steel production. The large amount of idle coke, iron and steel plant installation, both on the Mainland and on the Islands, presents many possible combinations of plant use. As plants become unusable through air attack or are isolated through destruction of transportation facilities or denial of shipping lanes, presently inoperative plants will be substituted.

Since 43% of all shipping is allotted to pig iron and iron ore, and an additional 21% to coal (of which a great proportion is used for coke), major changes in shipping operation may therefore become necessary. For this reason, cessation of all or partial production, or resumption of full or partial production at all plants covered should be carefully noted and reported.

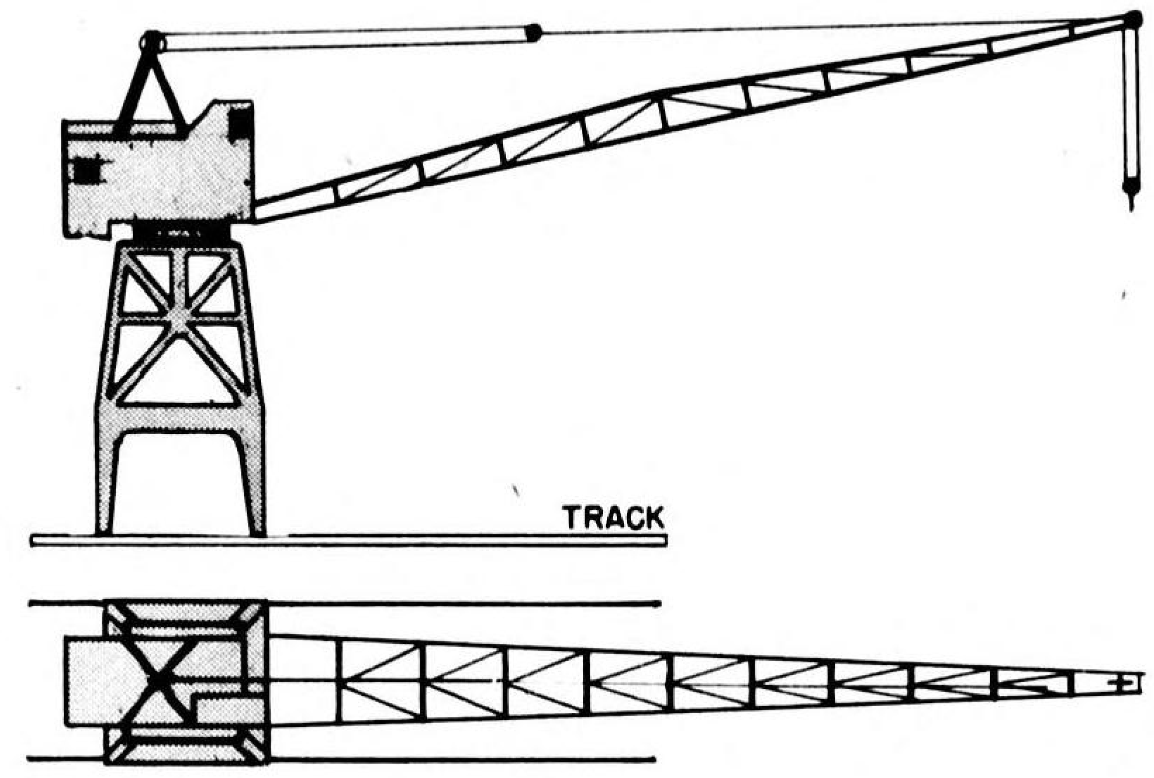
Production activity will be noted by

(1) presence of heat (manifested by visible steam or smoke, or by haziness on photo, usually at smokestacks, indicative of concentration of heat.)
(2) Change in stockpile.
(3) Presence of shipping. At most plants, this will consist of lighters.

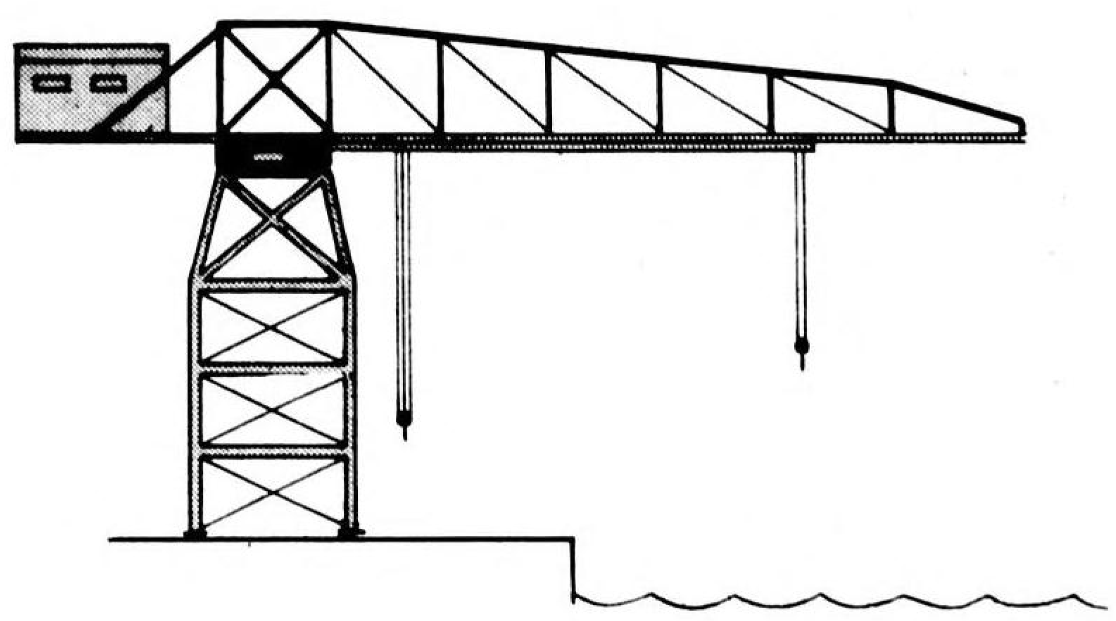
Quantitative distinctions (i.e., "2 of 6 open-hearth stacks show smoke or heat", - or, "10 lighters at dock".) should be made.



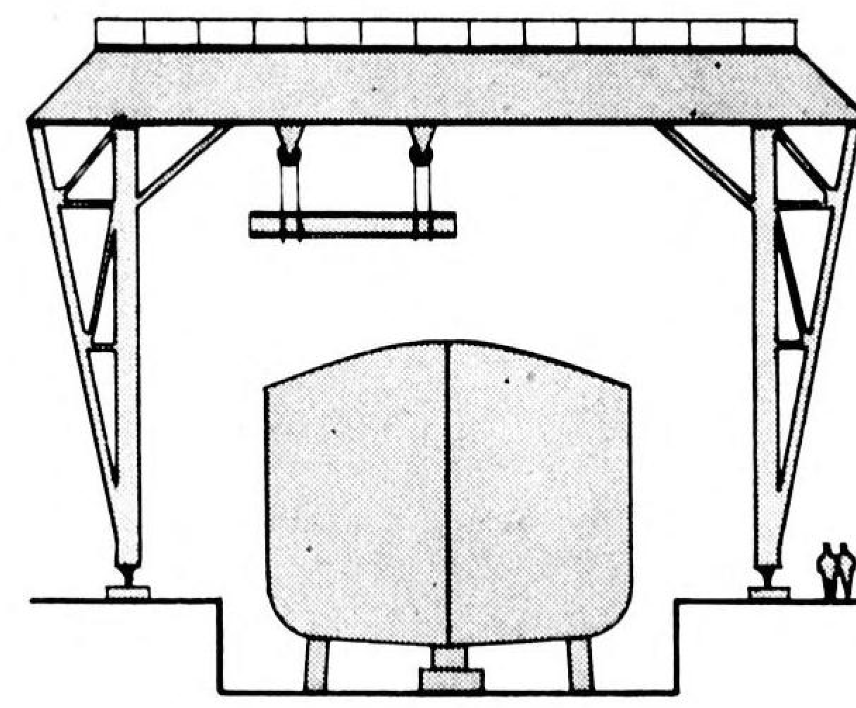
LOCOMOTIVE CRANE



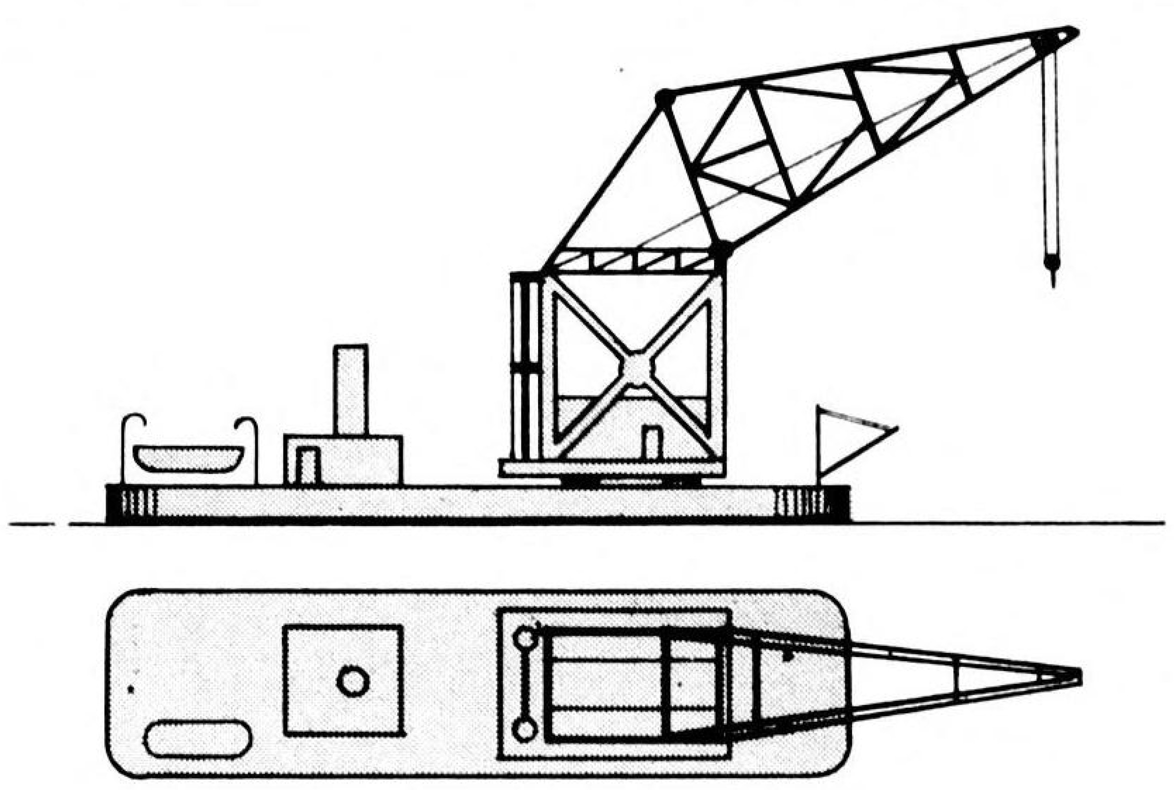
REVOLVING ELEVATED CRANE



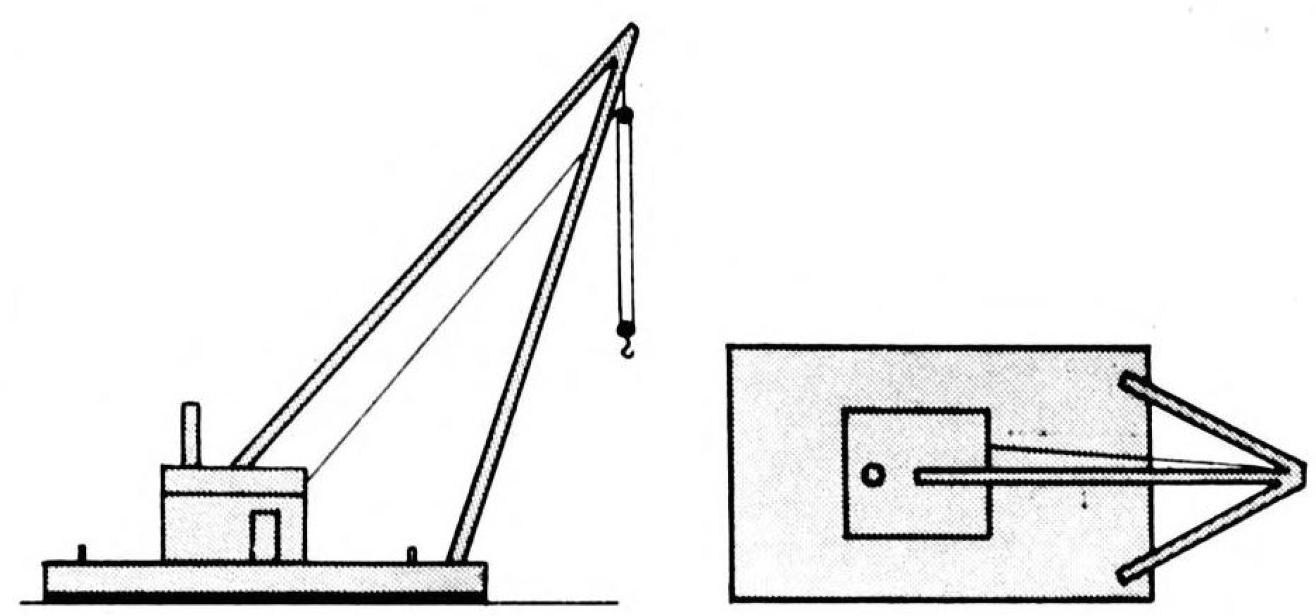
HAMMERHEAD CRANE



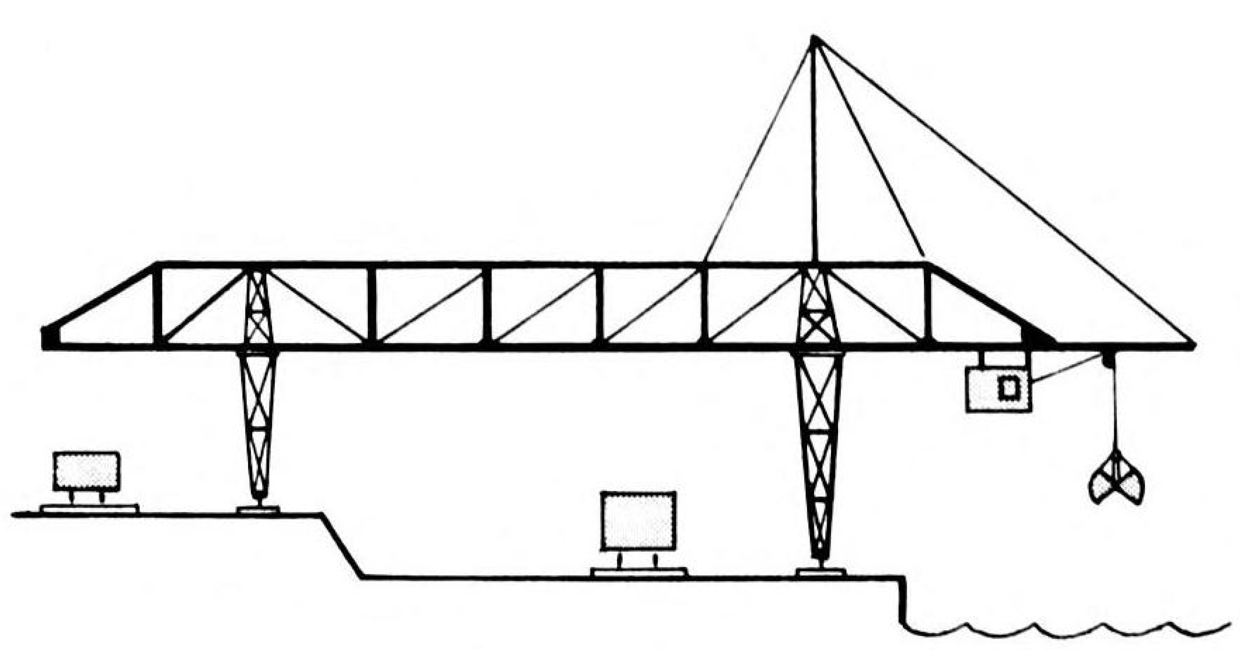
LARGE GANTRY CRANE



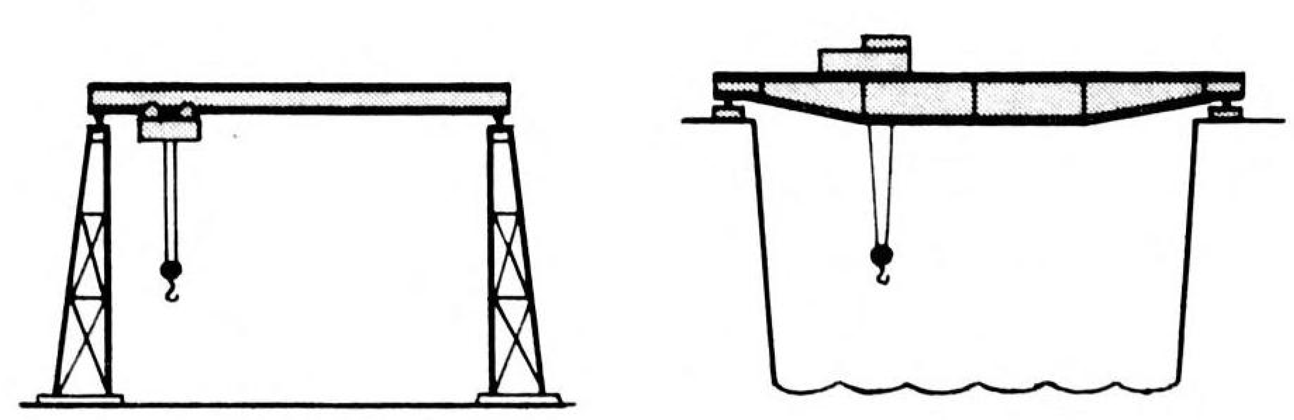
FLOATING CRANE



FLOATING SHEARLEGS



BRIDGE CRANE ON TRACKS

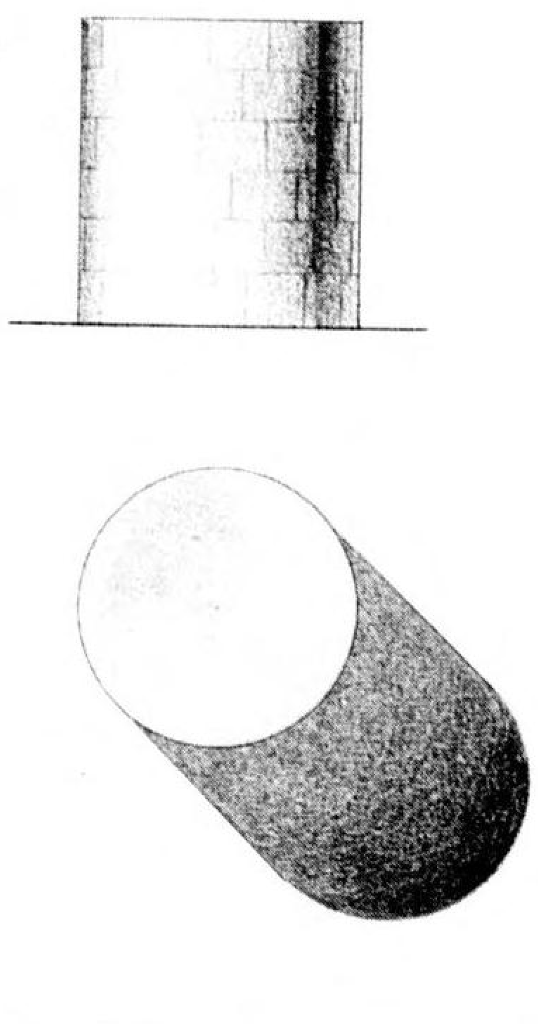


2 TYPES OF OVERHEAD CRANES

INDUSTRY
STORAGE TANKS - SHAPES

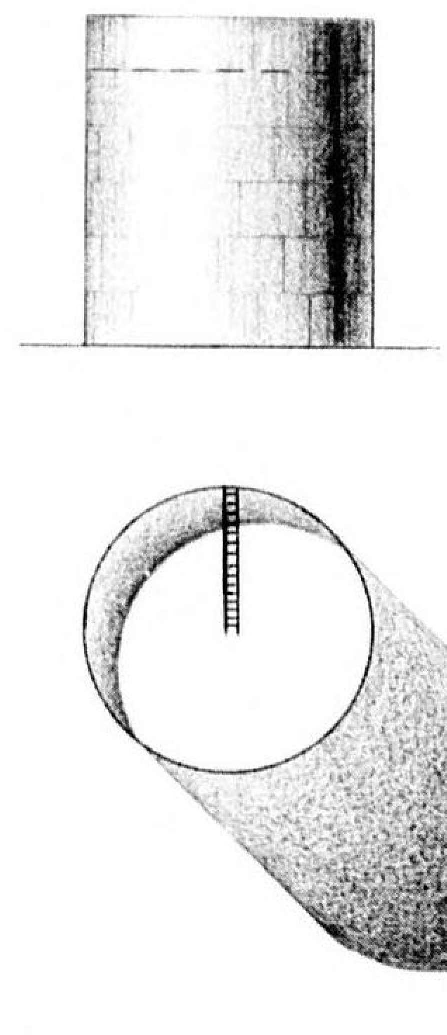
CYLINDRICAL - FLAT ROOFED TANK
1. CRUDE PETROLEUM
2. FUEL OIL
3. ASPHALT
4. TAR
5. MOLASSES
6. WATER
7. VEGETABLE OILS

30'-150' DIAMETER



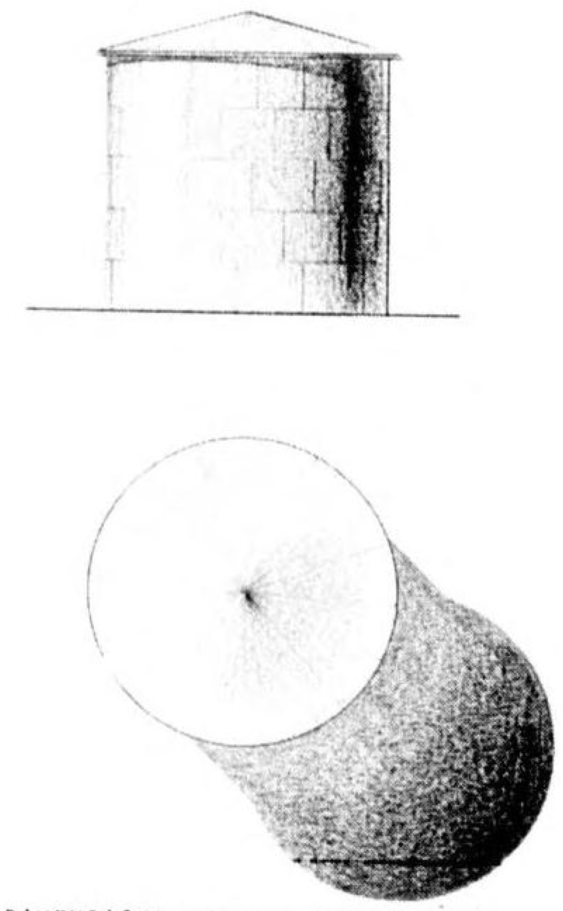
FLOATING TOP TANK
1. VOLATILE LIQUIDS
2. HIGH TEST GASOLINE

45'-115' DIAMETER



PEAKED-ROOF TANK
1. GASOLINE
2. KEROSENE
3. ALCOHOL
4. CRUDE OIL

36'-150' DIAMETER

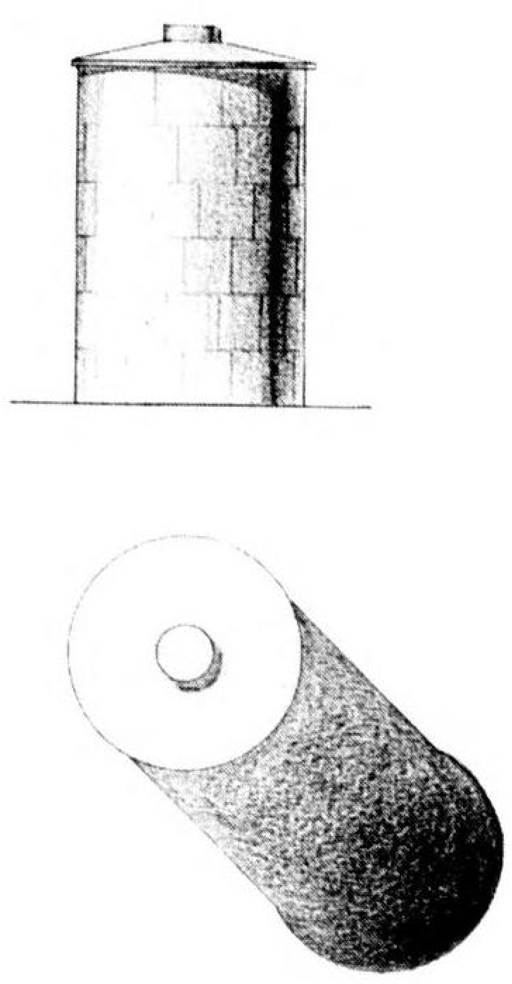


MOST COMMON DIMENSIONS ARE 35' HIGH X 114' DIAMETER.

TANK MAY NOT HAVE ROOF OVERHANG.

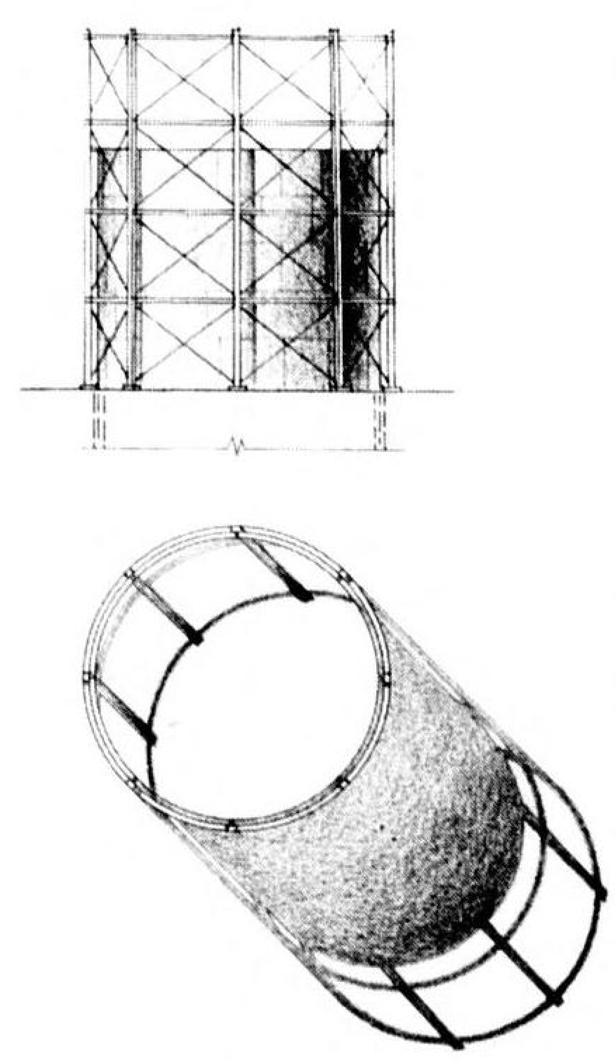
DRY GASOMETER
1. NATURAL GAS
2. PRODUCER (INDUSTRIAL) GAS
3. OTHER GASES

35'-100' DIAMETER



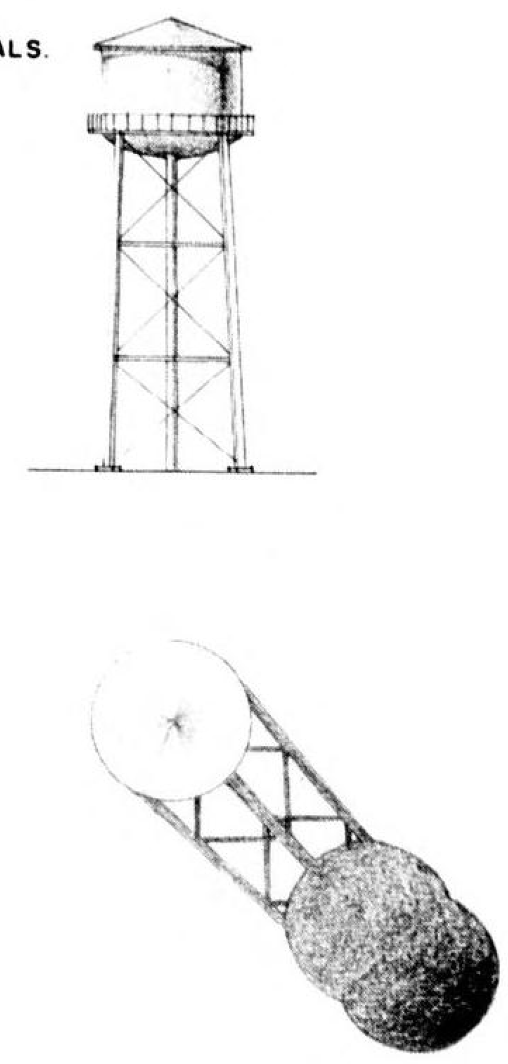
WET GASOMETER
1. NATURAL GAS
2. PRODUCER (INDUSTRIAL) GAS
3. HYDROGEN
4. NITROGEN
5. OXYGEN

ALL SIZES



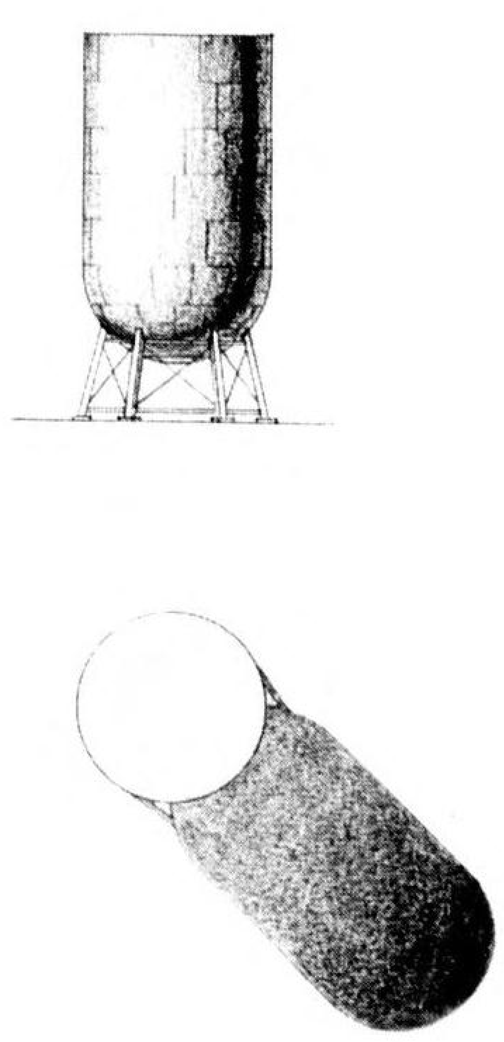
WATER TOWER
1. WATER STORAGE
2. WATER PRESSURE

30,000 - 1,000,000 GALS.



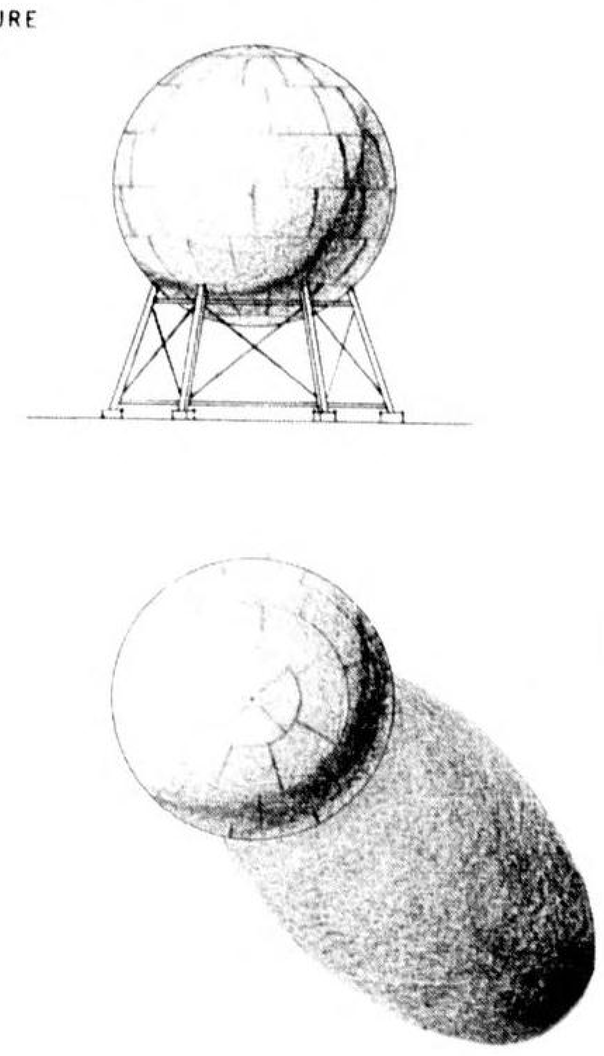
HOPPER TANK
1. AMMONIA
2. PRECIPITATION TANKS

25'-75' DIAMETER



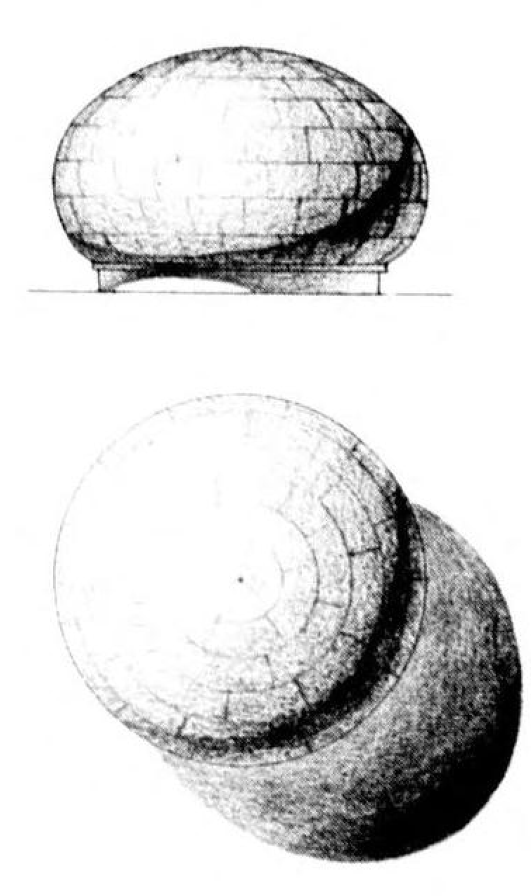
SPHERICAL TANK
1. GASES: NATURAL, PRODUCER, HELIUM, ETC.

15-55 LBS. PRESSURE
25'-60' DIAMETER



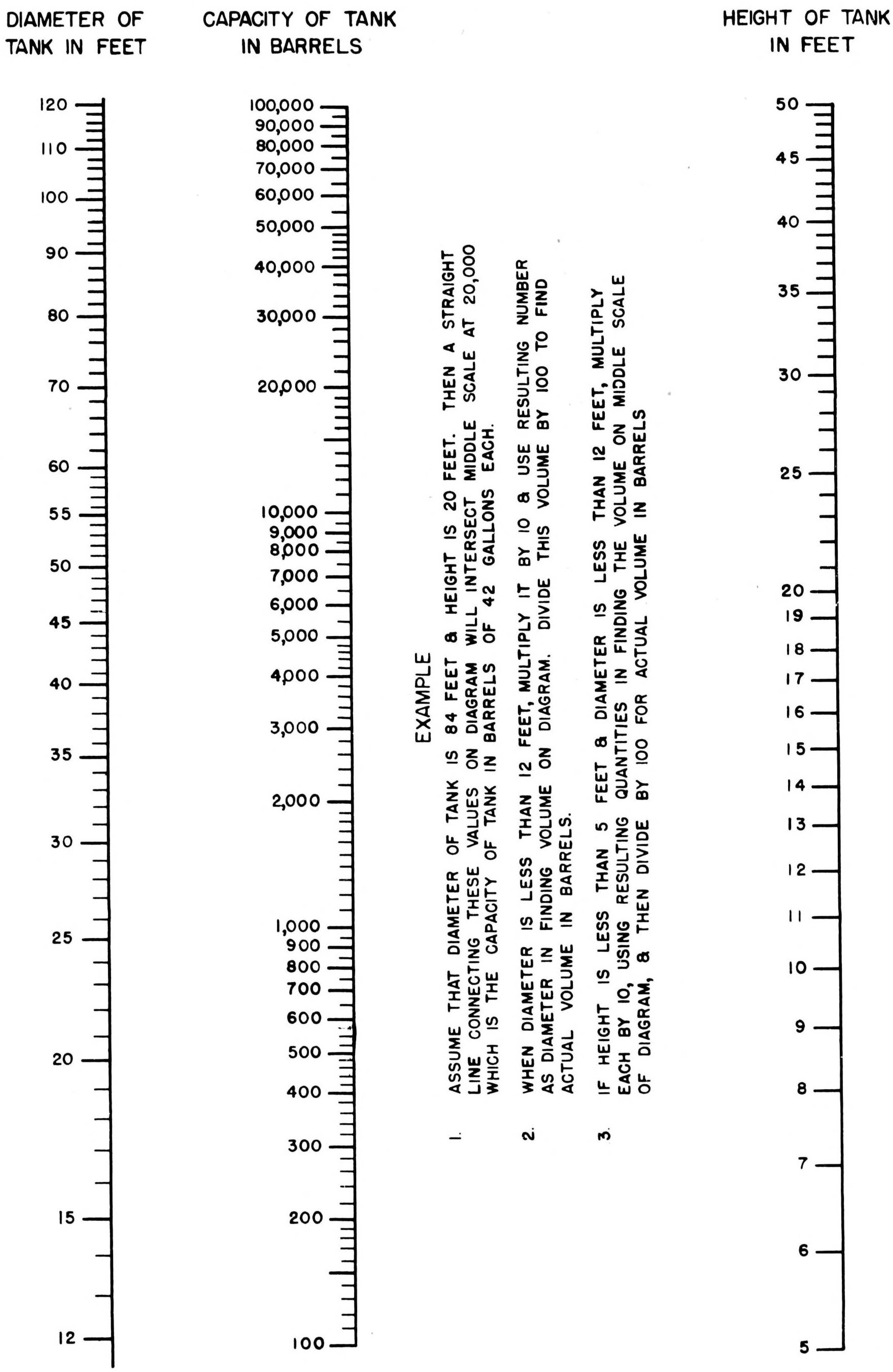
SPHEROID TANK
1. HIGHLY VOLATILE LIQUIDS

15-55 LBS. PRESSURE
25'-75' DIAMETER



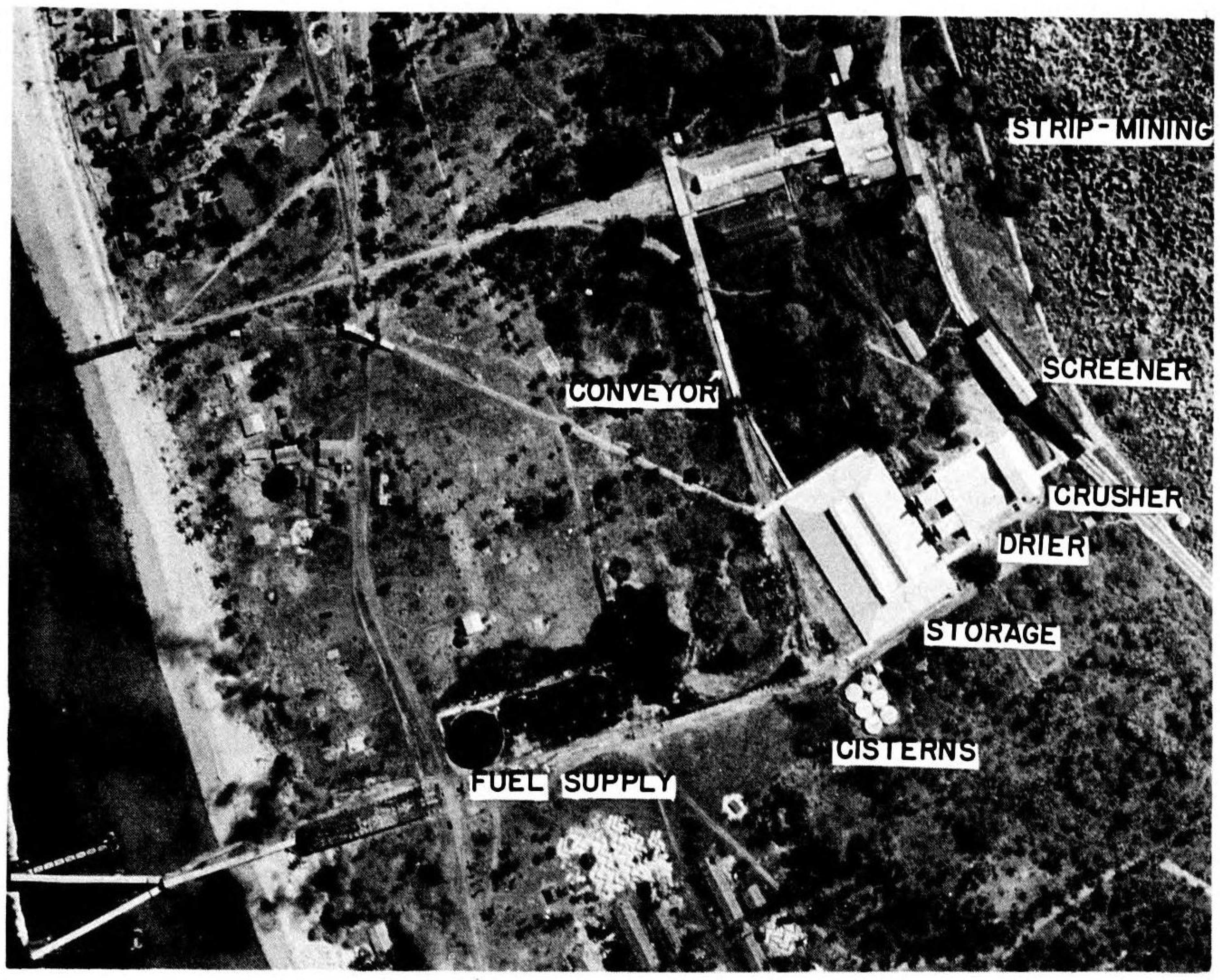
STORAGE TANK CAPACITY CHART

(42 GALLONS PER BARREL)



EXAMPLE

1. ASSUME THAT DIAMETER OF TANK IS 84 FEET & HEIGHT IS 20 FEET. THEN A STRAIGHT LINE CONNECTING THESE VALUES ON DIAGRAM WILL INTERSECT MIDDLE SCALE AT 20,000 WHICH IS THE CAPACITY OF TANK IN BARRELS OF 42 GALLONS EACH.
2. WHEN DIAMETER IS LESS THAN 12 FEET, MULTIPLY IT BY 10 & USE RESULTING NUMBER AS DIAMETER IN FINDING VOLUME ON DIAGRAM. DIVIDE THIS VOLUME BY 100 TO FIND ACTUAL VOLUME IN BARRELS.
3. IF HEIGHT IS LESS THAN 5 FEET & DIAMETER IS LESS THAN 12 FEET, MULTIPLY EACH BY 10, USING RESULTING QUANTITIES IN FINDING THE VOLUME ON MIDDLE SCALE OF DIAGRAM, & THEN DIVIDE BY 100 FOR ACTUAL VOLUME IN BARRELS



PHOSPHATE ROCK PLANT

DISTINGUISHING CHARACTERISTICS

1. Strip-mining.
2. Buildings for storage (larger than processing buildings).
3. Large loading and shipping facilities.
4. Processing buildings.
5. Source of power or fuel supply.

CYCLE OF OPERATIONS

1. Phosphate rock procured by strip-mining.
2. Rock is screened, crushed and calcined before storage.
3. Storage and shipment of treated rock.

Further processing occurs in the consuming areas. Sulphuric acid is poured over ground phosphate rock, or phosphate rock, coke and silica are joined in a blast furnace or electric furnace to produce the various phosphates. These plants vary in appearance, hence no distinguishing characteristics.

NOTE: Phosphate is used in the manufacture of fertilizers, incendiaries and phosphoric acid. The major sources of supply are United States, North Africa, Rasa and Anguar Islands, Marata Island, Christmas Island, Ocean Island and Nauru Island.

HYDROELECTRIC

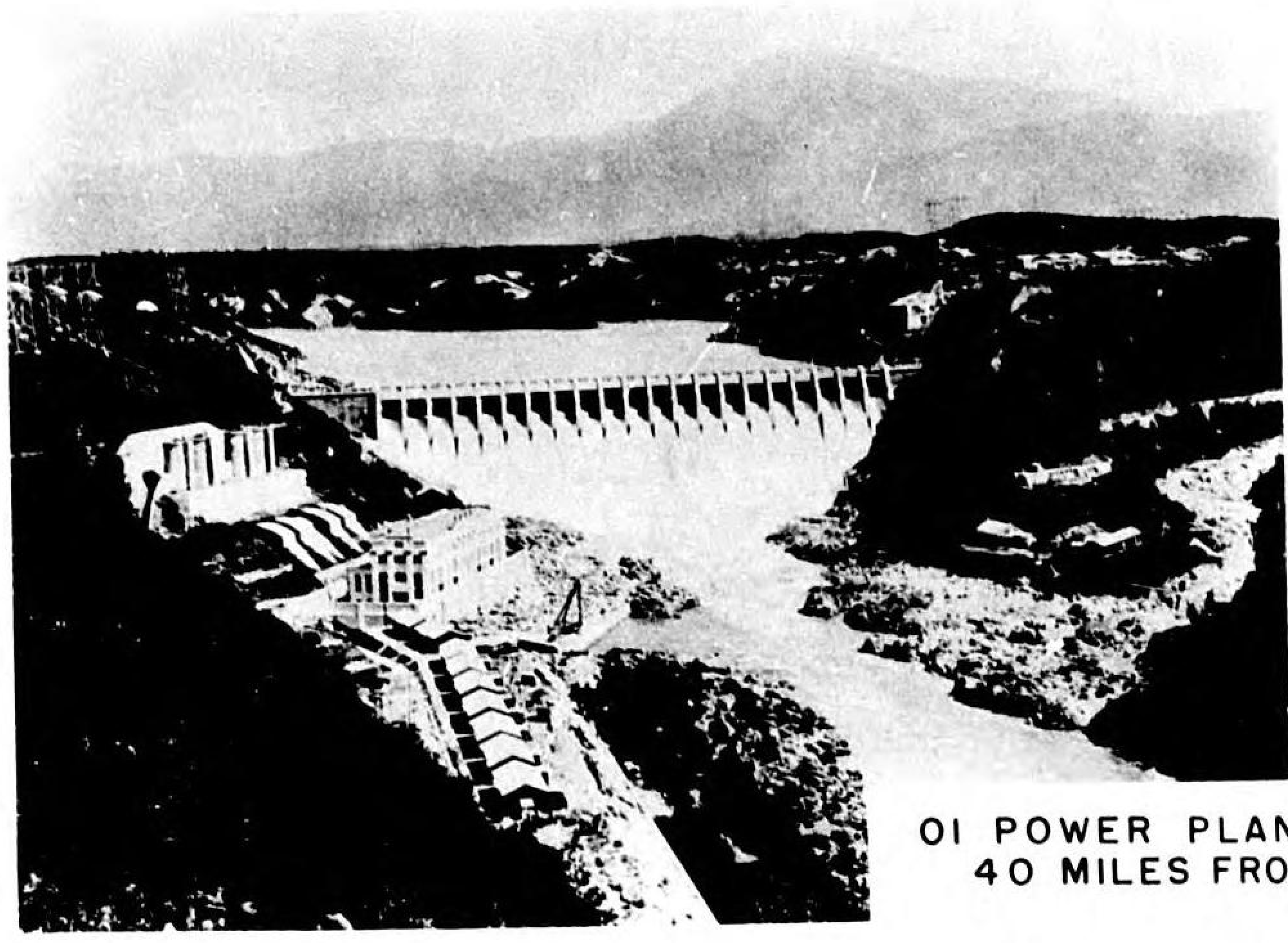
DISTINGUISHING CHARACTERISTICS:

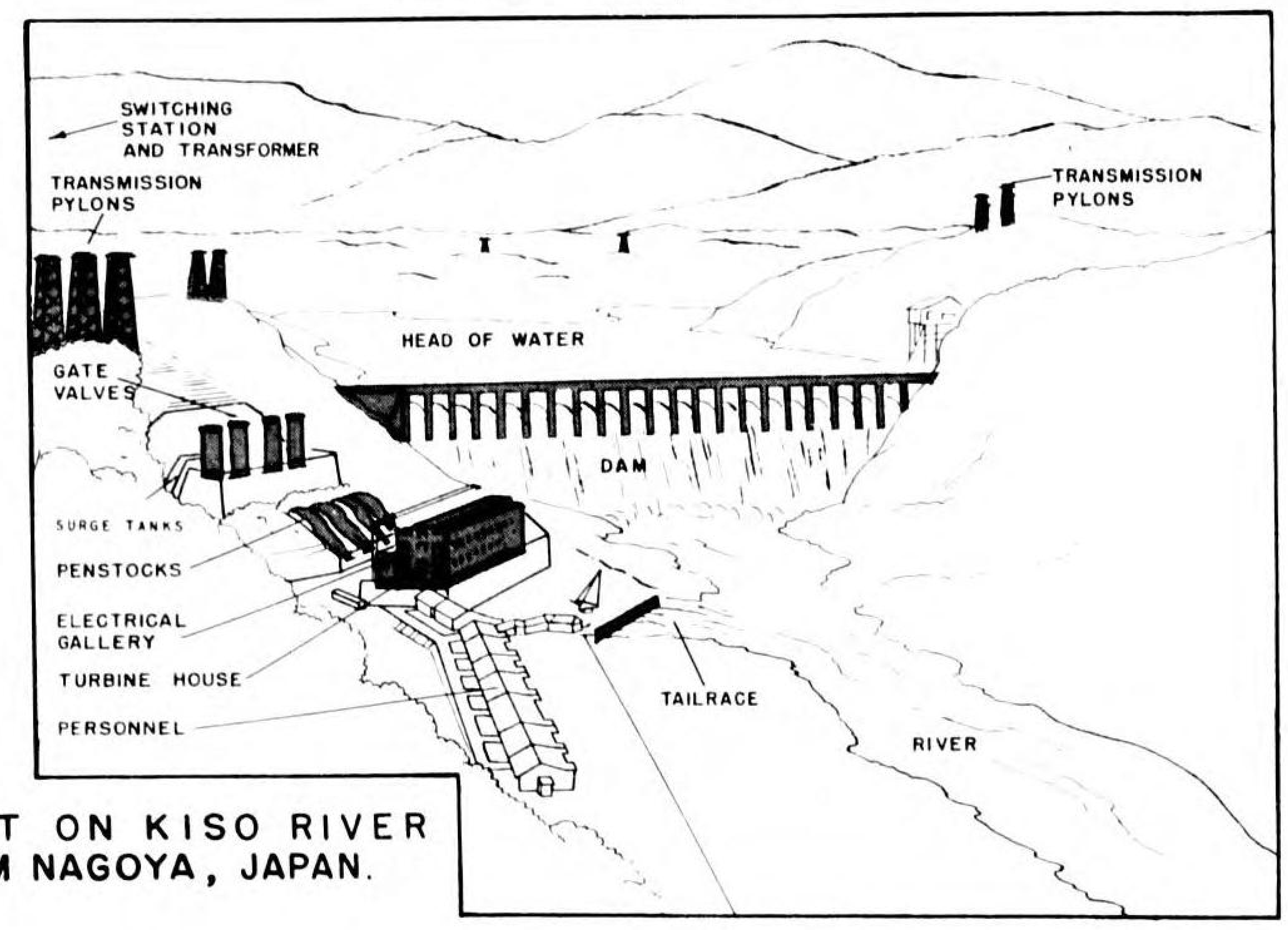
VITAL INSTALLATIONS

- D. 1. Head of water (dam or penstocks).
- 2. Main power line leading from generator house.
- A. 3. Generator building (main power house).
- 4. Tailrace of water below generator building.
- B. 5. Electrical gallery.
- C. 6. Transformer and switching station (network of overhead lines).

CYCLE OF OPERATION:

1. Head of water from the dam runs through gate valves and penstocks to the turbines
2. Water turns turbines, energy is led off from the generators through the electrical gallery to the transformer.
3. Transformer steps up the voltage
4. Switching station routes the electricity out.





OI POWER PLANT ON KISO RIVER 40 MILES FROM NAGOYA, JAPAN.

NOTE: The Hydroelectric Power Plant may be adjacent to the dam, from a few feet to several miles downstream, or miles away from both the stream and dam; provided that (1) it is at a lower elevation than the dam, and (2) it is connected to the dam by penstocks, pipeline or canal.

STEAM

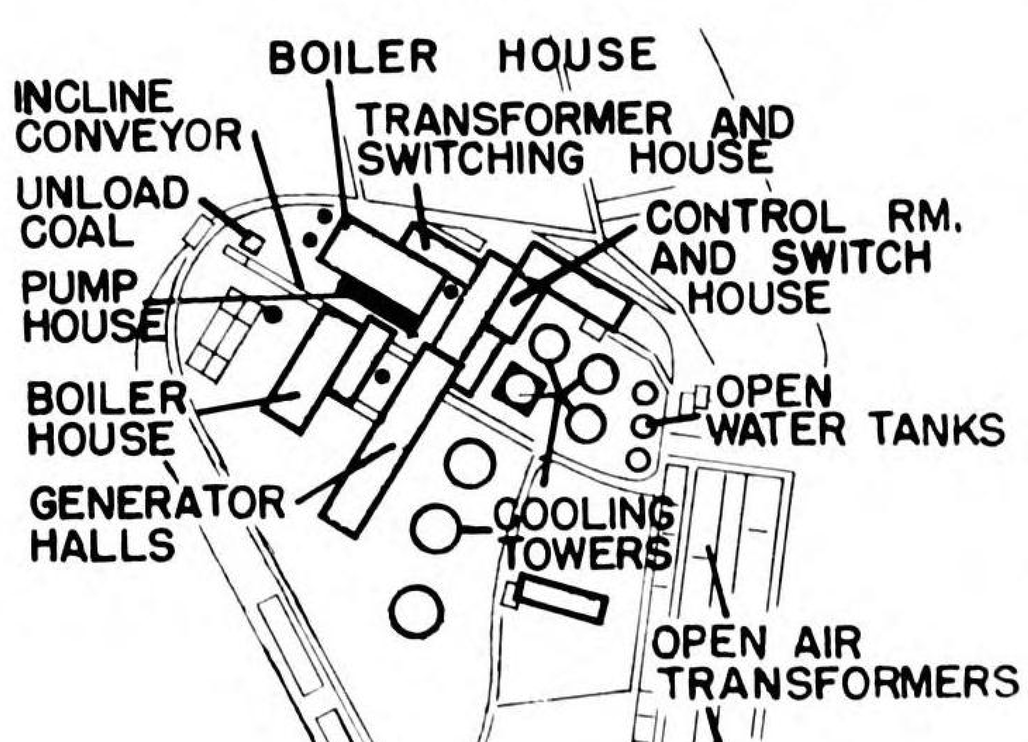
DISTINGUISHING CHARACTERISTICS:

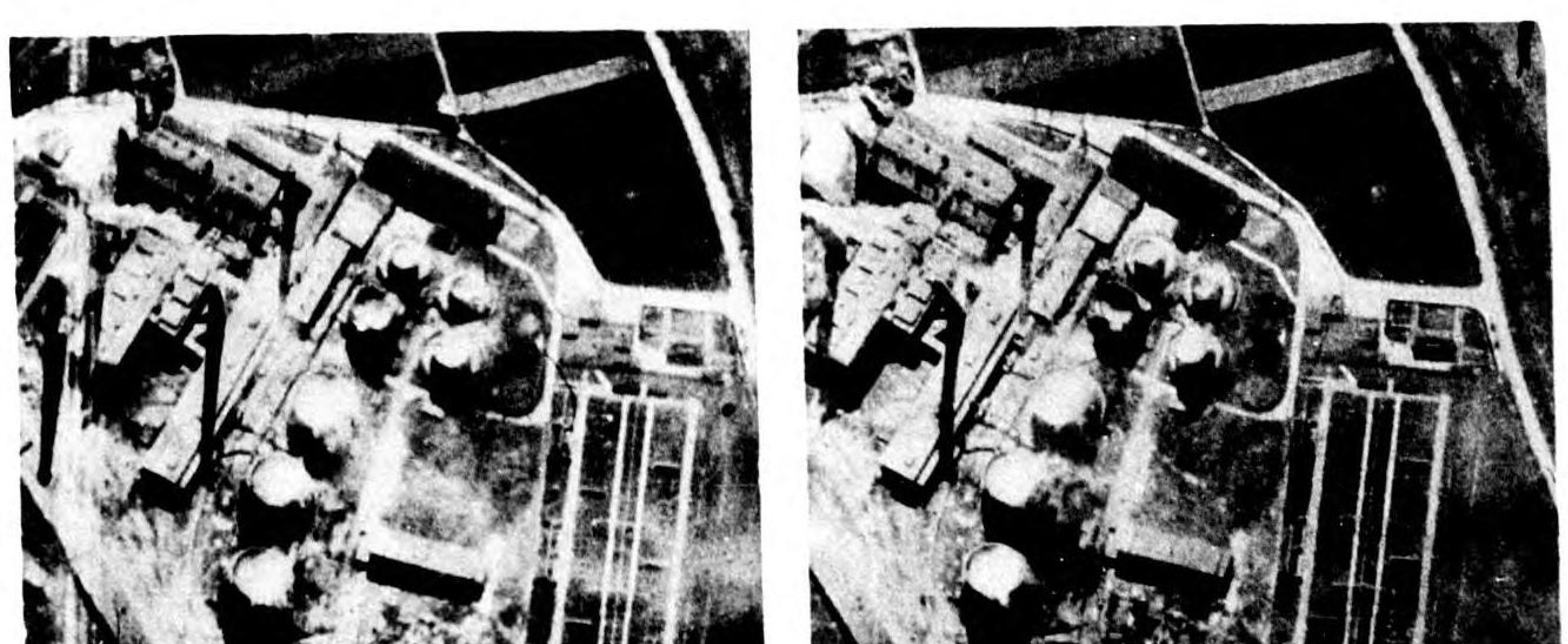
VITAL INSTALLATIONS

- B. 1. Boiler house (with tall stacks).
- E. 2. Condensing unit: cooling towers or a body of water.
- D. 3. Fuel storage: gas, coal, or oil..
- 4. Power lines leading from plant.
- C. 5. Transformer station: a network of wires.
- 6. Electrical gallery (control room and switch house).
- A. 7. Generator hall, near boiler house: a small building.

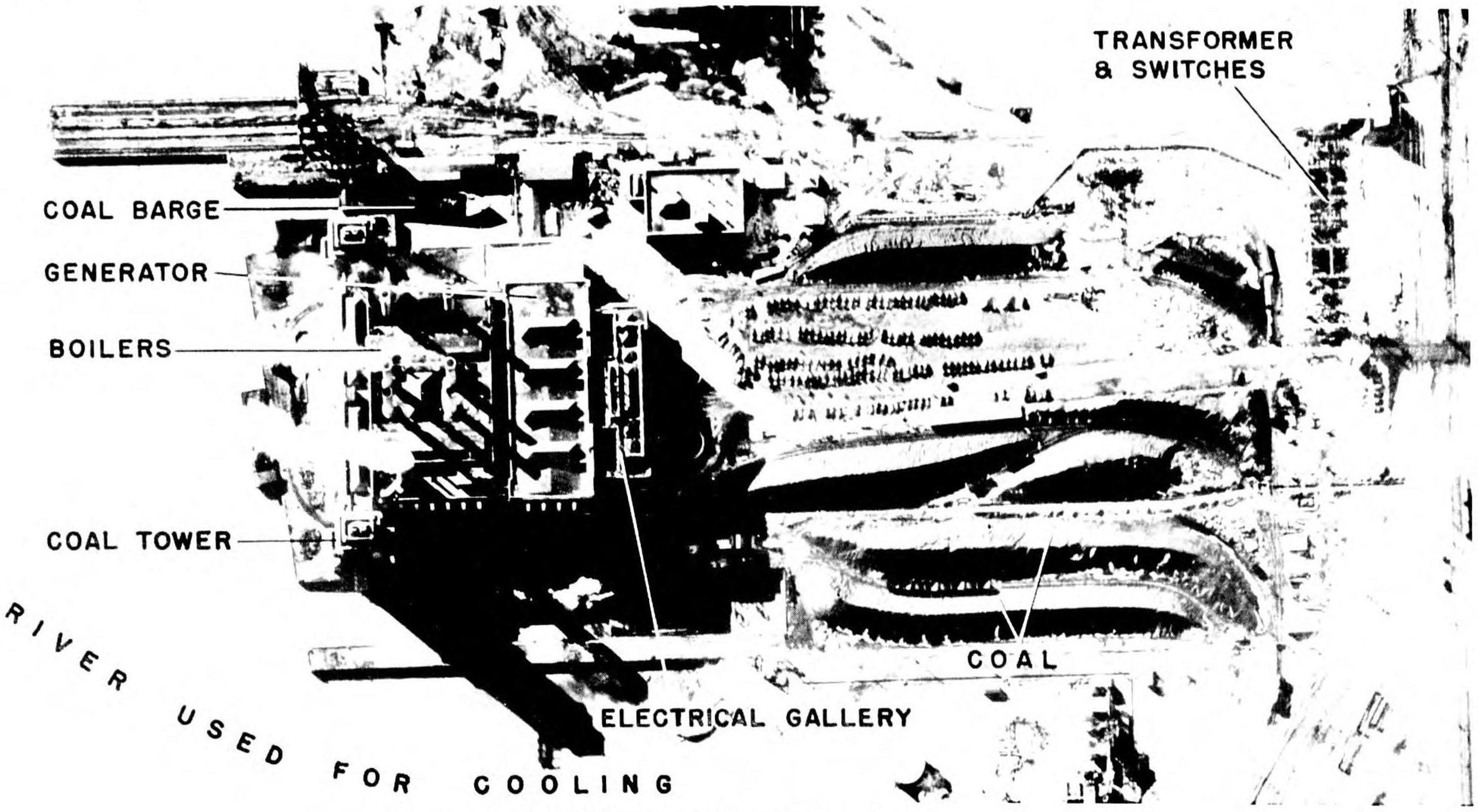
CYCLE OF OPERATION:

1. Fuel is burned to produce steam pressure.
2. This energy passes through turbines to produce electrical energy in the generators.
3. Voltage is stepped up by a transformer to permit economical transmission.
4. Condensers reduce the used steam to hot water and it is used again.

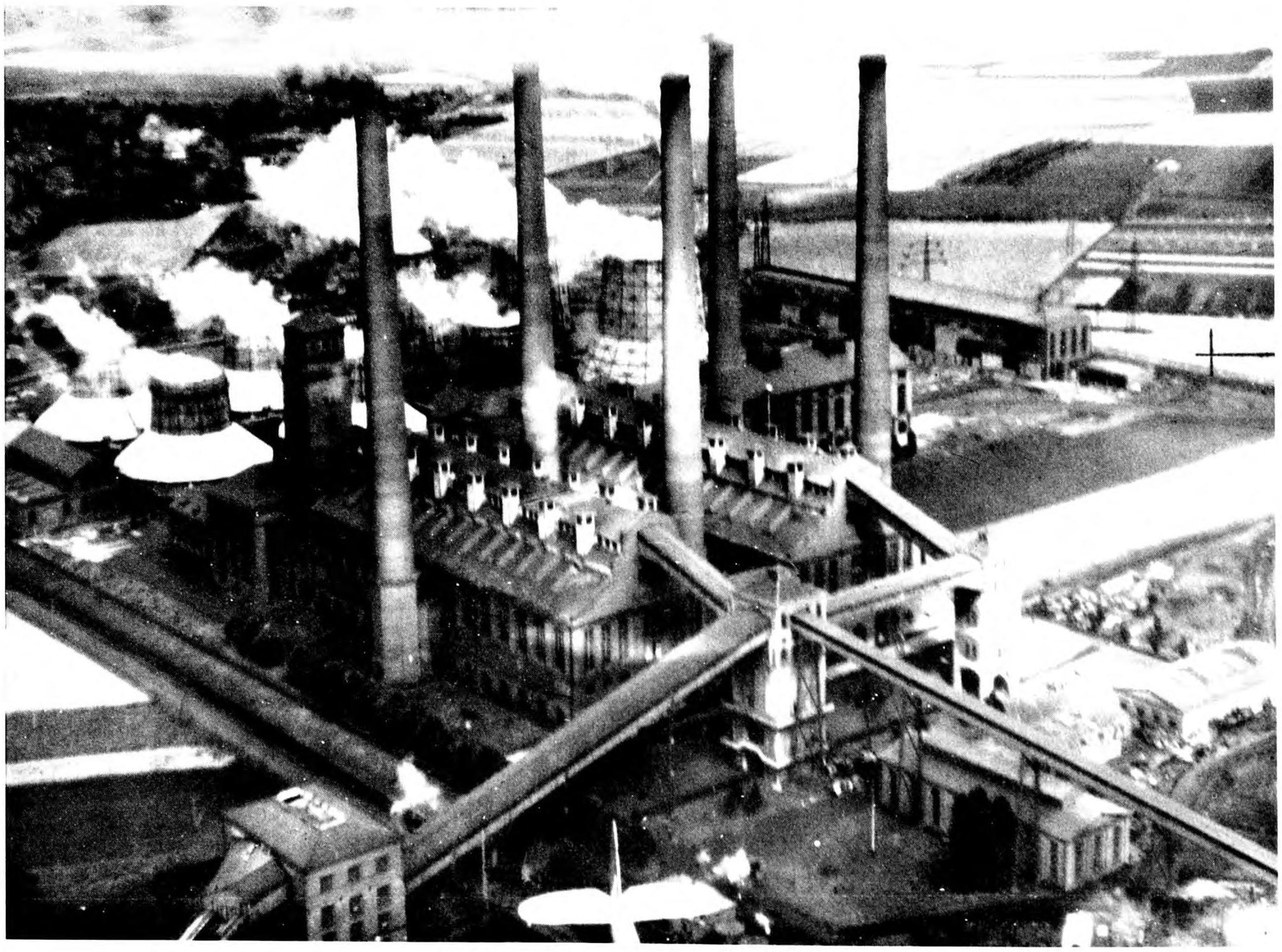




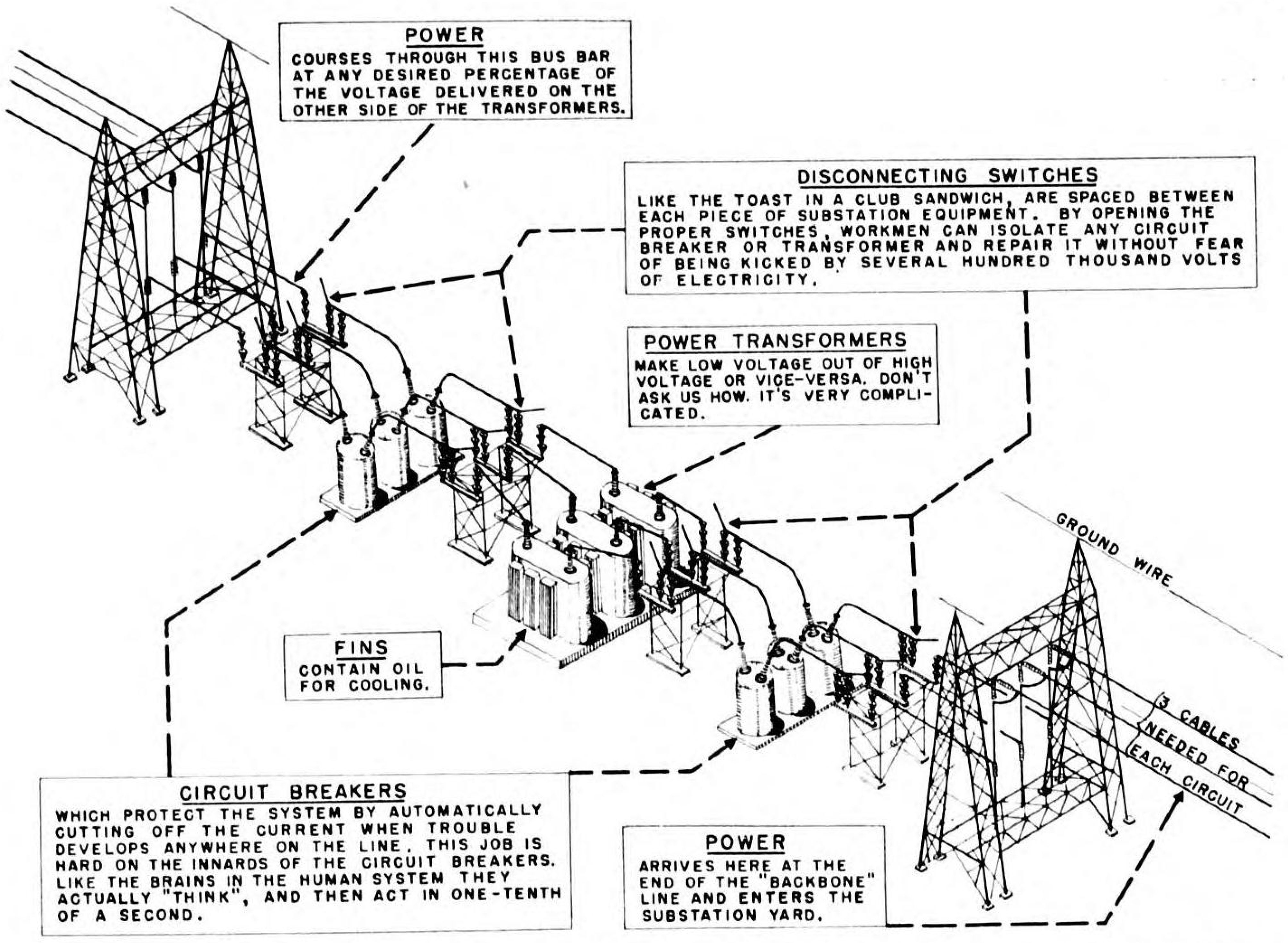
NOTE: In steel plants which use gas power the pipes from the blast furnaces to the central power plant are the distinguishing characteristics.



STEAM POWER PLANT IN THE U.S.

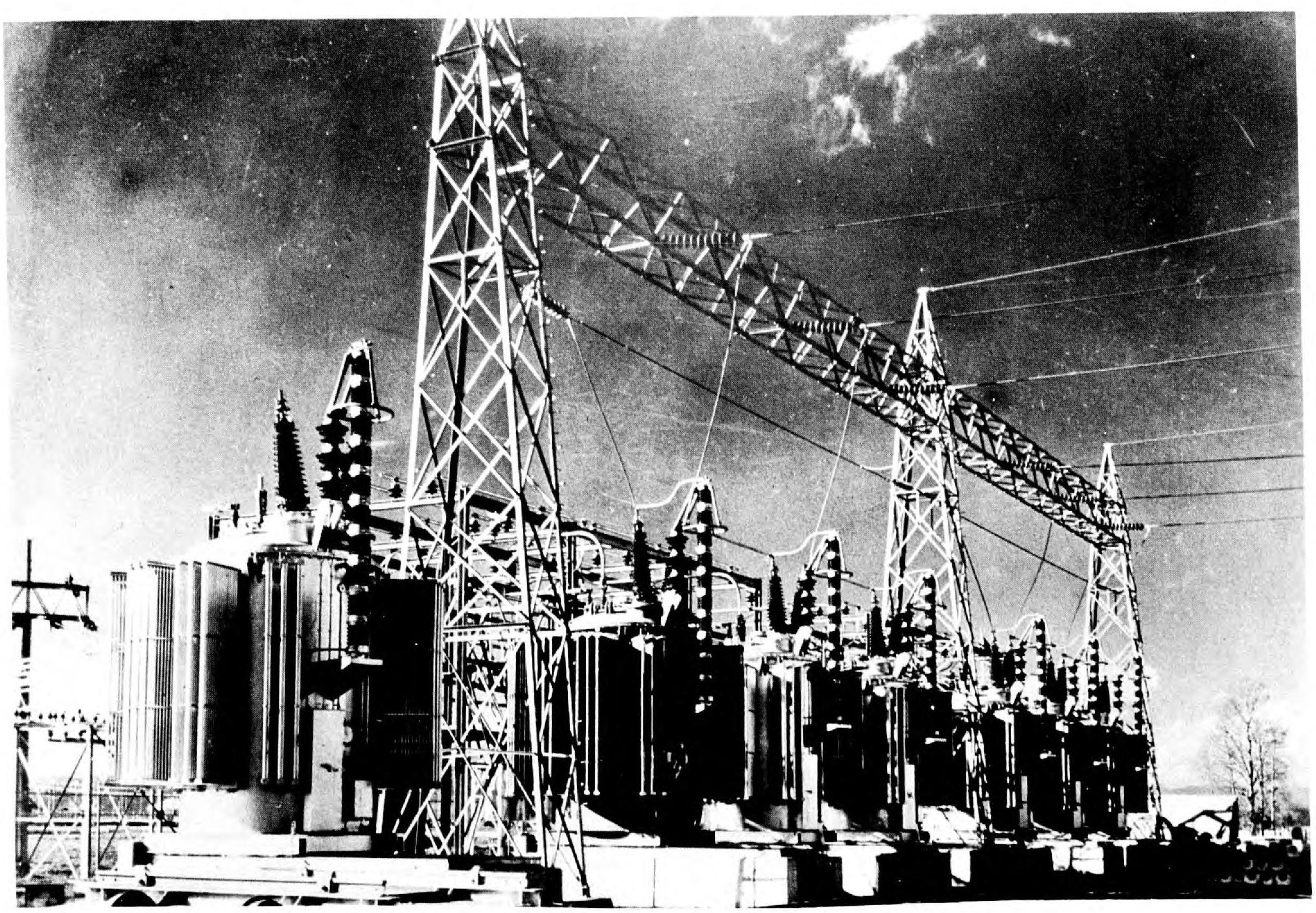


Close-up of Knapsack Power Plant near Koln, largest steam power plant in Europe. Note coal conveyors, boiler houses, turbine and generator halls, large cooling towers.

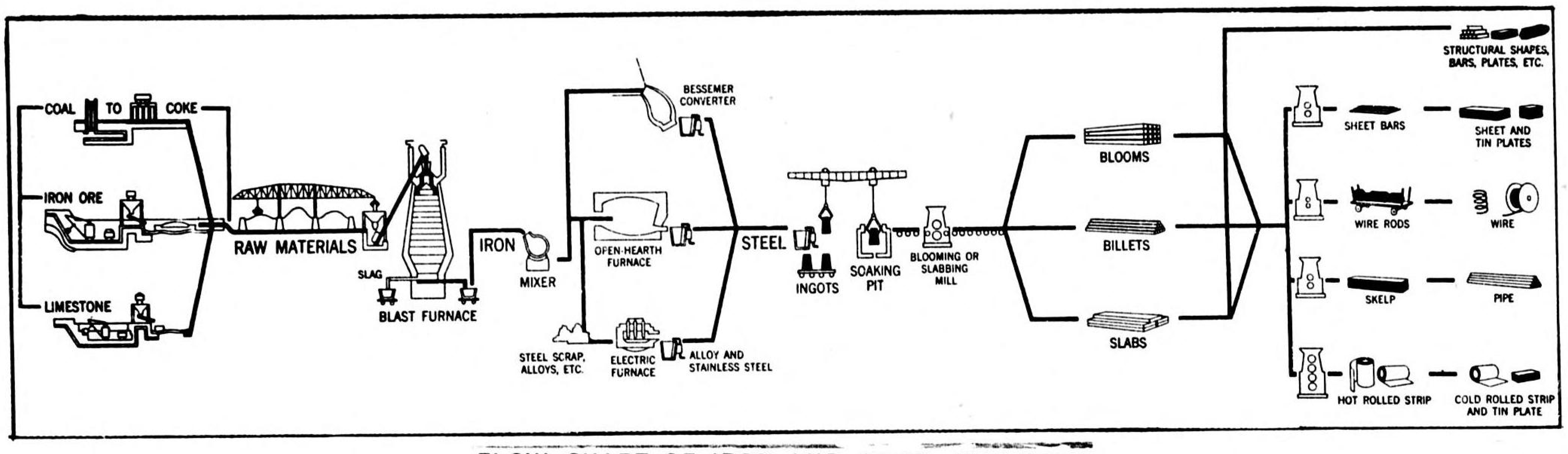


SWITCHING AND TRANSFORMING STATION REDUCED TO SIMPLE TERMS

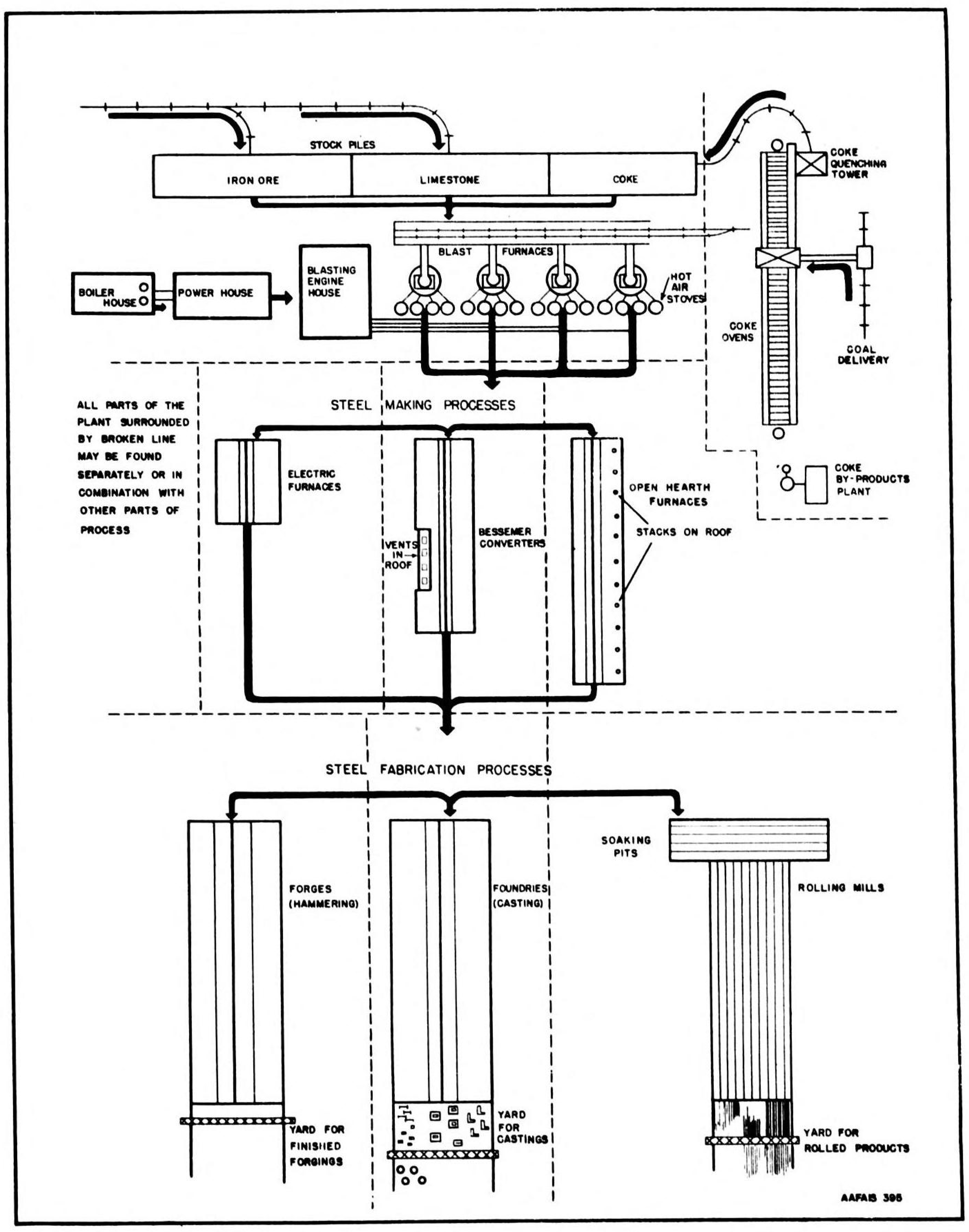
NOTE: Actually these installations are not spread out as illustrated, but are bunched together so that it is impossible to distinguish one from another in the ordinary aerial photo.



CLOSE-UP OF TRANSFORMER AND SWITCHING STATION

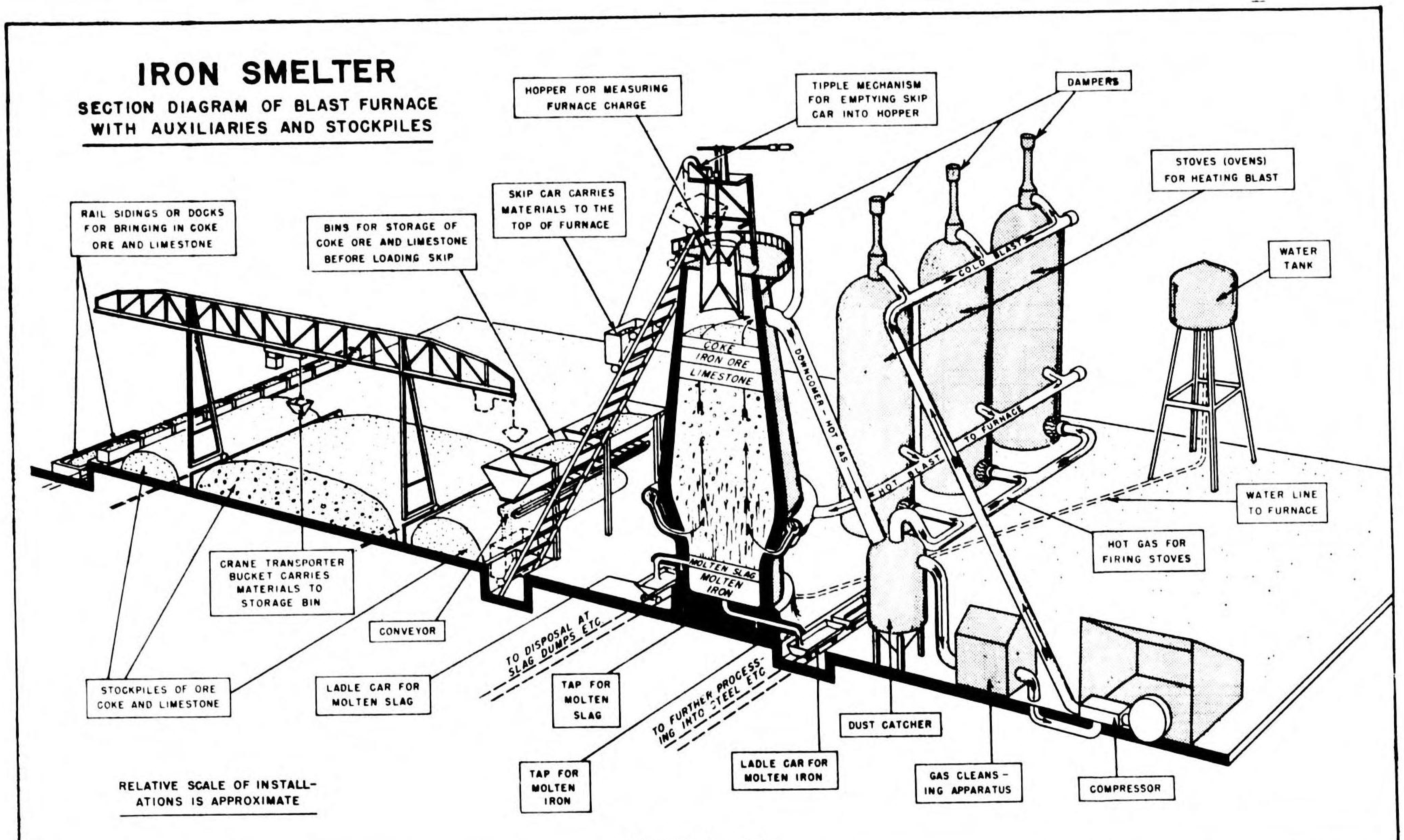


FLOW CHART OF IRON AND STEEL INDUSTRY



SIMPLIFIED LAYOUT OF IRON AND STEEL PLANT

All parts of the plant surrounded by broken line may be found separately or in combination with other parts of process

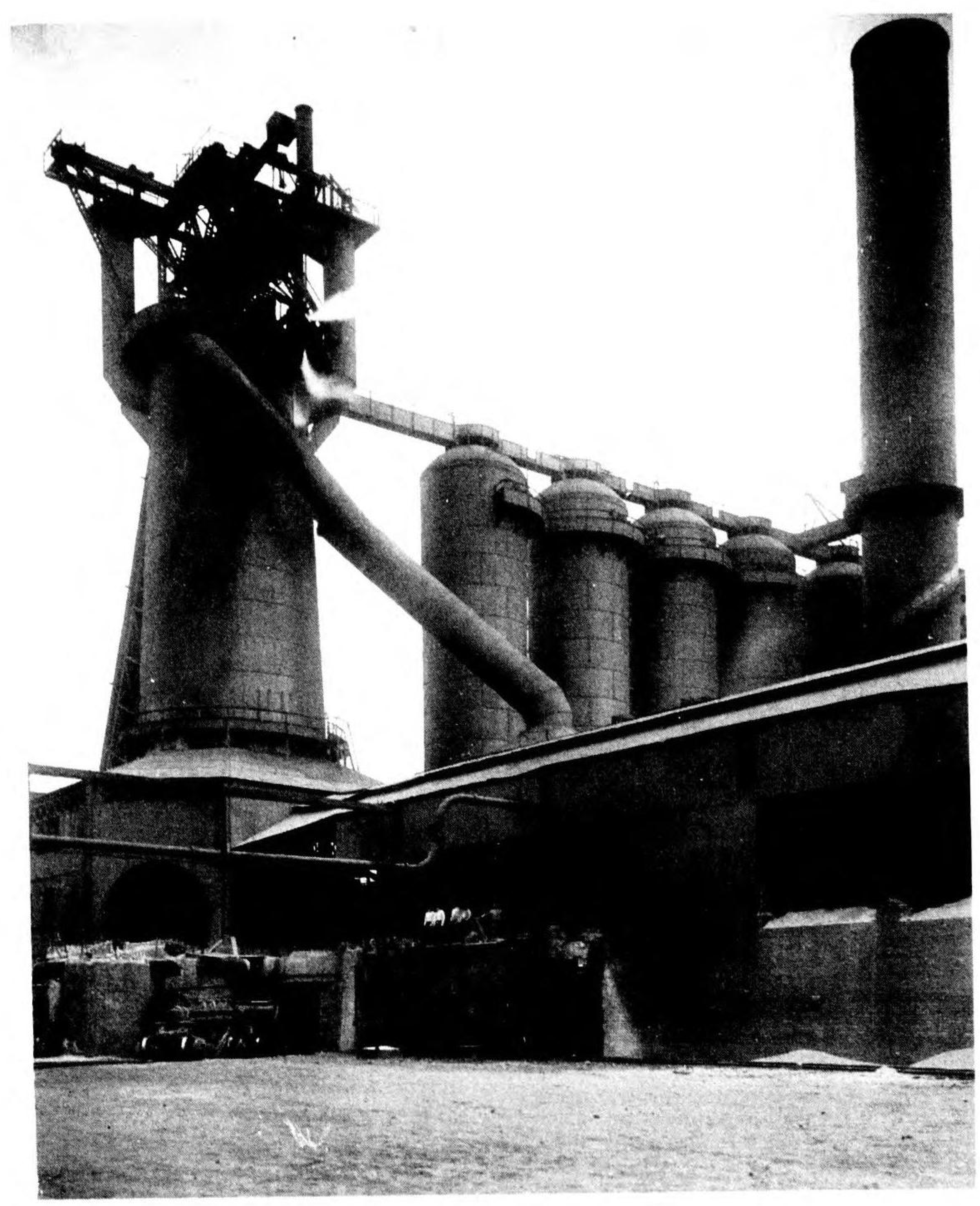


AAFAIS.389.

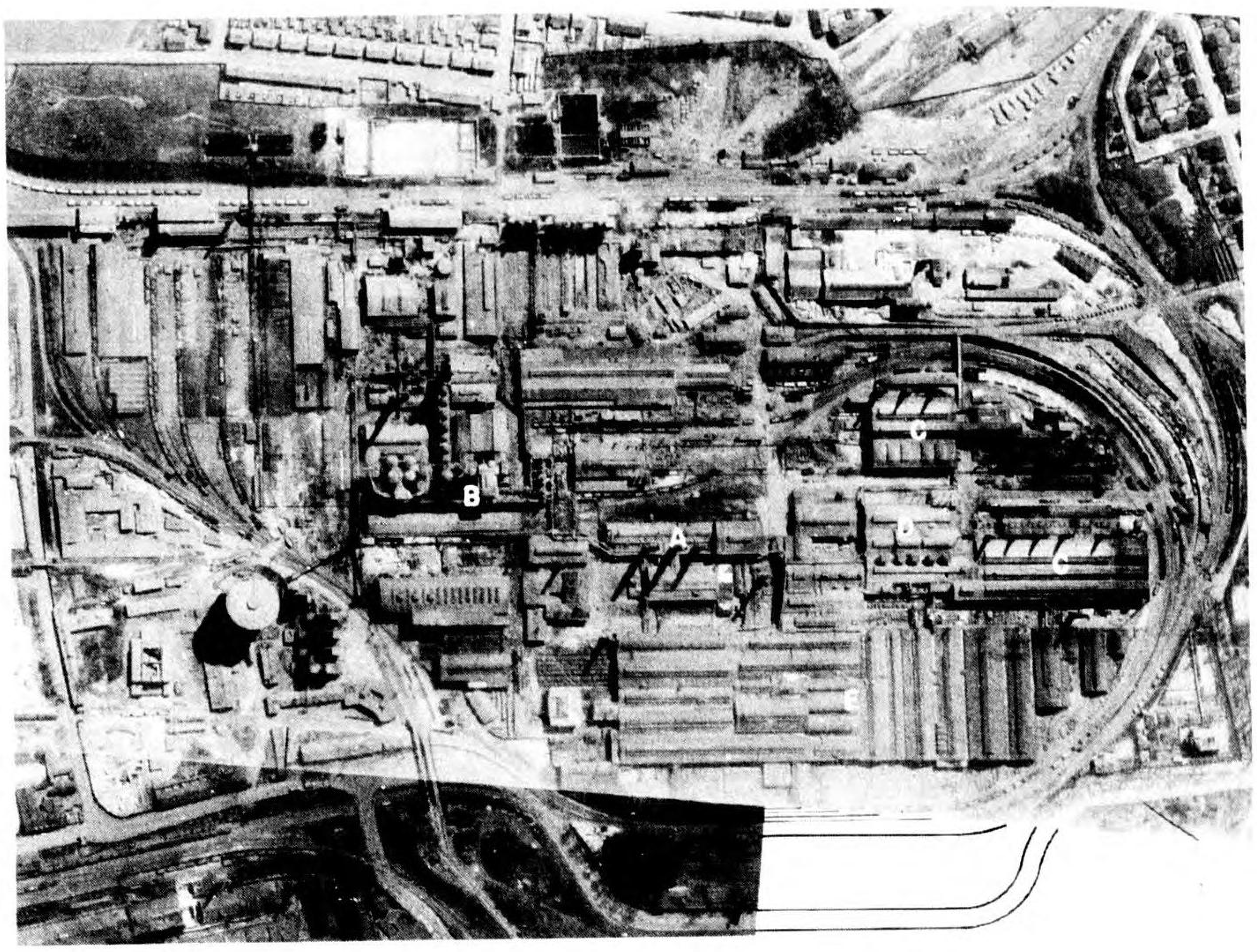
One blast furnace feeds many open-hearth steel furnaces.

Blast furnaces are rated by their daily production, such as 500, 750, 1000, 1200 tons, etc.

Most occidental blast furnaces are accompanied by four (4) hot stoves each, but oriental blast furnaces have only three (3) hot stoves each, making them more vulnerable. Oriental blast furnaces frequently are surrounded by steel framework and, therefore, do not have round shape.



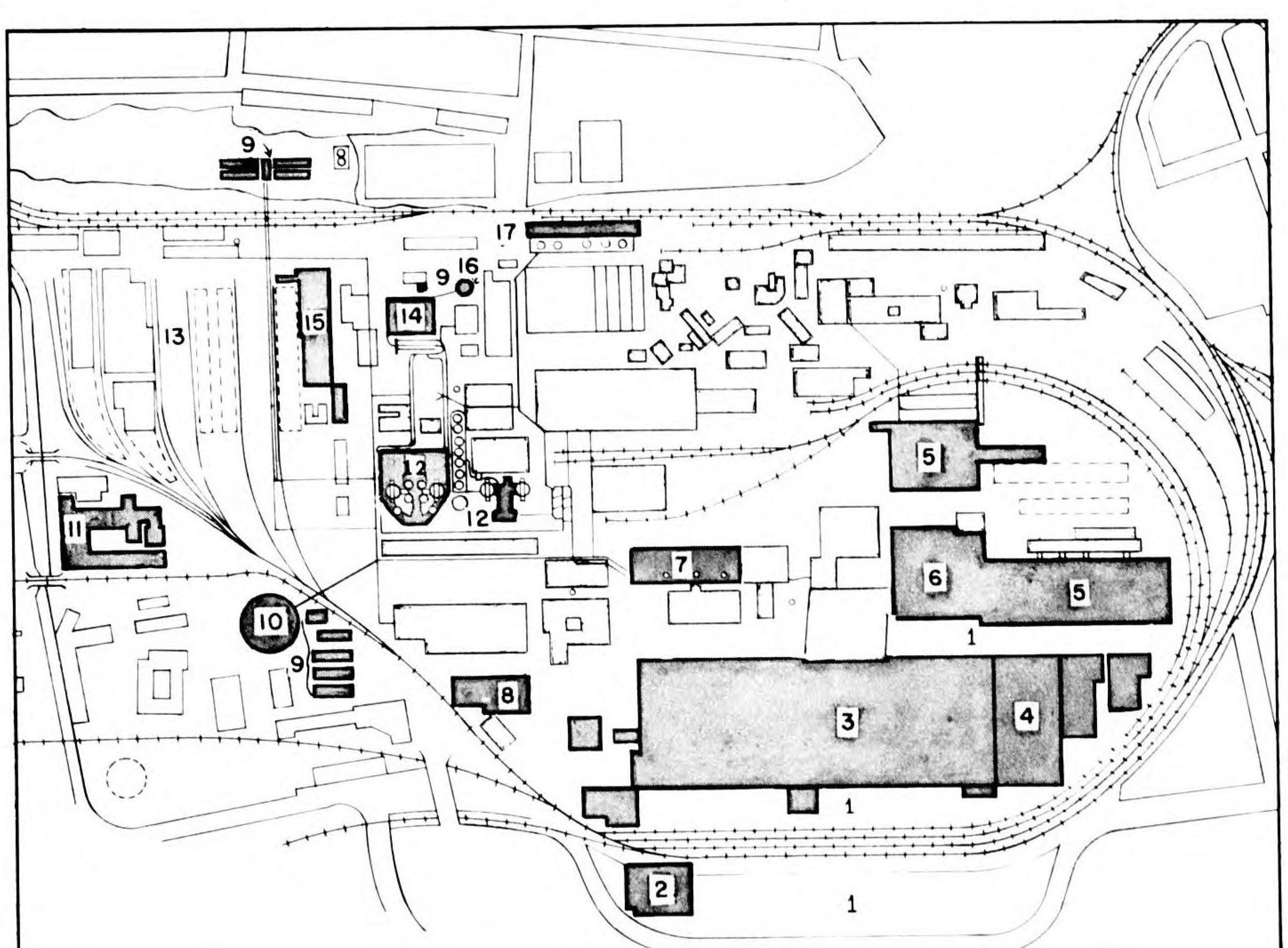
RESTRICTED



IRON AND STEEL PLANT

KLADNO, CZECHOSLOVAKIA

Vital Installations: A
B
C
D
E



DISTINGUISHING CHARACTERISTICS:

1. Stockyard for finished products
2. Warehouse

E. 3. Rolling Mill

4. Soaking pits

C. 5. Open-hearth furnaces

D. 6. Bessemer converter

A. 7. Boiler house and electric power station

8. Storehouse for steel bars
9. Cooling towers
10. Dry gas holder
11. Offices and laboratories

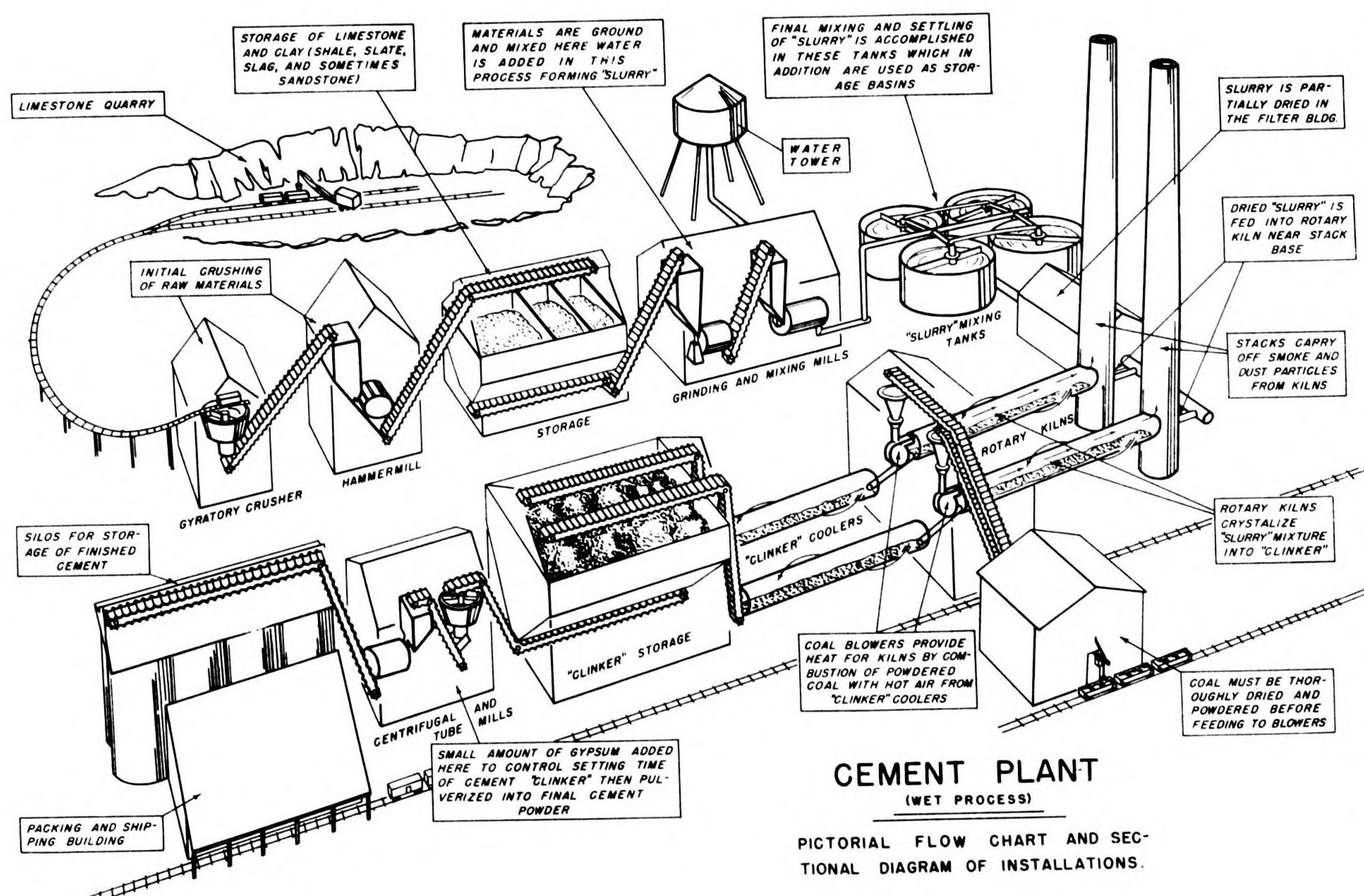
B. 12. Blast furnaces

13. Large coal bunkers (2 covered by sheds) served by 8 railway sidings
14. Gas cleaning plant
15. Shed alongside coal bunker
16. Wet gas holder
17. Row of five lime kilns

RESTRICTED

CYCLE OF OPERATIONS

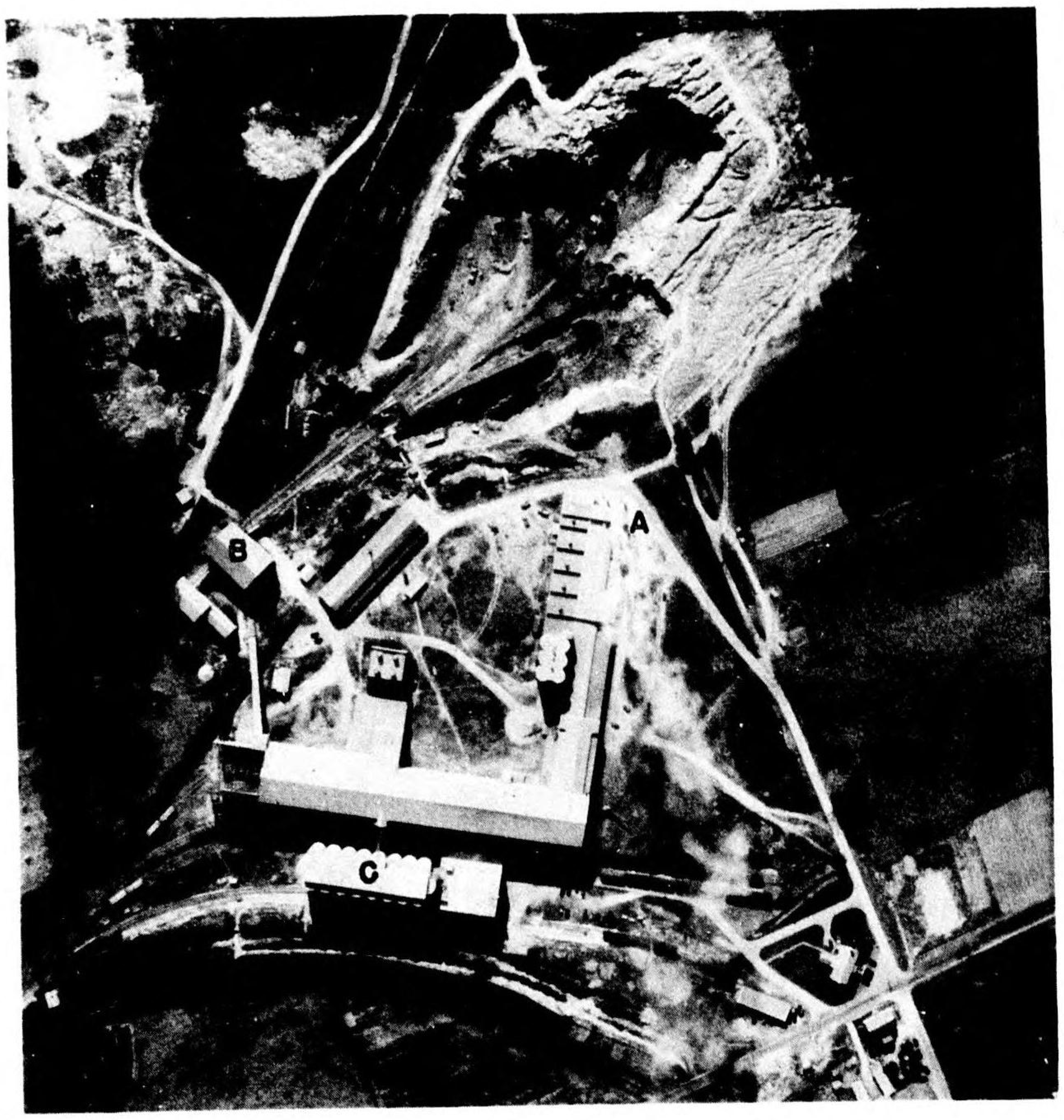
1. Limestone is excavated by shovel from an open quarry.
2. The excavated material is carried by narrow gauge railway up to a crusher building where it is crushed.
3. The crushed material is carried by conveyor from the crusher building to a storage building.
4. From the storage piles the crushed material is carried to the grinder building where it is pulverized and mixed with water.
5. The resultant sludgelike material is carried to silo storage tanks.
6. The sludge material is then put through long rotary kilns where, under intense heat, the sludge becomes clinker. After being stored, the clinker is carried to the grinder building for the final step.
7. The finished cement is carried by conveyor from the grinder building to storage silos.
8. The cement is shipped in bulk in box cars or is packaged and shipped.



CEMENT PLANT
(WET PROCESS)

PICTORIAL FLOW CHART AND SECTIONAL DIAGRAM OF INSTALLATIONS.

RESTRICTED

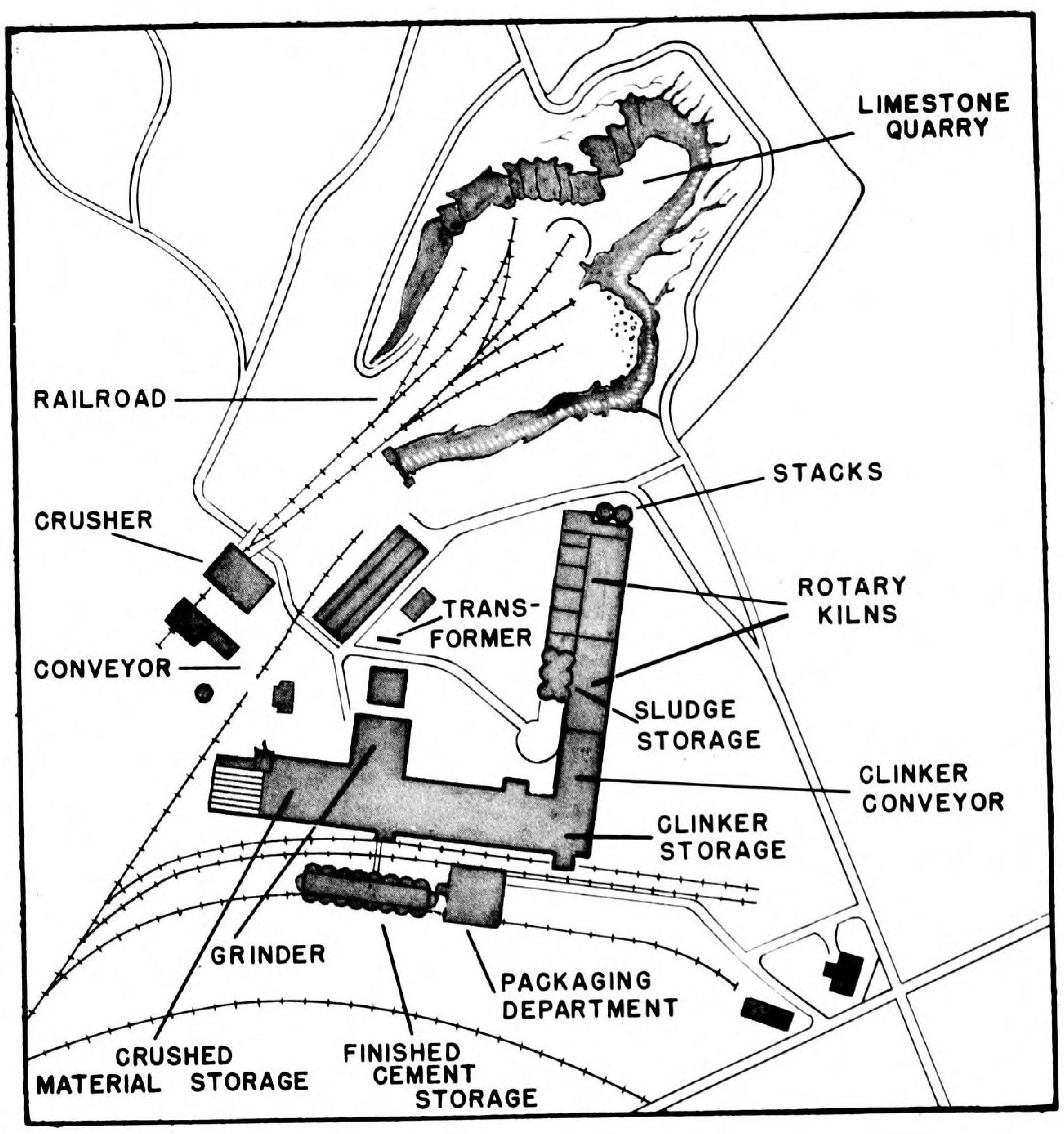


Vital Installations: A.
B.
C.

NOTE: Many Japanese cement plants import the limestone used.

1. No limestone will be observed.

2. The plant will probably be located on navigable water.



DISTINGUISHING CHARACTERISTICS

1. Steamlike smoke issuing from a stack or stacks at the end of a long narrow one-story building, frequently the longest single building in the plant.

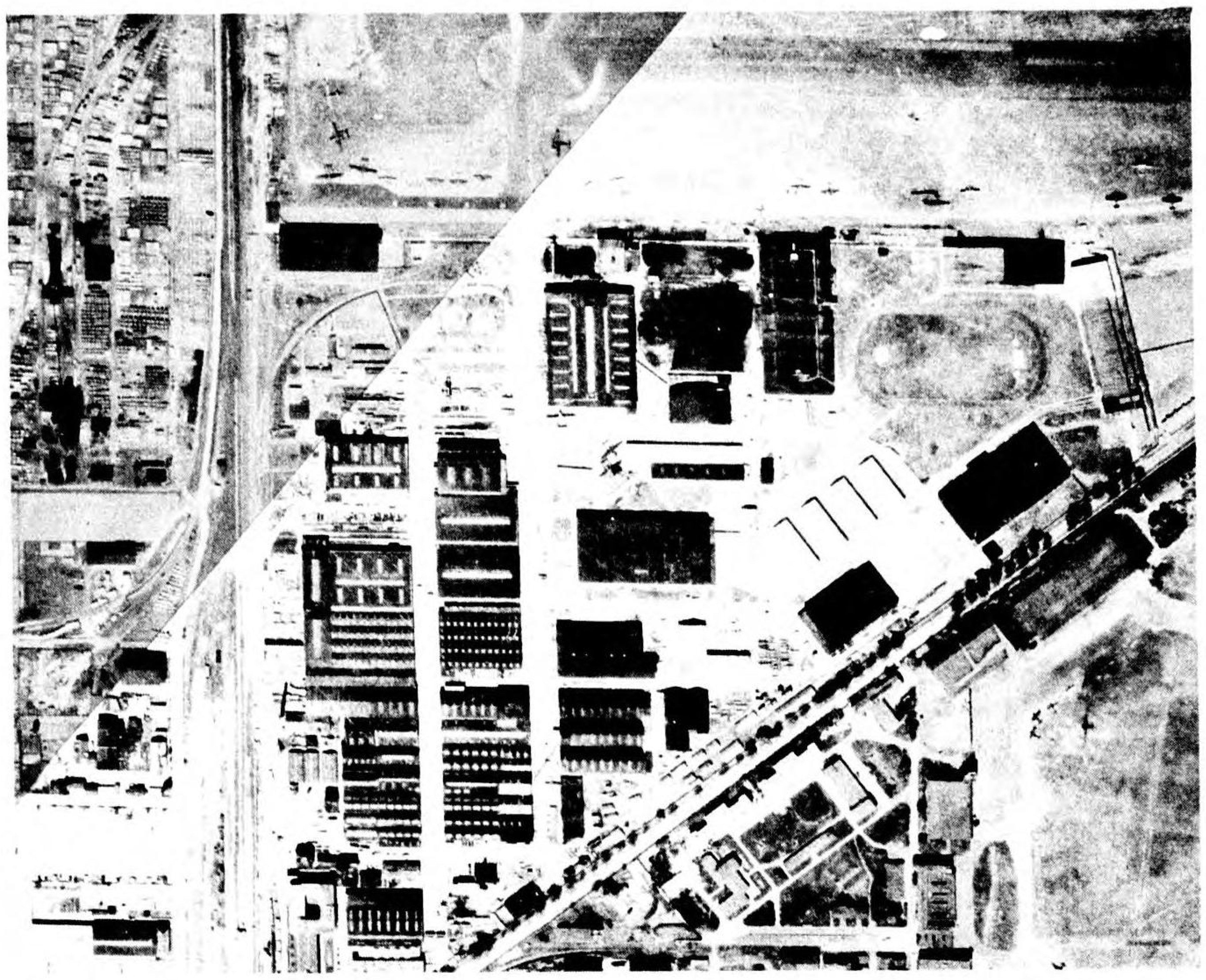
2. Open pit limestone quarry; narrow gauge railroad tracks leading from quarry to plant.

3. Storage silos for finished cement.

4. Crusher building at head of narrow gauge railroad tracks.

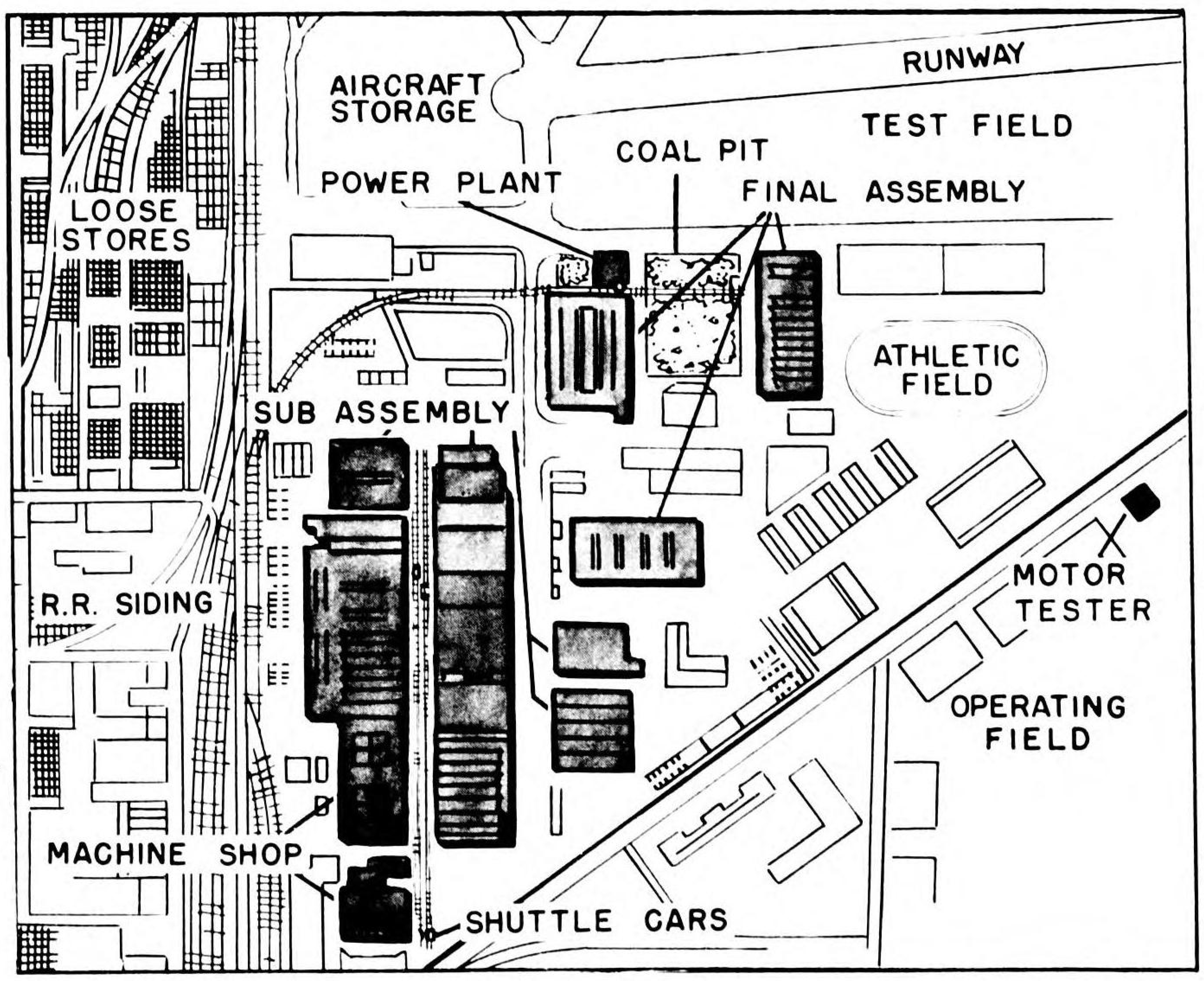
DISTINGUISHING CHARACTERISTICS

1. Landing field adjacent to plant for aircraft tests.
2. Storage area for finished planes awaiting shipment.
3. Final assembly building at edge of landing field; it resembles a hangar with a sawtooth roof.
4. All buildings usually one story in height.
5. Electricity the source of power; there may be a steam power plant or a transformer with incoming power lines.



CYCLE OF OPERATIONS

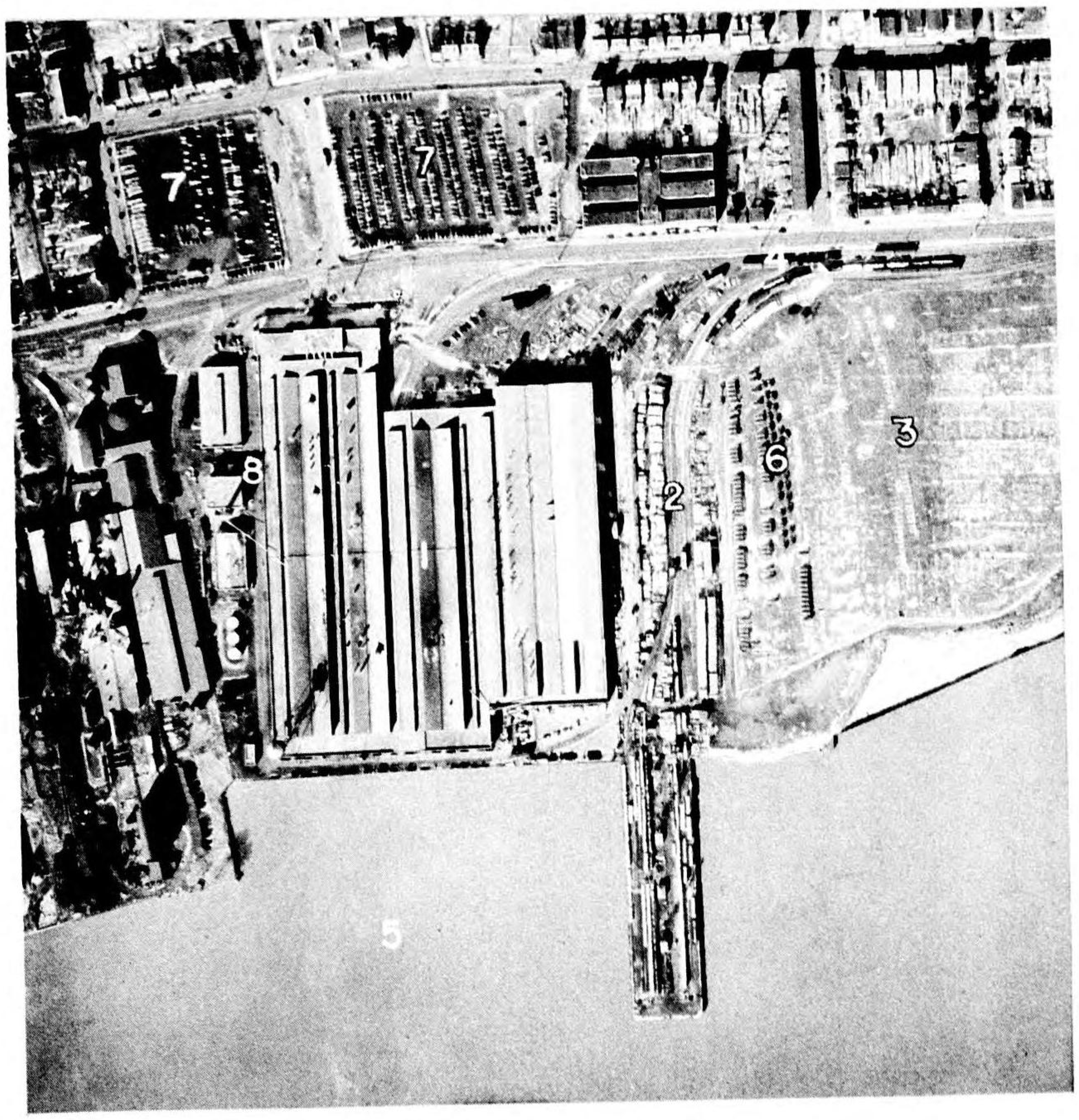
1. Railroad for transporting heavy material to plant.
2. Machine shops and assembly buildings in assembly line layout; buildings are usually characterized by roof construction permitting maximum number of skylights.
3. Final assembly building.
4. Aircraft test field.
5. Steam power plant or transformer with incoming power lines.



INDUSTRY

ASSEMBLY PLANTS

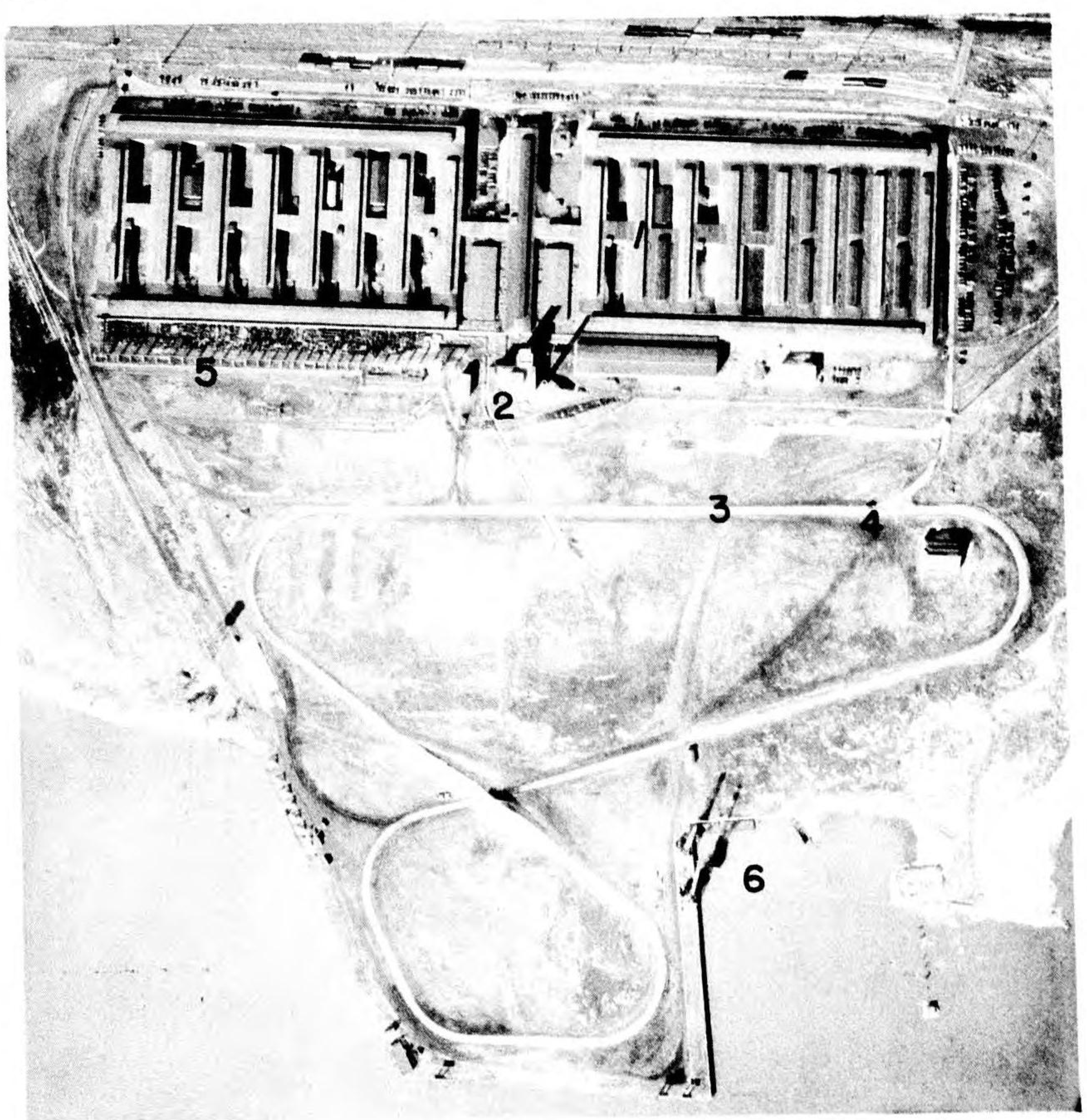
MOTOR VEHICLE



DISTINGUISHING CHARACTERISTICS

1. Assembly.
2. Storage of component parts.
3. Storage yard.
4. Railroad.
5. Water transportation often available.
6. Military vehicles. (note uniformity) Test track sometimes present.
7. Non-military vehicles.
8. Steam power.

TANK

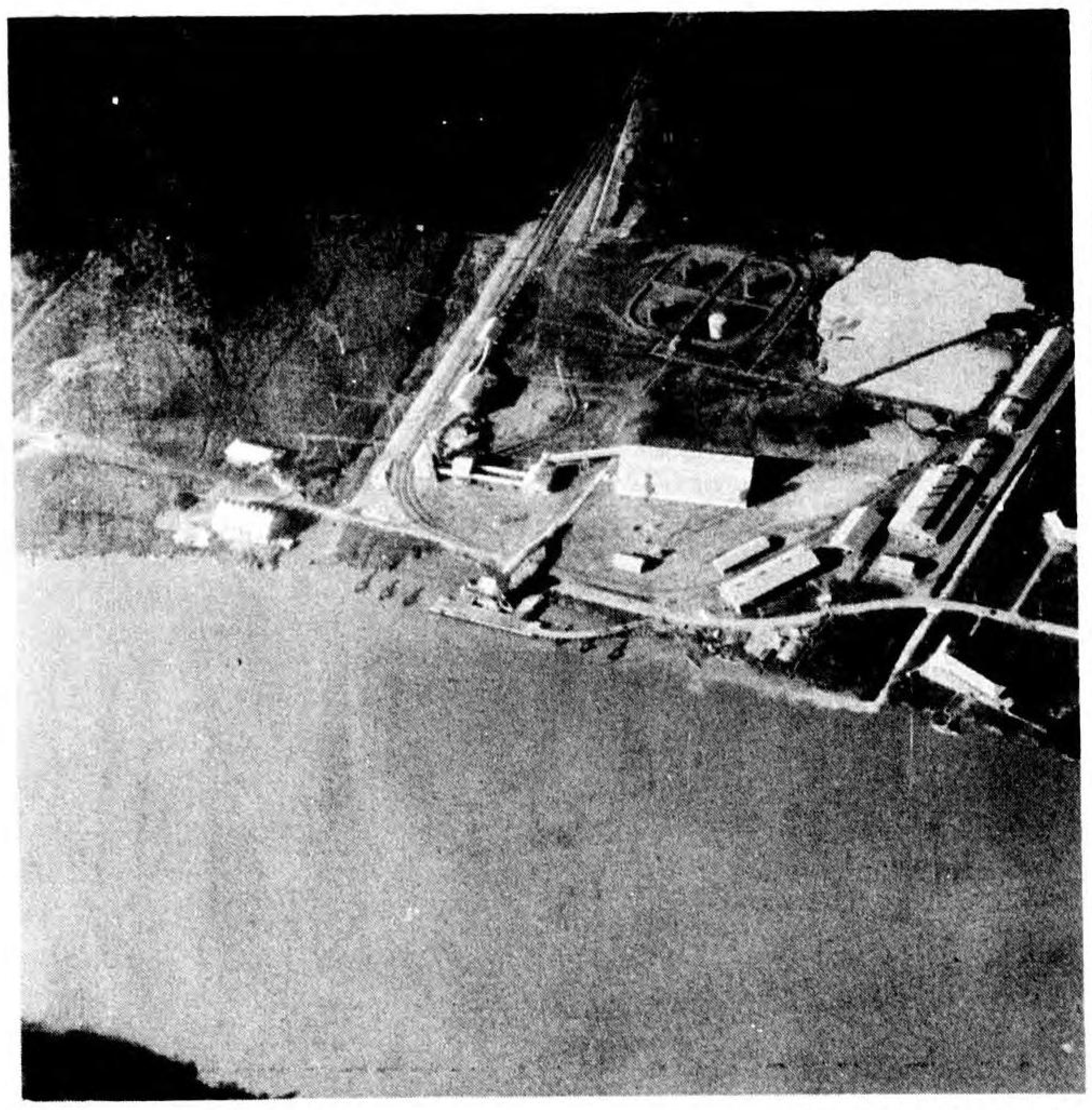


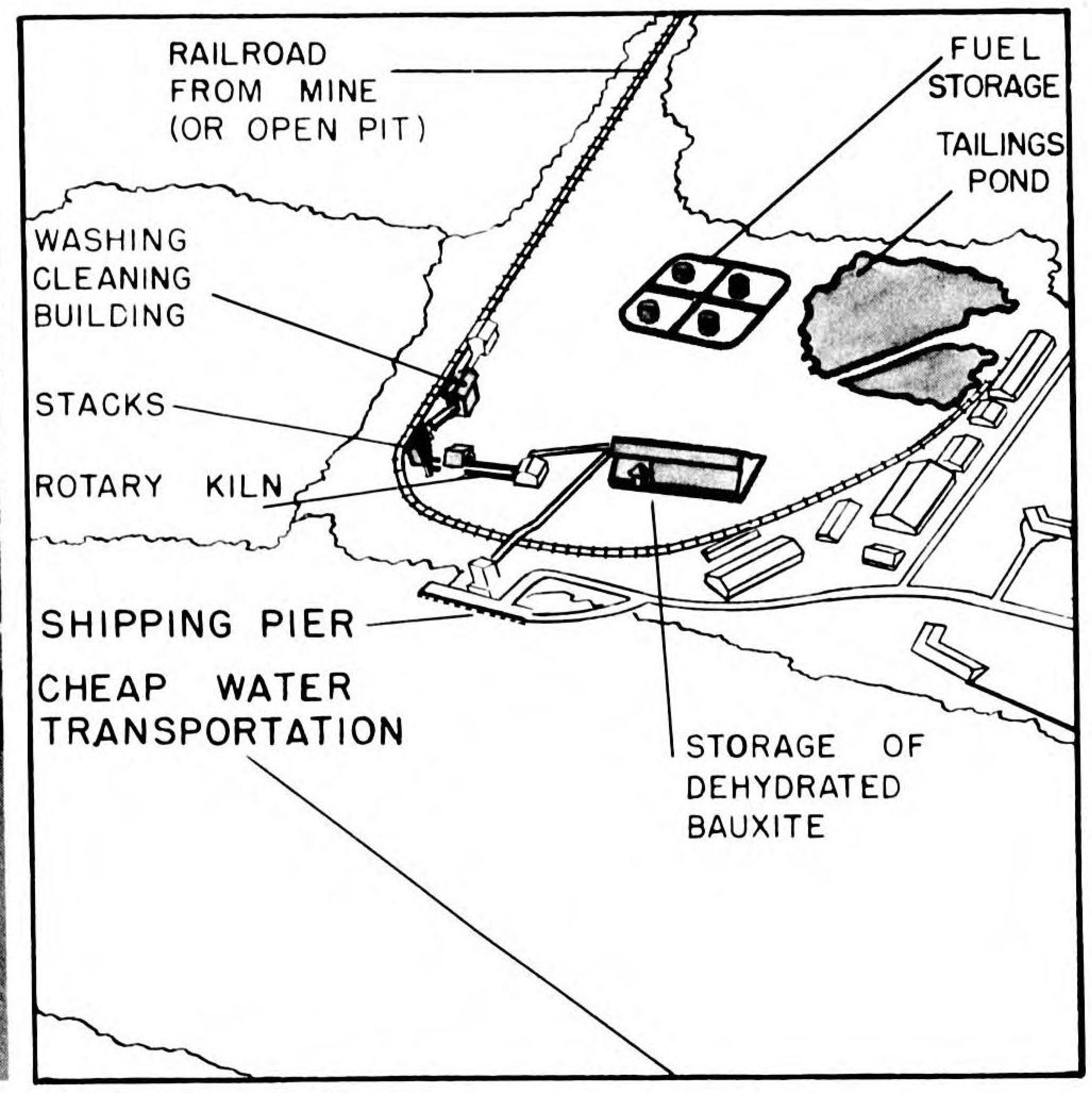
DISTINGUISHING CHARACTERISTICS

1. Assembly.
2. Steam power.
3. Test track.
4. Tank.
5. Overhead crane.
6. Hammerhead cranes. (This plant was converted from locomotive assembly)

The Aluminum Industry is divided into five sections: 1. Bauxite Mine, 2. Drying Station, 3. Alumina Plant, 4. Aluminum Plant, and 5. Fabrication.

BAUXITE





BAUXITE DRYING STATION

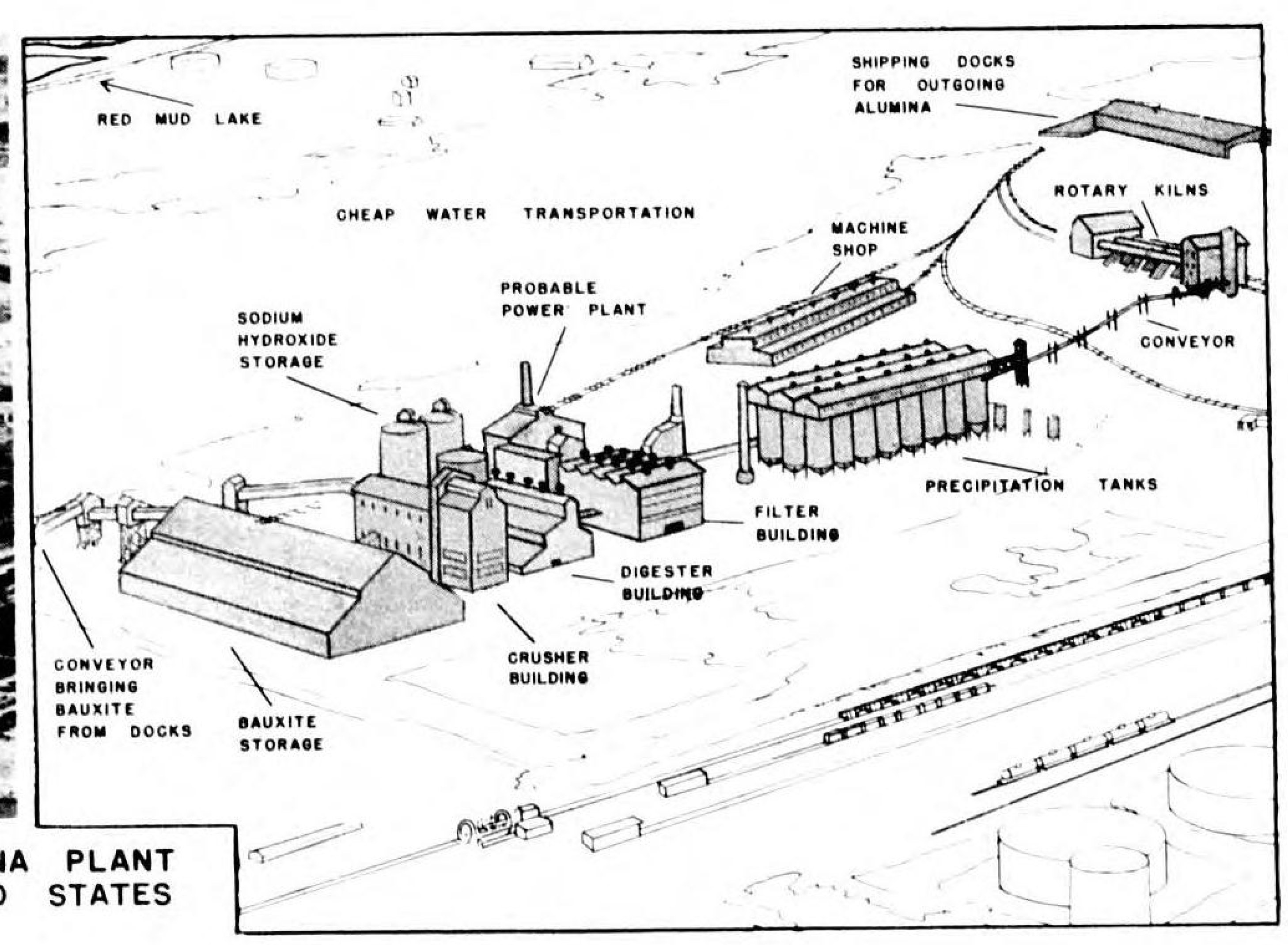
DISTINGUISHING CHARACTERISTICS:

1. Bauxite storage warehouse, (note the characteristic shape.)
B. 2. Rotary kilns.
A. 3. Precipitation tanks.
4. Conveyor system between buildings.
5. Dock and rail facilities
6. Storage tanks for sodium hydroxide.
7. Red mud lake for residue; often piped some distance from plant.

CYCLE OF OPERATIONS:

1. Bauxite stored on arrival from mine.
2. Bauxite crushed in crusher building.
3. In digester building bauxite treated with sodium hydroxide.
4. In filter building, impurities are removed.
5. Precipitation tanks remove alumina from solution.
6. Rotary kilns dry alumina.
7. Alumina stored before shipment to aluminum plant.

ALUMINA

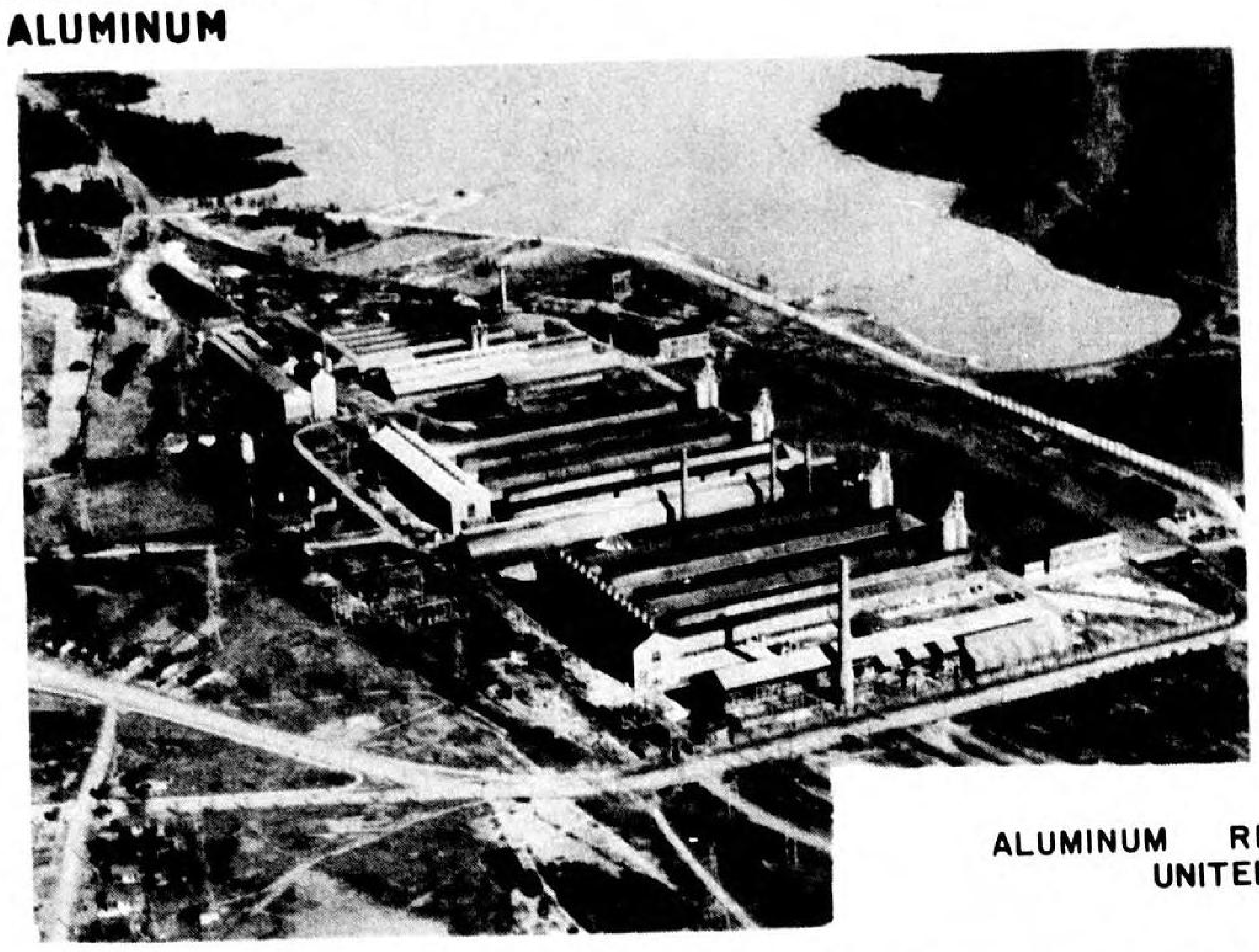


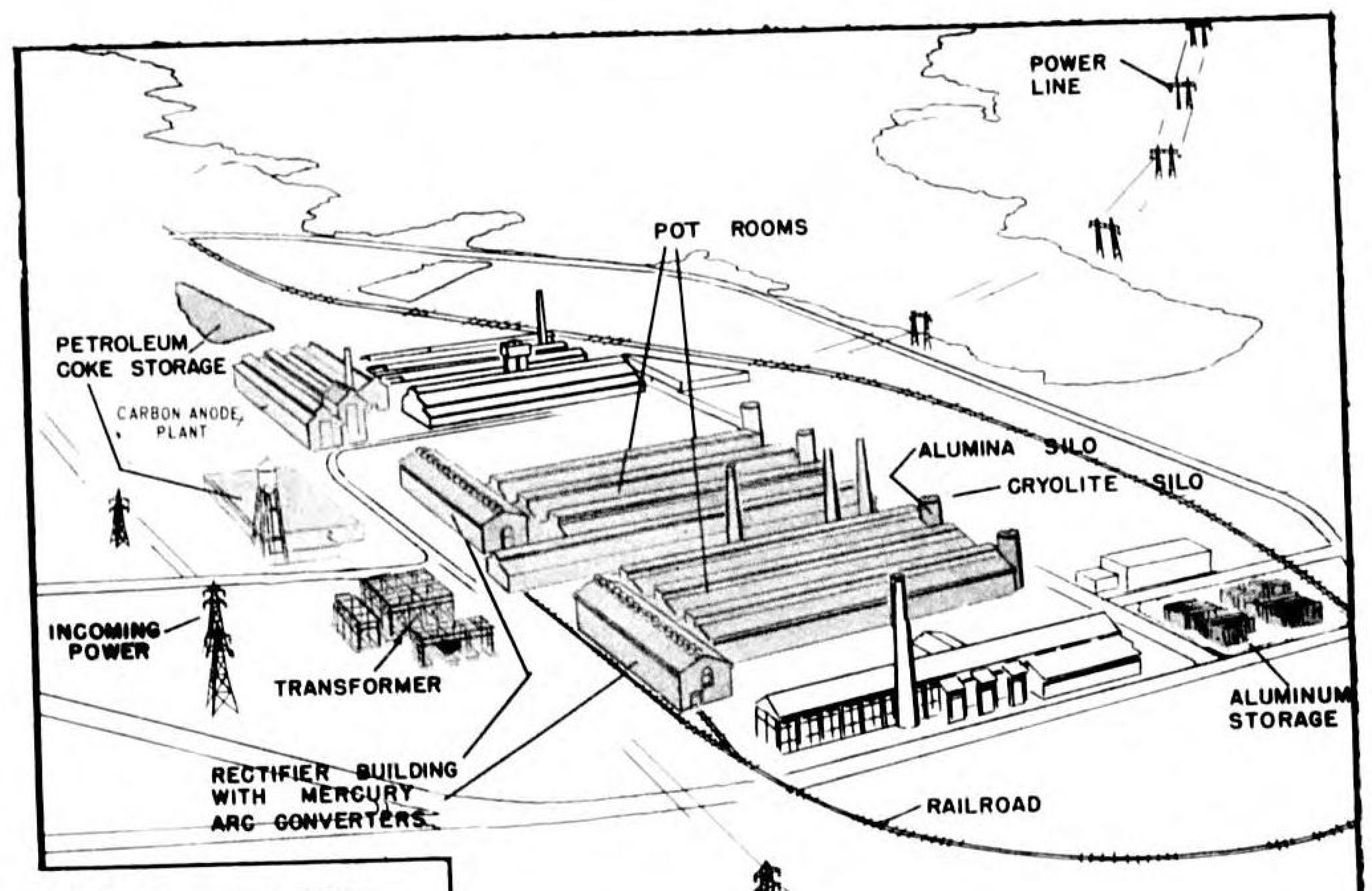
ALUMINA PLANT UNITED STATES

INDUSTRY

ALUMINUM (CONT.)

ALUMINUM





ALUMINUM REDUCTION PLANT
UNITED STATES

DISTINGUISHING CHARACTERISTICS

A. 1. 'T' shaped buildings with mercury arc converters as crossbars and pot rooms as uprights. (Note: many months necessary to replace mercury arcs; destruction of pot room 'freezes' aluminum in pots.

D. 2. Silos at end of pot rooms for storage of alumina and cryolite.

B. 3. Transformers and power lines.

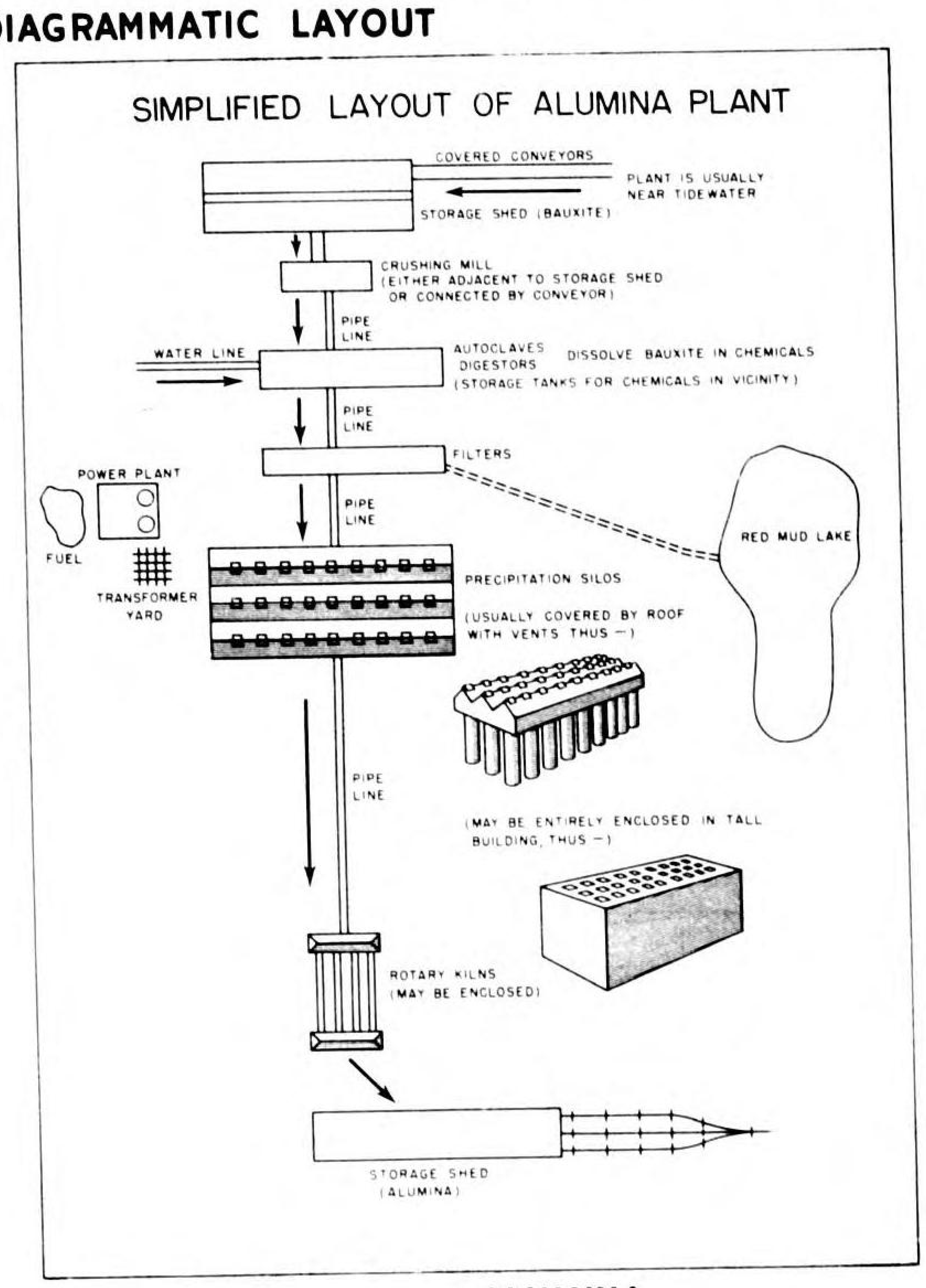
4. Aluminum ingots stored in open.

C. 5. Carbon anode plant associated; usually a tall stack, preparation rooms and baking ovens.

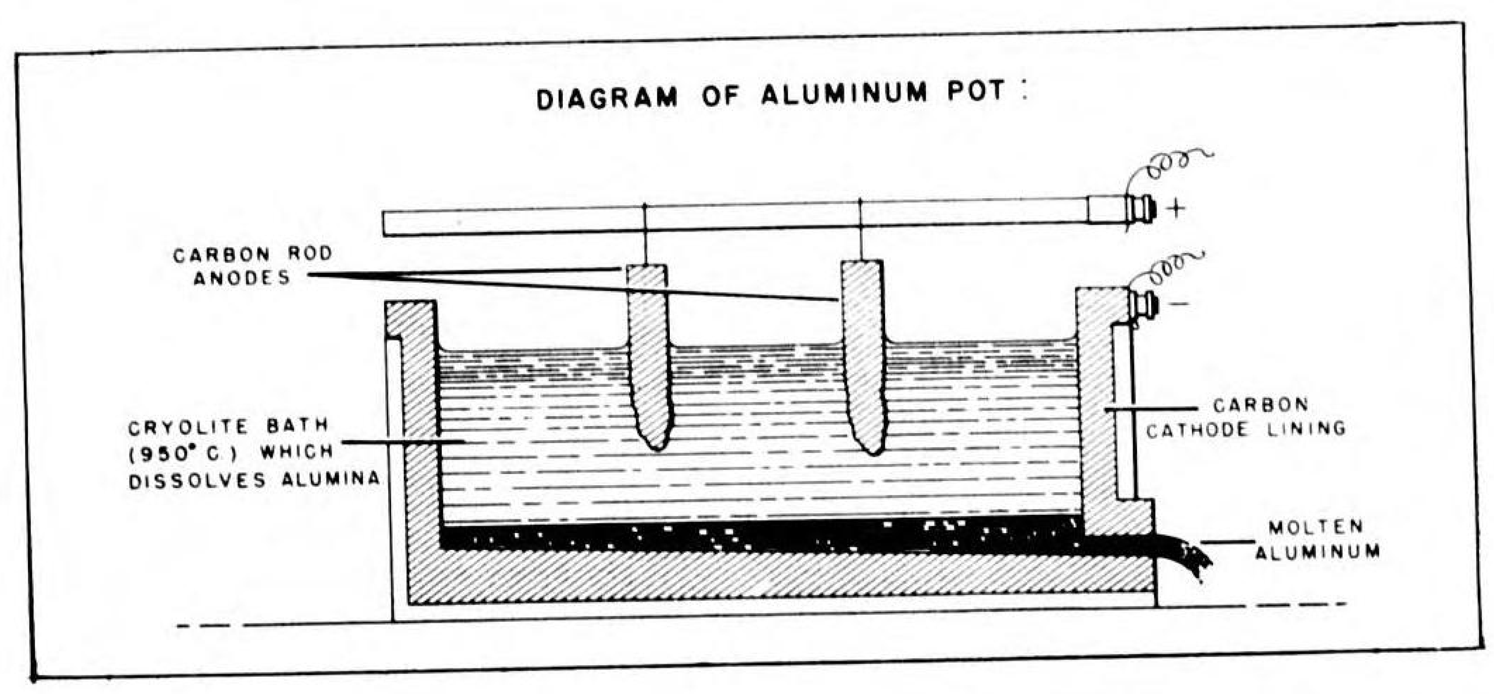
CYCLE OF OPERATION

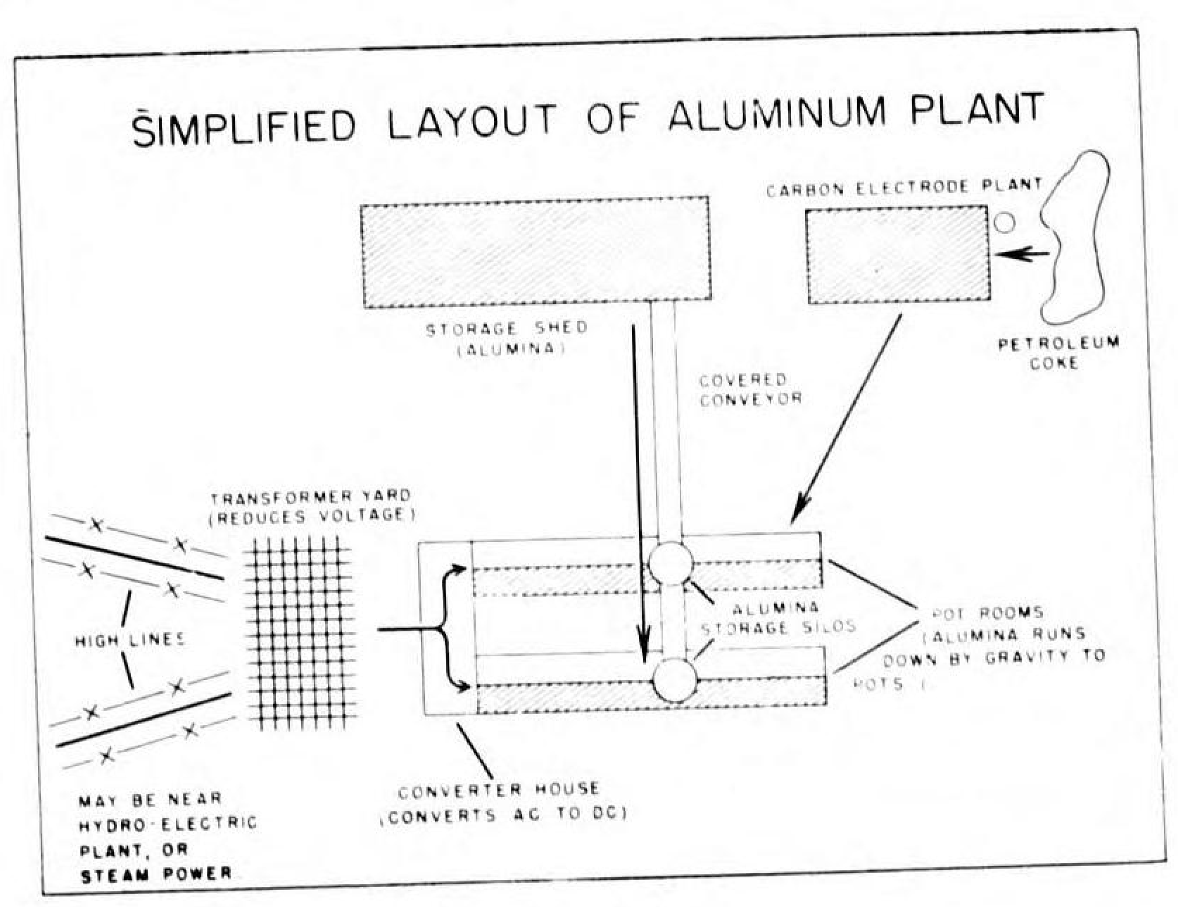
1. Alumina shipped in from alumina plant.
2. In the pot rooms alumina is reduced to aluminum by an electric furnace using carbon anodes and cathodes, and cryolite as a flux.
3. Aluminum stored in the open prior to shipment to a fabricating plant.

DIAGRAMMATIC LAYOUT



ALUMINA





ALUMINUM

1. Fabrication Plants have the appearance of rolling mills. (See Iron and Steel)
2. In some countries the five sections are located in different areas, many miles apart. In other countries (ex. Germany) all five sections are at the same plant.
3. The Alumina Plant is the most vital of the five divisions.

SMELTER

DISTINGUISHING CHARACTERISTICS OF SMELTERS

1. Rail connections with mine nearby.

2. Large dumps of waste rock.

3. One or more large stacks. These stacks are very tall, they may be placed on top a nearby hill or at some distance from the plant. There will be a connection at the base of the stack to the roasting ovens, the most vital installations.

REFINERY

DISTINGUISHING CHARACTERISTICS

A. 2. Large flat building (casting house) with ventilators on roof and tall stack.

B. 3. A visible source of electricity serving another large flat building (the tank house). This electric power:

(a) Purchased power: lines running to a switching station and/or a power house.

(b) Private power: a thermal electric power plant, possibly built inside the tank house.

C. 4. Tank house.

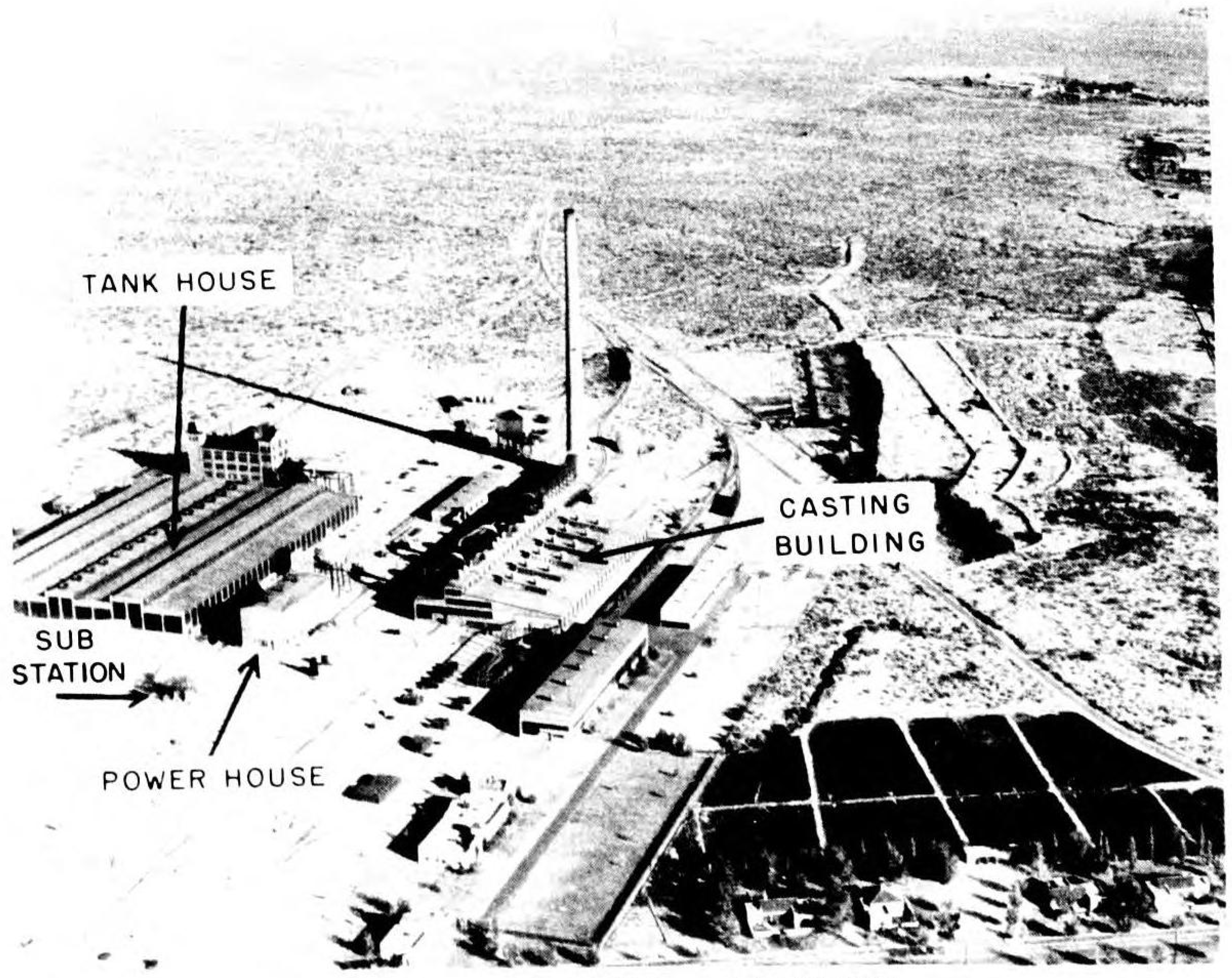
CYCLE OF OPERATIONS

1. Smelted copper is brought to the refinery by railroad and cast into anodes.

2. In the tank house it is purified of its gold and silver elements by the electrolytic process.

3. A solution of copper sulphate for use in the electrolytic process is maintained in the water treatment house, a small building either contained inside the tank house or auxiliary to it.

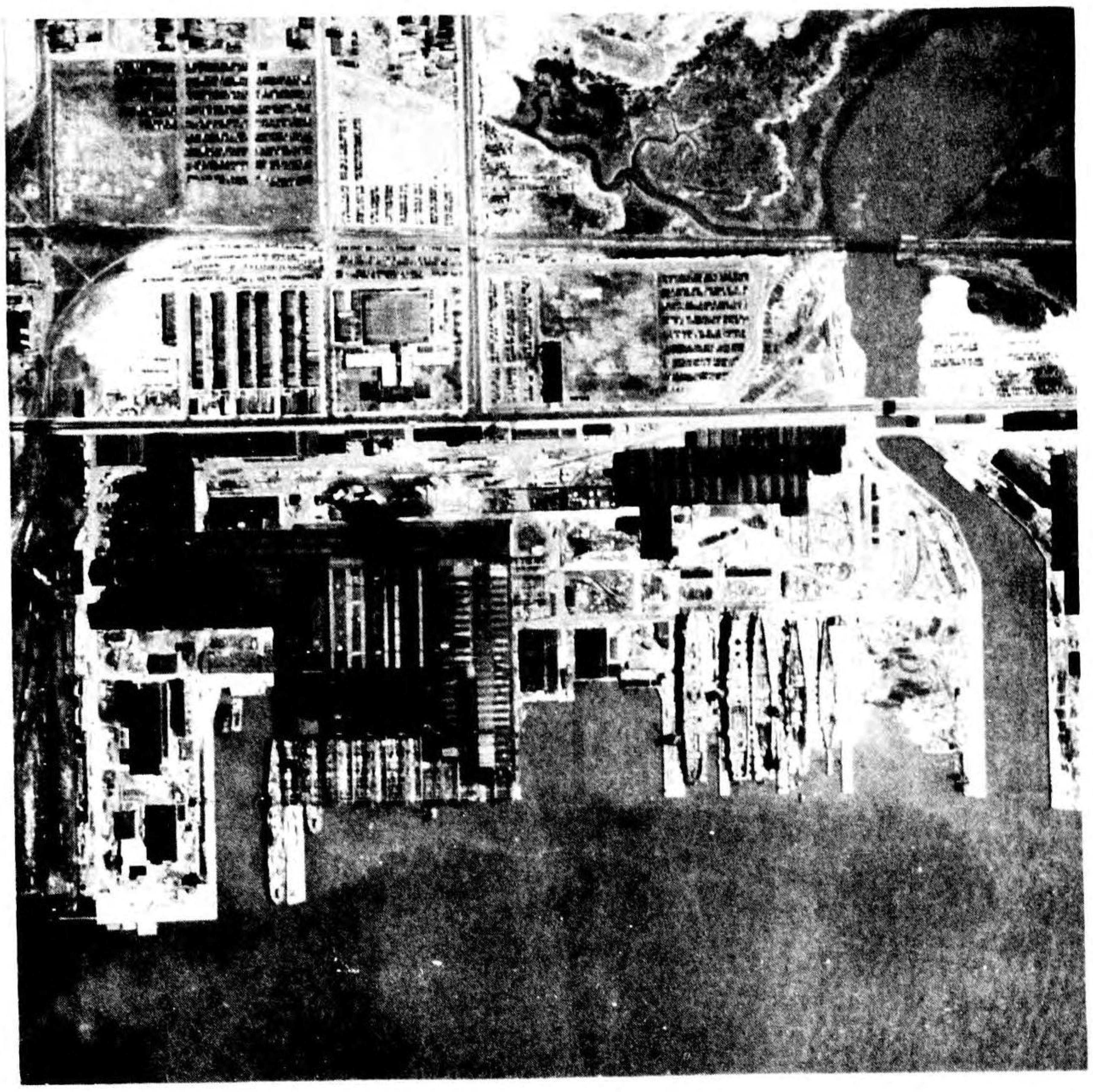
4. In the casting house the purified copper is melted down and cast into ingots.



UNITED STATES

NOTE: In most metal industries there are two distinct processes: Smelting and Refining. The smelter, located in the mining district, separates the ore from the gangue by mechanical methods, such as floatation, and isolates the metal from the ore by chemical methods, such as roasting. The refinery, located in the consuming districts, purifies the metal. When the mining and consuming districts coincide or economic conditions permit, both operations are done at the same time - as is sometimes the case in Alumina-Aluminum and Iron-Steel (refined iron).

INDUSTRY
SHIPBUILDING



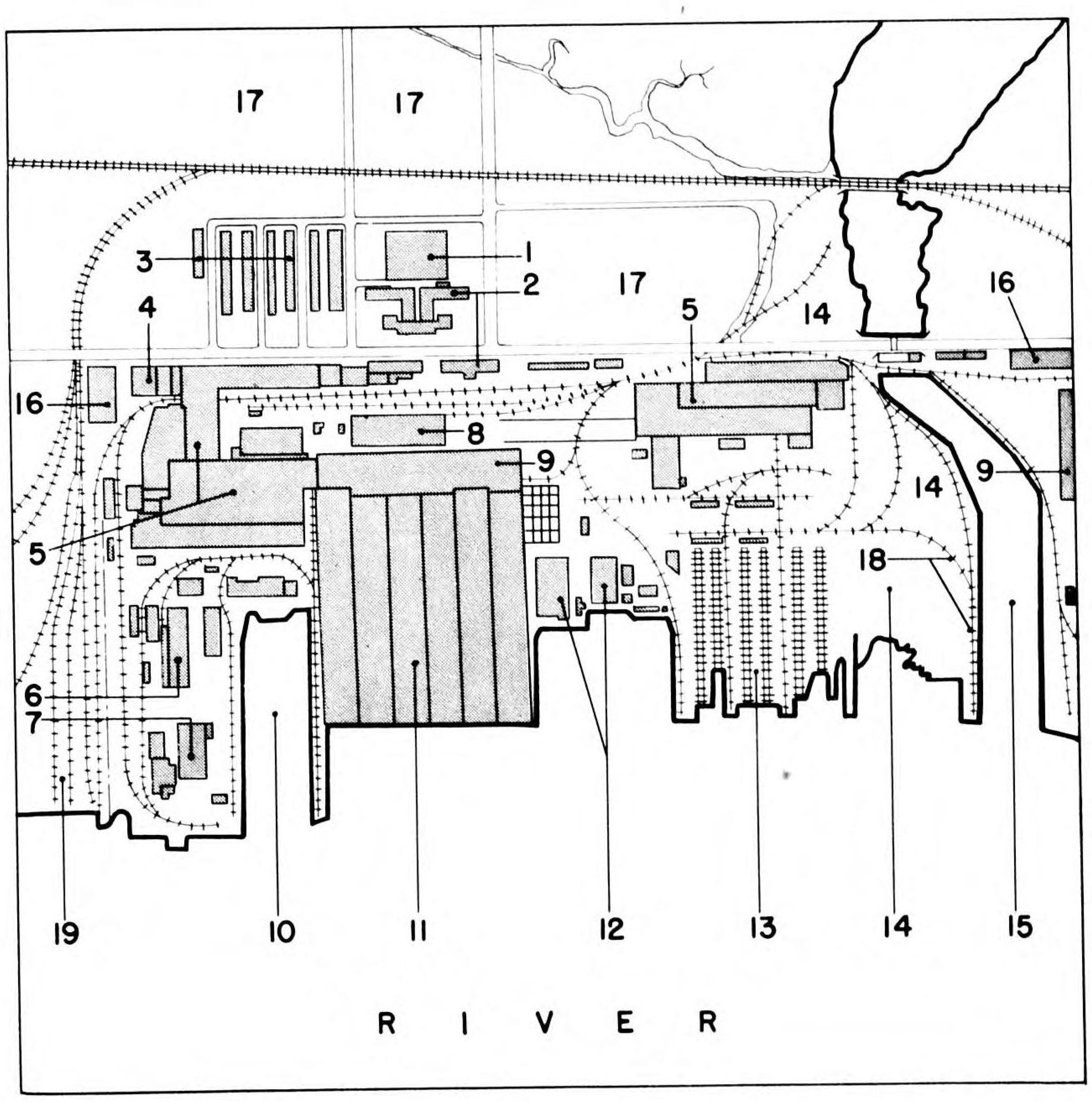
CYCLE OF OPERATIONS

1. MATERIAL: Steel and material by rail and water to open or covered storage thence to shops.

2. FABRICATION: Units fabricated in shops thence by rail and cranes to hull.

3. HULL ERECTION: Keel laid and ship's hull erected on ways.

4. LAUNCHING & FITTING OUT: After launching, ship is tied up for fitting out (installation of machinery, armament and rigging.)



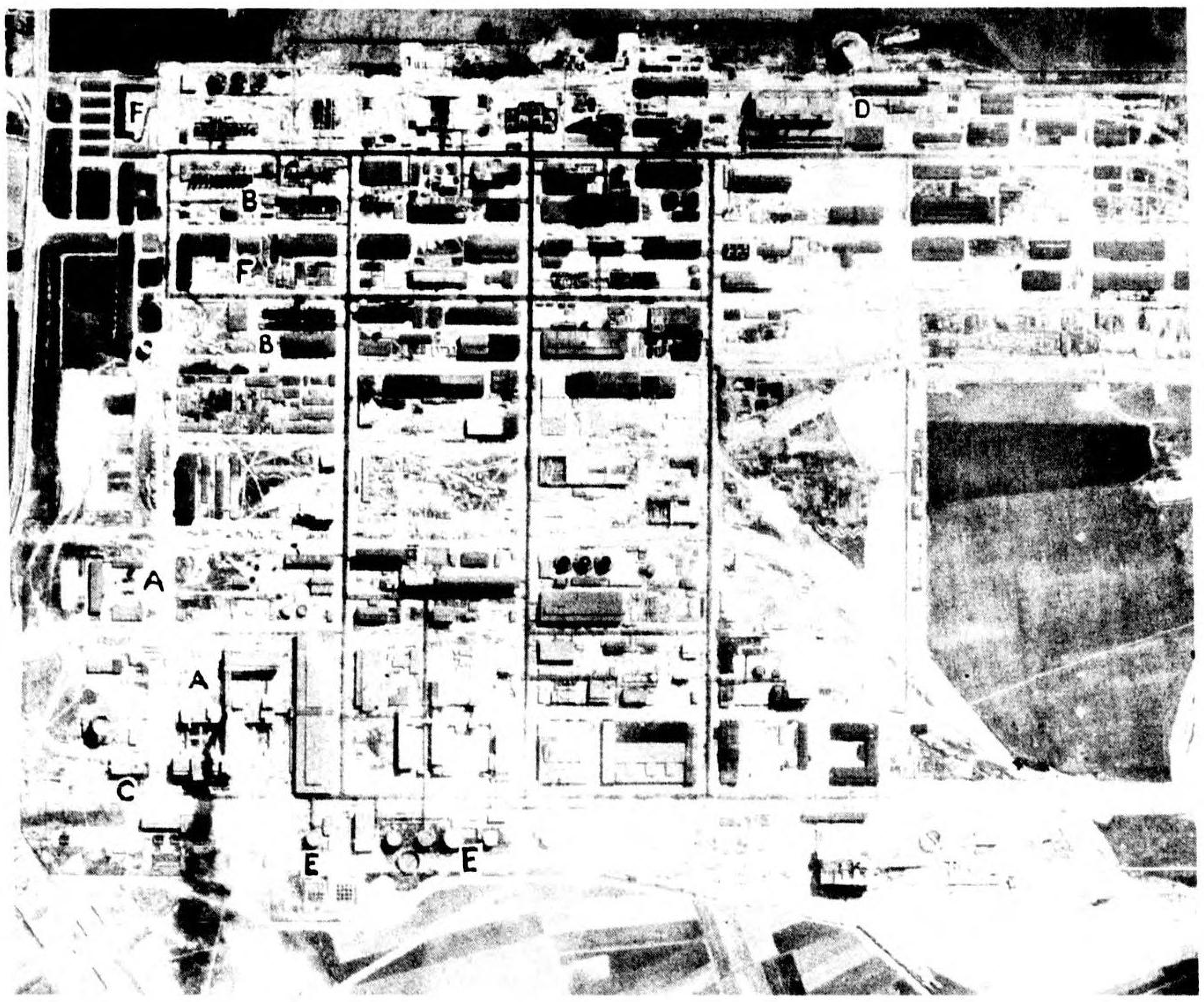
DISTINGUISHING CHARACTERISTICS

1. Mold loft
2. Administration
3. Workers' housing
4. Pattern shop
5. Fabricating shop
6. Outfitting storage
7. Copper shop
8. Power house
9. Machine shop
10. Outfitting basin
11. Covered ways
12. Sheet metal shop
13. Open ways
14. Plate and shape storage
15. Barge landing basin
16. Warehouse
17. Parking
18. Interyard railway
19. R.R. Storage yard

VITAL INSTALLATIONS:

A.
B.
C.
D.
E.
F.

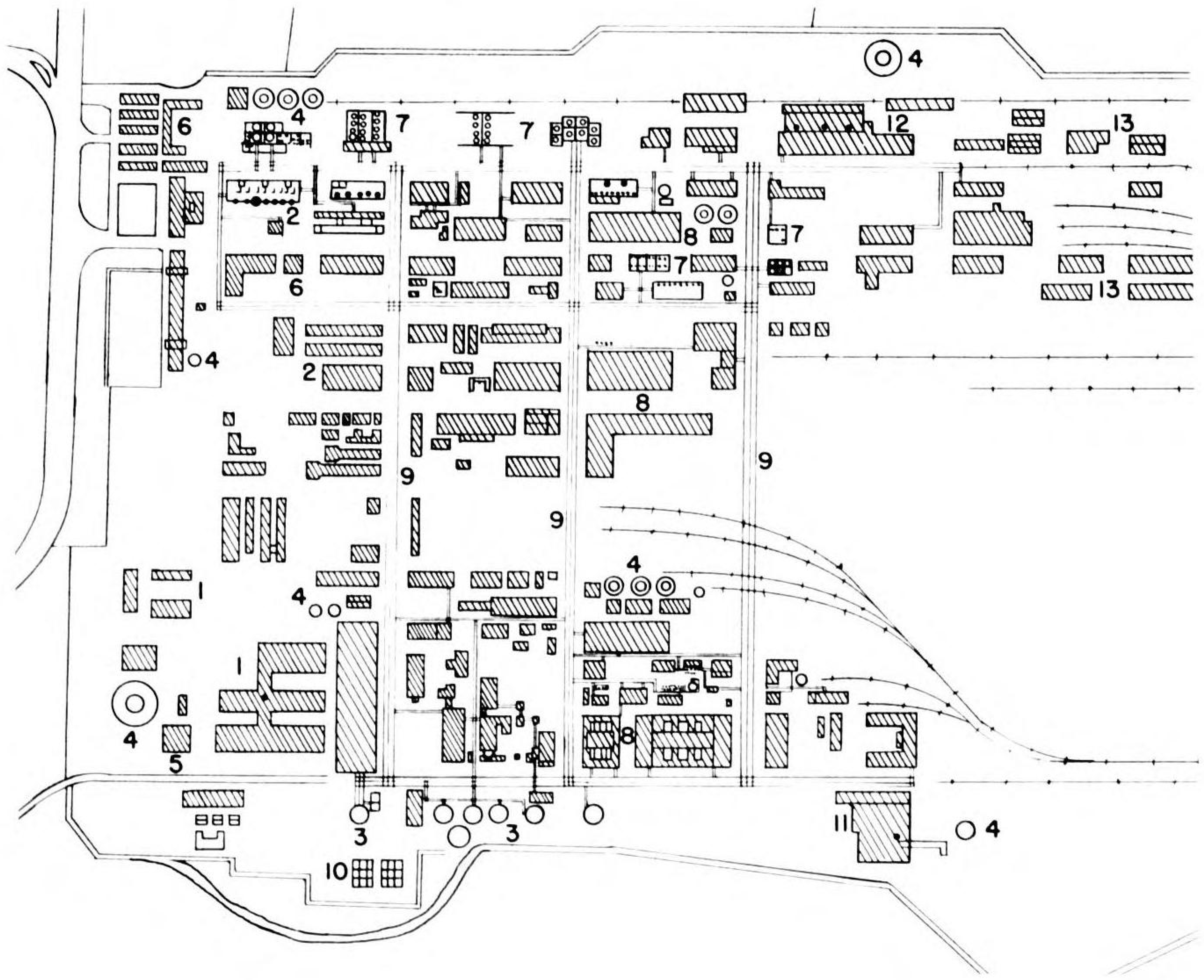
(Outward appearance of synthetic rubber plants tend to vary considerable)



SYNTHETIC RUBBER PLANT

DISTINGUISHING CHARACTERISTICS

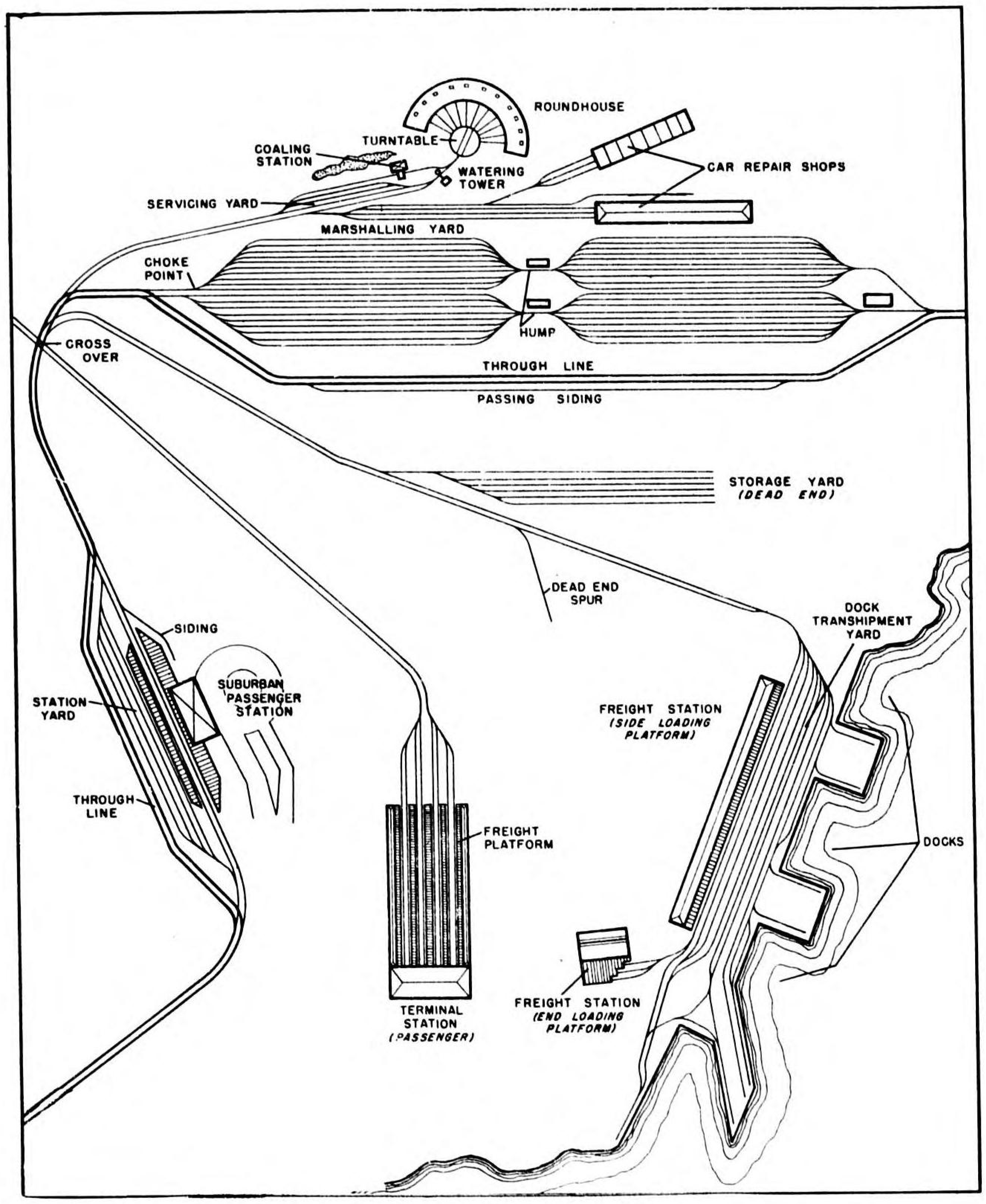
1. Carbide Plant
2. High Pressure Synthesis Cylinders
3. Acetylene Gas Storage
4. Cooling Towers
5. Transformers Station
6. Main Officer and Laboratories
7. Storage Tanks
8. Probable Finishing Houses
9. Overhead Pipe Lines
10. Reservoir
11. Lime Plant
12. Probable Steam Plant
13. Warehouses
14. Railway Sidings.



INDUSTRY
RAILROAD YARDS

VITAL INSTALLATIONS:

1. Rolling Stock
2. Tracks
3. Roundhouse
4. Repair Shops
5. Freight

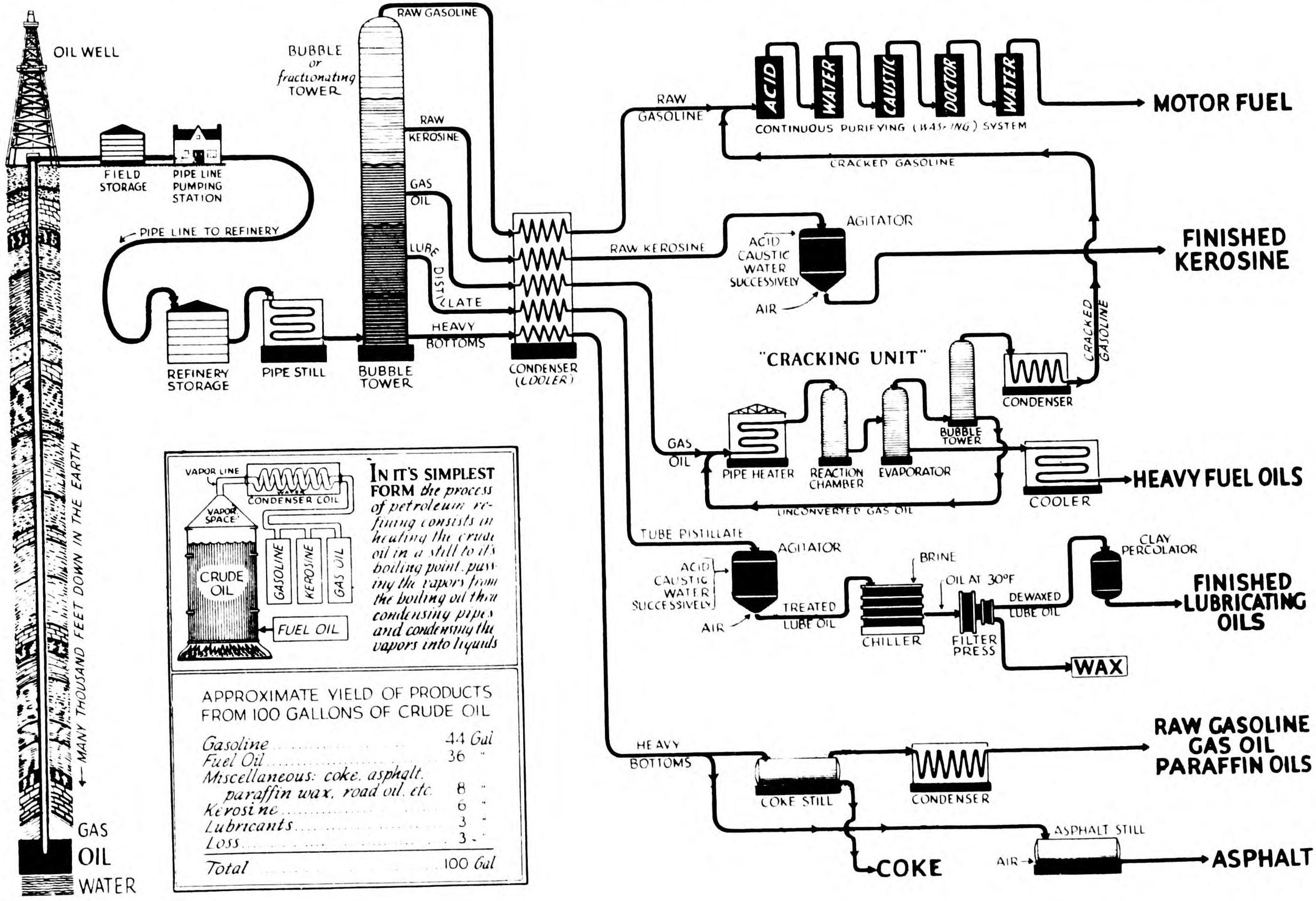


FIXED INSTALLATIONS

NURNBERG MARSHALLING YARDS (This is a one-way Yard)

(A) Reception Sidings.
(B) Sorting Sidings.
(C) Sorting Sidings for special traffic.
(D) Forwarding Sidings.
(E) Locomotive Depot.
(F) Railway Workshops.
(G) To REGENBURG.
(H) To AUGSBURG and FRANKFURT.

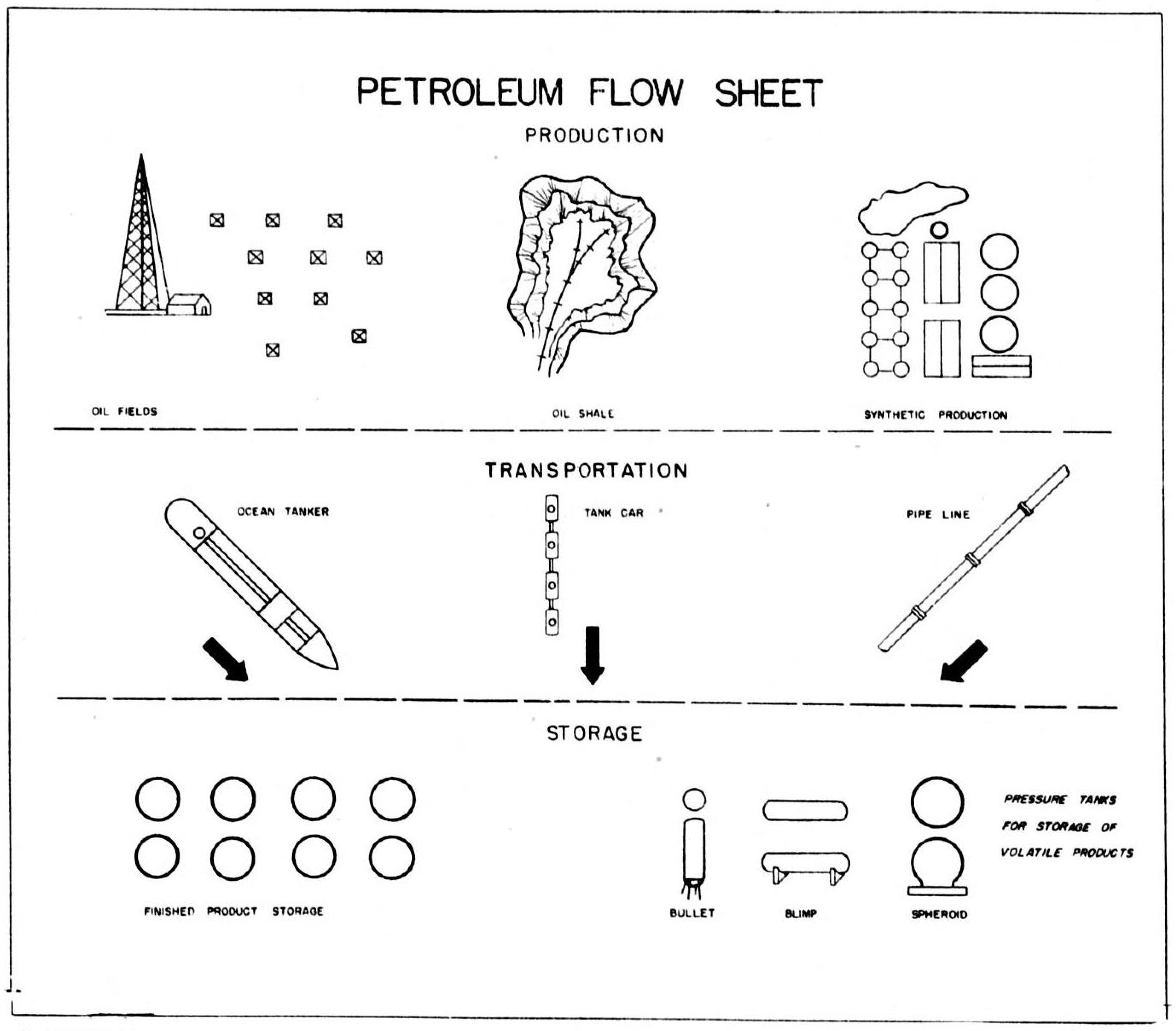
Typical FLOW CHART *tracing* crude oil *from well to finished product.*



APPROXIMATE YIELD OF PRODUCTS FROM 100 GALLONS OF CRUDE OIL

Gasoline	44 *Gal*
Fuel Oil	36 "
Miscellaneous: coke, asphalt, paraffin wax, road oil, etc.	8 "
Kerosine	6 "
Lubricants	3 "
Loss	3 "
Total	100 *Gal*

INDUSTRY
PETROLEUM (CONT.)

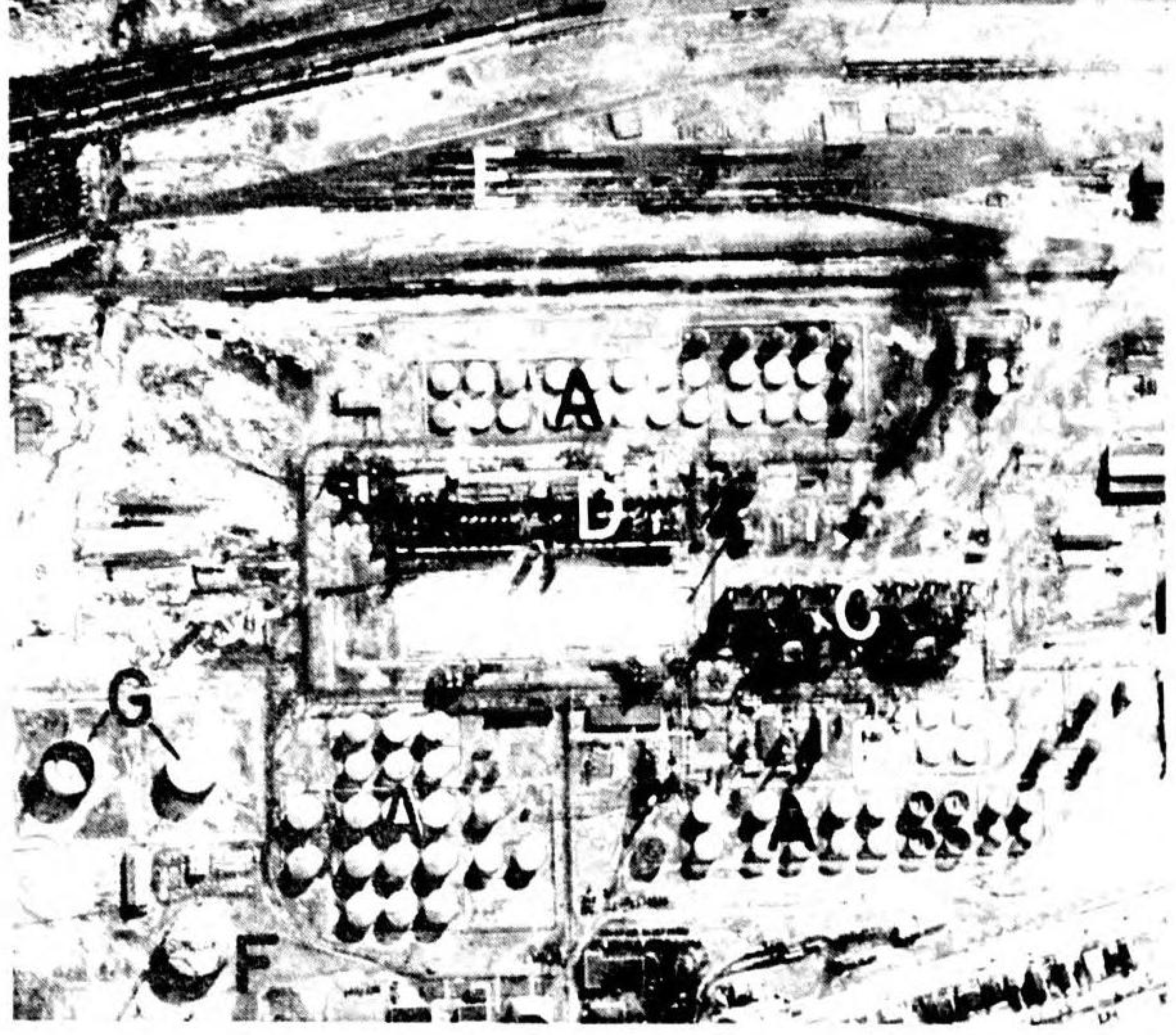


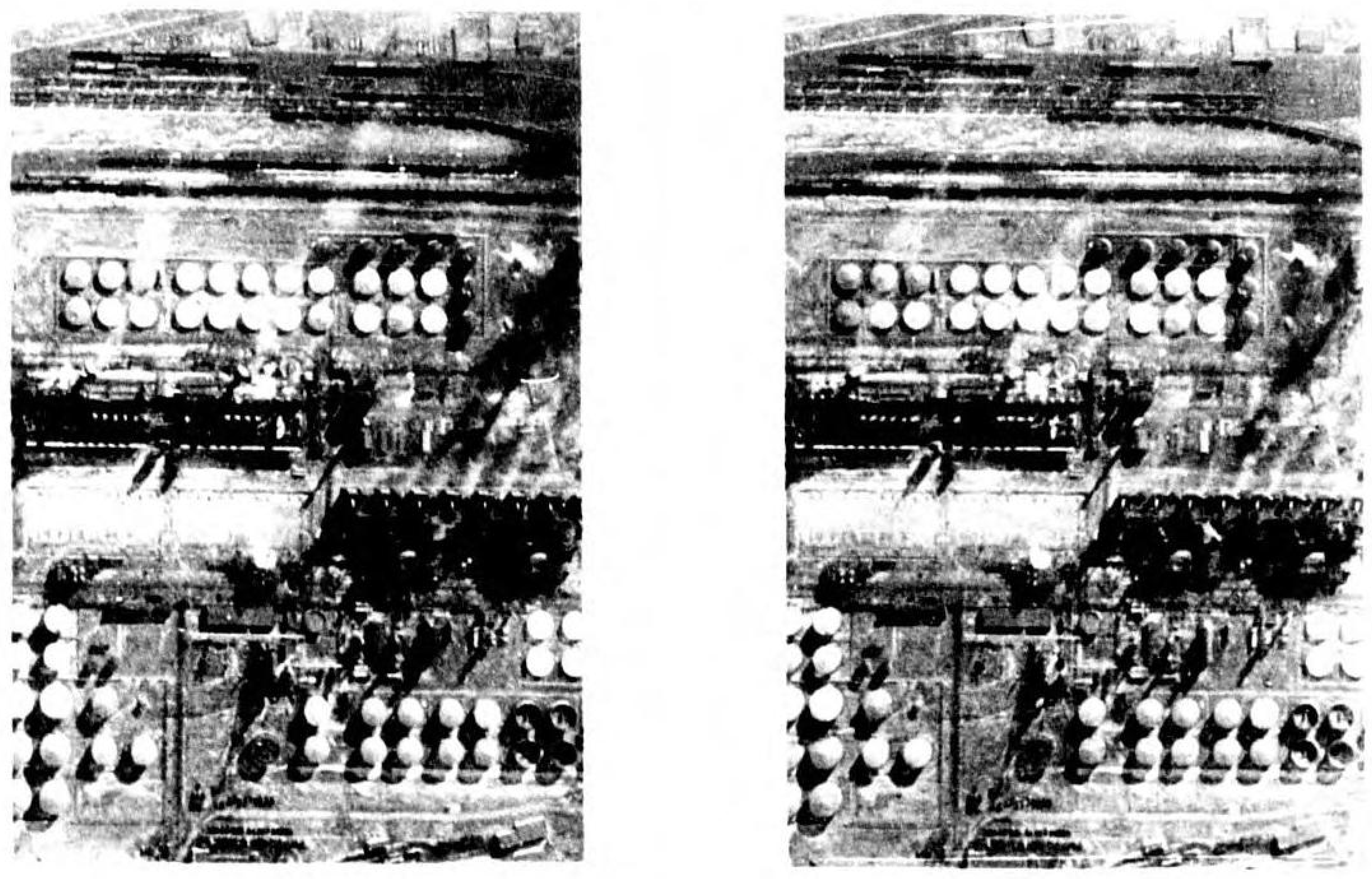
CYCLE OF OPERATIONS

1. Crude oil to tank farm storage by pipe line, tank car or bunkering pier.
2. Crude oil to fractioning tower.
3. Varicus distillates to small tanks.
4. Some distillate fractions are reworked under pressure in cracking plant to produce additional gasoline and/or other needed fractions.
5. Heavy distillates refined to lubricants, tars and waxes.
6. Storage and shipment of finished product.

DISTINGUISHING CHARACTERISTICS

1. Storage tanks for fractions
2. Storage tank farm
3. Fractioning (bubble) towers and/or | other type distillation units.
4. Cracking plant
5. Packing house for lubricants
6. Bunkering pier
7. RR tank car sidings





STEREO PAIR OF CRACKING TOWERS

A. Storage for petroleum fractions
B. Heat exchanger
C. 8 Large fractioning towers
D. Cracking plant
E. RR tank car storage
F. Wet gasometer for natural gas fraction
G. Floating top tank for highly volatile products
H. Pumping
J. Processing, canning and packing lubricants
K. Tank farm
L. Bunkering pier
M. Hi-test gasoline or equivelant in this type tank

NOTE: The vital installations in petroleum refineries are the producing rather than the storage units. These frequently appear as dark rectangular masses on aerial photographs and are commonly associated with many small storage tanks closely spaced.

INDUSTRY

PETROLEUM (CONT.)

OIL REFINERY AND HYDROGENATION PLANT

NOTE: In Germany, so called "synthetic oil" plants use the hydrogenation process with coal to produce oil. Such plants are characterized by cooling towers and a great number of storage tanks for wet gas, coal tars, and other by-products.

This plant in Italy uses the hydrogenation process to produce aviation gasoline and lubricating oil from low grade crudes.

CYCLE OF OPERATIONS

1. Coke or low grade crudes from storage tanks treated in hydrogenation stalls.
2. Treated crudes to distillation units.
3. Distillate to cracking units.
4. End products from cracking units to further refining in lubricating oil plant (elimination of wax or tar), and in butane-iso-octane plant (increase of octane and elimination of sulfur-dioxide).
5. Lubricating oil and aviation gasoline from refining units.
6. Other by-products include kerosene (from cracking units), asphalt (from distillation) and paraffin (from lubricating oil plant).
7. Storage and shipment.

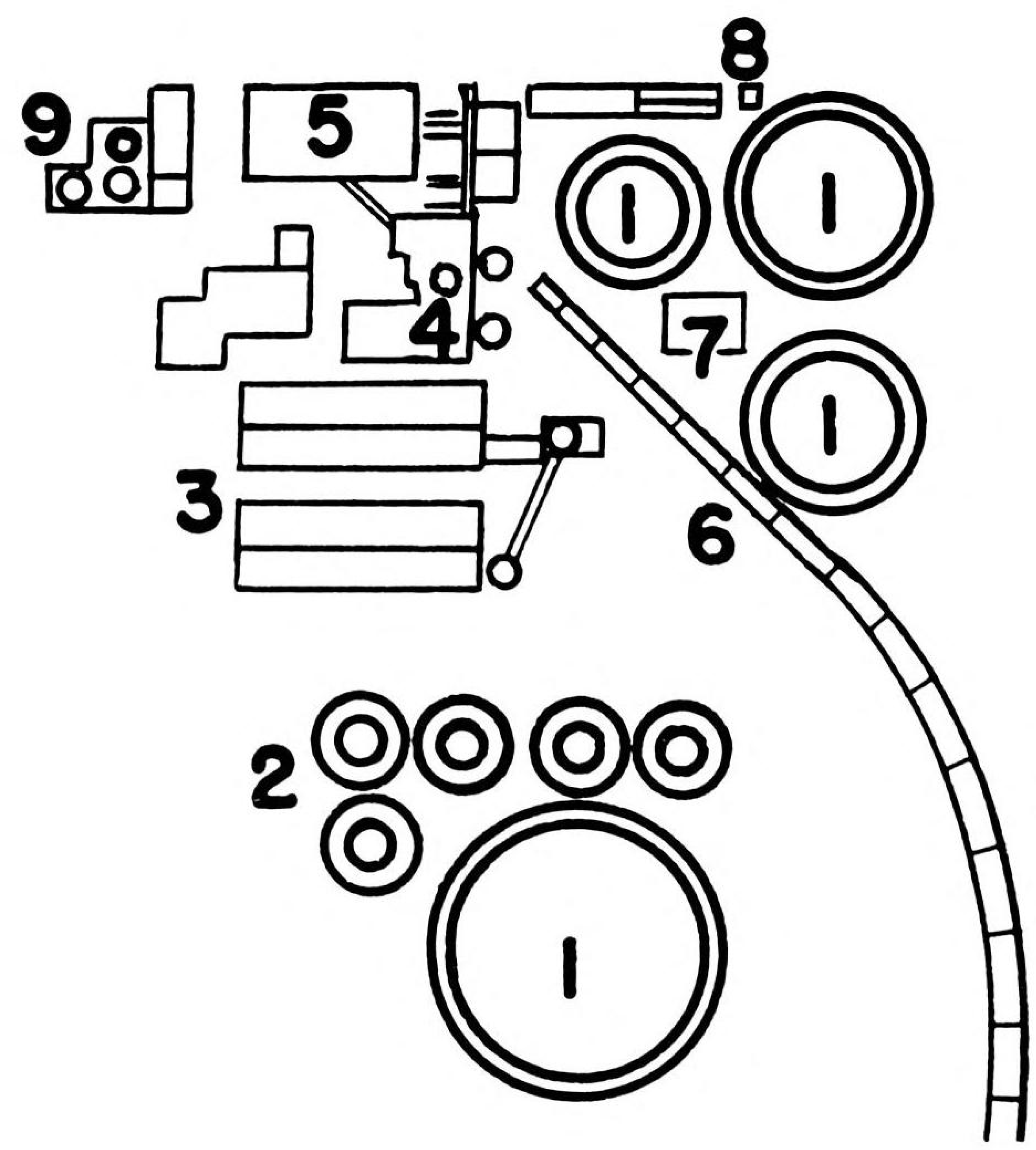
DISTINGUISHING CHARACTERISTICS

VITAL INSTALLATIONS

	1.	CRUDE OIL STORAGE TANKS.
	2.	INTERMEDIATE STORAGE TANKS.
	3.	COOLING TOWER.
J	4.	LUBRICATING OIL PLANT.
K	5.	BUTANE-ISO-OCTANE PLANT.
C	6.	DISTILLATION UNITS.
	7.	WATER TOWER.
	8.	COAL BUNKER.
B	9.	PYROLYTIC CRACKING UNITS.
A	10.	BOILER HOUSE AND POWER PLANT.
G	11.	COMPRESSOR HOUSE.
D	12.	HYDROGENATION STALLS.
F	13.	INJECTOR HOUSE.
	14.	WET GAS HOLDERS.
	15.	BUTANE STORAGE TANK.
H	16.	PROBABLE ELECTROLYTIC HYDROGEN PLANT
	17.	LARGE DRY GAS HOLDER.
E	18.	METHANE-STEAM PLANT.
I	19.	GASOLINE STORAGE TANKS.
	20.	PACKING HOUSES FOR LUBRICATING OILS, PARAFFIN, ETC.
	21.	OFFICE BUILDINGS.
L	22.	TRANSFORMER STATION.

STEREO PAIR OF GAS PLANT

V I T A L   I N S T A L L A T I O N S : A, B, C, D, E, F.



DISTINGUISHING CHARACTERISTICS

1. Wet gas holders
2. Natural gas storage
3. Retort houses
4. Condensers, scrubbers
5. Purifier
6. Elevated track for coal cars
7. Tar and other by-product storage
8. Meter house
9. Tar and by-product storage

CYCLE OF OPERATIONS

1. Coal and natural gas burned in retort house to produce coal gas.
2. Coal gas to condensers and scrubbers; tar and other by-products to storage.
3. Cleaned gas to purifier.
4. Purified gas to storage in wet gas holders.

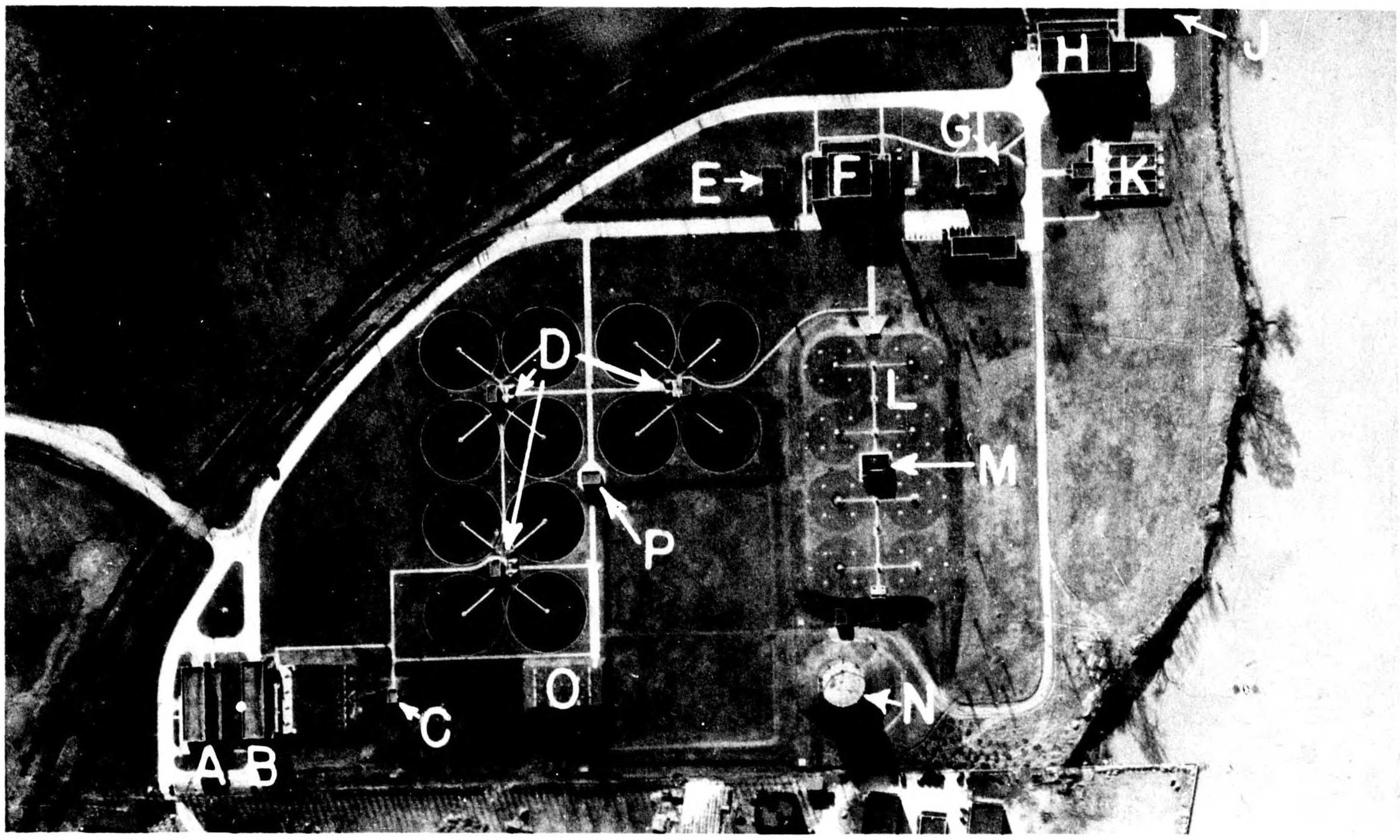
CYCLE OF OPERATIONS

1. Mains carry sewage to pumping station.
2. Sewage proceeds to grit chamber, grits removed to gondola cars.
3. Sewage passes through meter house to grease separation chambers.
4. Sludge is detained in sedimentation tanks.
5. Pumps force sludge into covered tanks where gas generated from process provides heat necessary for chemical digestion of sewage.
6. Gas formed is metered out through meter building into gasometer to burned in burners atop meter house.
7. Digested sludge goes to elutriation building for washing.
8. Washed sludge is dried and loaded into gondolas at dewatering bldg.

DISTINGUISHING CHARACTERISTICS

1. Clusters of sedimentation tanks, sometimes with catwalks to center.
2. Covered digestion tanks.
3. Gasometer.
4. Power house.
5. Rail or other disposal method.
6. Excess gas burner (lit at night).
7. Other buildings may not have distinguishing characteristics.

SEWAGE DISPOSAL



A. Pumping station
B. Grit chamber
C. Meter house
D. Sedimentation tanks 106'
E. Transformer
F. Power house (gas fired)
G. Administration
H. Dewatering building with processed sludge conveyor
J. Freight cars to be loaded
K. Elutriation
L. Sludge digestion tanks 84'
M. Gas meter (excess gas burner on roof)
N. Gas holder
O. Grease separation chambers
P. Sludge removal pumps

WATER PURIFICATION

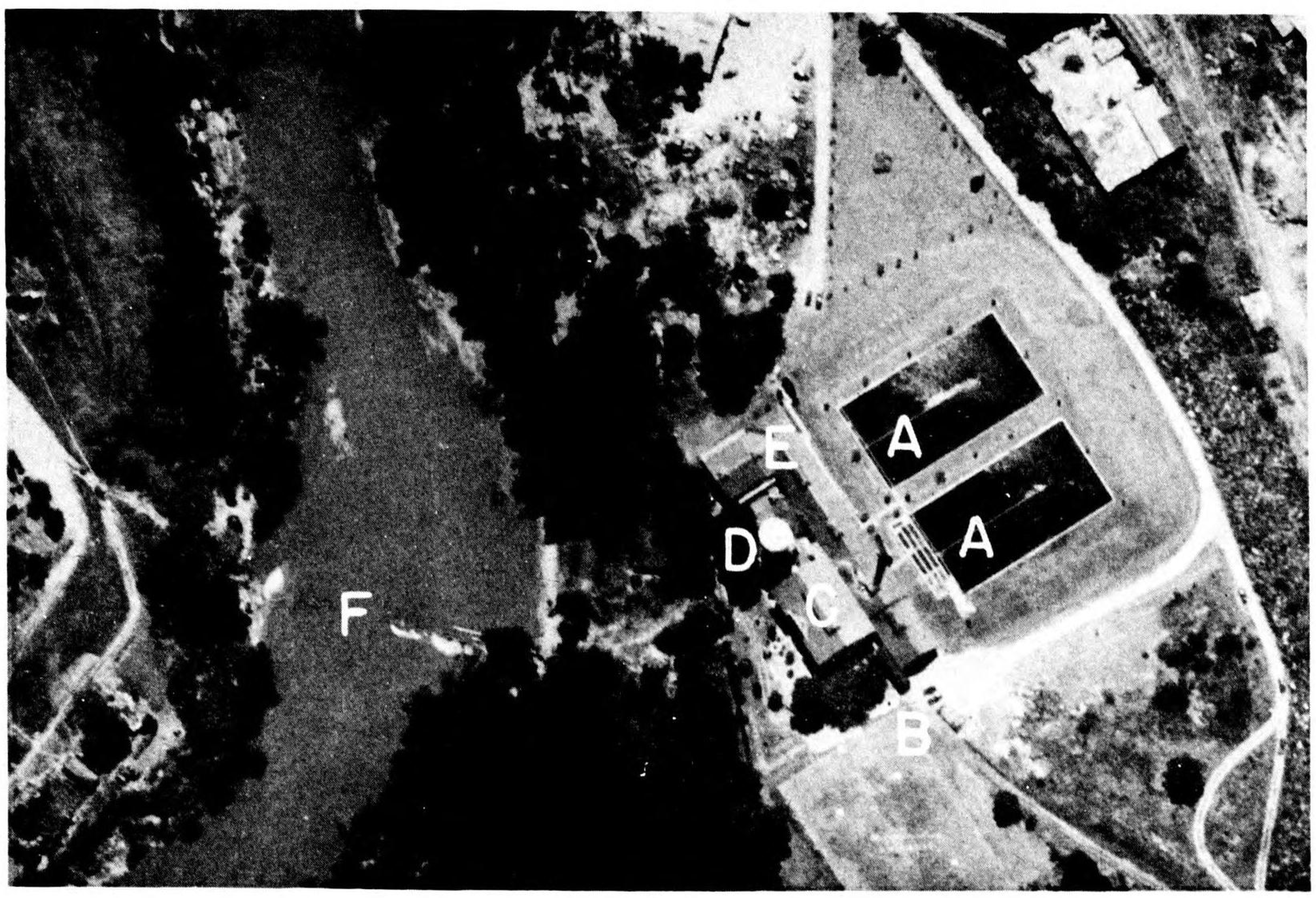
DISTINGUISHING CHARACTERISTICS

Identifying Characteristics
1) Sedimentation (basins)
2) Washwater tower
3) Aeration Tanks or pools
4) Resevoirs (frequently located on high point, some distance away)
5) Other buildings cannot always be identified.

CYCLE OF OPERATIONS

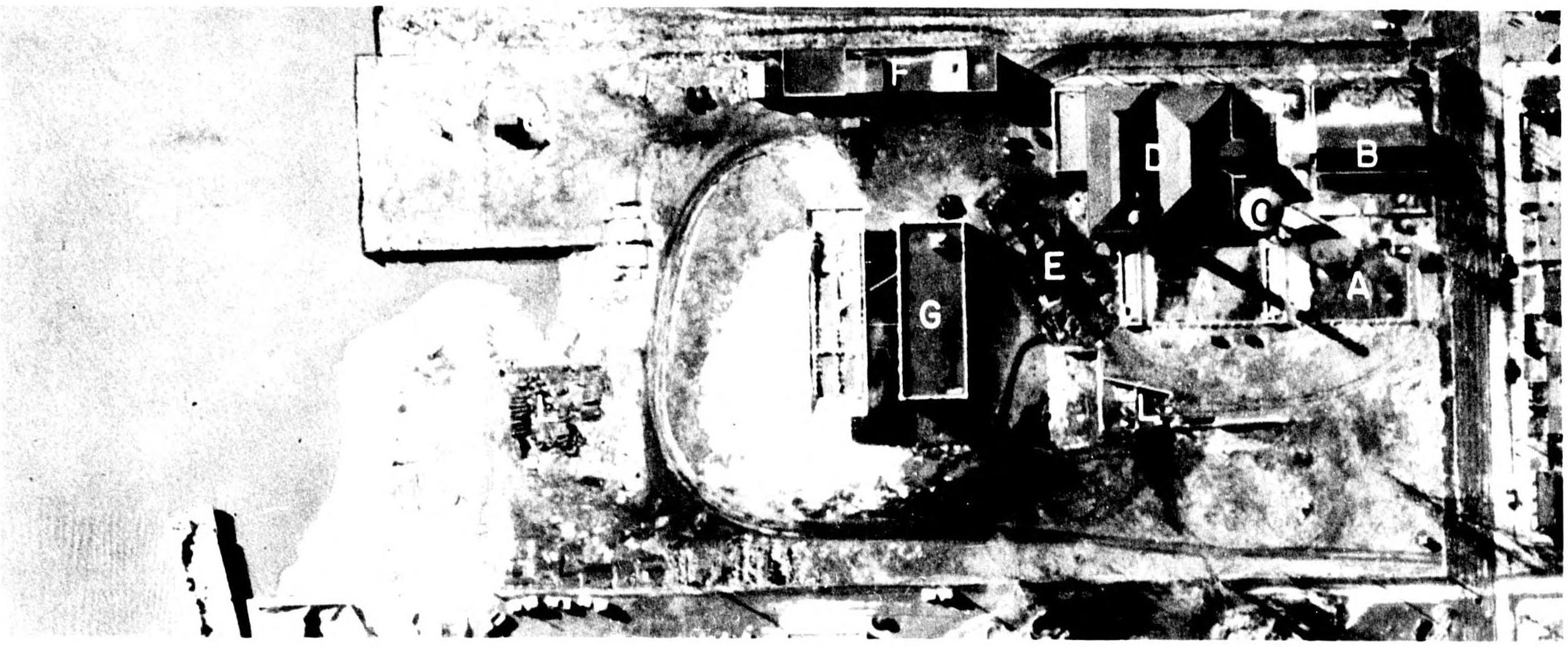
1) River water passes from intake pipes through screen house.
2) Screened water placed in underground well.
3) Well water pumped to aeration tanks (or basins).
4) Aerated water proceeds to chemical laboratory.
5) Treated water flows to sedimentation basins.
6) Settled water runs through filters in filter house, goes to pure water well.
7) Steam and pump house pumps water to reservoir.

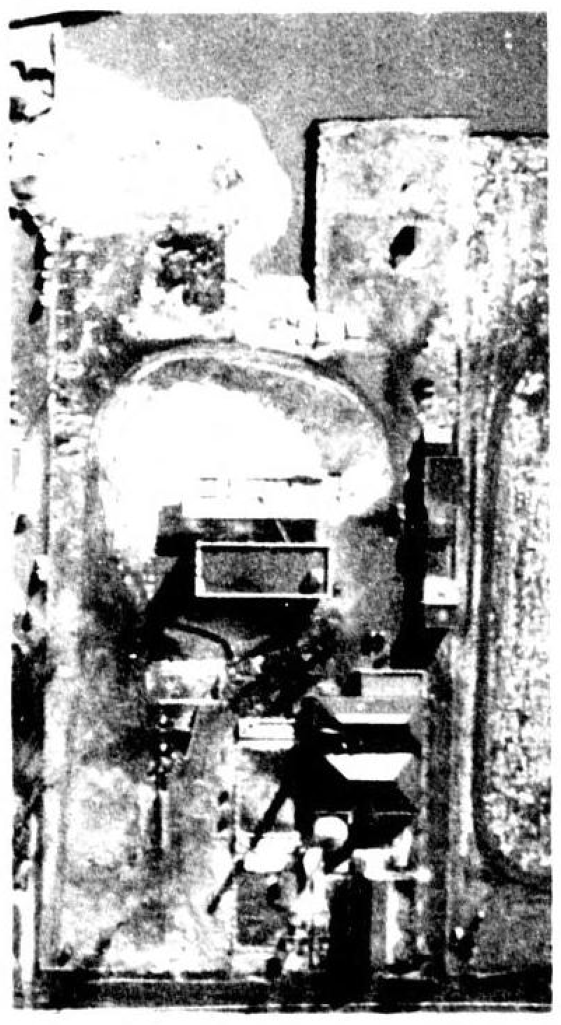
NOTE: Number of above processes used depends on degree of purety of water supply.

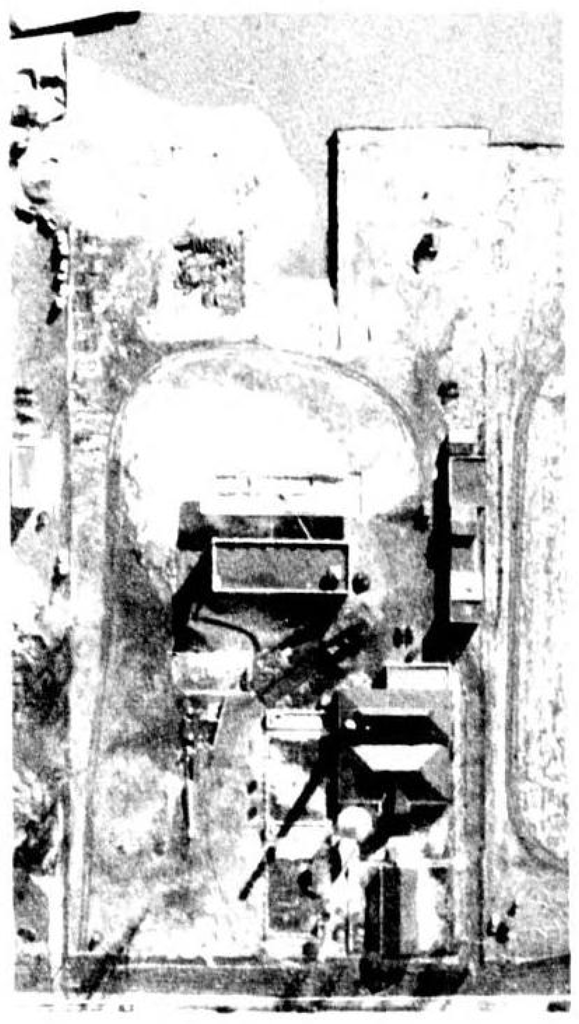


A. Aeration ponds
B. RR siding
C. Filter house
D. Washwater tower
E. Steam, pump, and chemical building
F. Wier dam in river to provide settling and depth for water

This type of plant used where water supply is polluted. Some areas merely aerate and chlorinate water, a few, where water is pure, chlorinate only.







A. 2 sedimentation basins
B. Filter plant
C. Washwater tower
D. Combination steam house and pumps
E. Trestle for coal cars
F. Garage
G. Chemical mixing laboratory
H. Aeration tanks, 2-45' tanks covered by aeriator
J. Screen house
K. Intake pipes extend 500' into river
L. Storage of pipe sections, elbows, etc.

SECTION 13
AIRCRAFT

13.01 — 13.99

RESTRICTED

SUPPLEMENT NO. 2

PHOTOGRAPHIC INTERPRETATION HANDBOOK — UNITED STATES FORCES

AIRCRAFT IDENTIFICATION

15 APRIL, 1945

PHOTOGRAPHIC INTELLIGENCE CENTER,
DIVISION OF NAVAL INTELLIGENCE, NAVY DEPARTMENT

RESTRICTED

Operational Japanese Aircraft have been given short Allied Code Names for purposes of simplicity in reporting. These code names take the form of male and female names, such as "TONY" and "SALLY". Male designations are given to Army and Navy fighter planes and to Navy reconnaissance float planes. All other planes receive female designations. At the present time the sole authority for the issuance of future code names is vested in the Technical Air Intelligence Center, NAS, Anacostia, D.C. Photographs and pertinent data on suspected new aircraft types should be forwarded immediately to the above activity. Tentative code names should not be assigned in the field or by other agencies.

In addition to a code name each aircraft has a model designation. Formerly, arbitrarily chosen "Mark Numbers" were used to indicate the various modifications of an aircraft type. These proved confusing, however, and inadequate to handle the numerous modifications being encountered. As a result the Mark System has been abandoned and, instead, the nomenclature applied to the planes by the Japanese themselves has been adopted. This consists of a system of separate Navy and Army model numbers.

Japanese Navy model numbers are composed of two digits and the first version of a Navy plane is always known as Model 11. As modifcations are made to this original version the first digit of the model number is increased if the change is structural and the second digit is increased if the engine is changed. Thus, a ZEKE 11 becomes a ZEKE 21 if the wing shape is altered, a ZEKE 12 if only the engine is changed and a ZEKE 22 if both changes are made. With further changes the digits increase in progression.

Japanese Army model numbers are composed of only one digit and the first version of an Army plane is always known as Model 1. This model number may be increased if either an engine or a structural change is made in the original version.

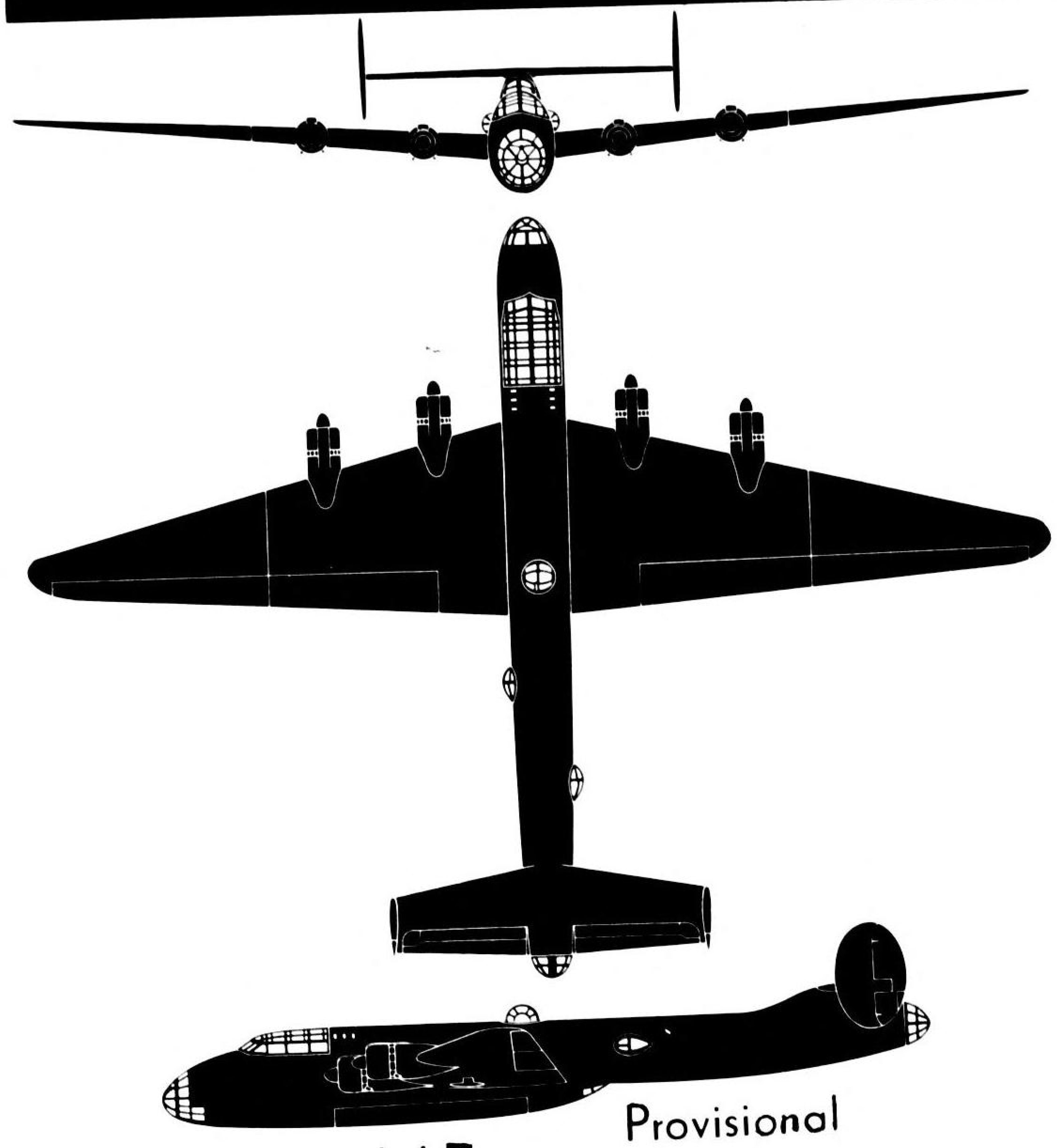
Training aircraft are now being assigned Allied Code Names as well. These designations will be in the form of tree names, such as "CEDAR" and "OAK", in order to avoid confusion with code names of combat aircraft.

Photo Interpretation reports should list the aircraft by code names and by model numbers whenever possible. Older forms of nomenclature listing the aircraft by manufacturer, year of adoption and purpose, such as "Kawanishi 97 Flying Boat", are awkward as well as unnecessary.

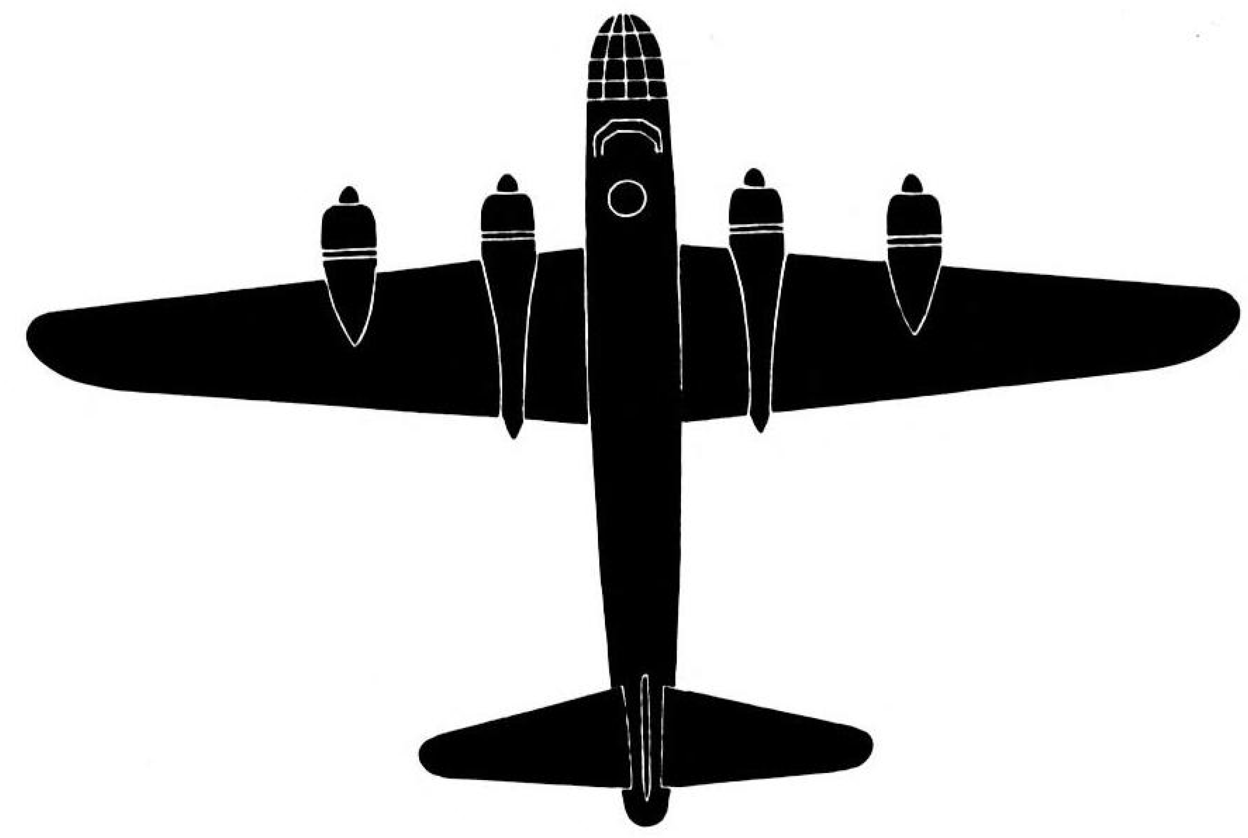
JAPANESE AIRCRAFT

AIRCRAFT
(IDENTIFICATION)
scale 1" = 40'

FOUR ENGINE LANDPLANES

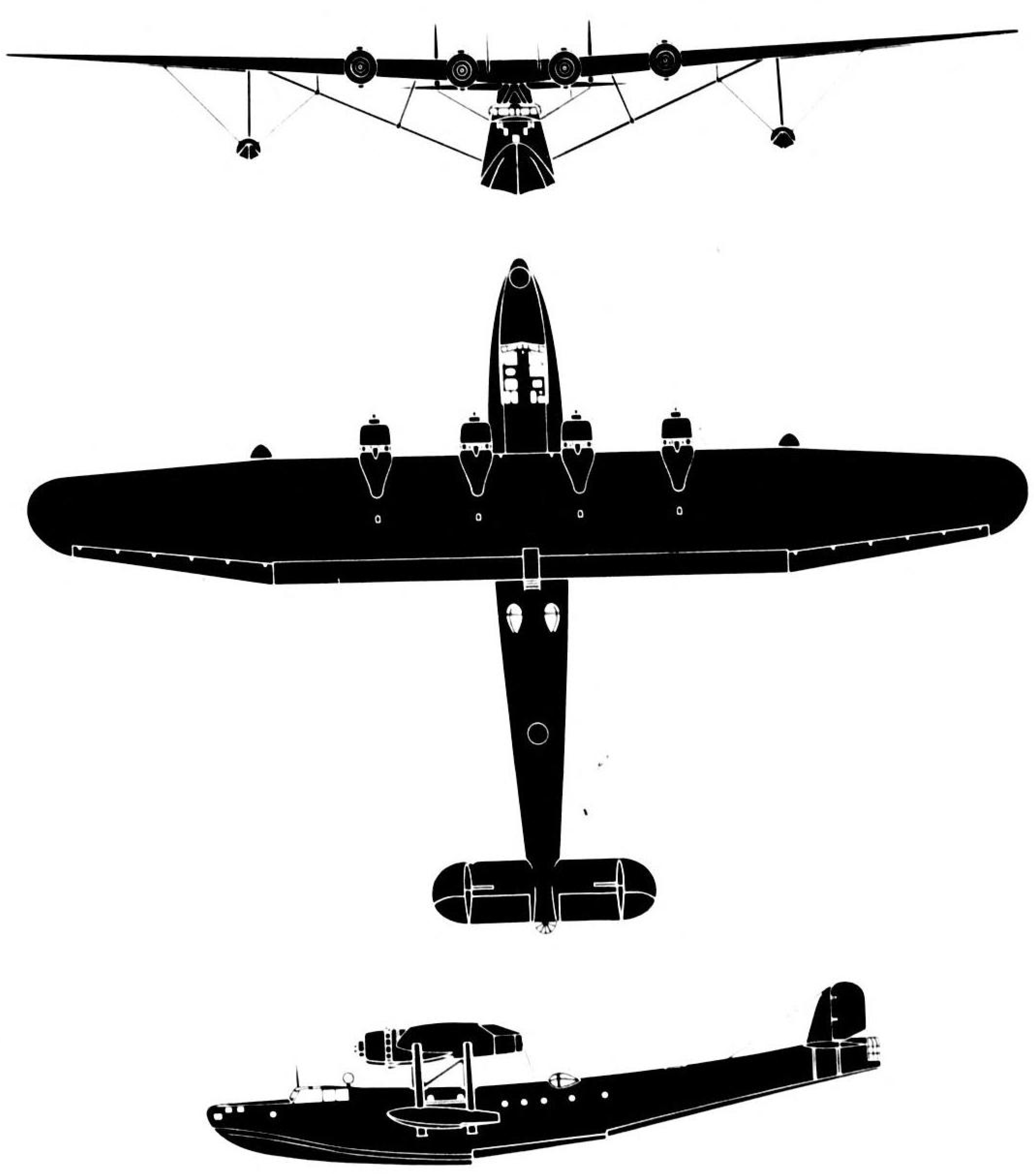


Provisional
LIZ
Navy Bomber – Transport
S–138'3" L–101'9"

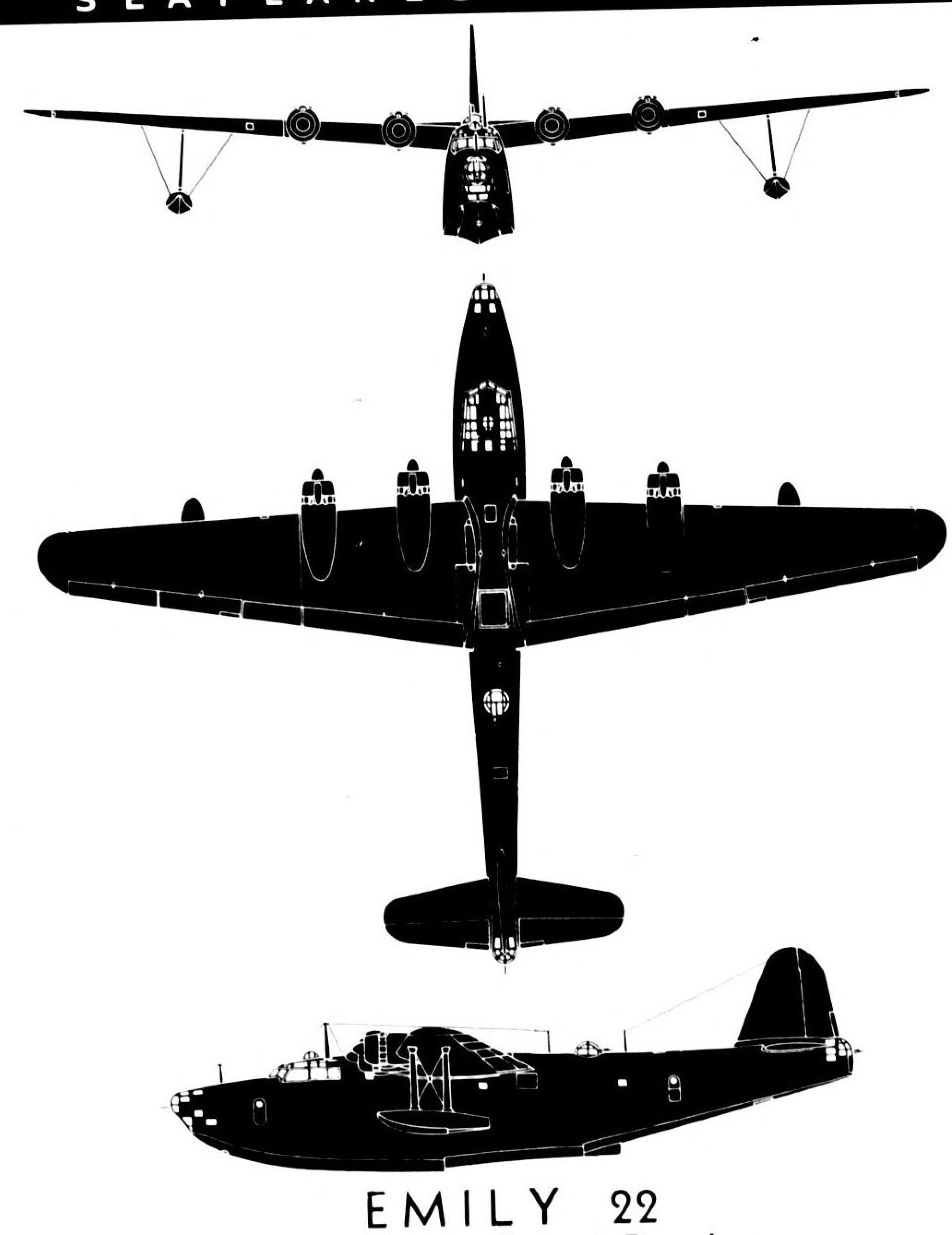


Provisional
RITA
Navy Bomber
S–107' L–75'

FOUR ENGINE SEAPLANES



MAVIS 22
Navy Patrol Bomber
S–131'4" L–84'1"

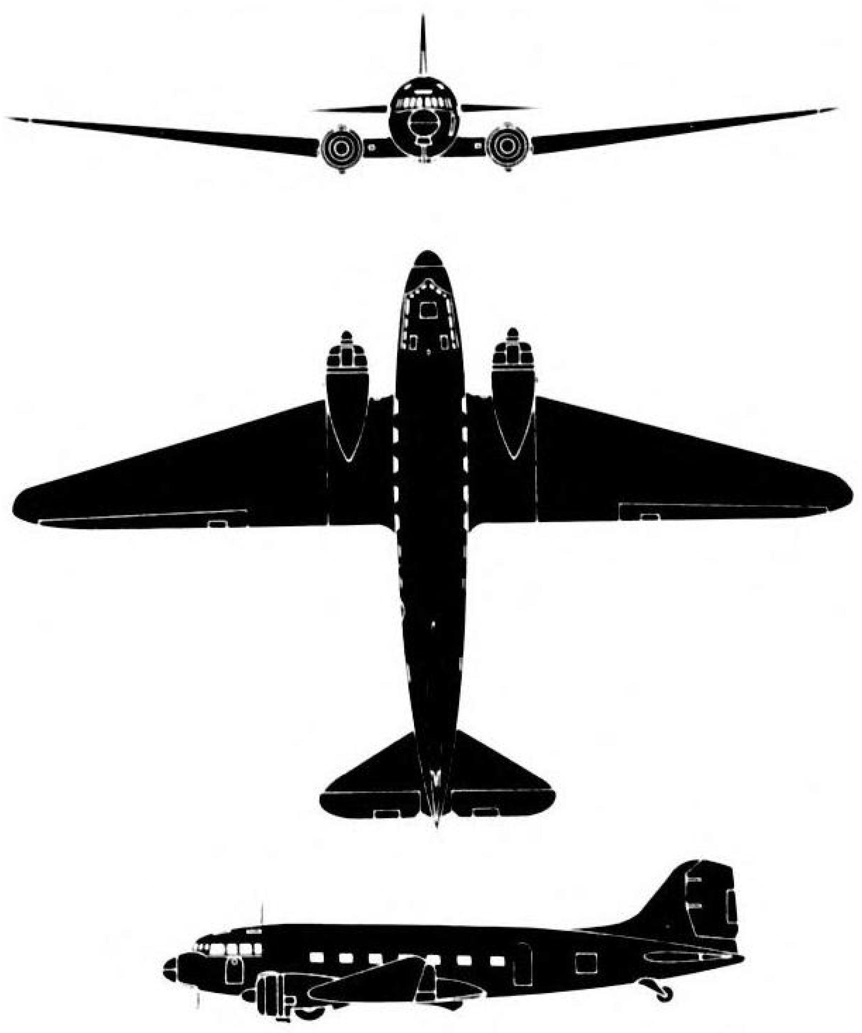


EMILY 22
Navy Patrol Bomber
S–124'8" L–92'3"

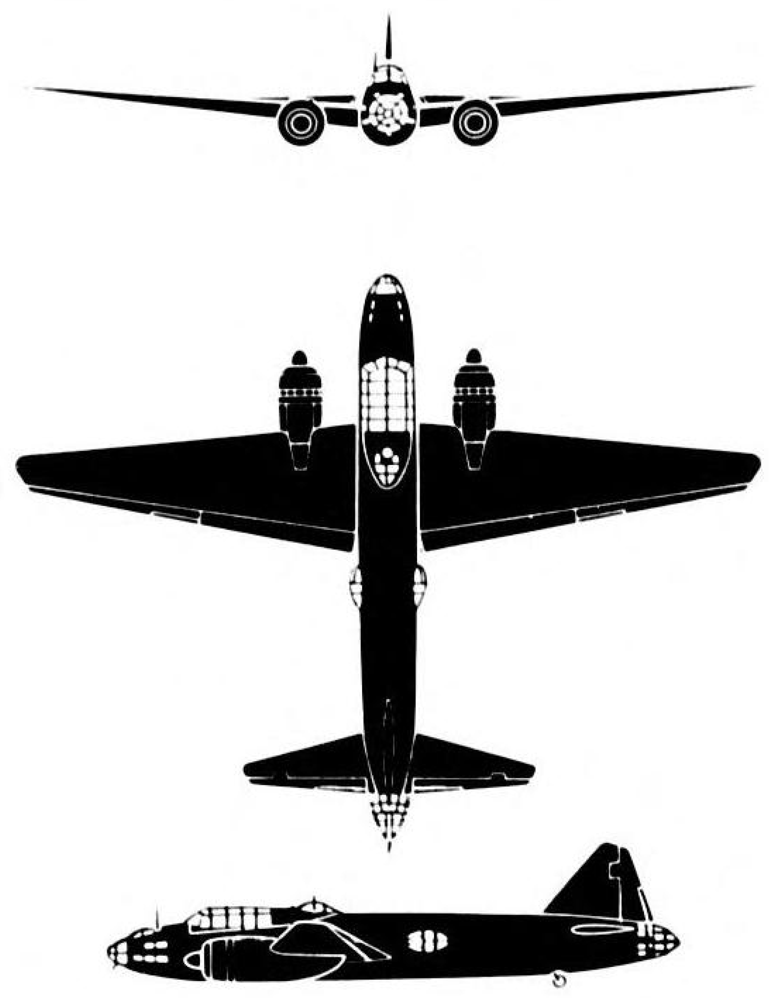
AIRCRAFT
(IDENTIFICATION)
scale I" = 50'

JAPANESE AIRCRAFT

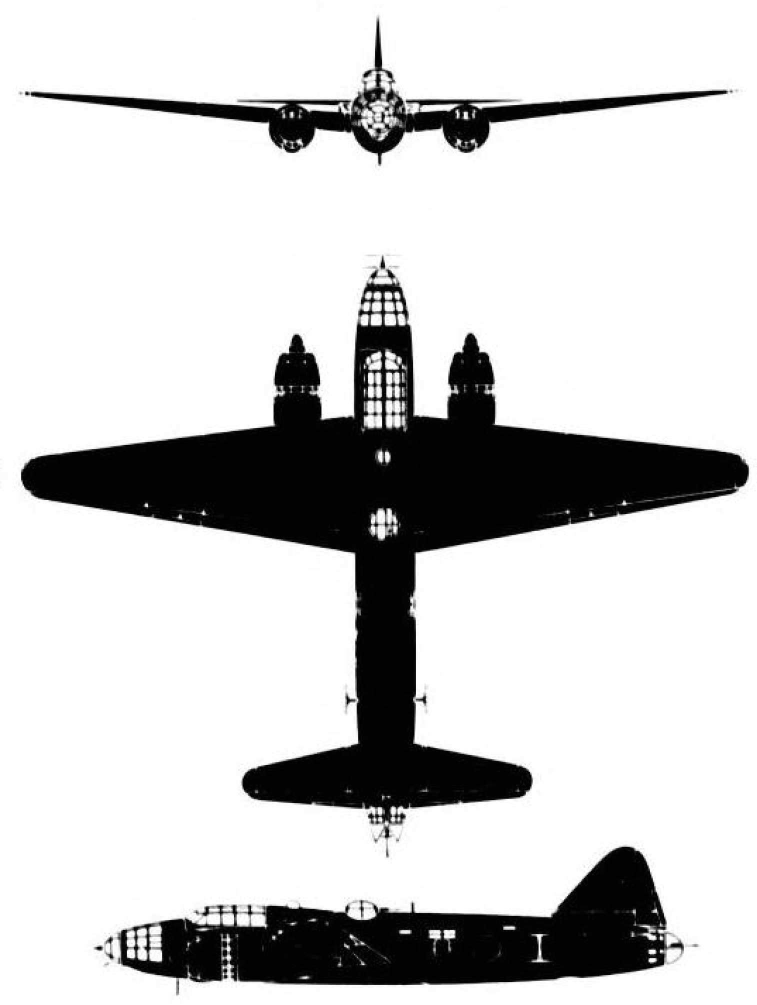
TWIN ENGINE LANDPLANES



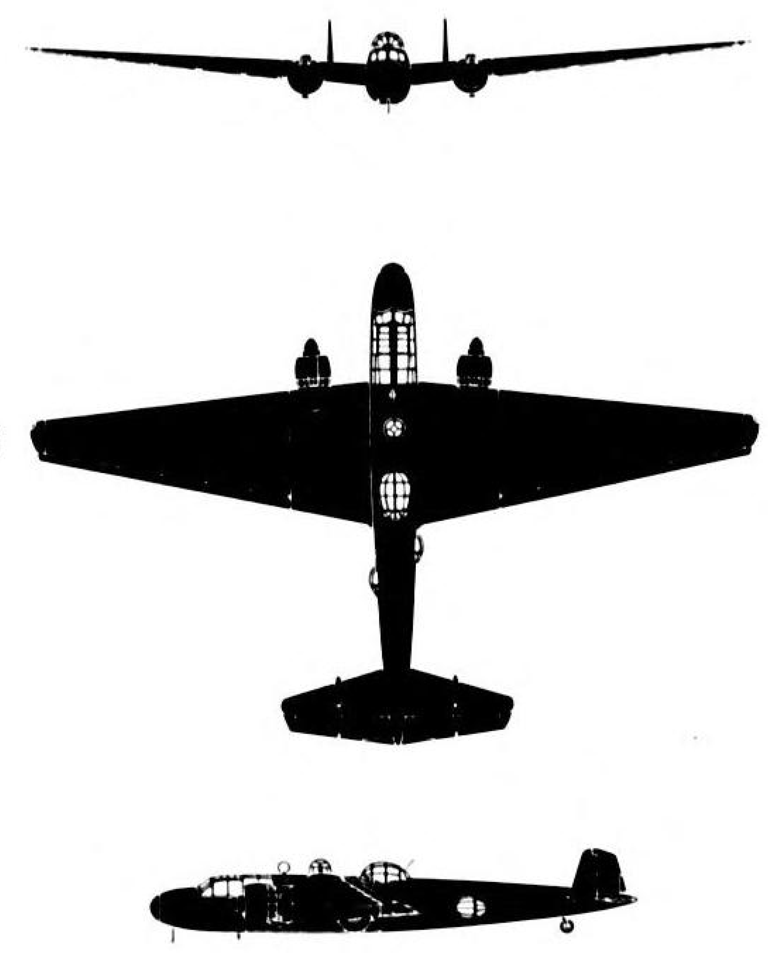
TABBY 32
Navy Transport
S–95′ L–64′8″



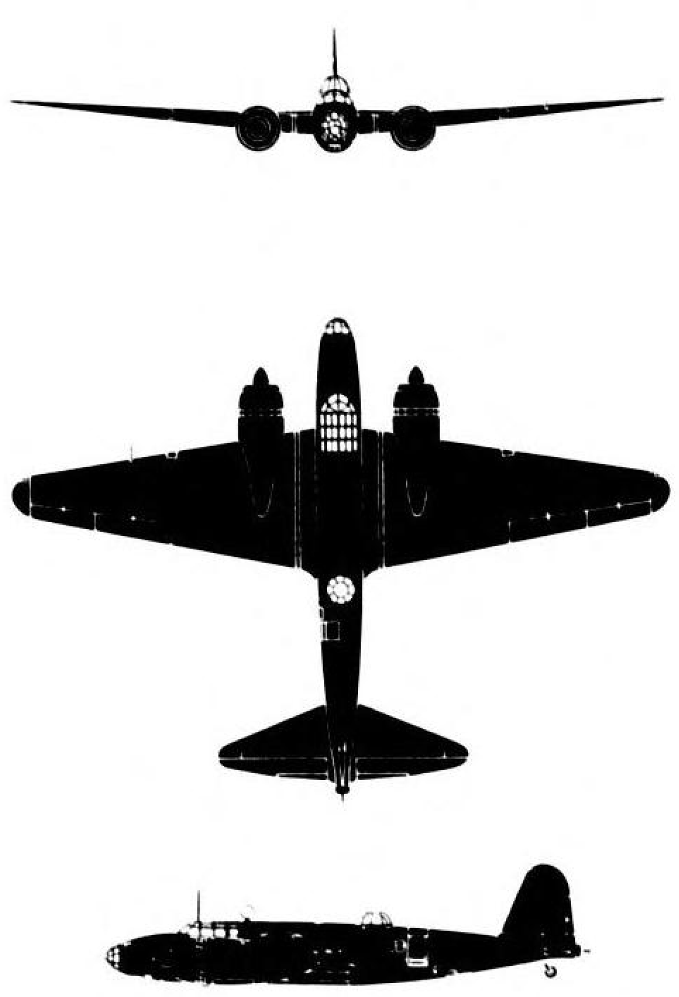
BETTY 11
Navy Land Attack
S–82′ L–65′7″



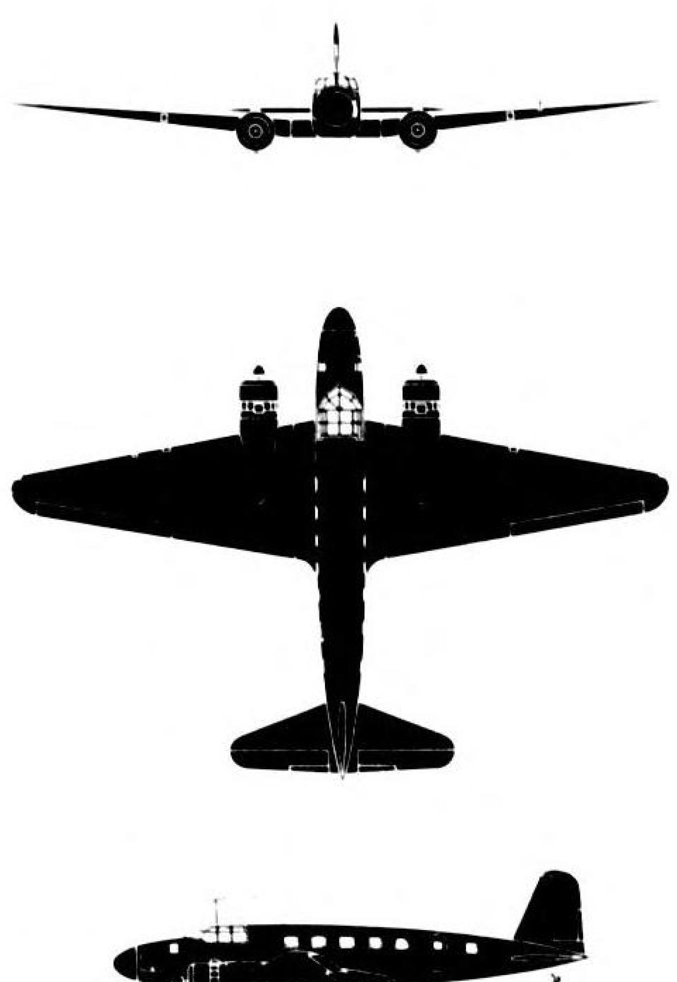
BETTY 22
Navy Land Attack
S–82′ L–64′6″



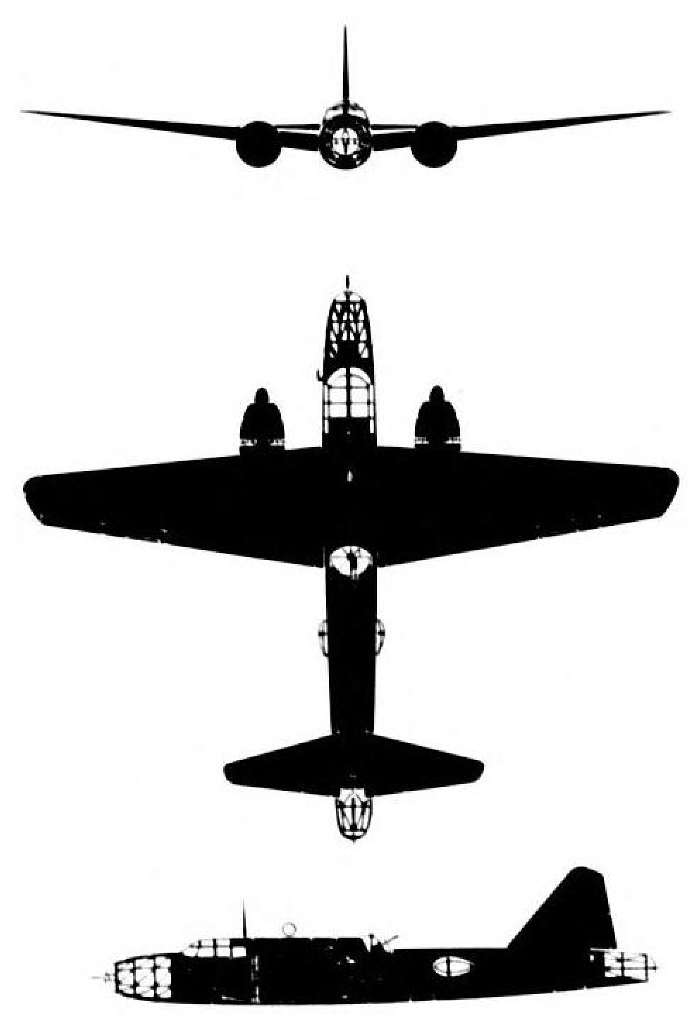
NELL 23
Navy Land Attack
S–82′ L–54′



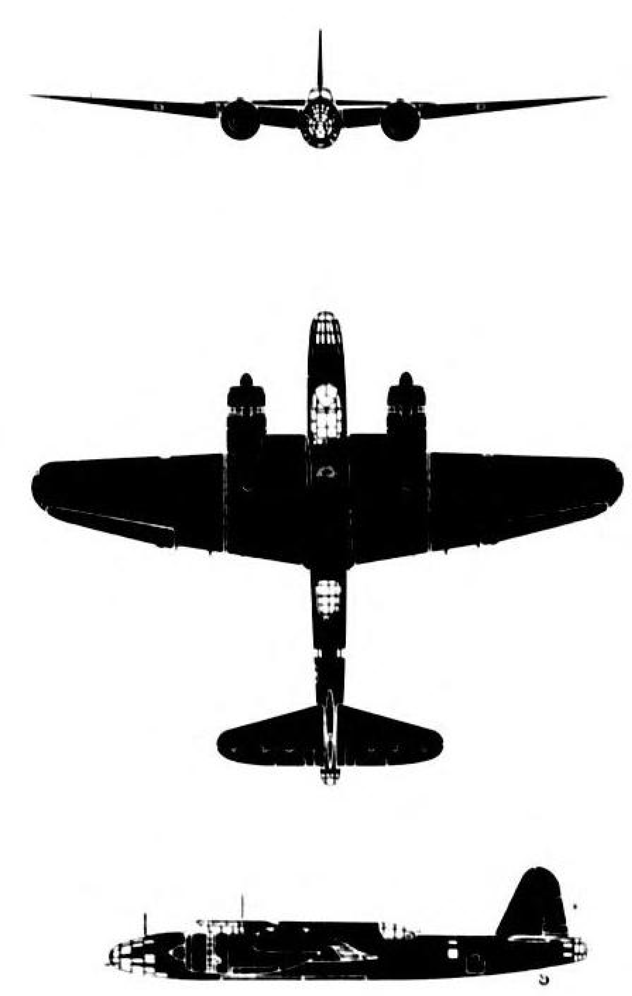
SALLY 2
Army Medium Bomber
S–74′8″ L–52′



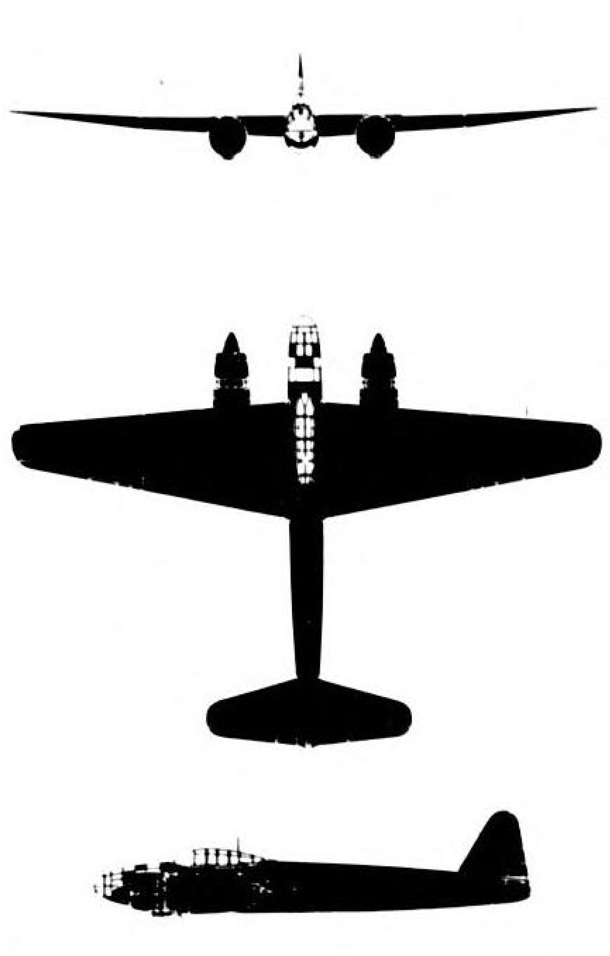
TOPSY 1
Army Transport
S–74′2″ L–52′10″



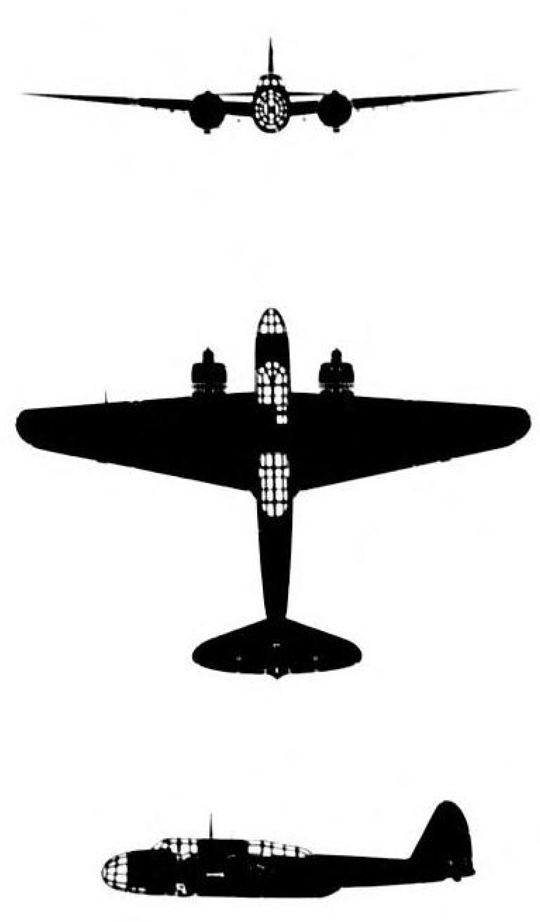
PEGGY 1
Army Medium Bomber
S–73′10″ L–61′4″



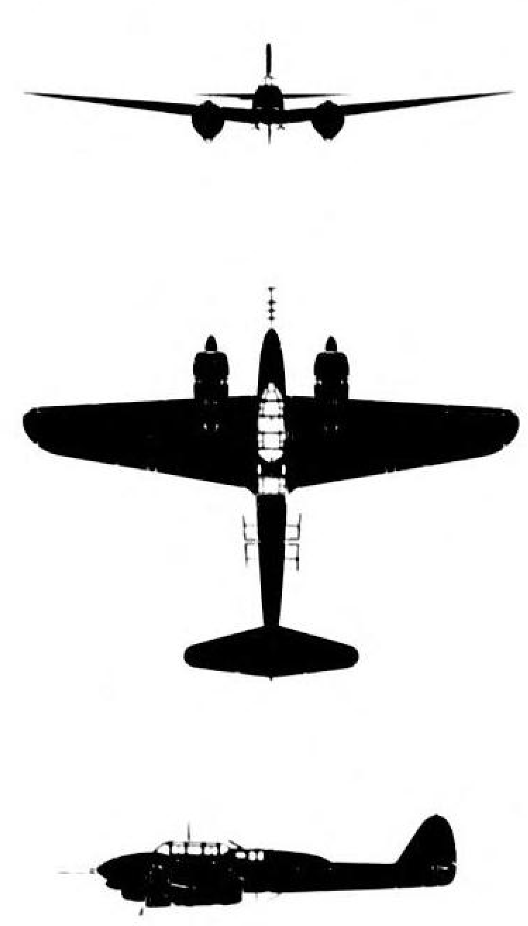
HELEN 2
ArmyMediumBomber
S–66′7″ L–53′



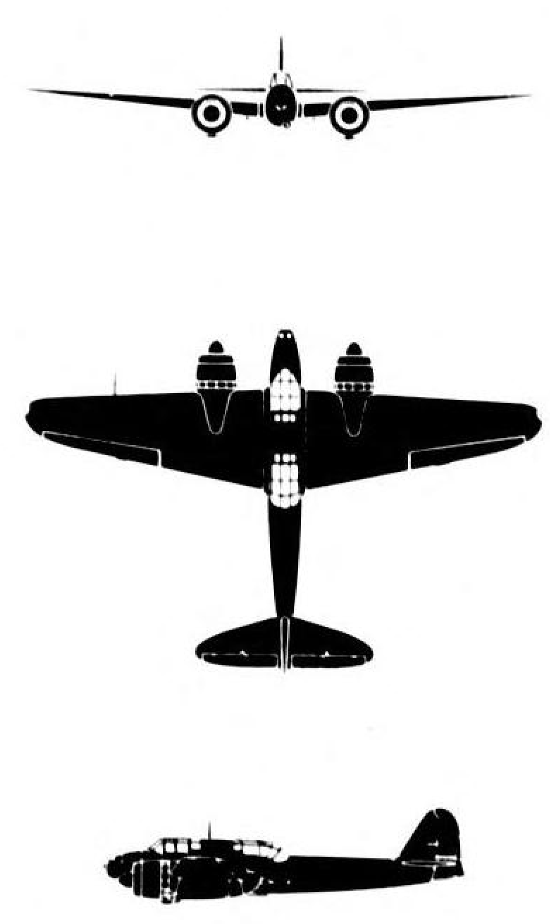
FRANCES 11
Navy TB–NF
S–65′7″ L–49′2″



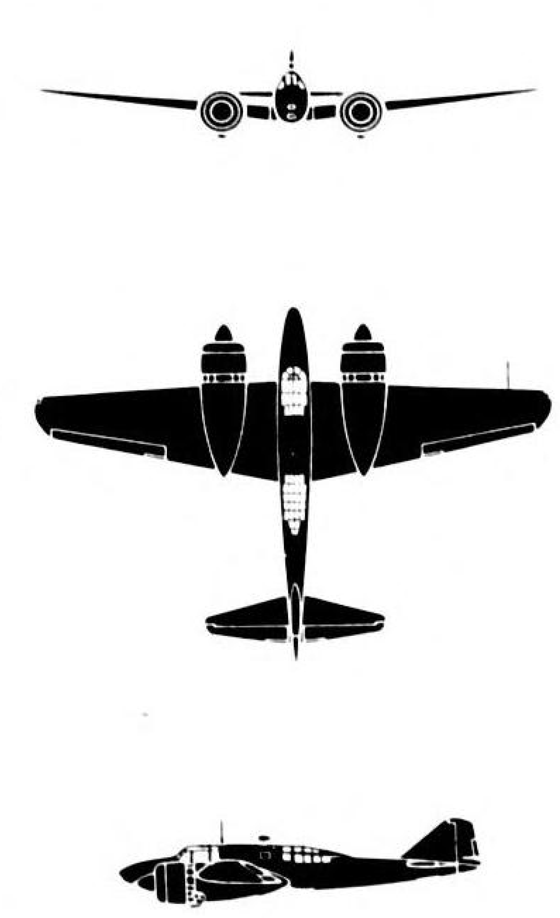
LILY 2
Army Light Bomber
S–57′4″ L–42′1″



IRVING 11
Navy R–NF
S–55′9″ L–39′11″



NICK 1
Army Fighter
S–49′6″ L–34′8″

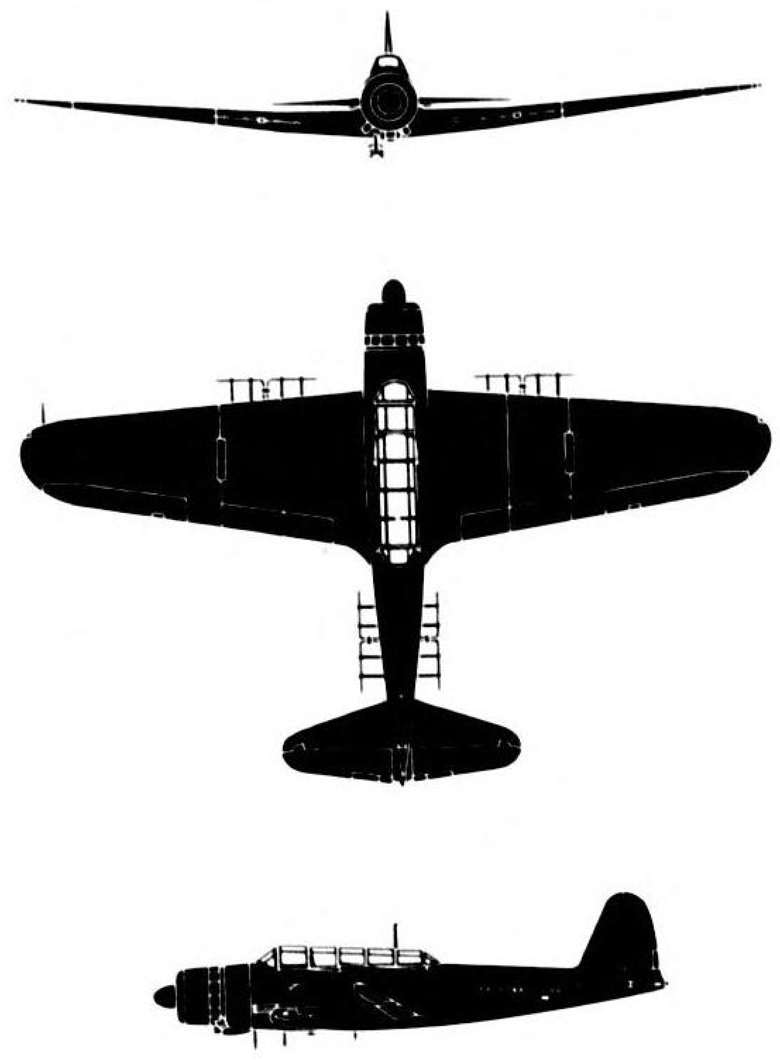


DINAH 3
Army Recco.
S–48′3″ L–36′1″

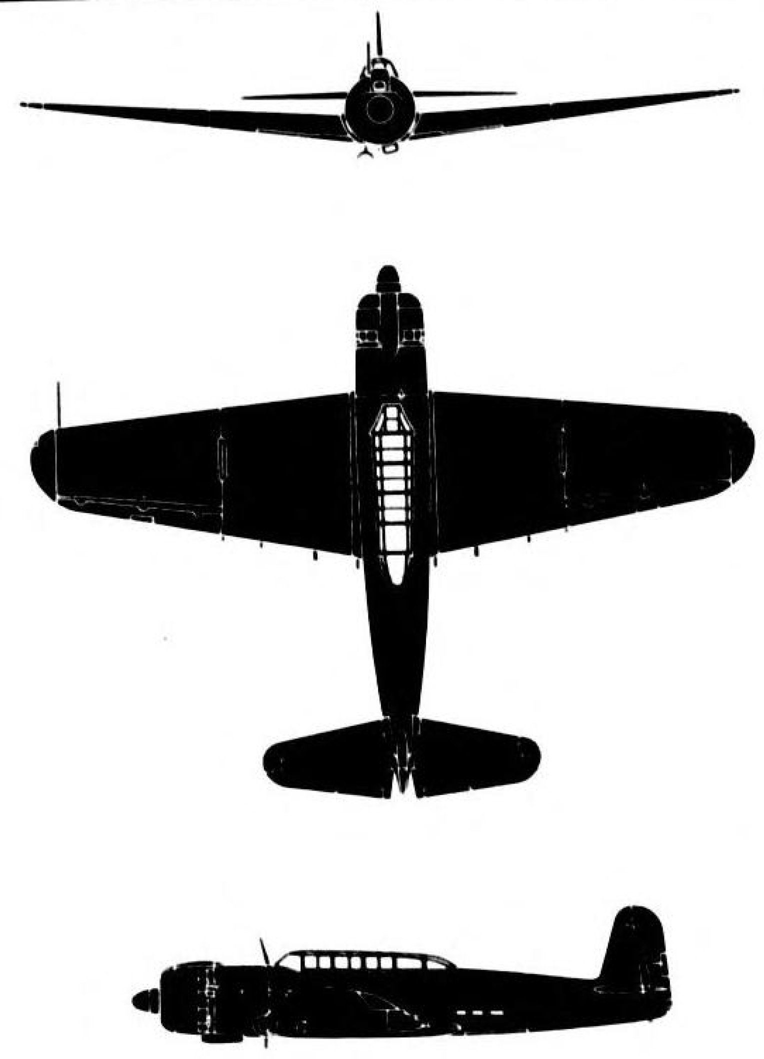
JAPANESE AIRCRAFT

AIRCRAFT (IDENTIFICATION)
scale 1" = 30'

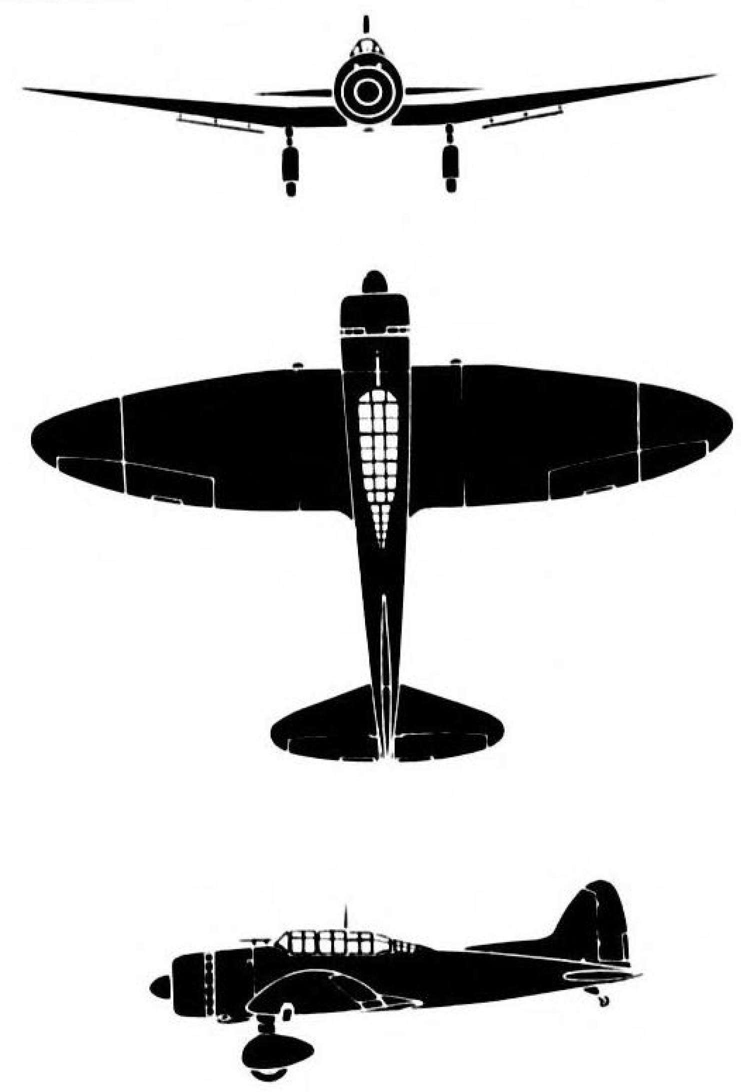
SINGLE ENGINE LANDPLANES



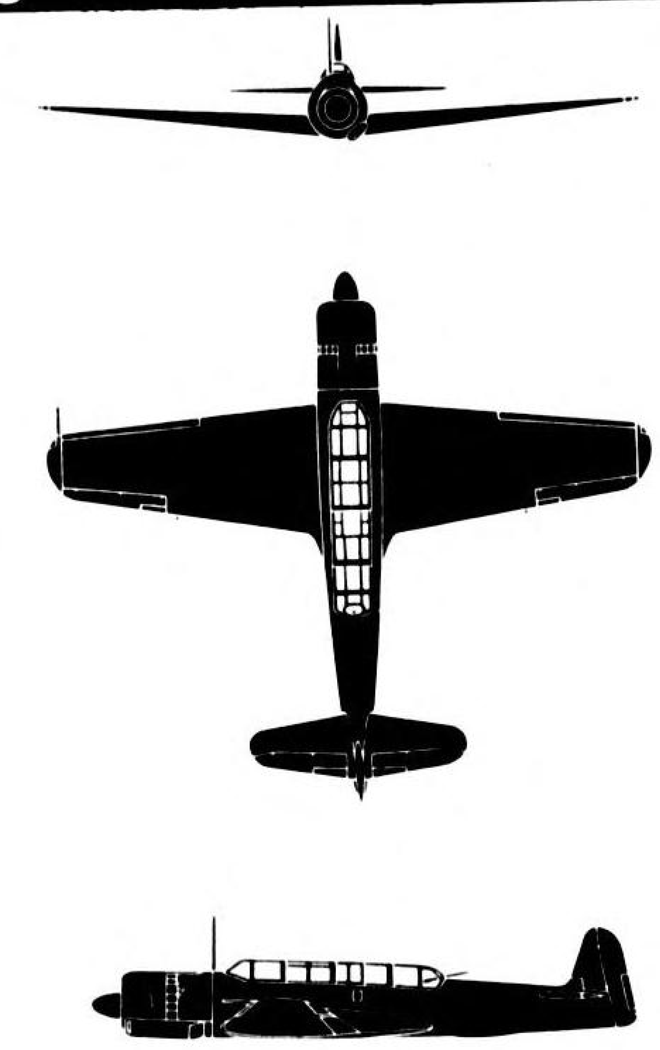
KATE 12
Navy Torpedo Bomber
S–50'11" L–34'3"



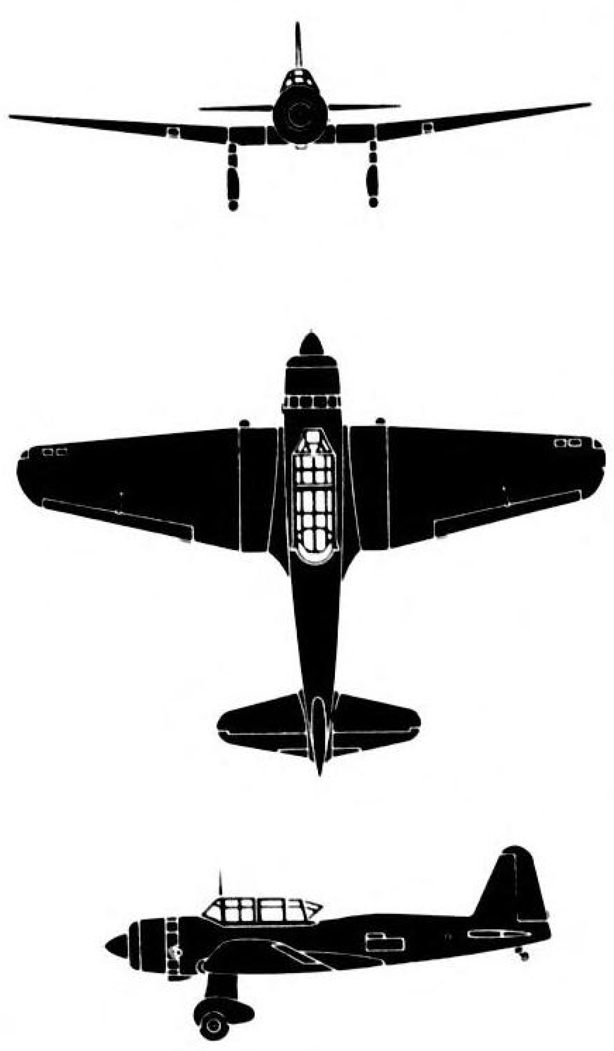
JILL 12
Navy Torpedo Bomber
S–49' L–36'1"



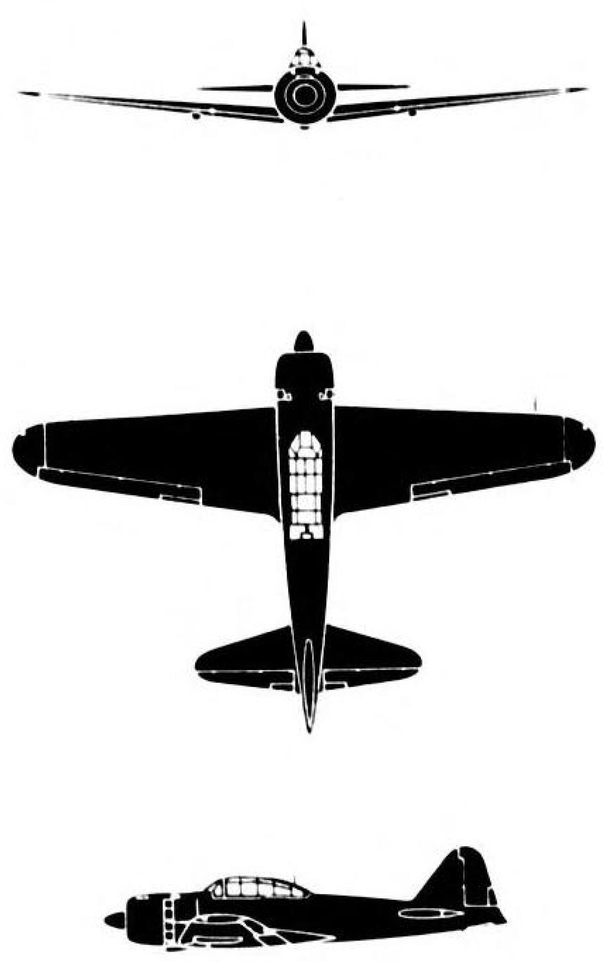
VAL 22
Navy Dive Bomber
S–47'7" L–35'5"



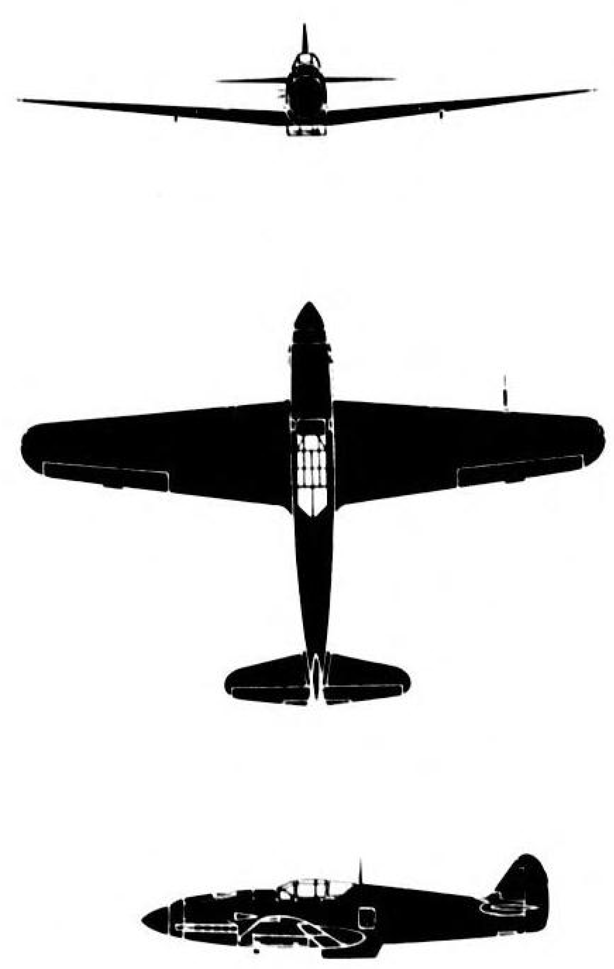
MYRT 11
Navy Reconnaissance
S–41'1" L–36'6"



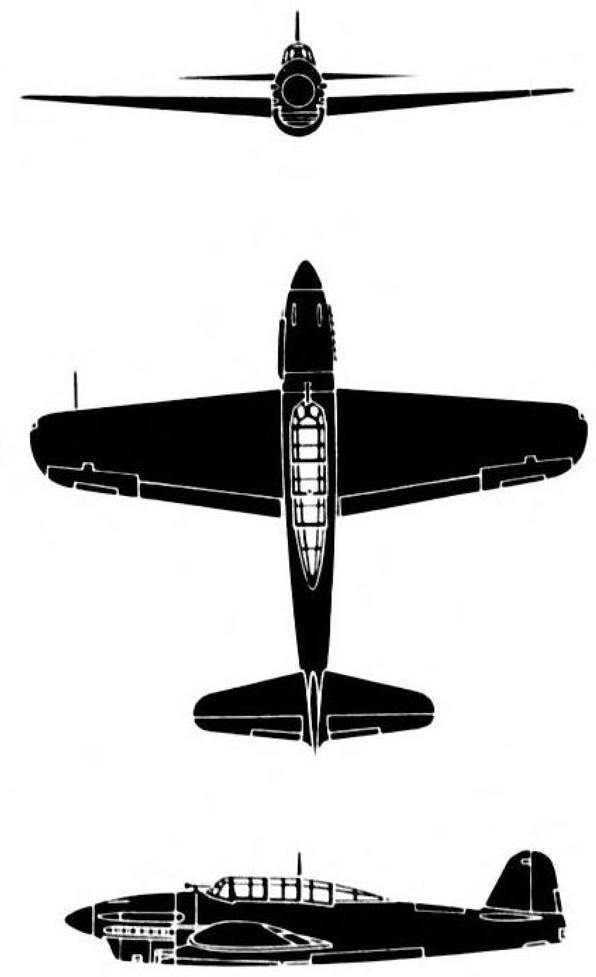
SONIA 1
Army Reconnaissance
S–39'10" L–30'2"



ZEKE 21
Navy Fighter
S–39'3" L–29'9"



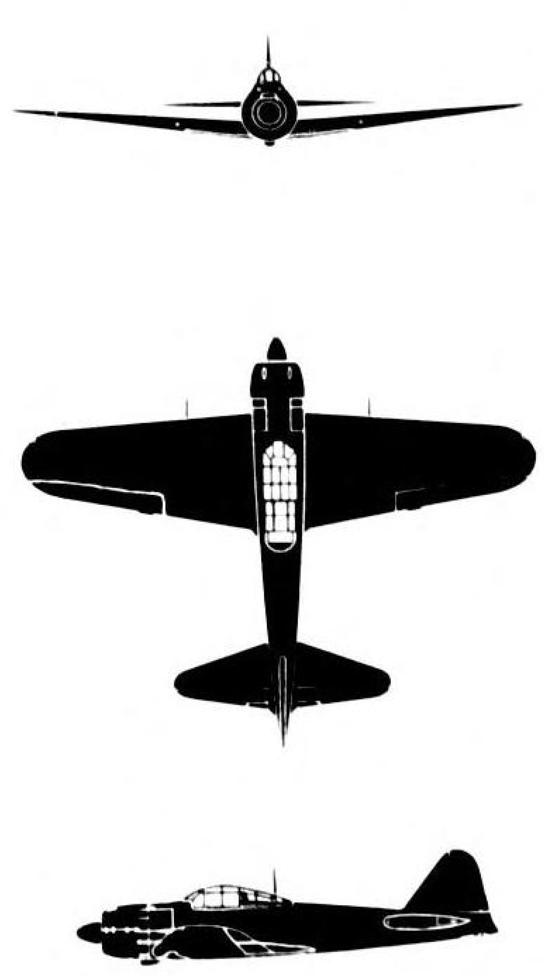
TONY 1
Army Fighter
S–39'4" L–28'9"



JUDY 11
Navy DB, Recco.
S–37'9" L–33'7"

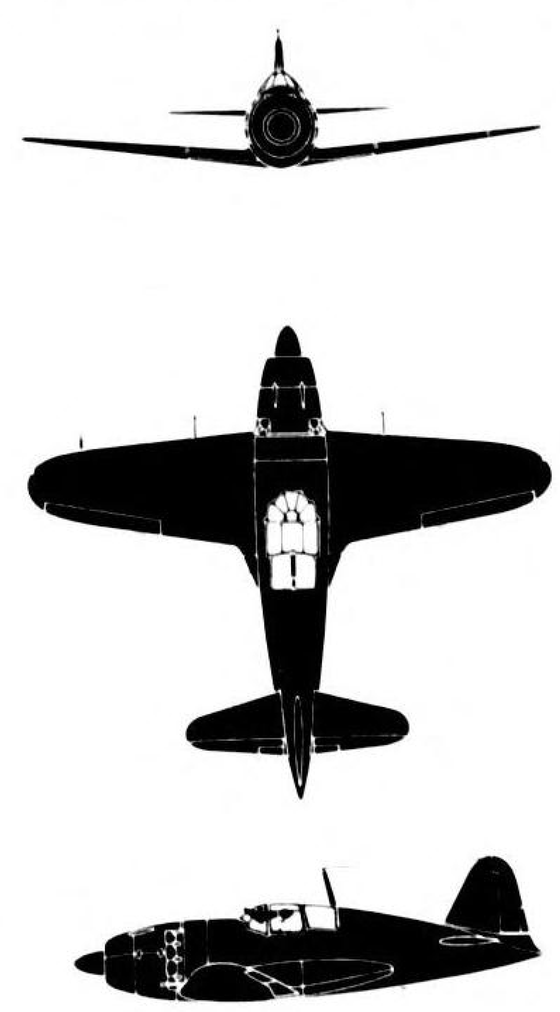
JUDY 33
Navy DB, Recco.
S–37'9" L–33'6"

FRANK 1
Army Fighter
S–37'1" L–32'4"

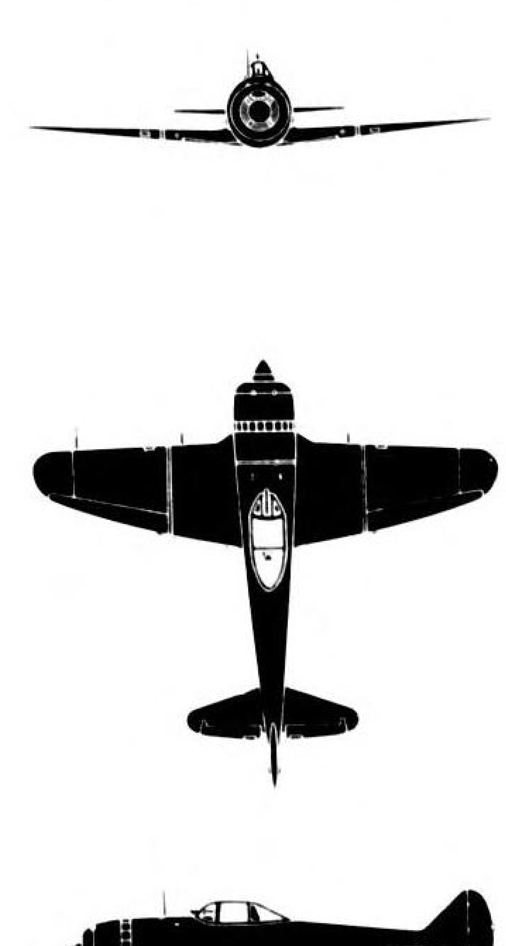


ZEKE 52
Navy Fighter
S–36'2" L–29'9"

OSCAR 2
Army Fighter
S–35'7" L–29'3"



JACK 11
Navy Fighter
S–35'5" L–31'9"

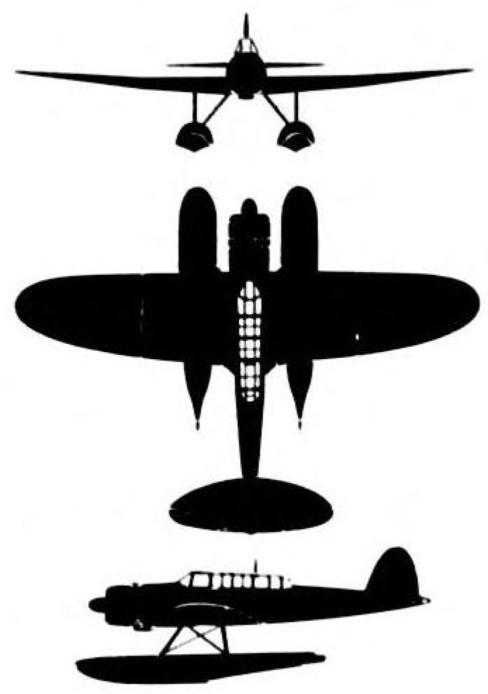


TOJO 2
Army Fighter
S–31' L–29'3"

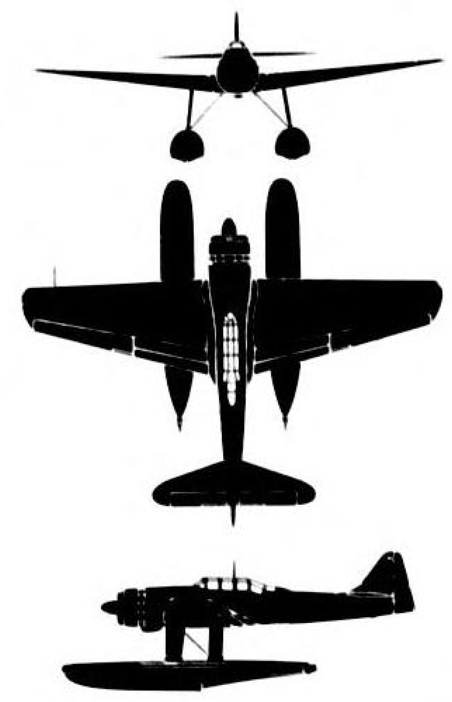
AIRCRAFT
(IDENTIFICATION)
scale 1" = 45'

JAPANESE AIRCRAFT

SINGLE ENGINE SEAPLANES

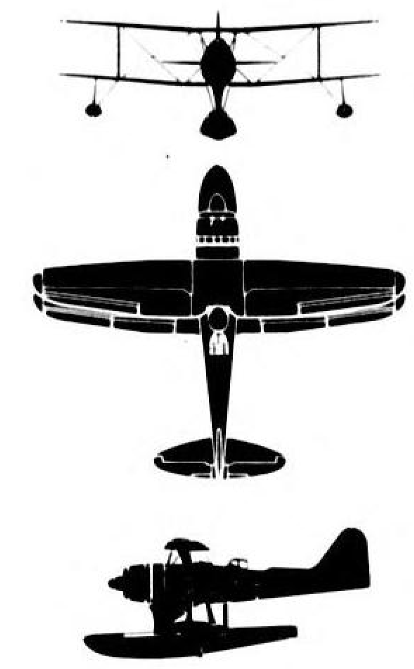


JAKE 11
Navy Reconnaissance
S-46'10" L-37'3"

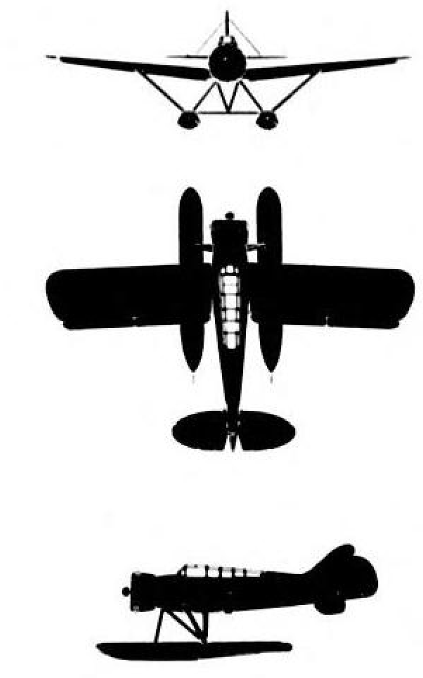


PAUL 11
Navy Dive Bomber Recco
S-42' L-35'7"

RUFE 11
Navy Fighter
S-39'3" L-33'10"

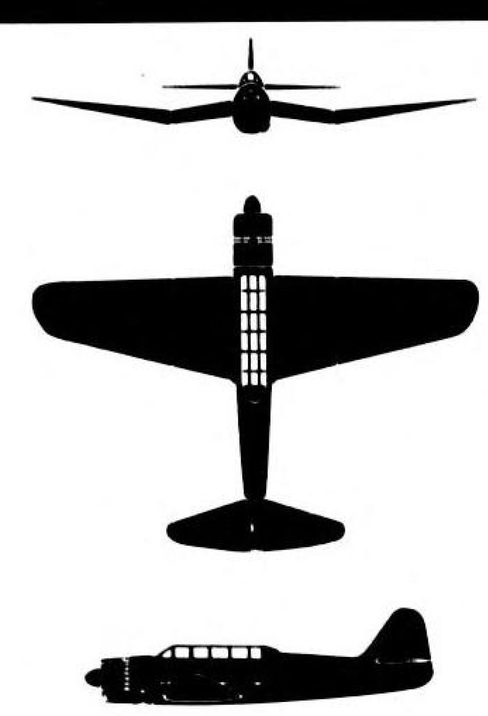


PETE 11
Navy Reconnaissance
S-36'1" L-31'1"



GLEN 11
Navy Recco
S-36' L-28'

NEW PLANES



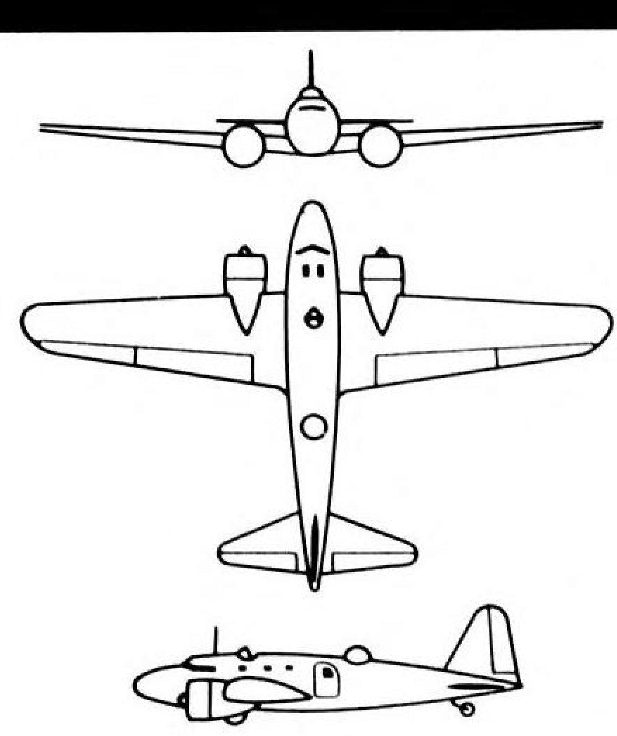
Provisional
GRACE 11
Torpedo Bomber
S-47'3" L-37'7"

Provisional
NORM
Navy Reconnaissance
S-45'10" L-37'7"

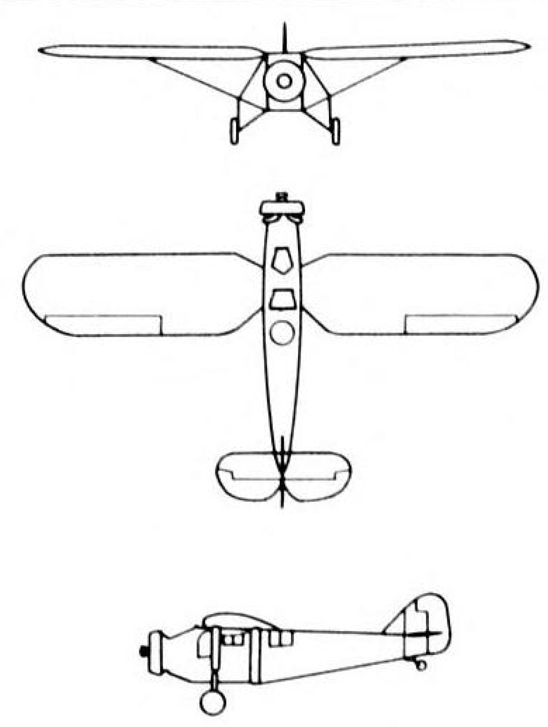
Provisional
REX
Navy Fighter
S-39'5" L-35'5"

GEORGE 11
Navy Fighter
S-39'5" L-29'7"

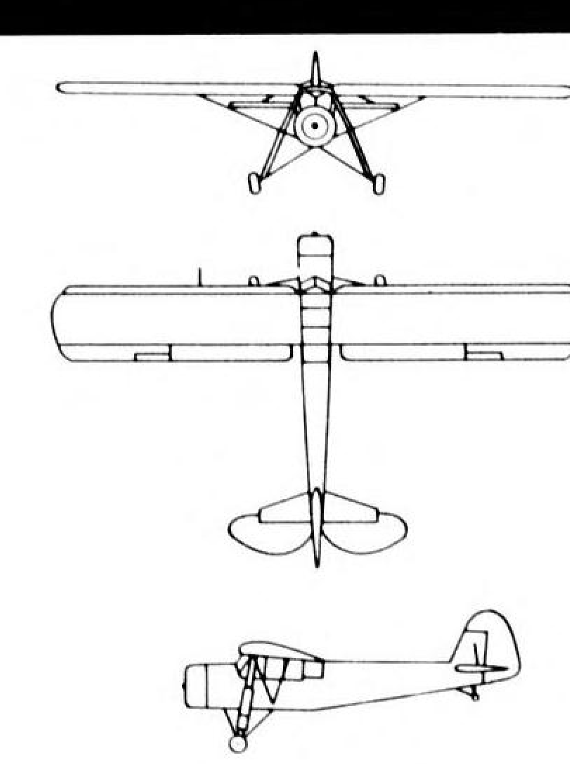
TRAINING PLANES



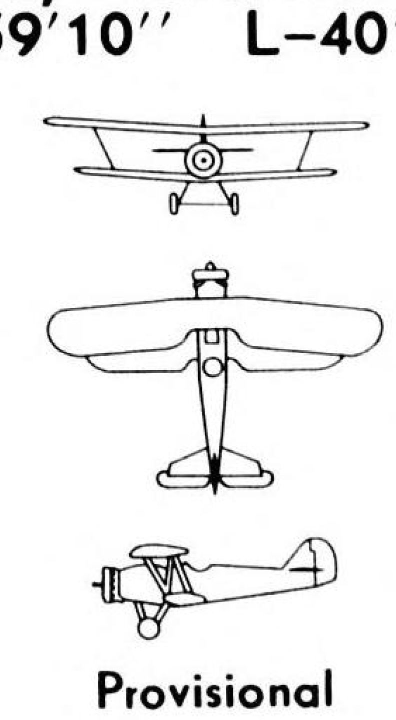
Provisional
HICKORY
Army Advanced Trainer
S-59'10" L-40'



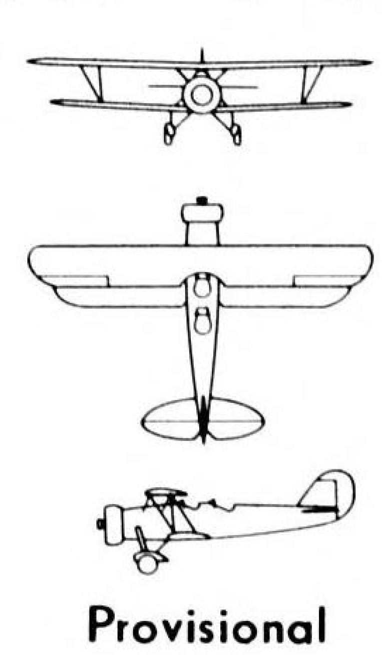
Provisional
PINE
Navy Advanced Trainer
S-51'10" L-31'4"



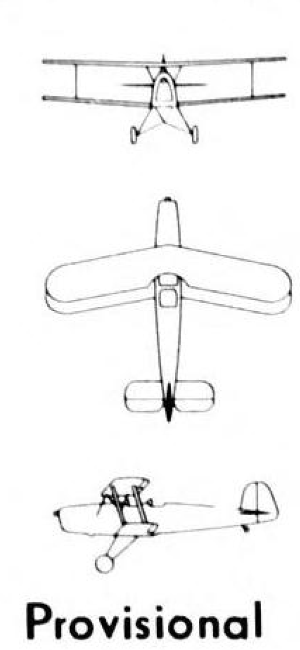
Provisional
STELLA
Observation
S-46'9" L-32'6"



Provisional
WILLOW
Navy Intermediate Trainer
S-36'1" L-26'5"



Provisional
SPRUCE
Army Trainer
S-32'10" L-26'3"

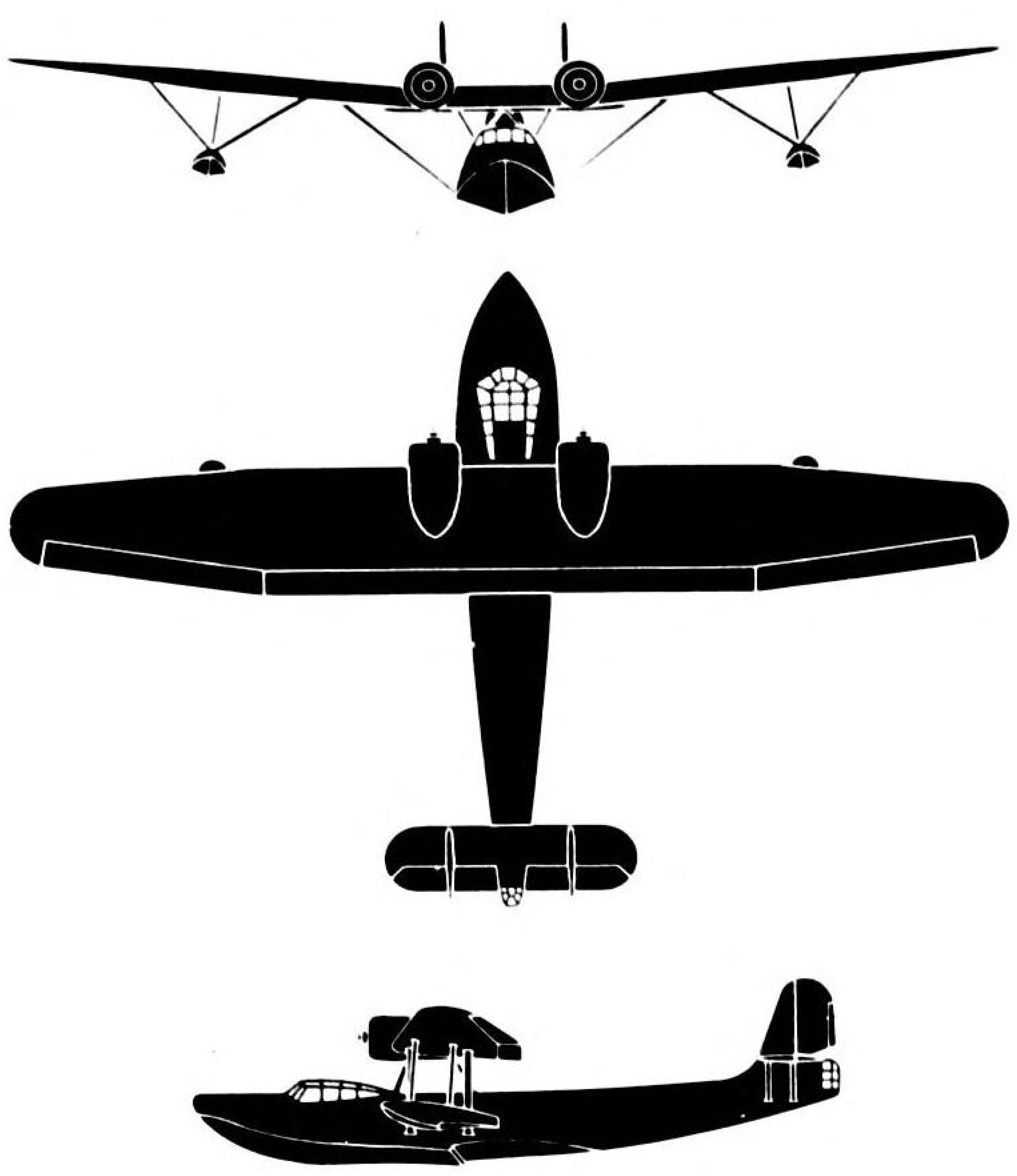


Provisional
CYPRESS
Army Trainer
S-24'3" L-21'8"

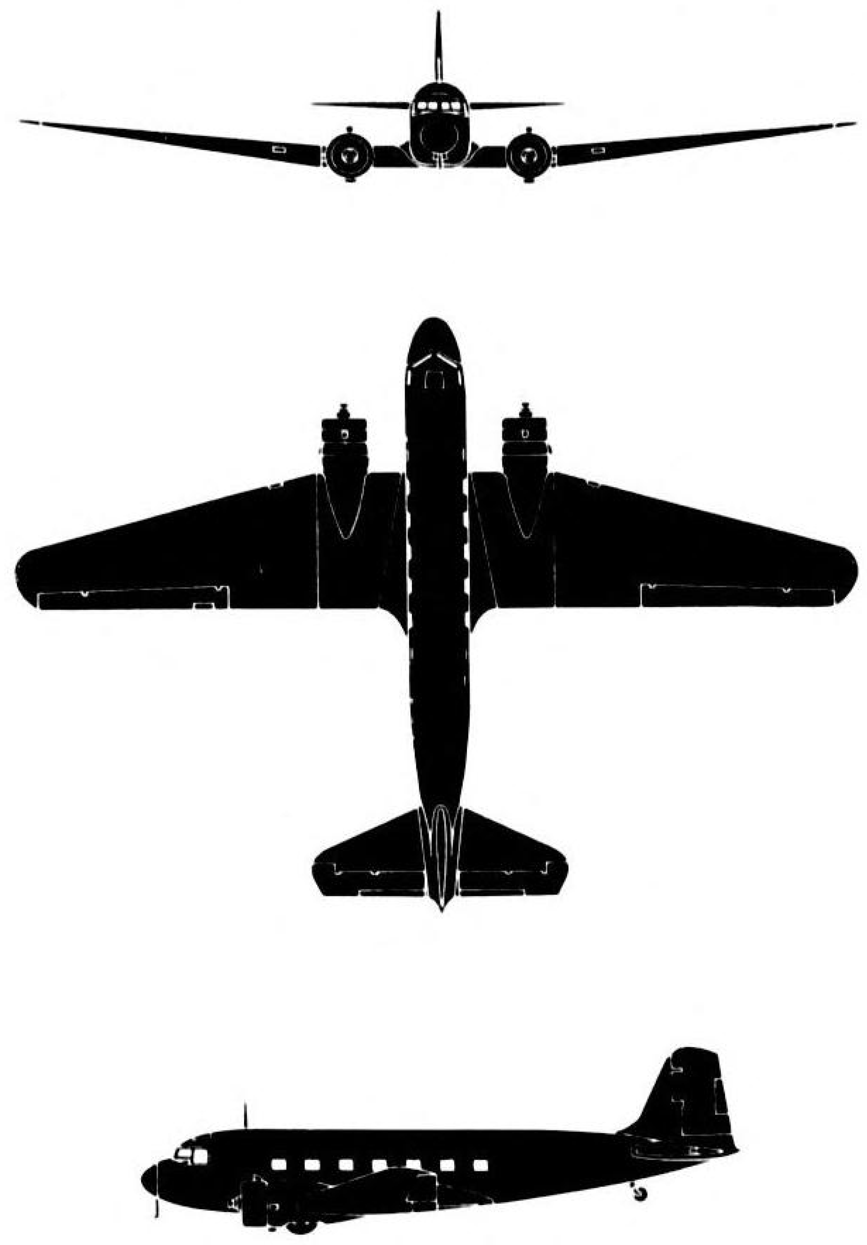
JAPANESE AIRCRAFT

AIRCRAFT
(IDENTIFICATION)
scale 1" = 45'

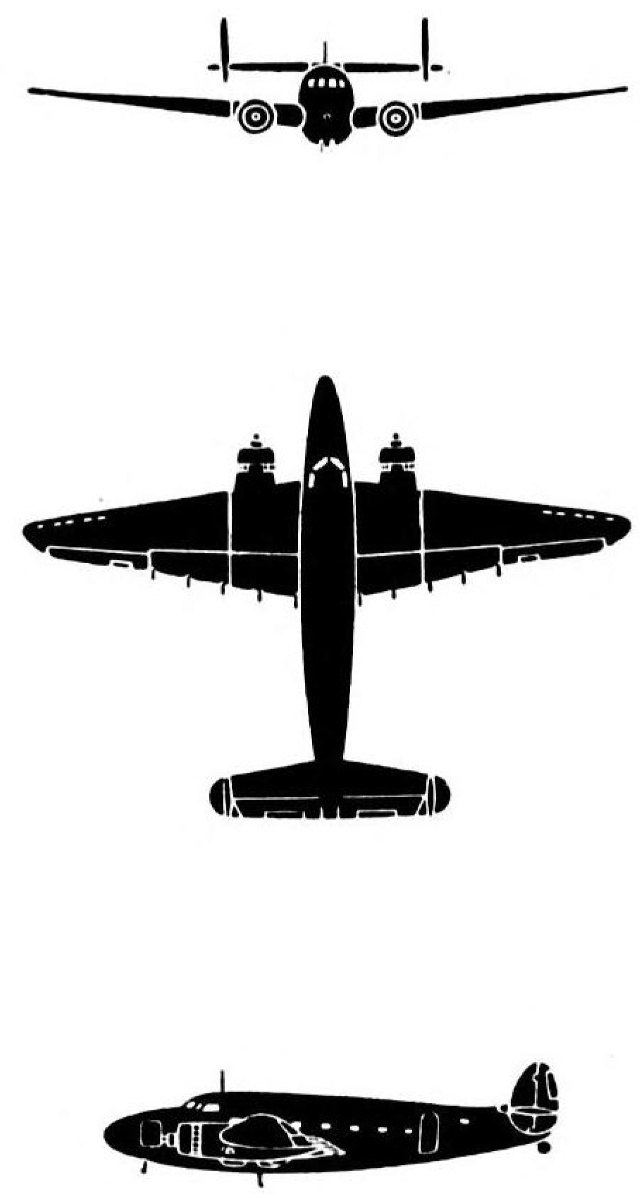
OBSOLETE PLANES



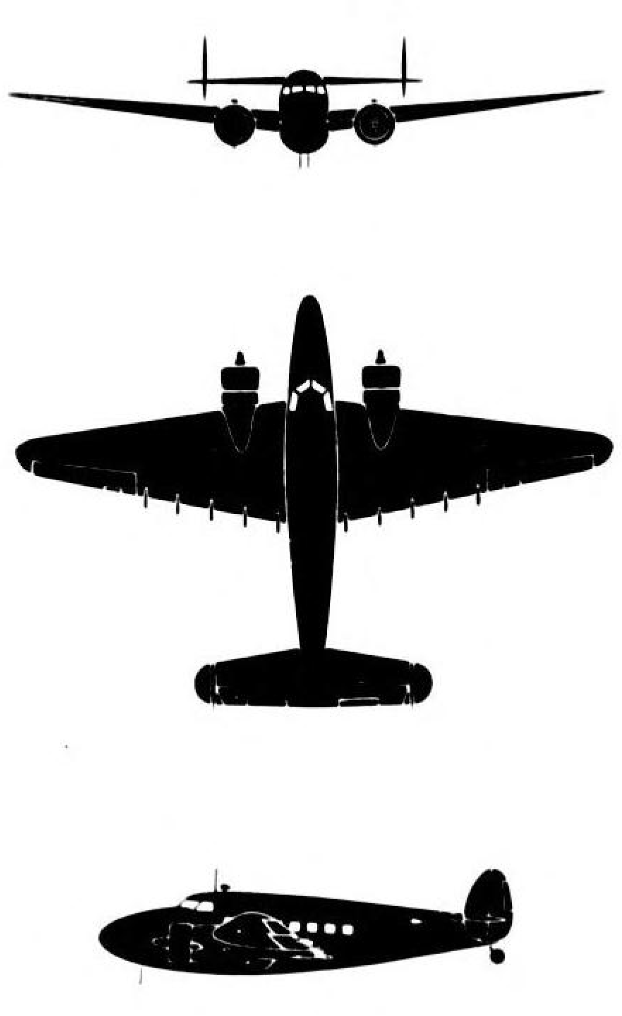
Provisional
CHERRY 11
Navy Patrol Bomber
S-(108') L-(70')



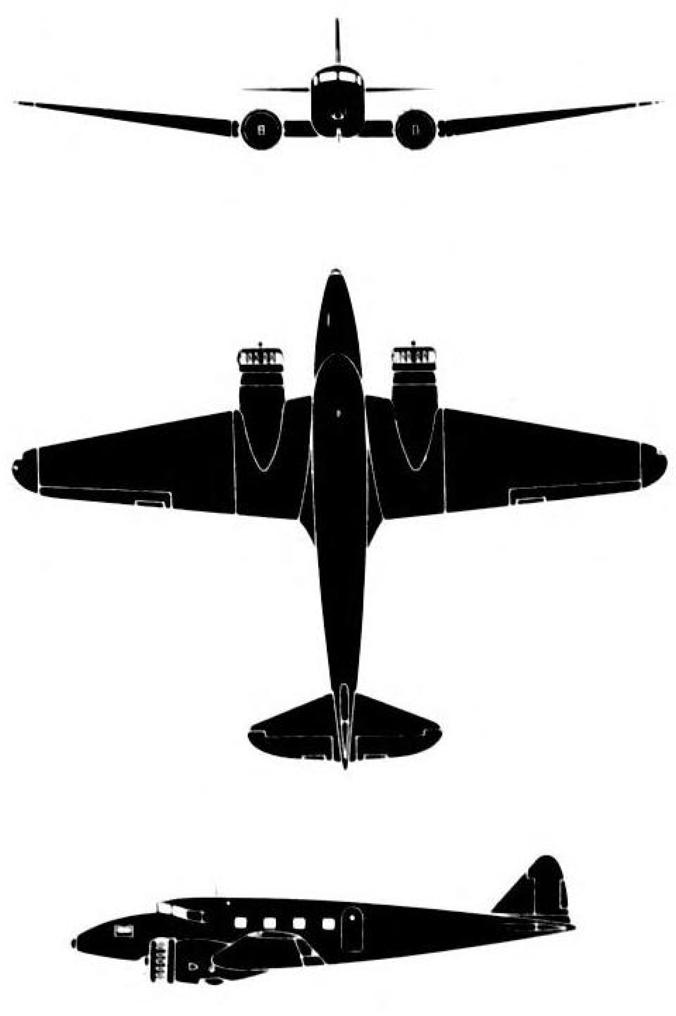
TESS 11
Navy Transport
S-85' L-62'



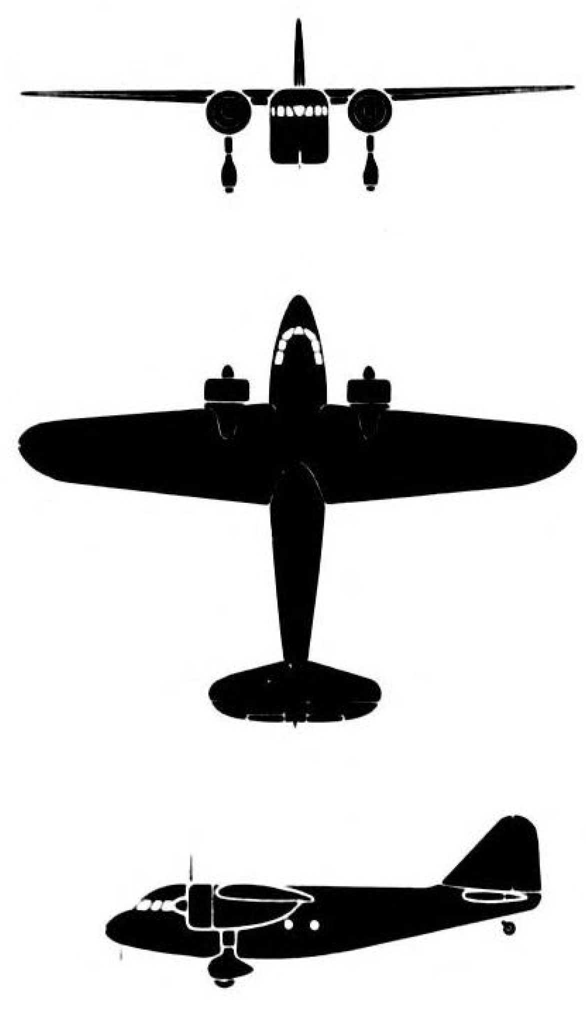
Provisional
THALIA 1
Army Transport
S-65'6" L-48'10"



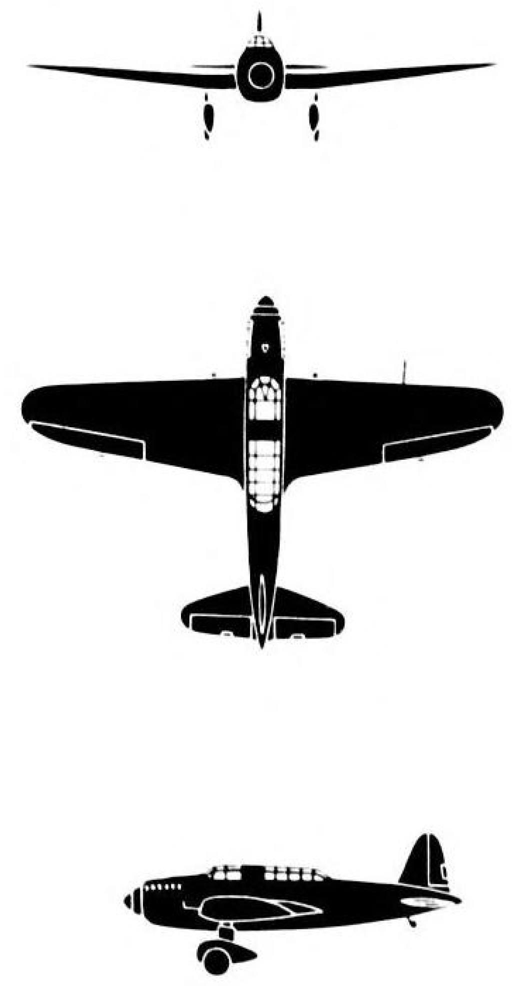
Provisional
THELMA 1
Army Transport
S-65'6" L-44' 4"



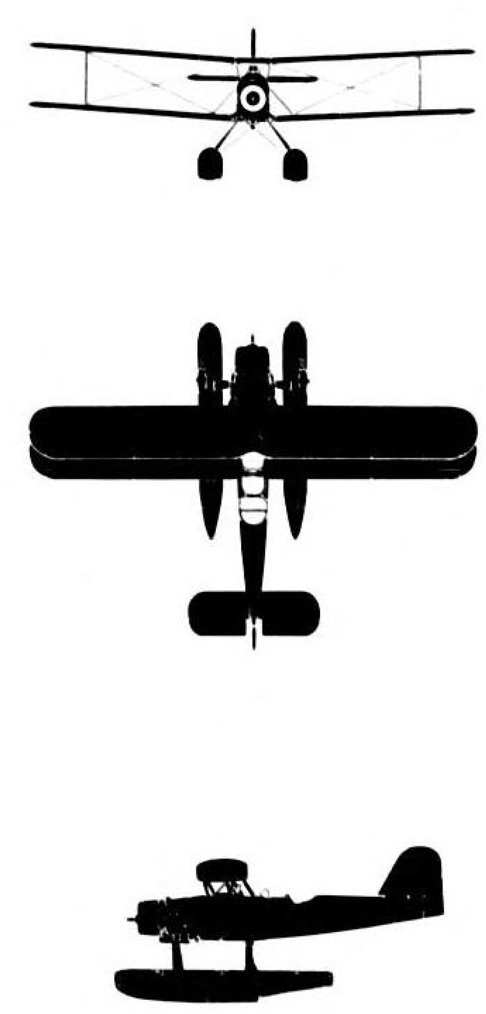
Provisional
THORA 1
Army Transport
S-65' 4" L-50'



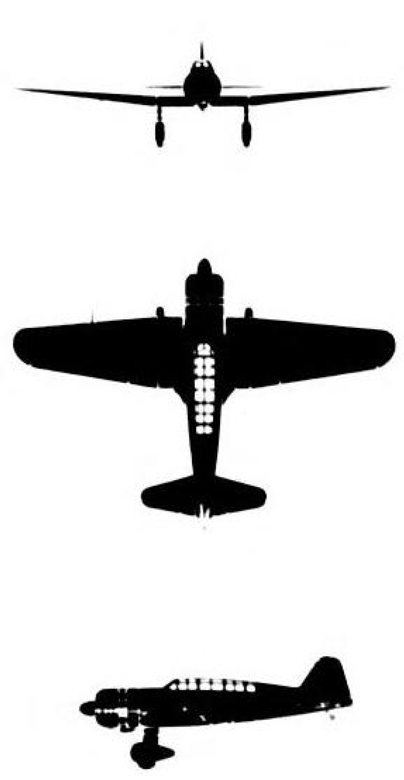
Provisional
THERESA 1
Transport
S-55' 9" L-41'



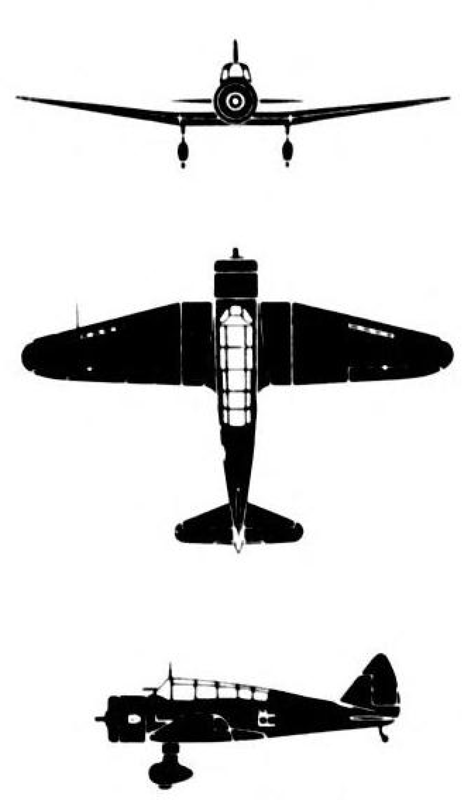
Provisional
MARY 1
Army Light Bomber
S-47' 8" L-35'



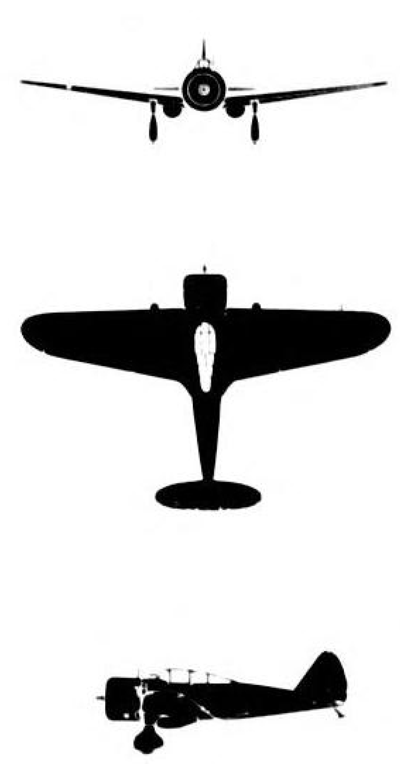
ALF 12
Navy Reconnaissance
S-46' 11" L-32' 7"



BABS 12
Navy Reconnaissance
S-39' 6" L-28' 6"



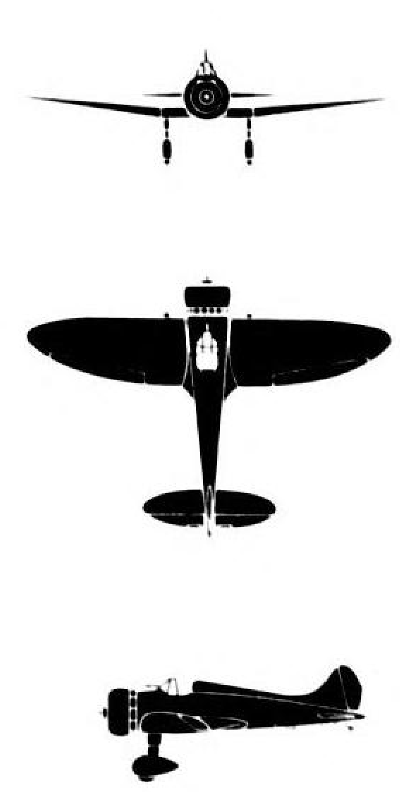
Provisional
IDA 1
Army Trainer
S-39' 5" L-27' 11"



NATE 1
Army Trainer
S-36' 9" L-24' 9"

ZEKE 32
Navy Fighter
S-36' 2" L-29' 9"

DAVE 11
Navy Reconnaissance
S-36' 6" L-28' 4"

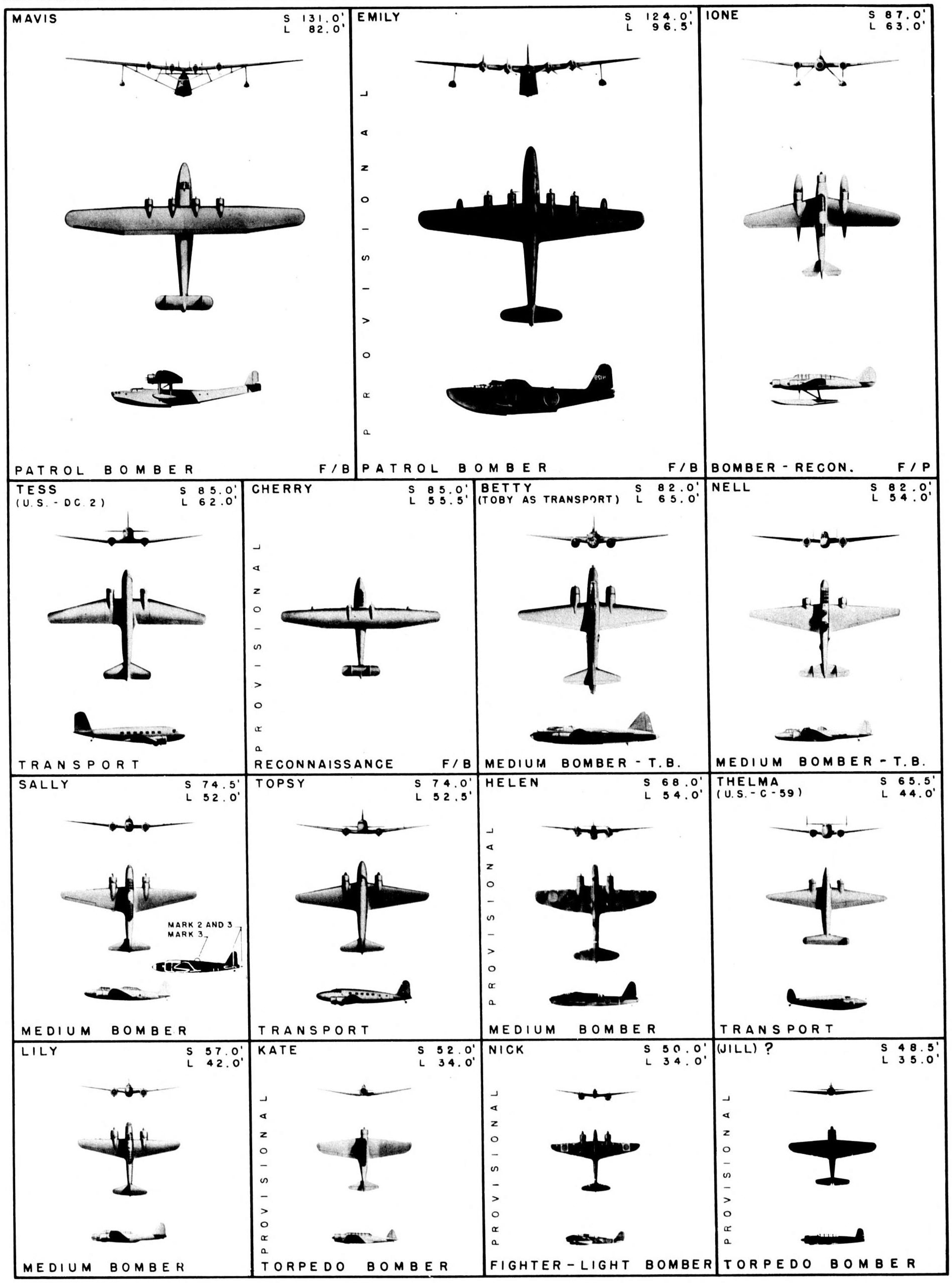


CLAUDE 14
Navy Trainer
S-36' L-24' 7"

JAPANESE AIRCRAFT

SCALE IN FEET
10 0 50 100

ALL DIMENSIONS TO THE NEAREST HALF FOOT

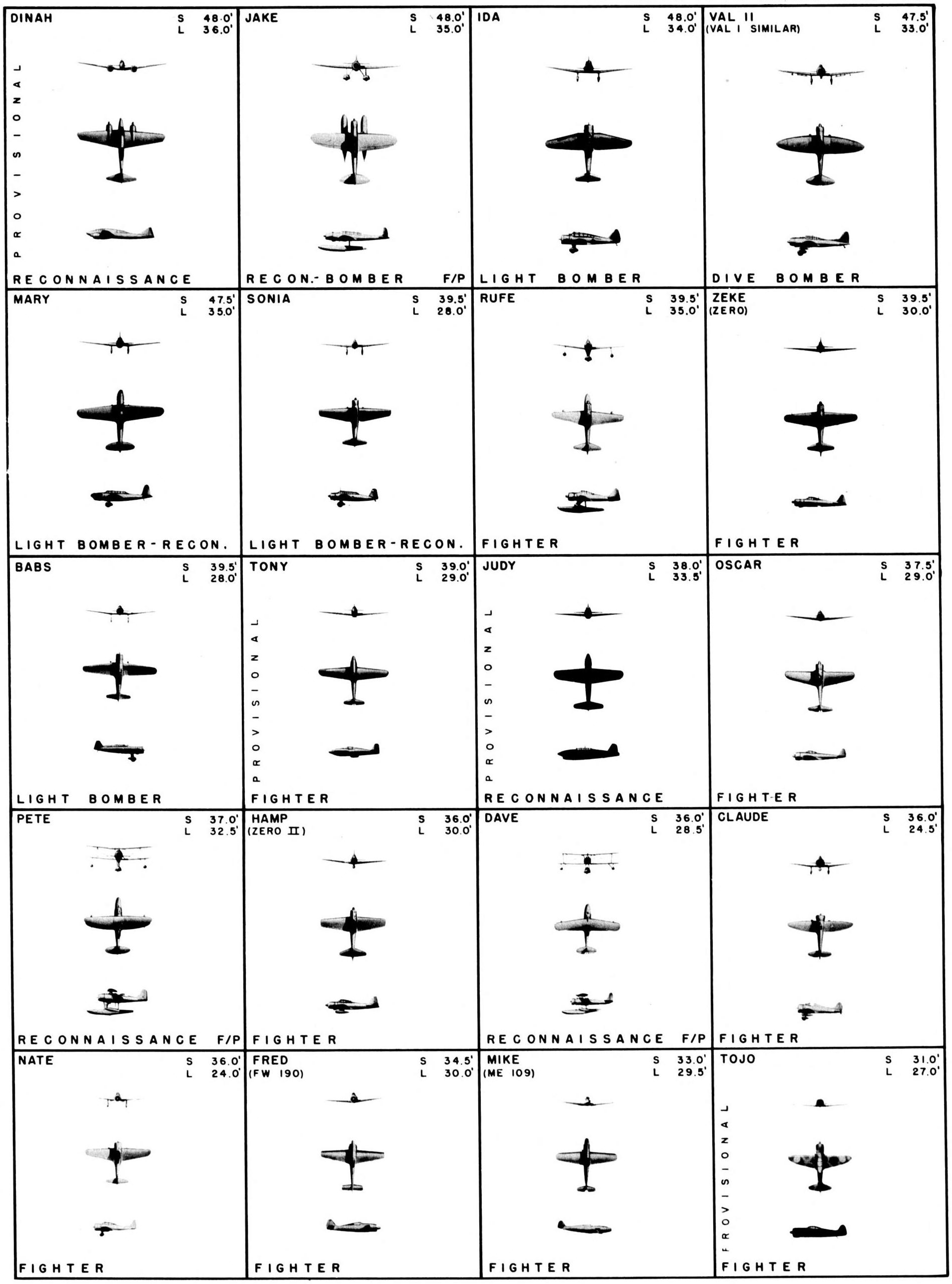


JAPANESE AIRCRAFT

SCALE IN FEET

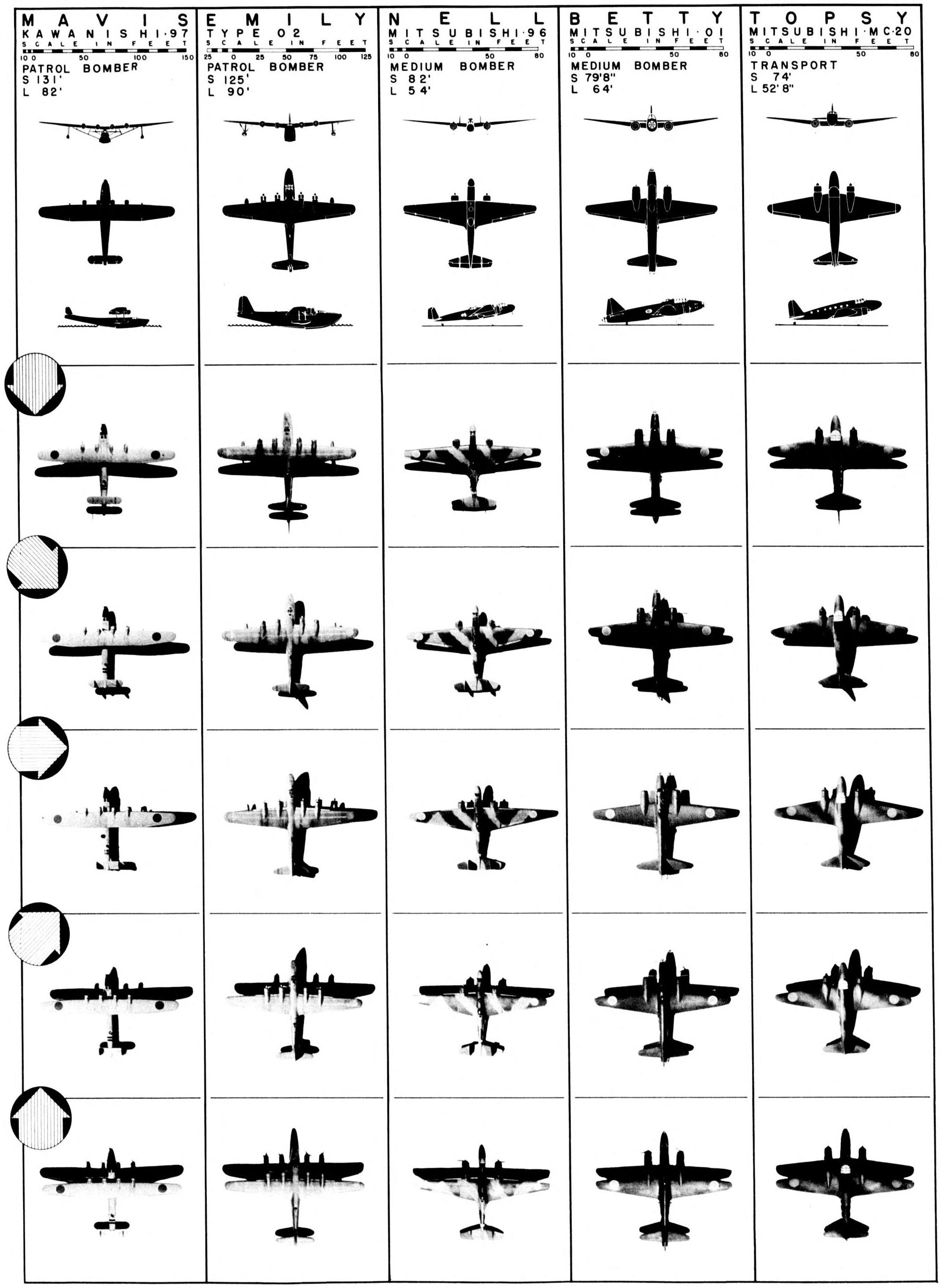
10 0 50 100

ALL DIMENSIONS TO THE NEAREST HALF FOOT



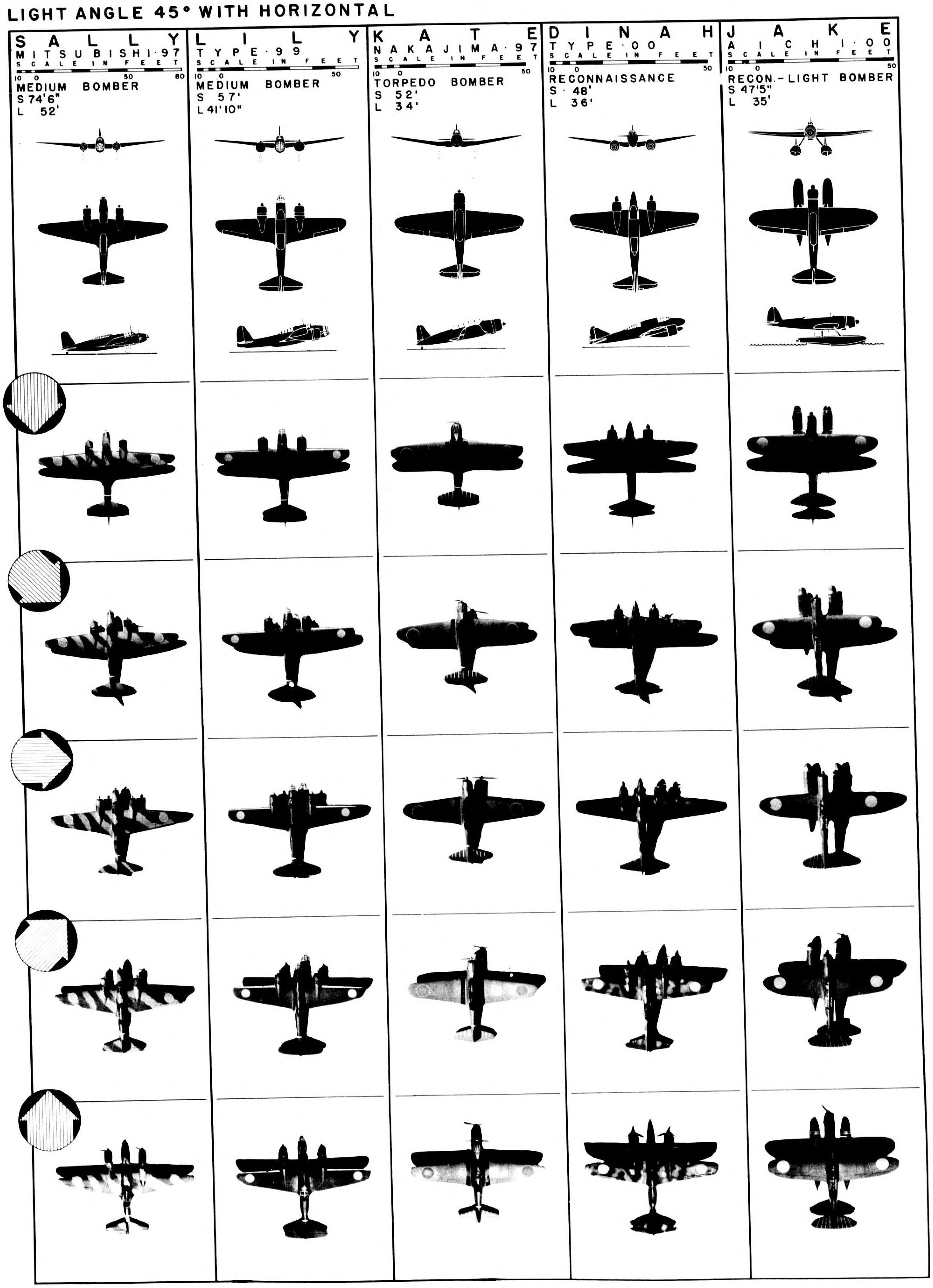
SHADOW STUDY OF JAPANESE AIRCRAFT

LIGHT ANGLE 45° WITH HORIZONTAL



SHADOW STUDY OF JAPANESE AIRCRAFT

LIGHT ANGLE 45° WITH HORIZONTAL

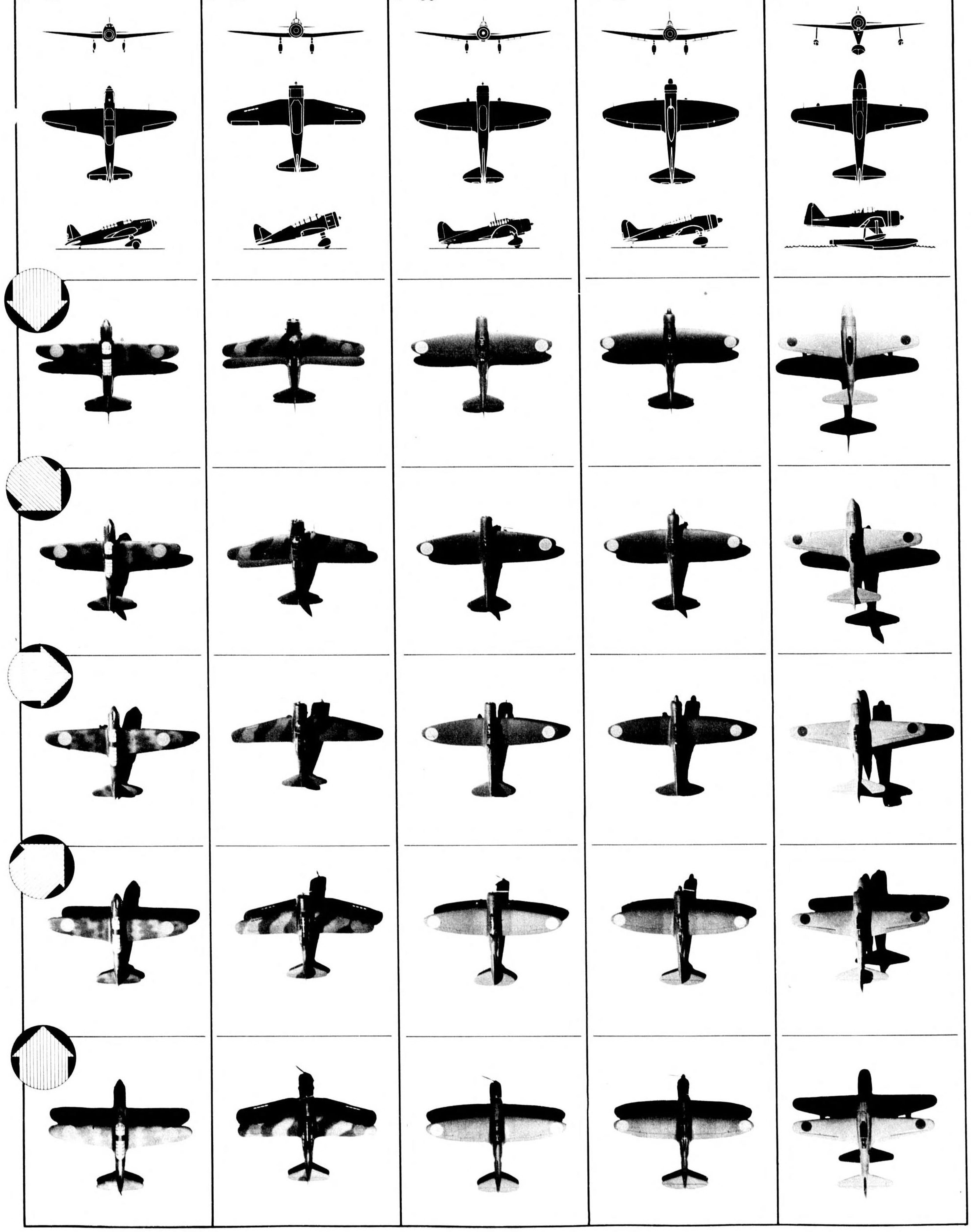


RESTRICTED

SHADOW STUDY OF JAPANESE AIRCRAFT

LIGHT ANGLE 45° WITH HORIZONTAL

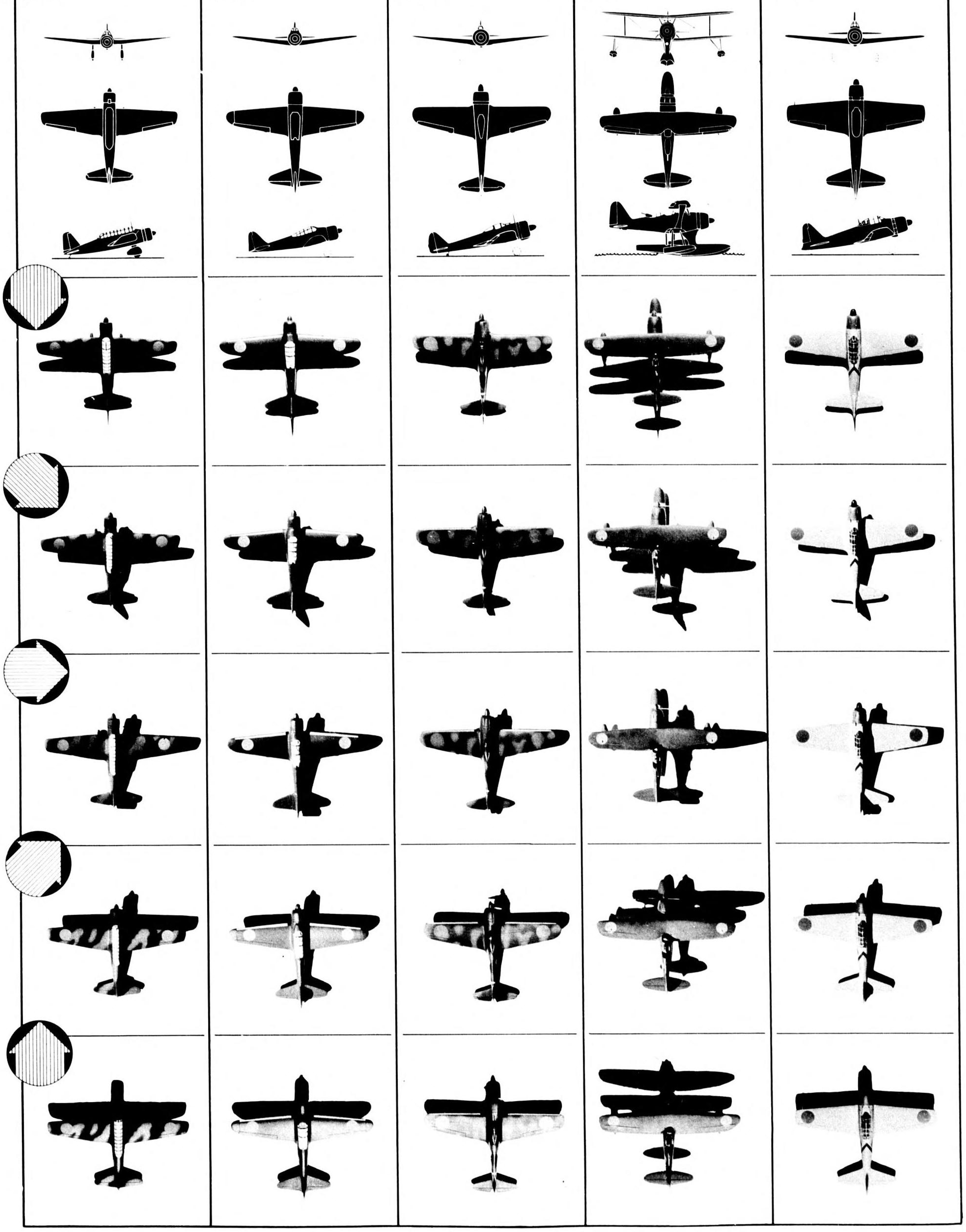
MARY	IDA	VAL I	VAL II	RUFE
KAWASAKI·97	MITSUBISHI·98	AICHI·99	AICHI·99	MITSUBISHI·00
SCALE IN FEET 10 0 50	SCALE IN FEET 10 0 50	SCALE IN FEET 10 0 50	SCALE IN FEET 10 0 50	SCALE IN FEET 10 0 40
LIGHT BOMBER	LIGHT BOMBER	DIVE BOMBER	DIVE BOMBER	FIGHTER-F/P
S 47'7"	S 47'9"	S 47'8"	S 47'8"	S 39'5"
L 35'	L 34'	L 33'	L 33'	L 35'



SHADOW STUDY OF JAPANESE AIRCRAFT

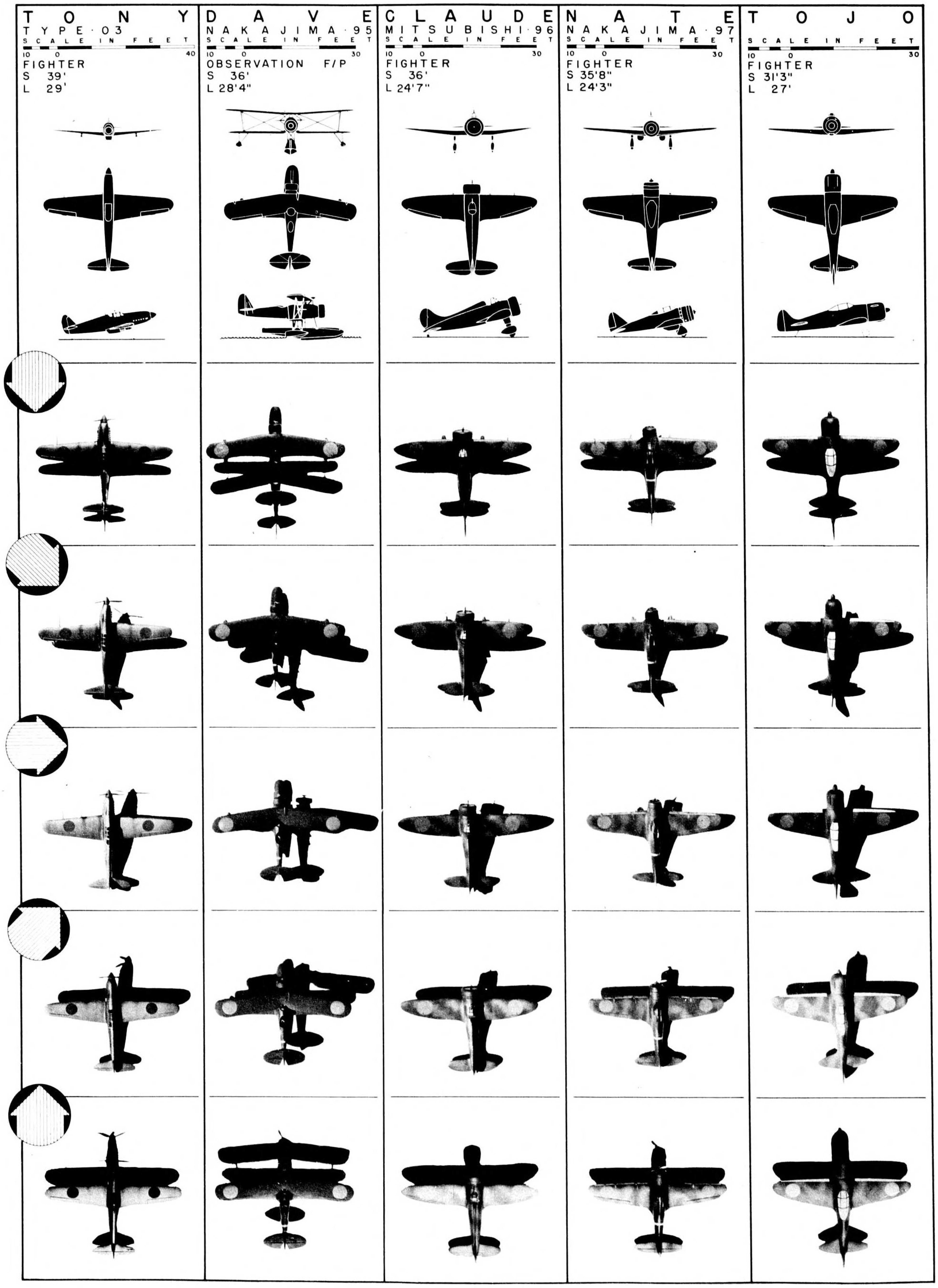
LIGHT ANGLE 45° WITH HORIZONTAL

SONIA	ZEKE·II	OSCAR	PETE	HAMP
MITSUBISHI·98	MITSUBISHI·00	PIENCHUAN·01	SASEBO·00	MITSUBISHI·00
SCALE IN FEET 10 0 40	SCALE IN FEET 10 0 40	SCALE IN FEET 10 0 30	SCALE IN FEET 10 0 30	SCALE IN FEET 10 0 30
LIGHT BOMBER-RECON.	FIGHTER	FIGHTER	OBSERVATION F/P	FIGHTER
S 39'4"	S 39'5"	S 37'7"	S 37'	S 36'
L 27'11"	L 29'8"	L 28'7"	L 32'4"	L 30'



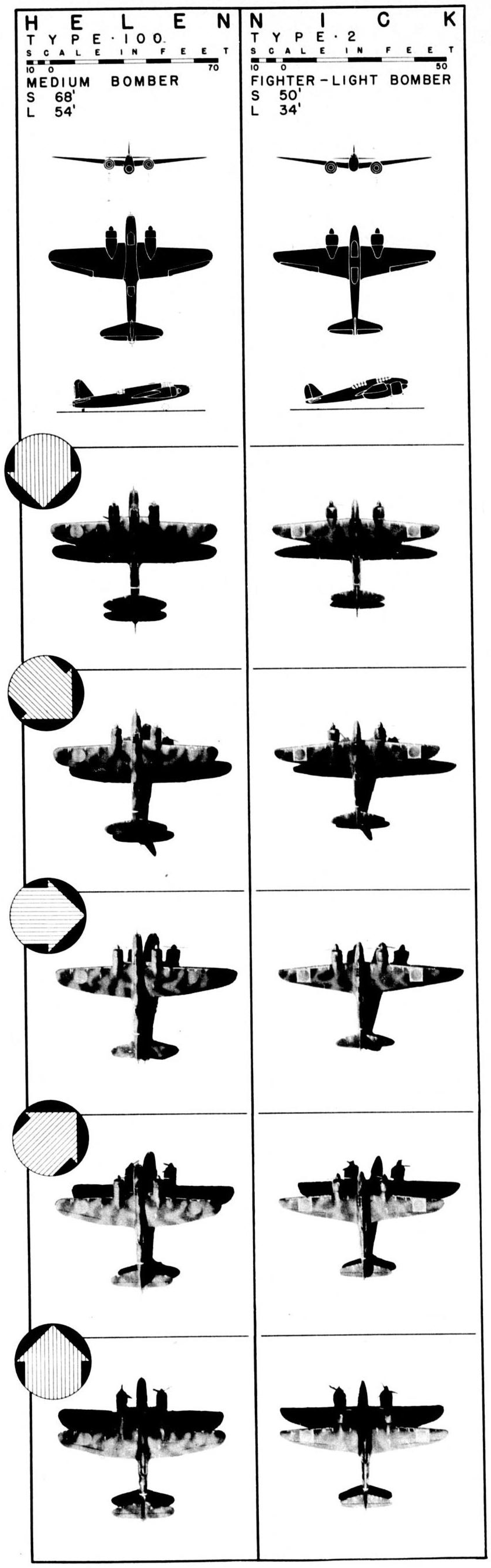
SHADOW STUDY OF JAPANESE AIRCRAFT

LIGHT ANGLE 45° WITH HORIZONTAL



SHADOW STUDY OF JAPANESE AIRCRAFT

LIGHT ANGLE 45° WITH HORIZONTAL



AIRCRAFT
(IDENTIFICATION)

GERMAN AIRCRAFT

LAND PLANES

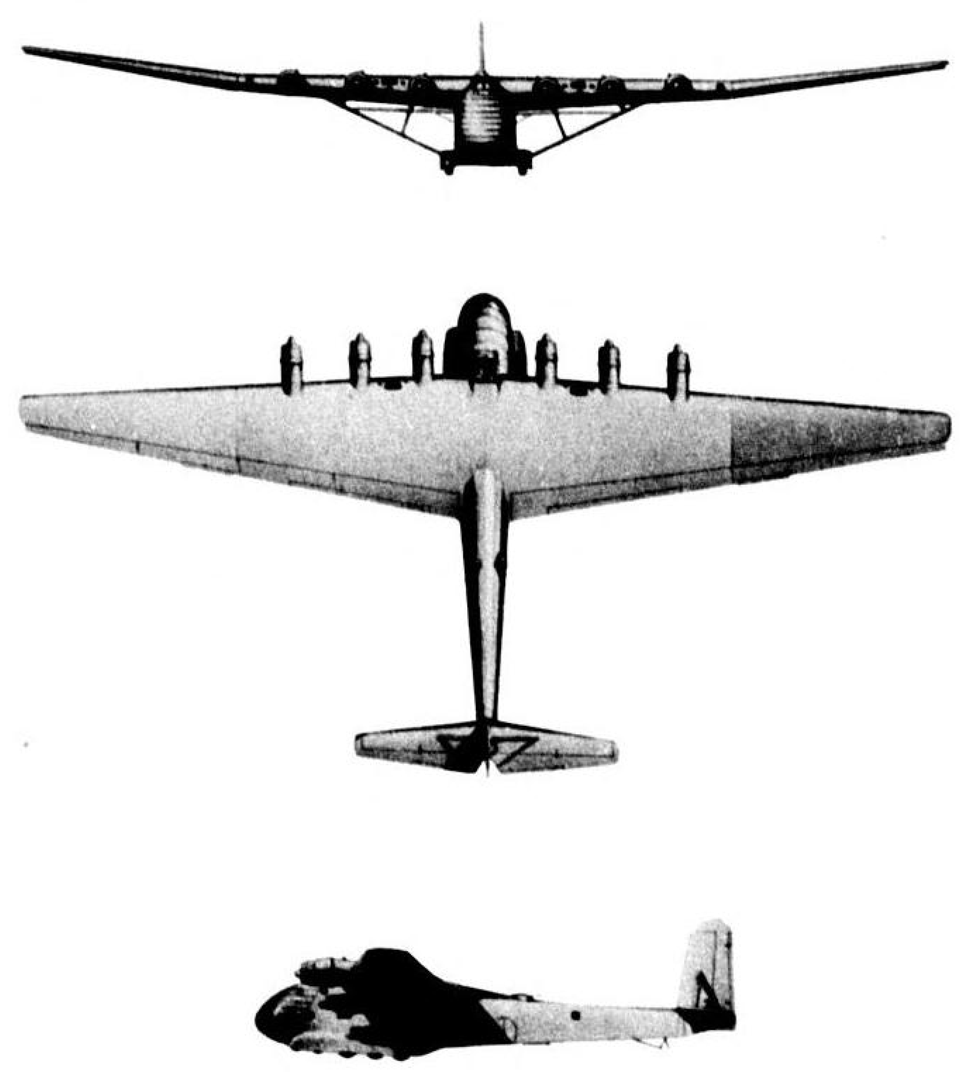
SCALE IN FEET

10 0 50 100

ALL DIMENSIONS TO THE NEAREST HALF FOOT

ME-323

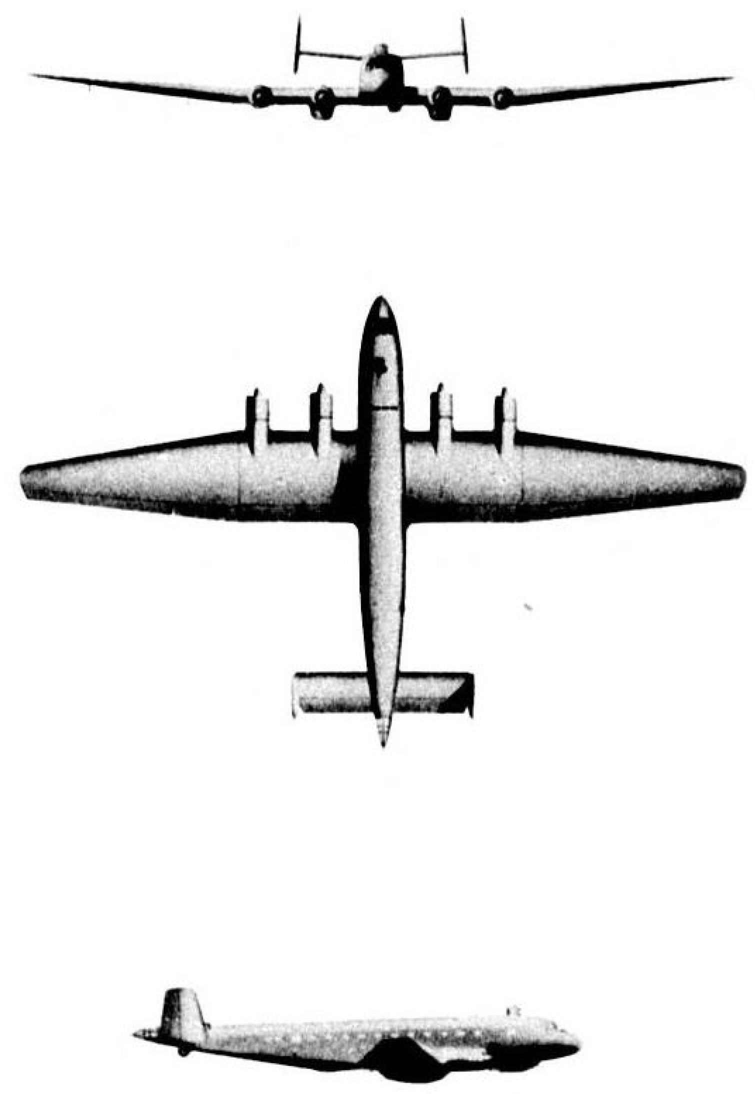
S 181.0'
L 93.0'



POWERED GLIDER

JU-290

S 138.0'
L 93.0'



TRANSPORT- HEAVY BOMBER

JU-90

S 115.5'
L 85.0'

TRANSPORT — HEAVY BOMBER

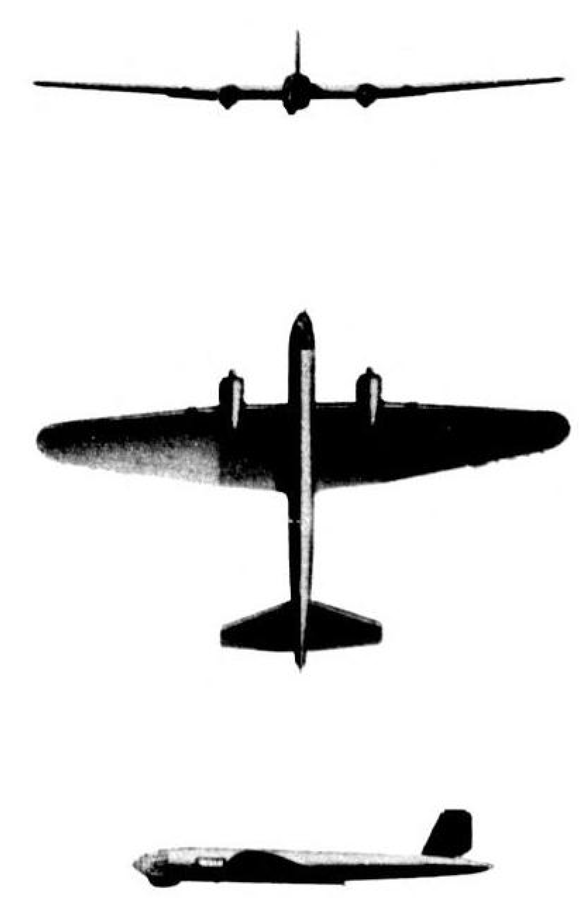
FW-200

S 108.0'
L 78.0'

TRANSPORT — HEAVY BOMBER

HE-177

S 104.0'
L 67.5'



HEAVY BOMBER

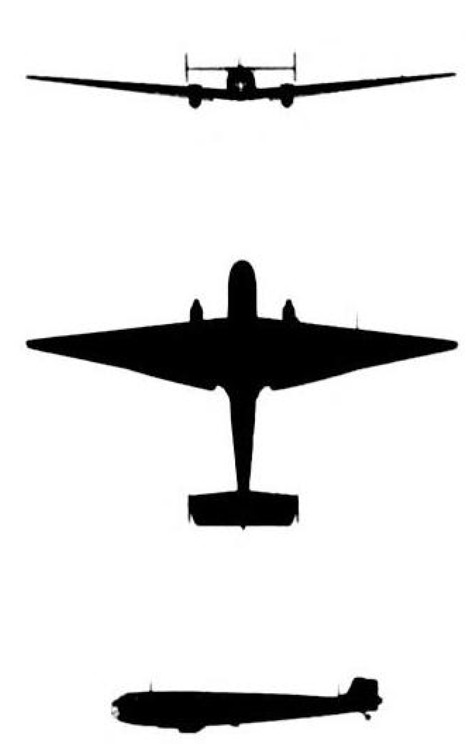
JU-52

S 96.0'
L 62.0'

TRANSPORT- GLIDER TUG

JU-86 P

S 84.0'
L 53.0'



HIGH ALTITUDE RECON

GO-242

S 79.0'
L 52.5'

GLIDER

AIRCRAFT
(IDENTIFICATION)

GERMAN AIRCRAFT

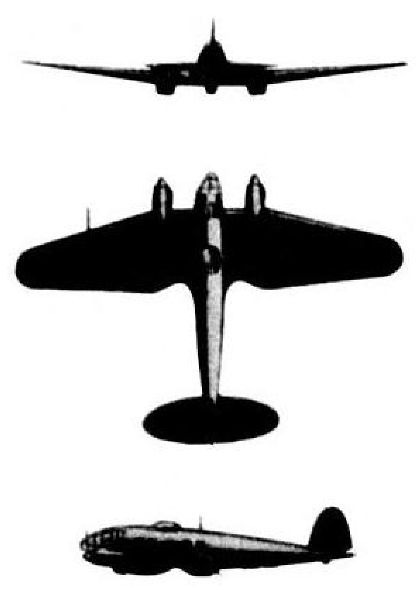
LAND PLANES

SCALE IN FEET

10 0 50 100

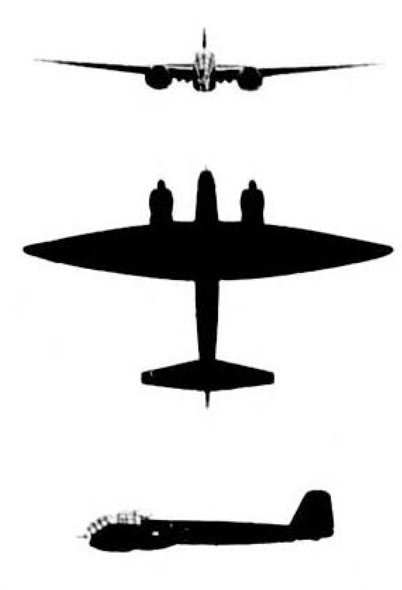
ALL DIMENSIONS TO THE NEAREST HALF FOOT

HE-111K S 74.0' L 54.0'



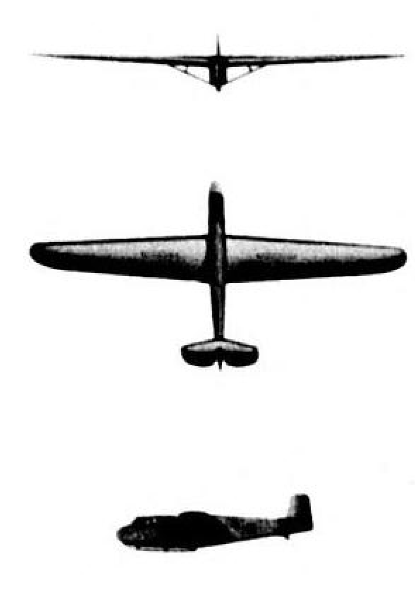
MEDIUM BOMBER

JU-188 S 72.5' L 49.0'



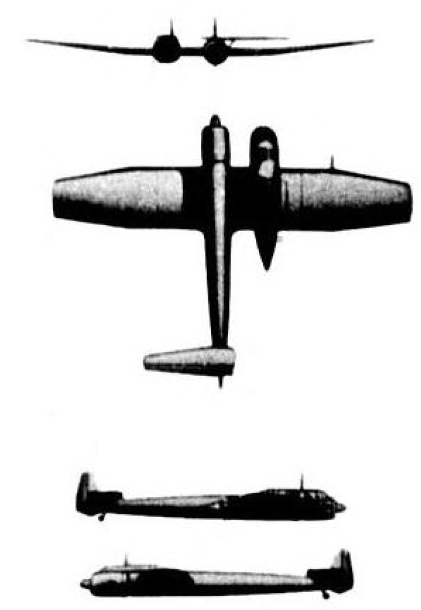
MEDIUM BOMBER

DFS-230 S 72.5' L 37.5'



GLIDER

BV-141 S 66.0' L 49.0'



ARMY COOPERATION

JU-88-A6 S 66.0' L 47.0'

MEDIUM BOMBER-FIGHTER

DO-217E S 62.5' L 56.5'

MEDIUM & DIVE BOMBER

FW-189 S 60.5' L 39.5'

ARMY COOPERATION

DO-17Z S 59.0' L 52.0'

RECONNAISSANCE-BOMBER

ME-410 S 54.0' L 41.0'

FIGHTER-BOMBER

ME-210 S 54.0' L 40.0'

FIGHTER-BOMBER

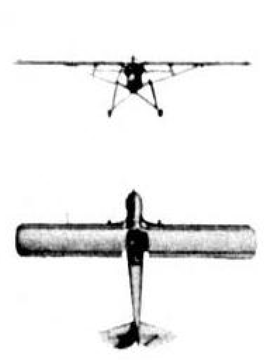
ME-110 S 53.5' L 40.5'

FIGHTER-BOMBER

HS-126 S 47.5' L 35.5'

ARMY COOPERATION

FI-156 S 47.0' L 32.5'

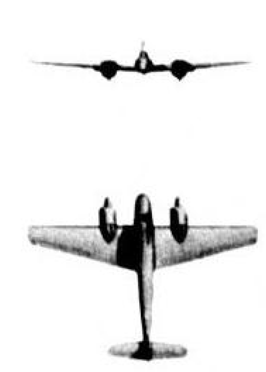


ARMY COOPERATION

JU-87B S 45.0' L 36.5'

DIVE BOMBER

HS-129 S 44.5' L 33.0'



ATTACK BOMBER

FW-190 S 34.5' L 29.0'

FIGHTER

ME-109F S 32.5' L 30.0'

FIGHTER

HE-113 S 31.0' L 27.0'

FIGHTER

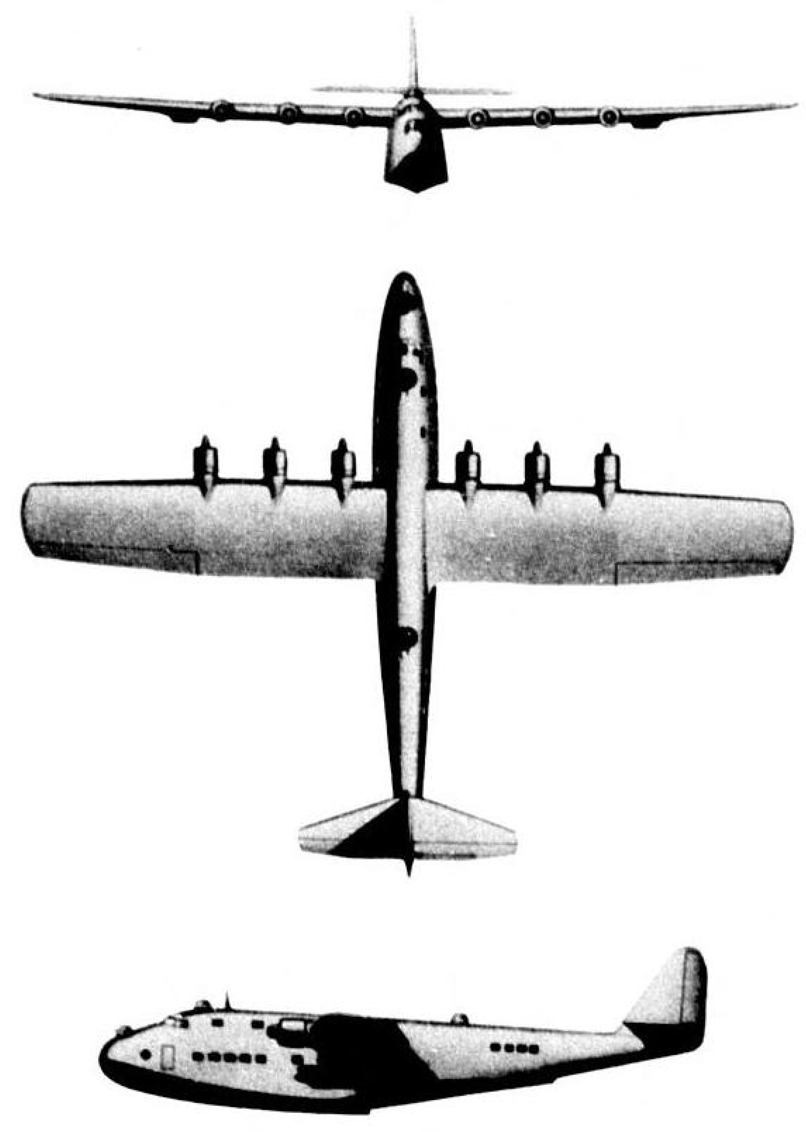
GERMAN AIRCRAFT

SEA PLANES

SCALE IN FEET
10 0 50 100

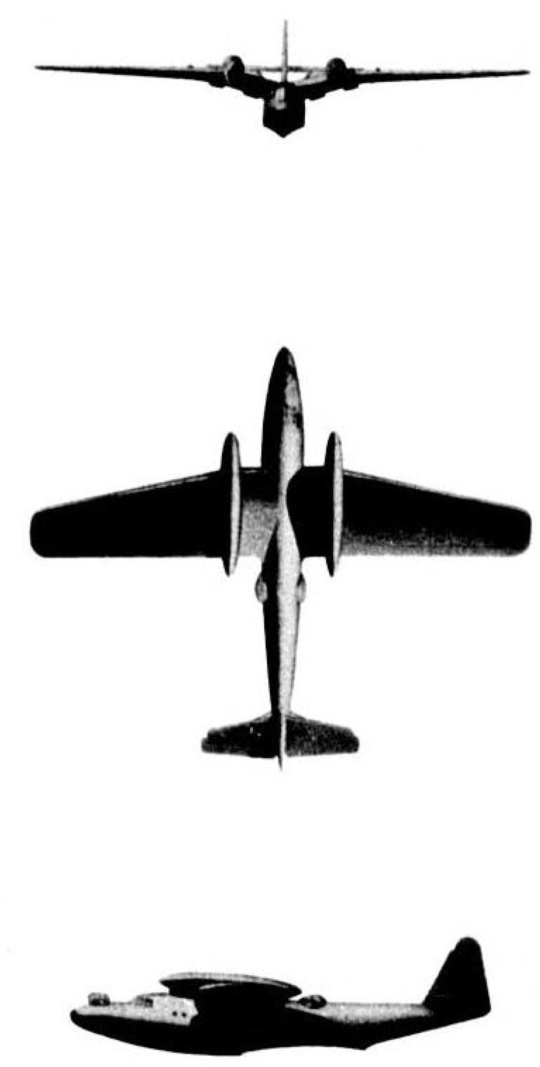
ALL DIMENSIONS TO THE NEAREST HALF FOOT

BV-222 — S 150.0' L 115.0'



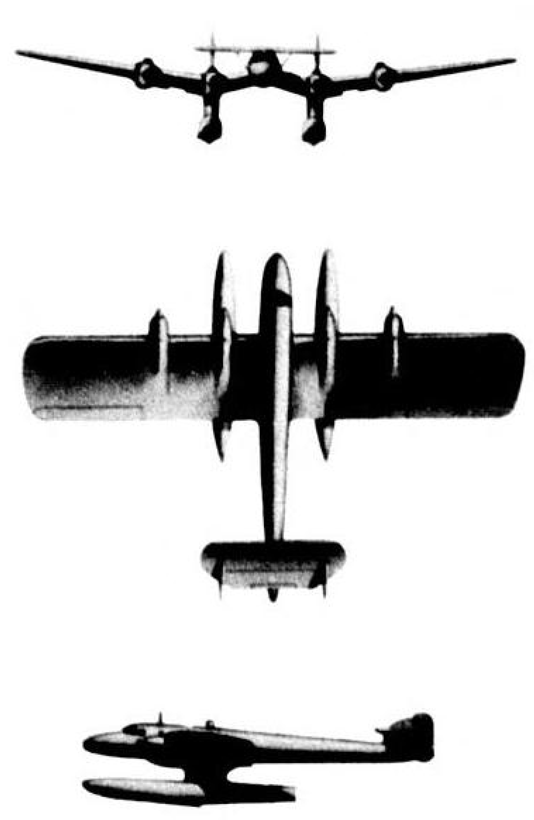
TRANSPORT F/B

DO-26 — S 98.5' L 80.5'



RECONNAISSANCE F/B

HA-139 — S 97.0' L 64.5'

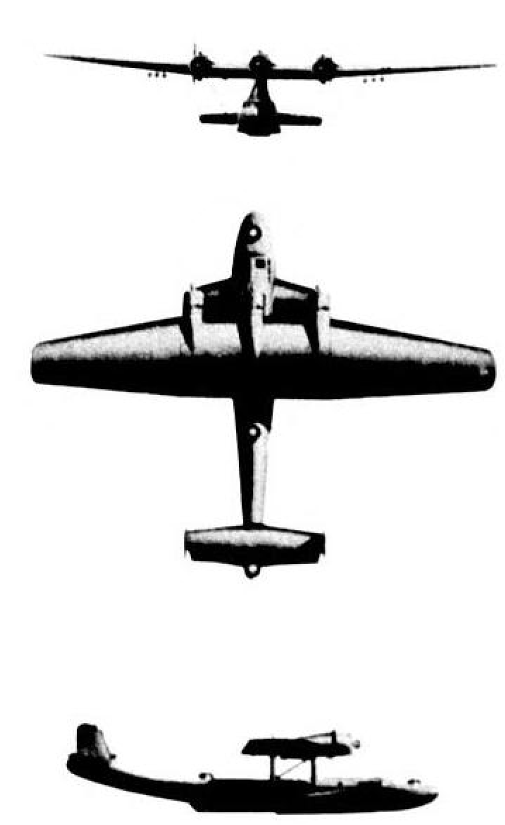


RECONNAISSANCE F/P

HA-138B — S 88.5' L 65.5'

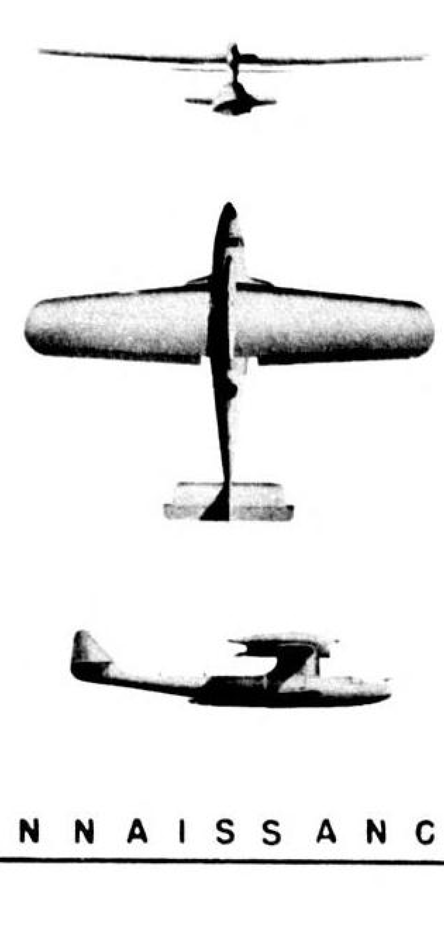
RECONNAISSANCE F/B

DO-24 — S 88.5' L 72.0'



RECONNAISSANCE F/B

DO-18 — S 78.0' L 63.0'



RECONNAISSANCE F/B

HE-115K — S 76.0' L 57.0'

RECON.-TORPEDO BOMBER F/P

AR.-196 — S 41.0' L 36.0'

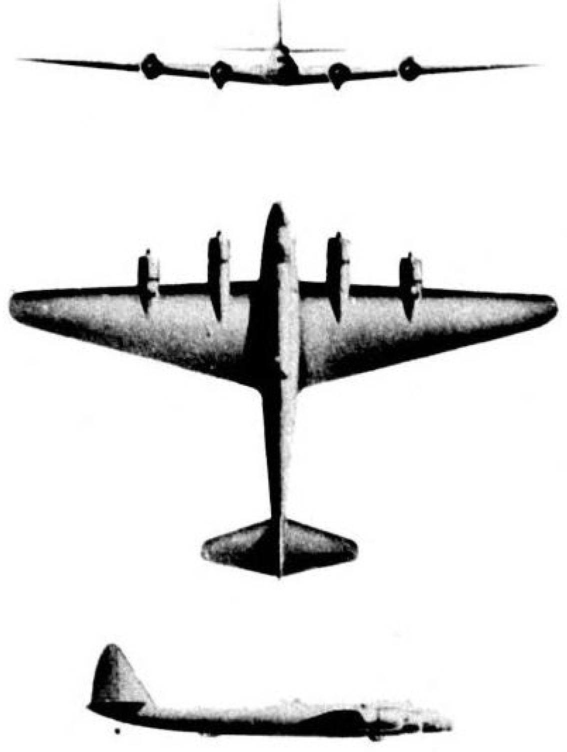
RECON.- FIGHTER

ITALIAN AIRCRAFT

SCALE IN FEET
10 0 50 100

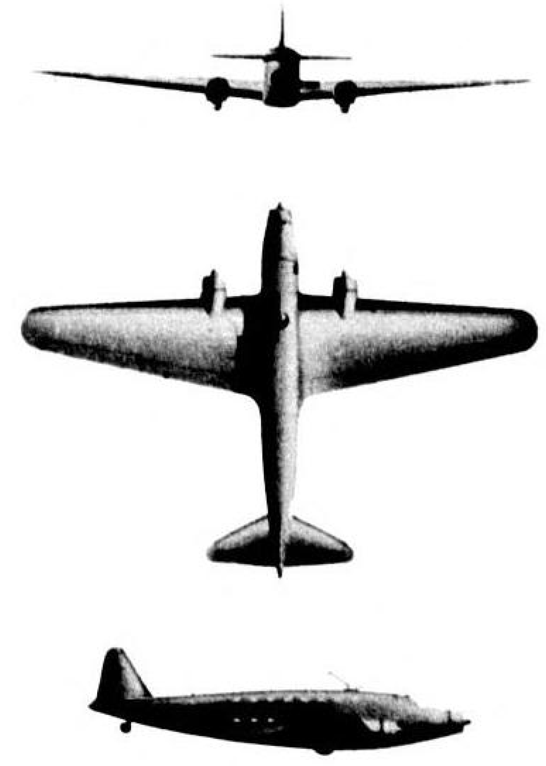
ALL DIMENSIONS TO THE NEAREST HALF FOOT

P-108 S 106.0' L 73.5'



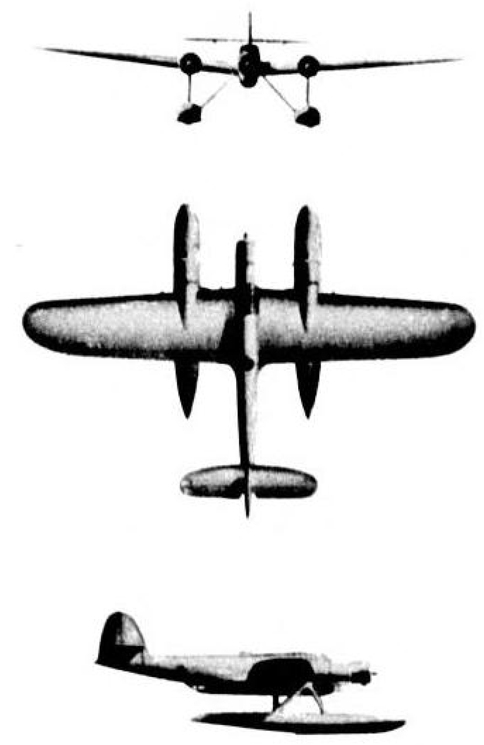
HEAVY BOMBER

SM-82 S 97.5' L 73.5'



TRANSPORT

CANT Z-506 S 87.0' L 62.0'

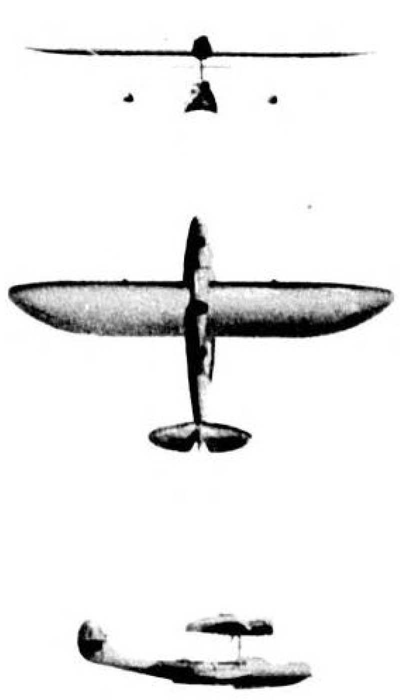


RECONNAISSANCE F/P

CANT Z-1007 BIS 81.5' 60.5'

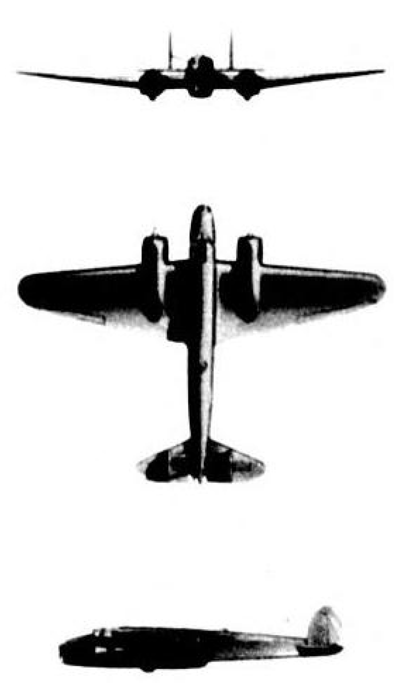
MEDIUM BOMBER - RECON

CANT Z-501 S 74.0' L 47.0'



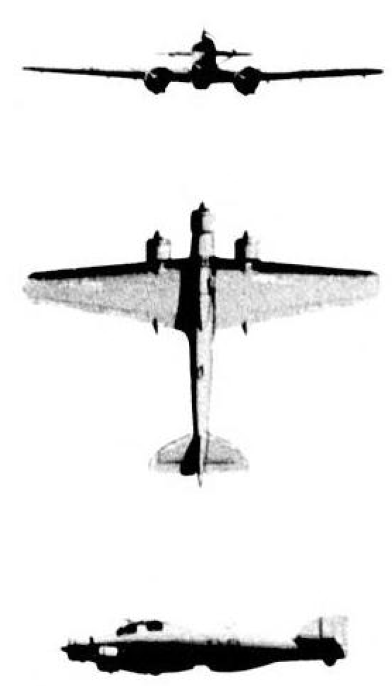
RECONNAISSANCE F/B

BR-20 S 71.5' L 53.0'



MEDIUM BOMBER - RECON

SM-79 S 69.5' L 54.5'



BOMBER-TORPEDO BOMBER

SM-84 S 69.0' L 60.0'

BOMBER - TORPEDO BOMBER

CANT 311-312 BIS S 53.0' L 35.5'

LIGHT BOMBER - RECON

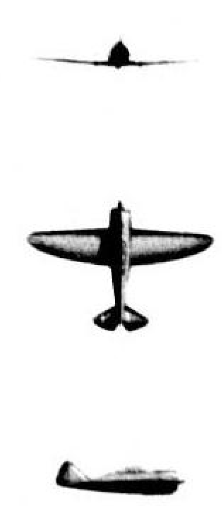
RO-37 BIS S 36.5' L 28.0'

ARMY COOPERATION

RE-2001 S 36.0' L 28.5'

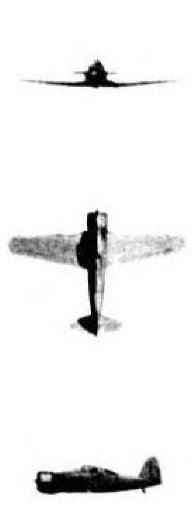
FIGHTER

RE-2000 S 36.0' L 25.5'



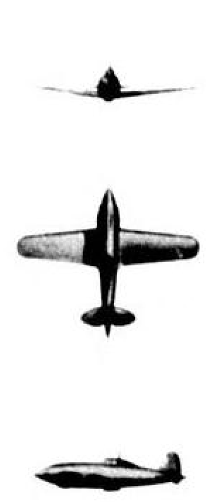
FIGHTER

G-50 S 36.0' L 25.5'



FIGHTER

MC-202 S 35.0' L 29.5'



FIGHTER

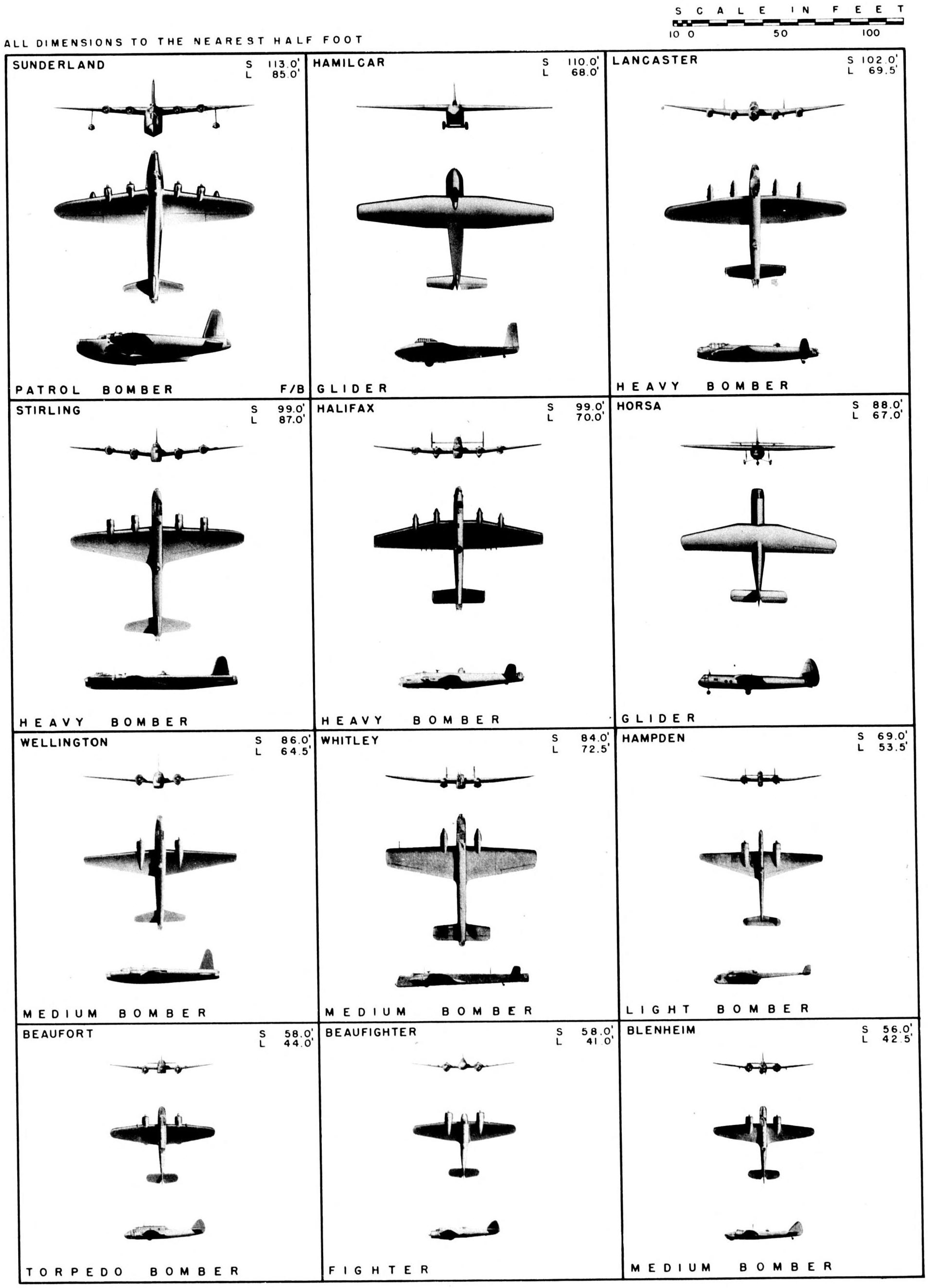
MC-200 S 35.0' L 27.0'

FIGHTER

CR-42 S 31.5' L 27.0'

NIGHT FIGHTER

BRITISH AIRCRAFT



BRITISH AIRCRAFT

SCALE IN FEET

10 0 50 100

ALL DIMENSIONS TO THE NEAREST HALF FOOT

MOSQUITO S 54.0' L 41.0'

LIGHT BOMBER-FIGHTER

ALBACORE S 50.0' L 40.0'

TORPEDO BOMBER-RECON.

BARRACUDA S 50.0' L 40.0'

TORPEDO BOMBER-RECON.

SKUA S 46.0' L 35.5'

FIGHTER

FULMAR S 46.0' L 40.0'

FIGHTER-RECON.

HOTSPUR II S 46.0' L 39.0'

GLIDER

SWORDFISH S 45.5' L 36.0'

TORPEDO BOMBER-RECON.

TYPHOON S 41.5' L 32.0'

FIGHTER

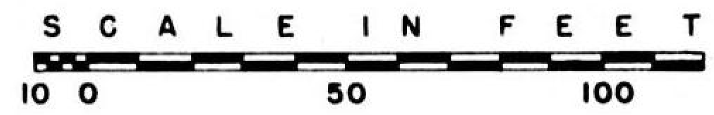
HURRICANE S 40.0' L 31.5'

FIGHTER-LIGHT BOMBER

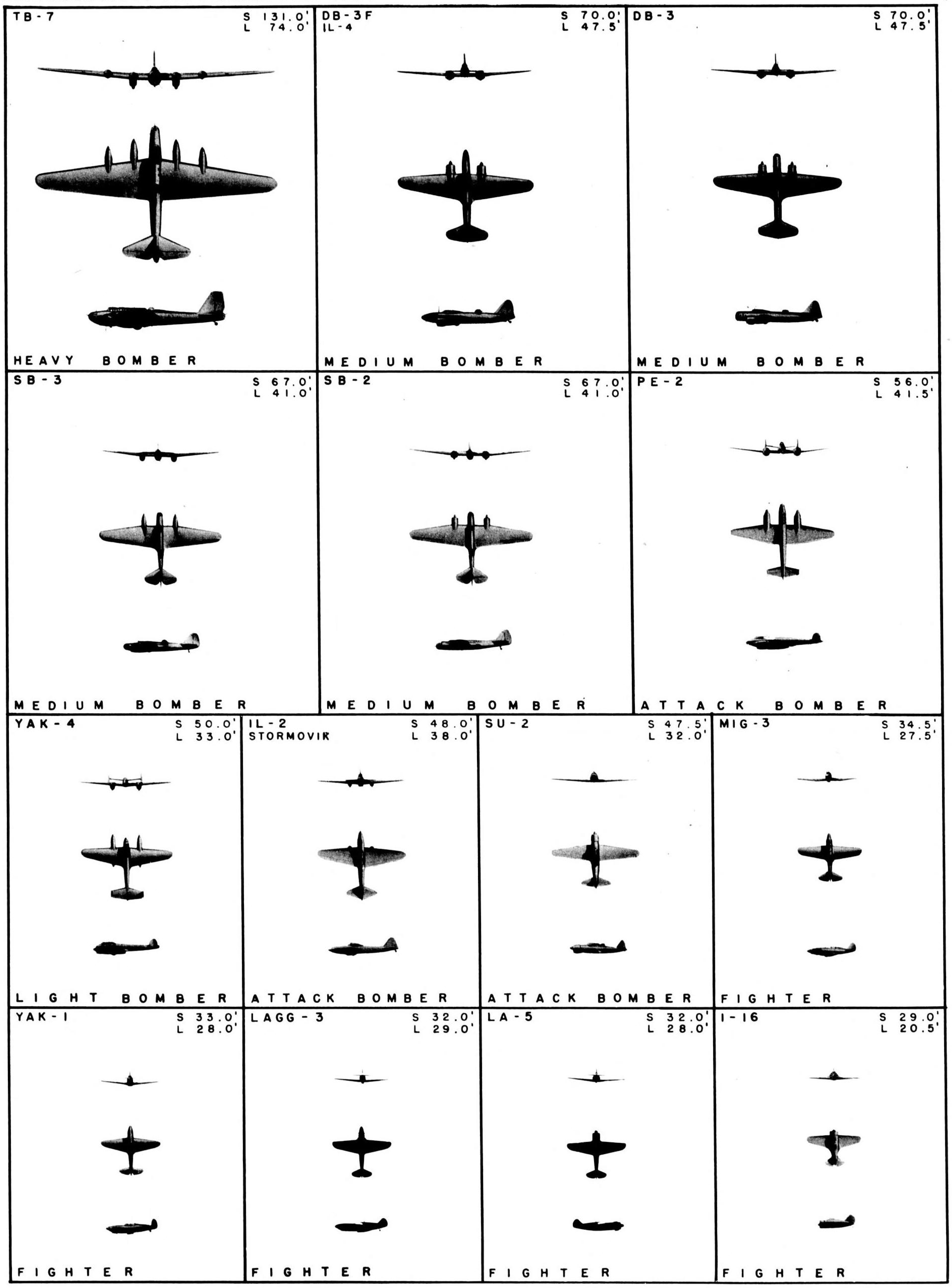
SPITFIRE S 37.0' L 30.0'

FIGHTER

U. S. S. R. AIRCRAFT ★



ALL DIMENSIONS TO THE NEAREST HALF FOOT



AIRCRAFT
(IDENTIFICATION)

NAVY

'V' designates heavier-than-air
'Z' designates lighter-than-air

	Designation		Designation
Bombing	VB	Observation-Scouting	VOS
Fighting	VF	Patrol-Bombing	VPB
Observation	VO	Scouting-Bombing	VSB
Patrol	VP	Scouting-Observation	VSO
Scouting	VS	Torpedo-Bombing	VTB
Torpedo	VT	Utility-Transport	VJR
Training	VN	Miscellaneous	VM
Transport (multi-engine)	VR	Photographic	VD
Transport (single-engine)	VG	Ambulance	VH
Utility	VJ	Glider	VL

EXAMPLE:

	Class	Number of the model built by manufacturer	Manufacturer	Number of the modification of the model
PBY-2	PB	1	Consolidated	2
PB2Y-3	PB	2	Consolidated	3

A - Brewster Aeronautical Corp.
B - Beech Aircraft Company
Boeing Aircraft Company
C - Curtiss Aeroplane Div., Curtiss-Wright Corp.
D - Douglas Aircraft Co., Inc.
E - Bellanca Aircraft Corp.
F - Grumman Aircraft Eng. Corp.
G - Great Lakes Aircraft Corp.
H - Hall-Aluminum Aircraft Corp.
J - North American Aviation
K - Fairchild Aircraft Corp.
L - Bell Aircraft Corp.
M - Glenn L. Martin Co.
N - Naval Aircraft Factory
O - Lockheed Aircraft Corp.
P - Spartan Aircraft Co.
Q - Stinson Aircraft
R - W. L. Maxon Corp.
Ryan Aeronautical Co.
S - Vought-Sikorsky Aircraft
Stearman Aircraft Co.
T - El Segundo Div., Douglas Aircraft Co.
U - Vought-Sikorsky Aircraft Div., United Aircraft Corp.
W - Waco Aircraft Company
X - Experimental
Y - Consolidated Aircraft Corp.

ARMY

Amphibian	OA	Training (primary)	PT
Army Reconnaissance (photographic)	F	Transport (cargo personnel)	C
Bombardment (light)	A	Utility Transport (less than 9 places or less than 1,400 lbs. of cargo)	UC
Bombardment (medium & heavy)	B	Glider (troop)	CG
Fighter	P	Glider (training)	TG
Liaison	L	Target (control)	CQ
Observation	O	Target (aerial)	OQ
Training (advanced)	AT	Target (aerial)	PQ
Training (basic)	BT		

PREFIXES: R - Restricted (no longer first line aircraft); X - Experimental; Y - Service Test; Z - Obsolete.

AIRCRAFT
(IDENTIFICATION)

UNITED STATES AIRCRAFT

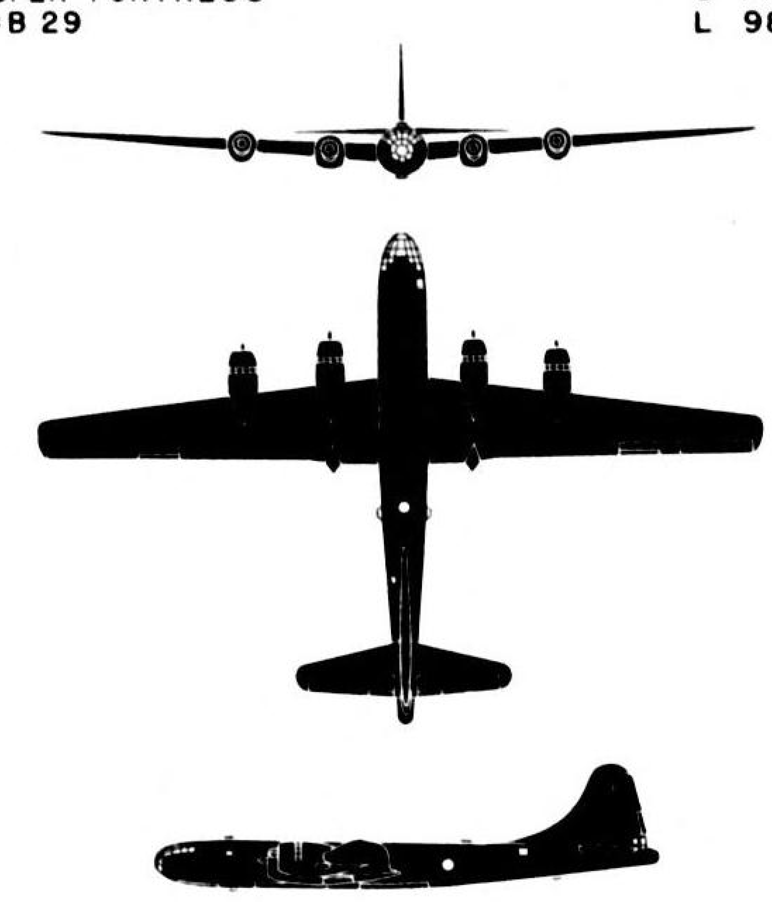
LAND PLANES

SCALE IN FEET

10 0 50 100

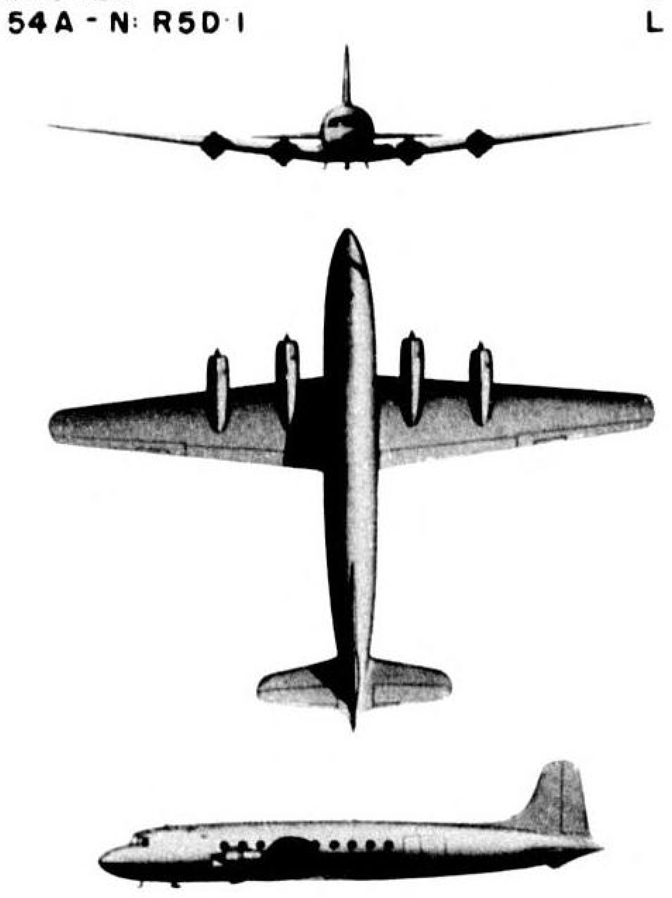
ALL DIMENSIONS TO THE NEAREST HALF FOOT

SUPER FORTRESS S 141.0'
A: B 29 L 98.0'



HEAVY BOMBER

SKYMASTER S 117.5'
A: C 54A - N: R5D 1 L 94.0'

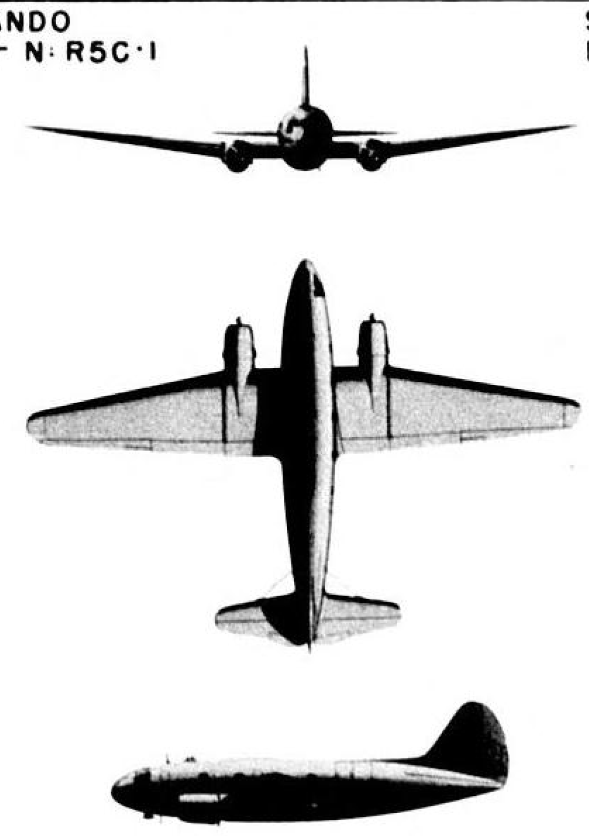


CARGO-TRANSPORT

LIBERATOR S 110.0'
A: B 24-E - N: PB4Y-1 L 66.0'

HEAVY BOMBER

COMMANDO S 108.0'
A: C 46 - N: R5C-1 L 76.0'



CARGO-TRANSPORT

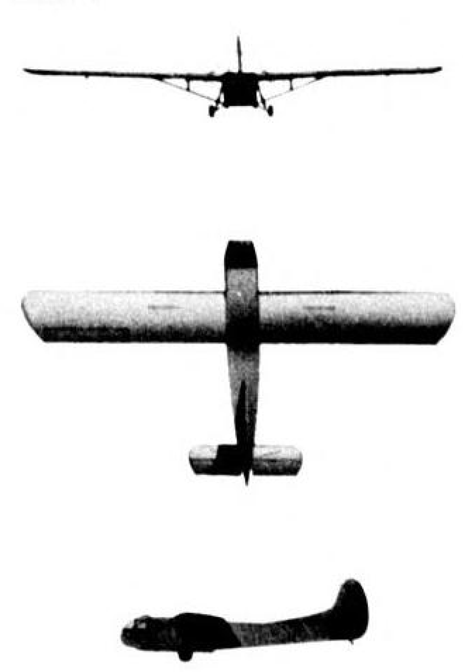
FORTRESS S 104.0'
A: B 17-E L 75.0'

HEAVY BOMBER

SKYTRAIN S 95.0'
A: C 47 TO 53 - N: R4D L 64.5'

CARGO-TRANSPORT

S 83.5'
A: CG4A - N: LRW1 L 48.5'

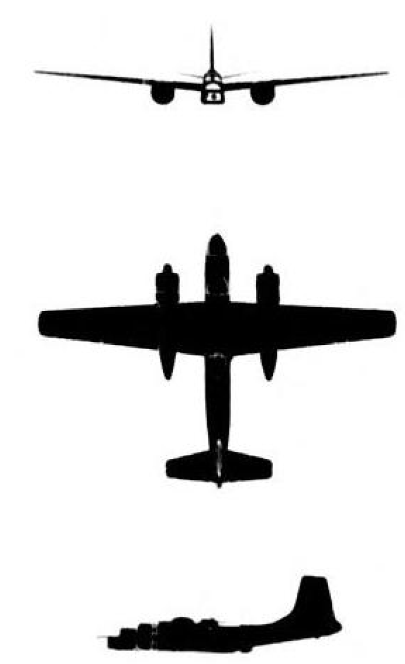


GLIDER

MARAUDER S 71.0'
A: B26-B L 58.0'

MEDIUM BOMBER

S 70.0'
A: A26-B L 50.5'

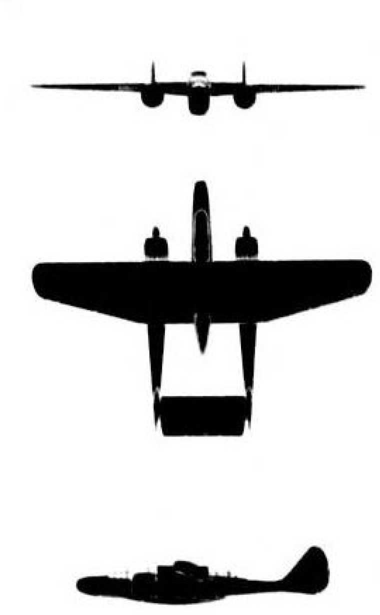


ATTACK BOMBER

MITCHELL S 67.5'
A: B25-C - N: PBJ1 L 54.0'

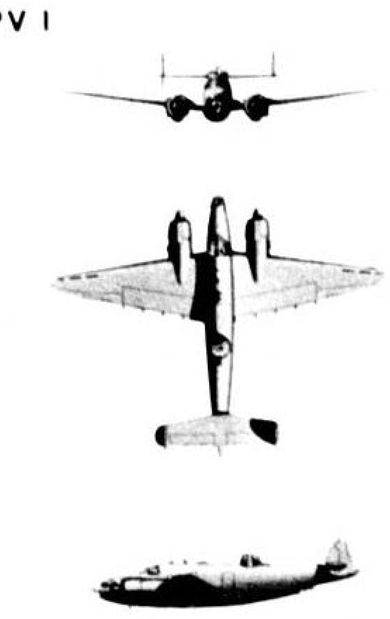
MEDIUM BOMBER

BLACK WIDOW S 66.0'
A: P61-A L 49.0'



FIGHTER BOMBER

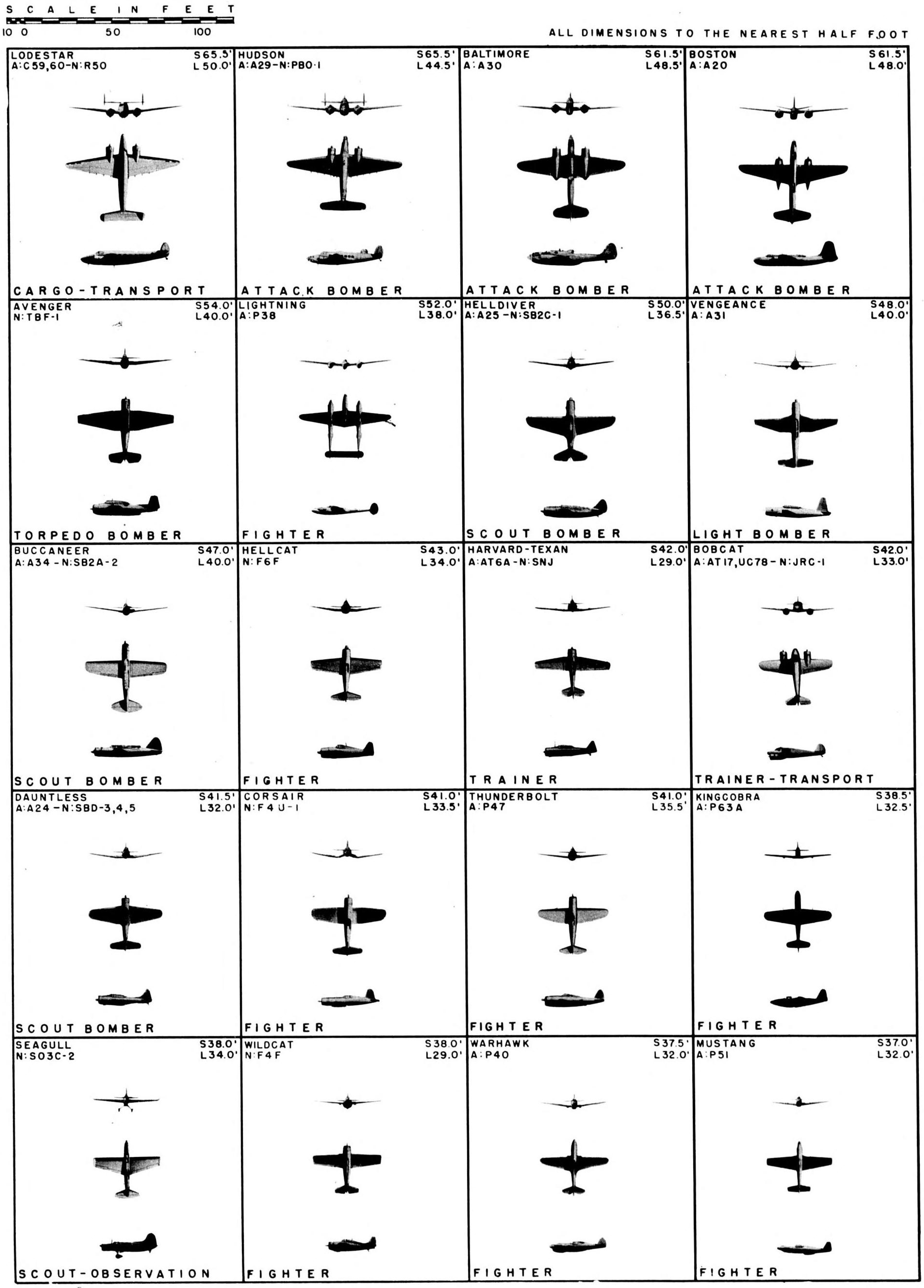
VENTURA S 65.5'
A: B34 - N: PV1 L 51.5'



PATROL BOMBER

UNITED STATES AIRCRAFT

LAND PLANES



UNITED STATES AIRCRAFT

LAND PLANES

SCALE IN FEET: 10 0 50 100

ALL DIMENSIONS TO THE NEAREST HALF FOOT

KINGFISHER S 36.0'
N: OS2U-3 L 30.0'

SCOUT - OBSERVATION

GRASSHOPPER S 35.0'
A: L4-A- N: NE-1 L 22.5'

LIAISON

AIRACOBRA S 34.0'
A: P39-E L 30.0'

FIGHTER

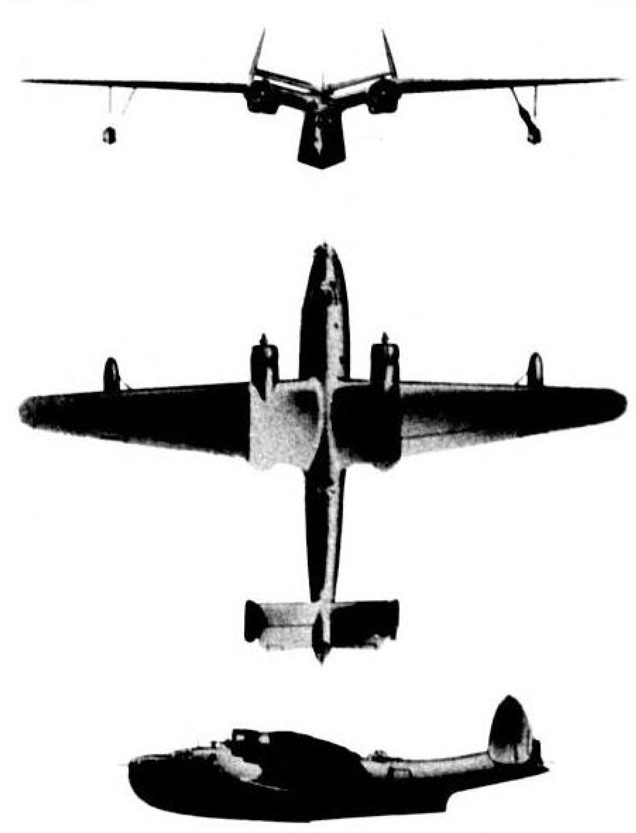
SENTINEL S 34.0'
A: L-5 L 24.0'

LIAISON

SEA PLANES

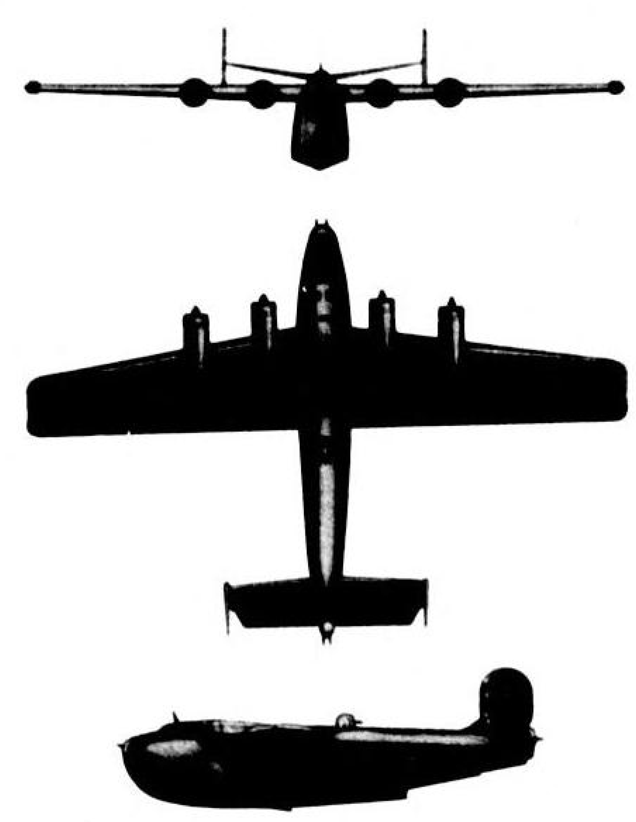
SCALE IN FEET: 10 0 50 100

MARINER S 118.0'
N: PBM-3 L 80.0'



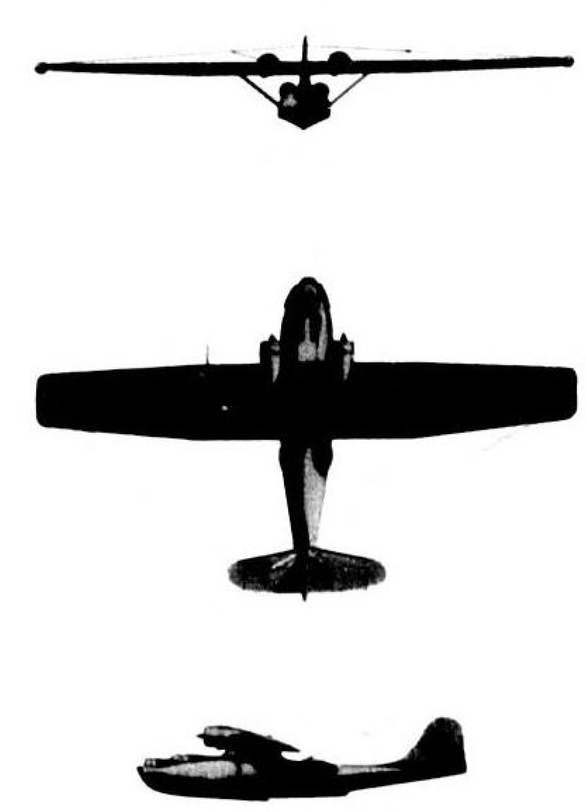
PATROL BOMBER F/B

CORONADO S 115.0'
N: PB2Y-3 L 79.0'



PATROL BOMBER F/B

CATALINA S 104.0'
N: PBY-5 L 64.0'



PATROL BOMBER F/B

HELLDIVER S 50.0'
N: SB2C-2 L 40.0'

SCOUT BOMBER F/P

DUCK S 39.0'
A: OA-12- N: J2F-5 L 34.0'

UTILITY F/B

SEAGULL S 38.0'
N: SO3C-1 L 34.0'

SCOUT-OBSERVATION F/P

KINGFISHER S 36.0'
N: OS2U-1 L 34.0'

SCOUT-OBSERVATION F/P

N: SOC-1,2,3 S 36.0'
L 26.0'

SCOUT-OBSERVATION F/P