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E. LESTER JONES, DIRECTOR

MAGNETIC RANGES

SAN FRANCISCO BAY, CALIFORNIA

SPECIAL PUBLICATION No. 1

(Revised Edition)

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PREFACE.

In 1898 the first edition of Special Publication No. 1, entitled: "California, Bay of San Francisco, Magnetic Ranges for Determining the Deviation of the Compass, with Short Explanations of How to Find the Deviation and Error of the Compass," was published by the Coast and Geodetic Survey.

The earthquake and fire of 1906 destroyed nearly all the range objects which had been determined in 1898, and rendered the original publication of little or no value. Accordingly it was suggested that a new edition be prepared, and the work of determining the positions of the new range objects and preparing the text of the proposed new edition was assigned to Fremont Morse, hydrographic and geodetic engineer, inspector of the San Francisco field station.

In 1920 special observations for magnetic declination, or variation, were made at 10 stations on the bay shore and the islands in the bay for the value of the variation to be used in computing the magnetic bearings of the ranges after their true bearings had been deduced from the triangulation observations. The resulting variation used in the computations was 18° 22′ east.

The ranges are located principally for the use of shipmasters in testing their compasses while under way, either in entering or leaving port.

E. Lester Jones,
Director.

MAGNETIC RANGES ABOUT THE BAY OF SAN FRANCISCO, CALIF., FOR DETERMINING THE DEVIATION OF THE COMPASS.

These ranges comprise such objects as can be seen in clear weather, and used by vessels under way, approximately in mid-channel, either entering or leaving port, between the entrance to the bay and Mission Rock; together with a few located for use in compass adjusting in the areas of little traffic southeastward from Mission Rock and to the eastward of Angel Island.

Good photographs of distant objects are difficult to obtain; but it is hoped that the photographs secured of the ranges, taken in conjunction with the accompanying map, and the close views of the range objects, as shown on the pages opposite the pictures of the ranges, will enable the navigator to readily identify them.

In order to show the range objects more clearly the photographs were in most cases taken with the range open. They should, of course, be closed and the objects accurately in range when the observations for deviation are taken.

HOW TO FIND THE DEVIATION OF THE COMPASS.

The vessel should be steadied for two or three minutes on the compass course whose deviation is required before arriving on the range selected.

The difference between the magnetic bearing of the range and the bearing of the range by compass will be the deviation of the compass for the point on which the ship heads, keeping in mind that if the magnetic bearing of the range is to the right of the bearing of the range by compass the deviation will be east, and, if to the left, west.

EXAMPLES.

1. Ship's head, when crossing range, northwest per compass:

Magnetic bearing of range No. 6	S. 76° 32′ W.
Bearing of range by compass	S. 72° 30′ W.
Deviation of compass for ship's head northwest	4° 02′ E.

2. Ship's head, when crossing range, southwest per compass:

Magnetic bearing of range No. 1	N. 65° 51′ W.
Bearing of range by compass	N. 60° 30′ W.
Deviation of compass for ship's head southwest	5° 21′ W.

3. Ship's head, when crossing range, southeast per compass:

Magnetic bearing of range No. 4	N. 43° 23′ E.
Bearing of range by compass	N. 40° 00′ E.
Deviation of compass for ship's head, southeast	3° 23′ E.

4. Ship's head, when crossing range, northeast, per compass:

Magnetic bearing of range No. 11	S. 62° 48′ E.
Bearing of range by compass	S. 60° 30′ E.
Deviation of compass for ship's head northeast	2° 18′ W.

If the vessel is equipped with compasses graduated clockwise from 0° to 360°, the rule given above for determining whether the deviation is east or west can be simplified to read: If the magnetic bearing of the range is greater than the bearing of the range by compass the deviation will be east; if less, west.

EXAMPLES.

5. Ship's head, when crossing range, northwest per compass:

Magnetic bearing of range No. 6	256° 32′
Bearing of range by compass	252° 30′
Deviation of compass for ship's head northwest	4° 02′ E.

6. Ship's head, when crossing range, southwest per compass:

Magnetic bearing of range No. 1	294° 09′
Bearing of range by compass	299° 30′
Deviation of compass for ship's head southwest	5° 21′ W.

7. Ship's head, when crossing range, southeast per compass:

Magnetic bearing of range No. 4	43° 23′
Bearing of range by compass	40° 00′
Deviation of compass for ship's head southeast	3° 23′ E.

8. Ship's head, when crossing range, northeast per compass:

Magnetic bearing of range No. 11	117° 12′
Bearing of range by compass	119° 30′
Deviation of compass for ship's head northeast	2° 18′ W.

HOW TO FIND THE COMPASS ERROR.

If it is desired to find the compass error on any course after the deviation on that course has been determined as above, it may be obtained by adding, algebraically, the variation and the deviation.

Bearing in mind that easterly variation and deviation are positive, or +, and that westerly variation and deviation are negative, or −, quantities; and that the formula for error is:

$e=v+d$, in which
e represents compass error,
v represents variation, and
d represents deviation, we have, for the examples given above:

9. Ship's head northwest per compass:

$v=+18° 22′$ (easterly variation).
$d=+\ 4° 02′$ (easterly deviation).

$e=+22° 24′$, or the error on northwest is 22° 24′ E.

10. Ship's head southwest per compass:
$v = +18° 22'$ (easterly variation).
$d = -\ 5° 21'$ (westerly deviation).
$e = +13° 01'$, or the error on southwest is 13° 01′ E.

11. Ship's head southeast per compass:
$v = +18° 22'$ (easterly variation).
$d = +\ 3° 23'$ (easterly deviation).
$e = +21° 45'$, or the error on southeast is 21° 45′ E.

12. Ship's head northeast per compass:
$v = +18° 22'$ (easterly variation).
$d = -\ 2° 09'$ (westerly deviation).
$e = +16° 13'$, or the error on northeast is 16° 13′ E.

For the benefit of those not familiar with the use of algebraic signs the following rules are given for finding the compass error when the variation and deviation are known:

(1) If the names of the variation and deviation are alike—that is, both east or both west—add the variation and deviation and to the sum give the common name, east or west, as the case may be.

(2) If the names of the variation and deviation are different—that is, one east and the other west—subtract the less from the greater, and to the result give the name of the greater.

EXAMPLES.

13. Ship's head northwest per compass:
$v = 18° 22'$ E.
$d = 4° 02'$ E.
$e = 22° 24'$ E. on NW.

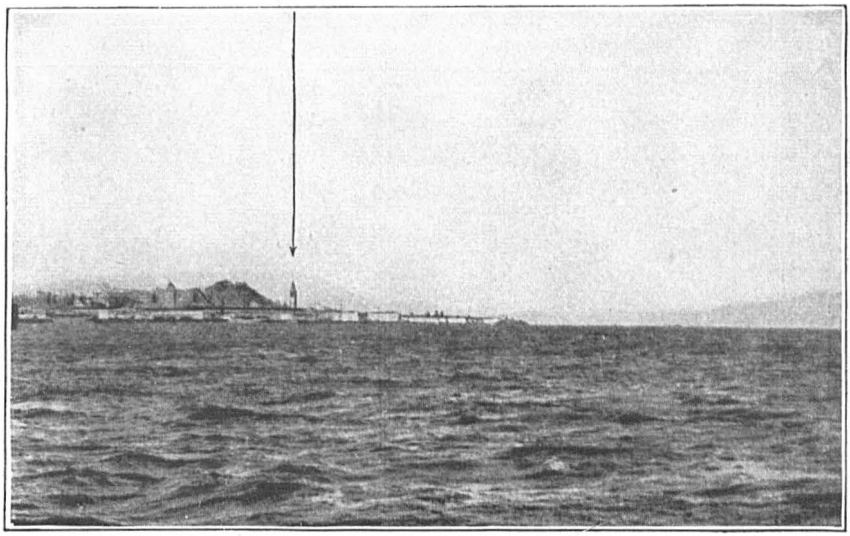
14. Ship's head southwest per compass:
$v = 18° 22'$ E.
$d = 5° 21'$ W.
$e = 13° 01'$ E. on SW.

15. Ship's head southeast per compass:
$v = 18° 22°$ E.
$d = 3° 23'$ E.
$e = 21° 45'$ E. on SE.

16. Ship's head northeast per compass:
$v = 18° 22'$ E.
$d = 2° 09'$ W.
$e = 16° 13'$ E. on NE.

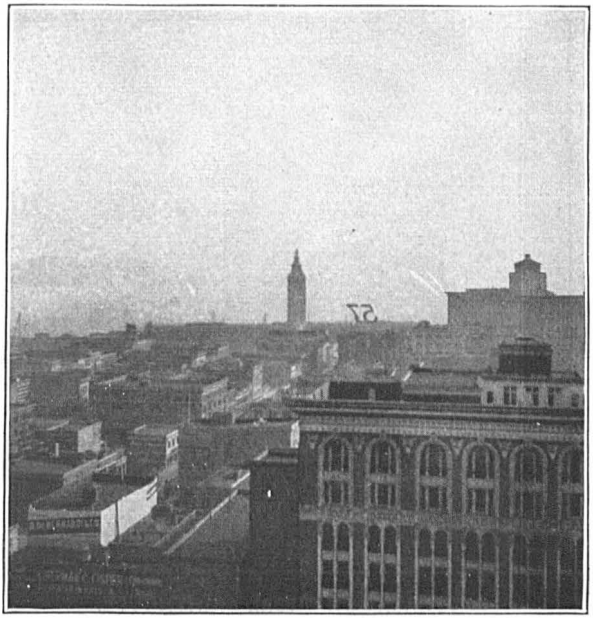
Form for ranges in San Francisco Bay for determining the deviation of the compass.

Range No.	Description and location of ranges.		Magnetic bearing of range.	Bearing of range per compass.	Deviation.	Ship's head per compass.
	Front.	Back.				
1	Ferry tower	Mount Tamalpais, east peak.	294° 09′ or N. 65° 51′ W.			
2	Left tangent, Goat Island	Southampton Shoal Lighthouse.	324° 35′ or N. 35° 25′ W.			
3	South power tower	Oakland City Hall	39° 47′ or N. 39° 47′ E.			
4	North power tower	do	43° 23′ or N. 43° 23′ E.			
5	Pier 44 (outer gable)	City Hall dome, San Francisco.	250° 23′ or S. 70° 23′ W.			
6	Black tank	Humboldt Bank Building.	256° 32′ or S. 76° 32′ W.			
7	Yerba Buena Lighthouse	U. C. Campanile	33° 34′ or N. 33° 34′ E.			
8	Southern Pacific cupola	Hobart Building	211° 39′ or S. 31° 39′ W.			
9	Light tower, Pier 41	Fort Point Lighthouse	251° 00′ or S. 71° 00′ W.			
10	Merchants' Exchange	Spreckels Building	173° 00′ or S. 7° 00′ E.			
11	High black tank	Ferry tower	117° 12′ or S. 62° 48′ E.			
12	Fort Mason stack	Square cupola	179° 18′ or S. 00° 42′ E.			
13	Point Blunt rock	Southampton Shoal Lighthouse.	7° 33′ or N. 7° 33′ E.			
14	Fort Point Lighthouse	Alcatraz Lighthouse	51° 53′ or N. 51° 53′ E.			
15	North Dutch windmill	Lone Mountain Cross.	60° 33′ or N. 60° 33′ E.			
16	Prayer Book Cross	do	52° 01′ or N. 52° 01′ E.			
17	Point Blunt rock	Fort Point Lighthouse	209° 45′ or S. 29° 45′ W.			
18	do	Alcatraz Lighthouse	168° 23′ or S. 11° 37′ E.			



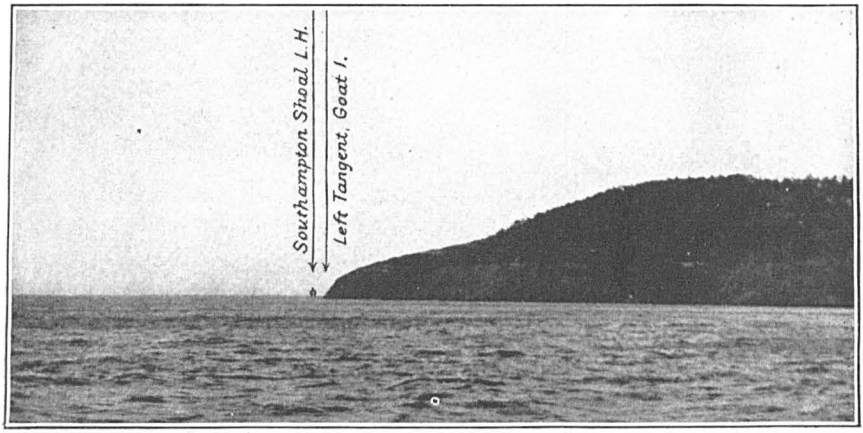
RANGE NO. 1: FERRY TOWER AND MOUNT TAMALPAIS.

East Peak, Observatory.

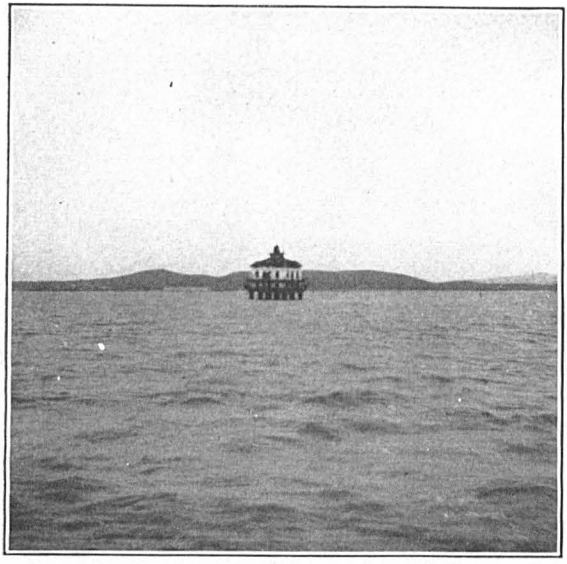


FERRY TOWER.

Front range.

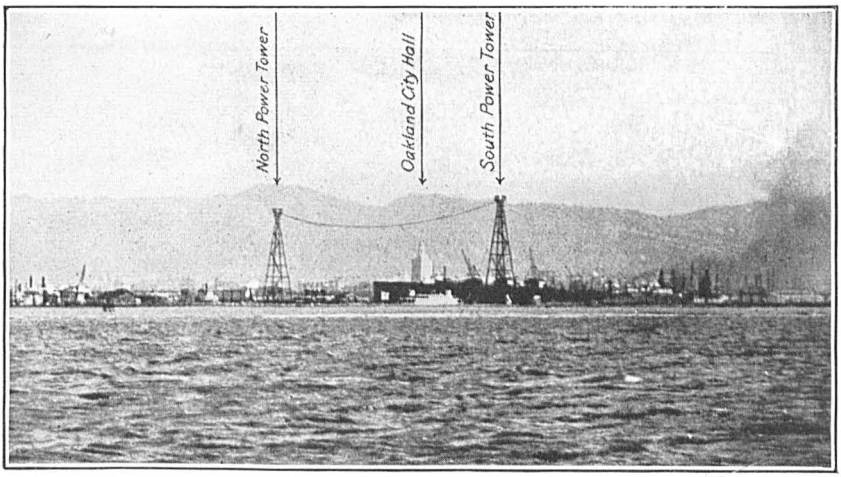


RANGE NO. 2: LEFT TANGENT GOAT ISLAND AND SOUTHAMPTON SHOAL LIGHTHOUSE.

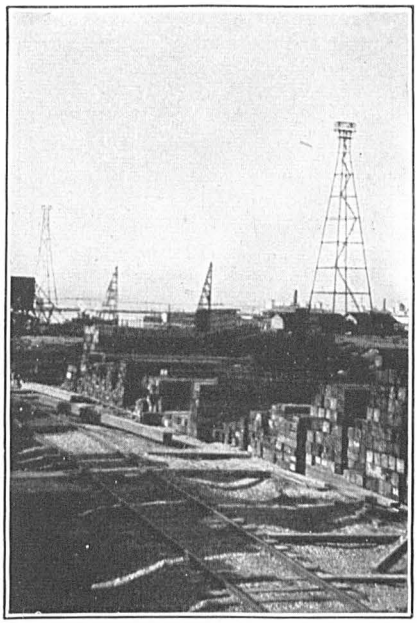


SOUTHAMPTON SHOAL LIGHTHOUSE.

Rear range.



RANGE NO. 3: SOUTH POWER TOWER AND OAKLAND CITY HALL.
RANGE NO. 4: NORTH POWER TOWER AND OAKLAND CITY HALL.

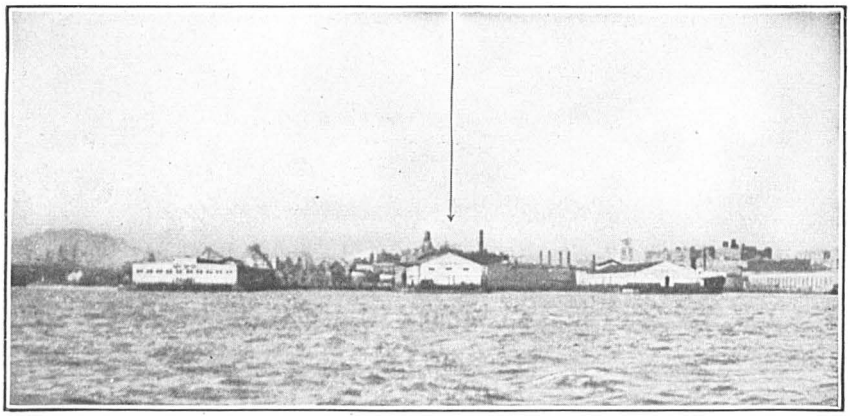


ELECTRIC POWER TOWERS, OAKLAND CREEK.

Front ranges.

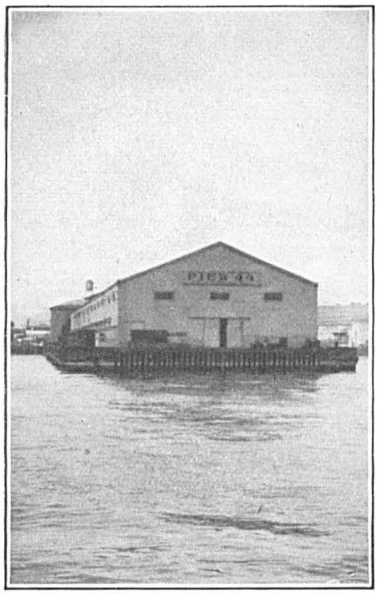
OAKLAND CITY HALL.

Rear range.



RANGE NO. 5: PIER 44 (OUTER GABLE) AND CITY HALL DOME.

Only the top of the dome is visible. The high tank and smokestack are good guides for picking up the range.

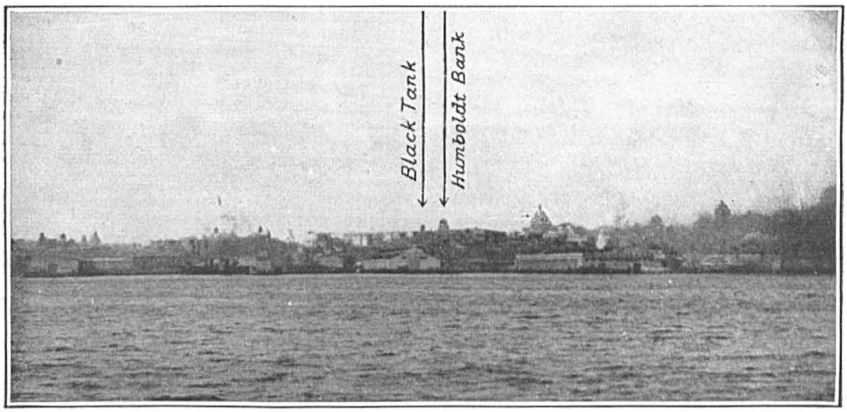


PIER 44.

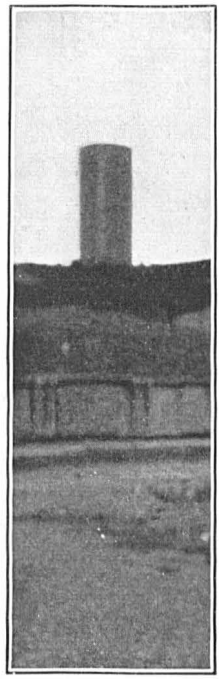
Front range.

CITY HALL, SAN FRANCISCO.

Rear range.



RANGE NO. 6: BLACK TANK AND HUMBOLDT BANK BUILDING.

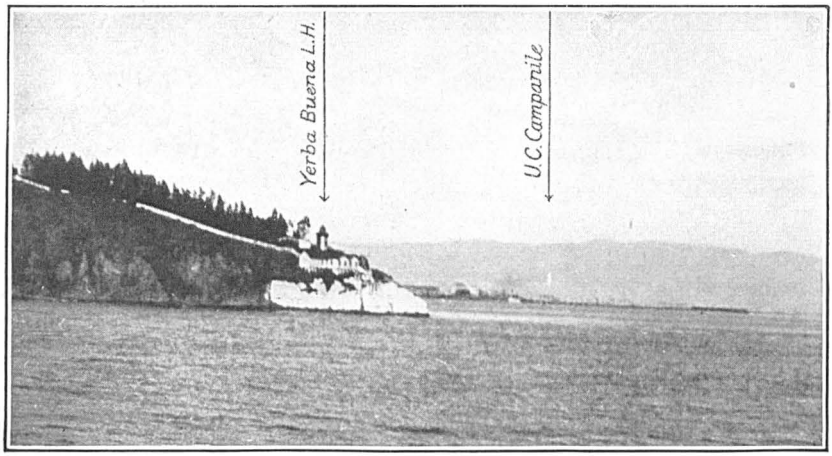


BLACK TANK.

Front range.

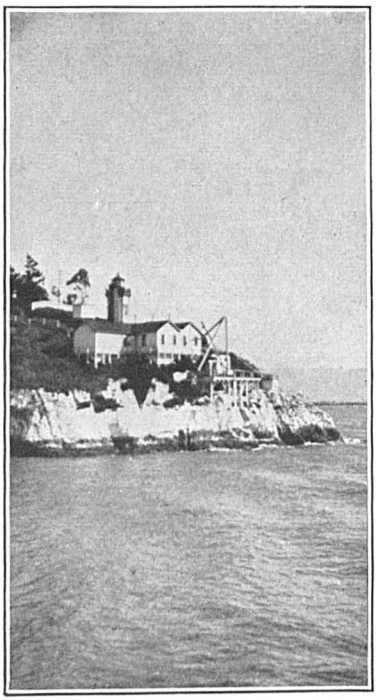
HUMBOLDT BANK BUILDING.

Rear range.



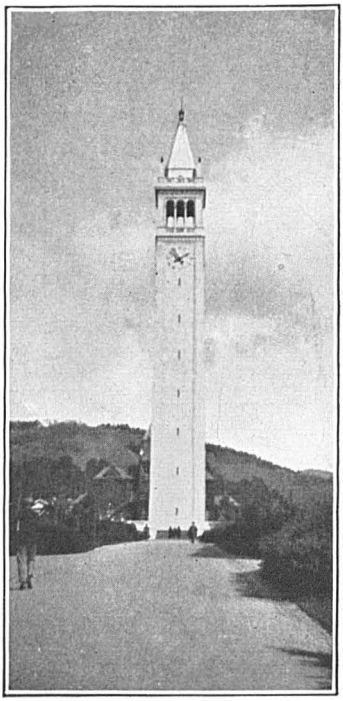
RANGE NO. 7: YERBA BUENA LIGHTHOUSE AND THE CAMPANILE, UNIVERSITY OF CALIFORNIA.

The Campanile is a white granite shaft over 300 feet high and is the most prominent object in Berkeley.



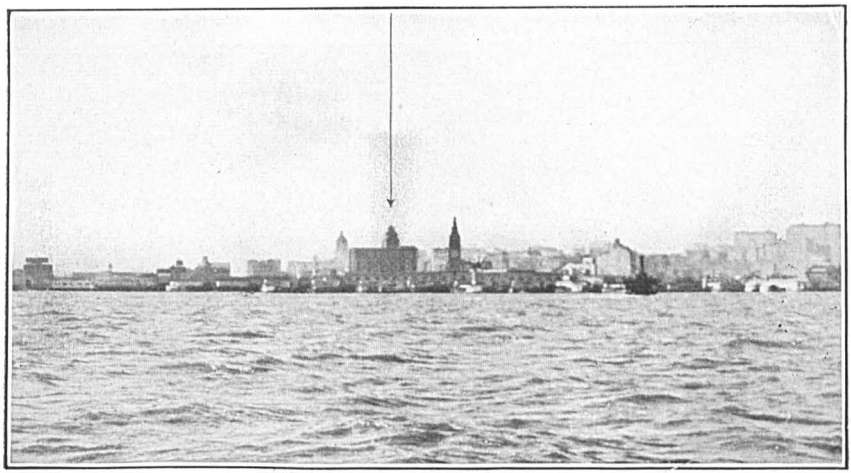
YERBA BUENA LIGHTHOUSE.

Front range.

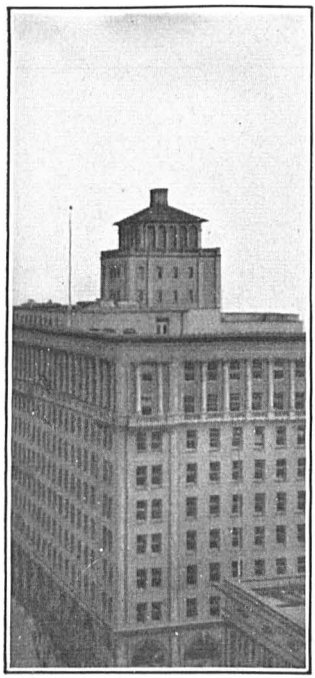


THE CAMPANILE, UNIVERSITY OF CALIFORNIA.

Rear range.

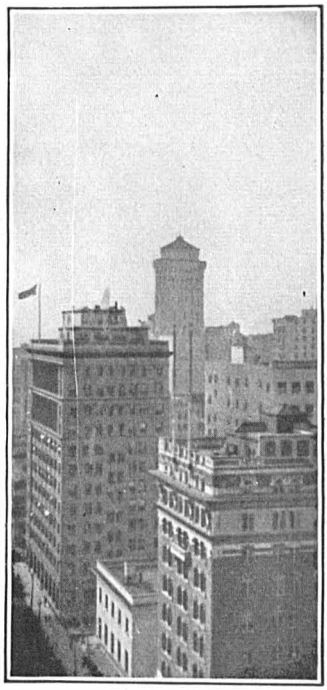


RANGE NO. 8: SOUTHERN PACIFIC CUPOLA AND HOBART BUILDING.



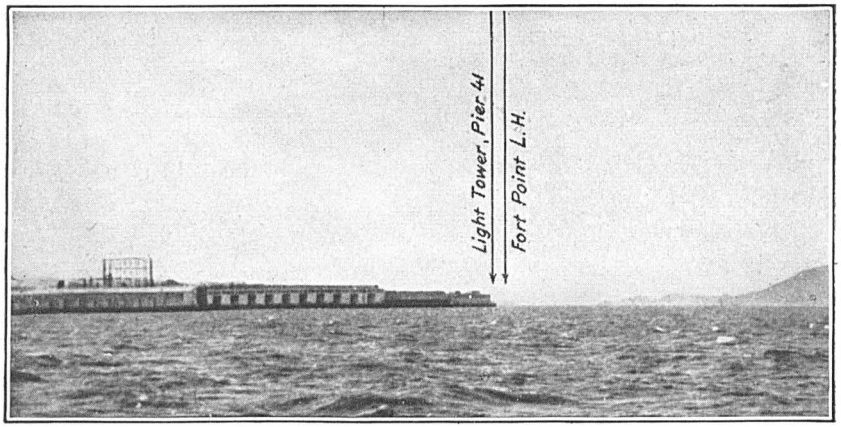
SOUTHERN PACIFIC CUPOLA.

Front range.

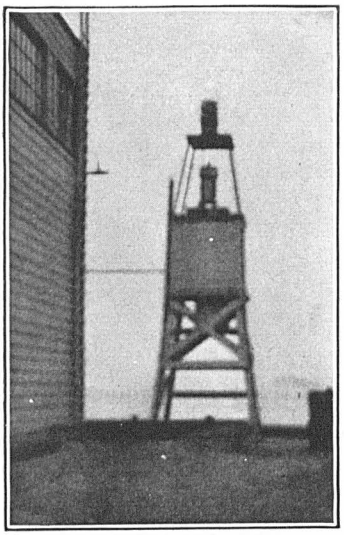


HOBART BUILDING.

Rear range.

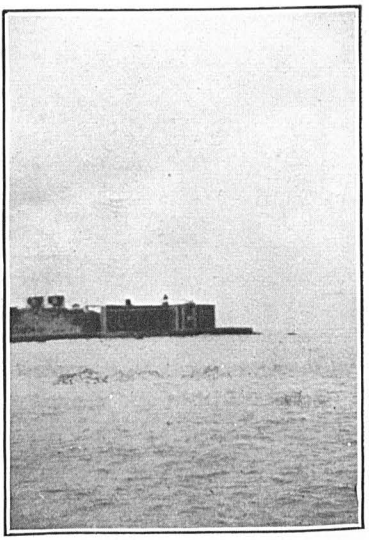


RANGE NO. 9: LIGHT TOWER, PIER 41, AND FORT POINT LIGHTHOUSE.



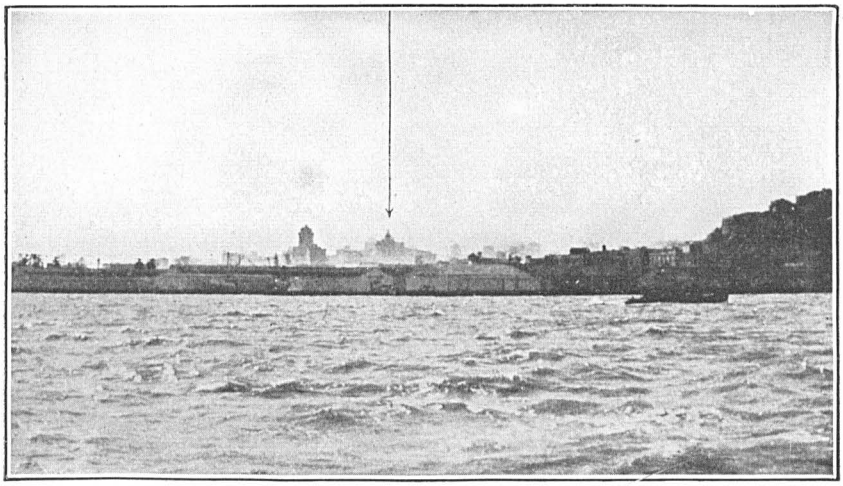
LIGHT TOWER, PIER 41.

Front range.

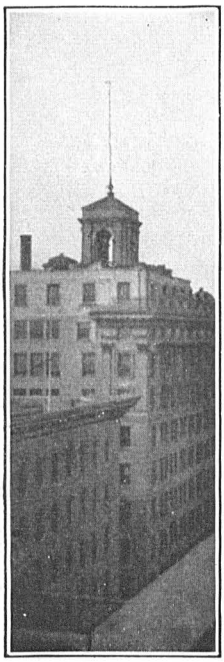


FORT POINT LIGHTHOUSE.

Rear range.

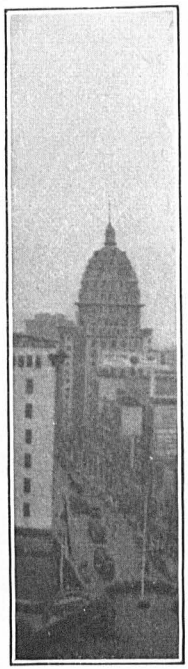


RANGE NO. 10: MERCHANTS EXCHANGE AND SPRECKELS BUILDING.



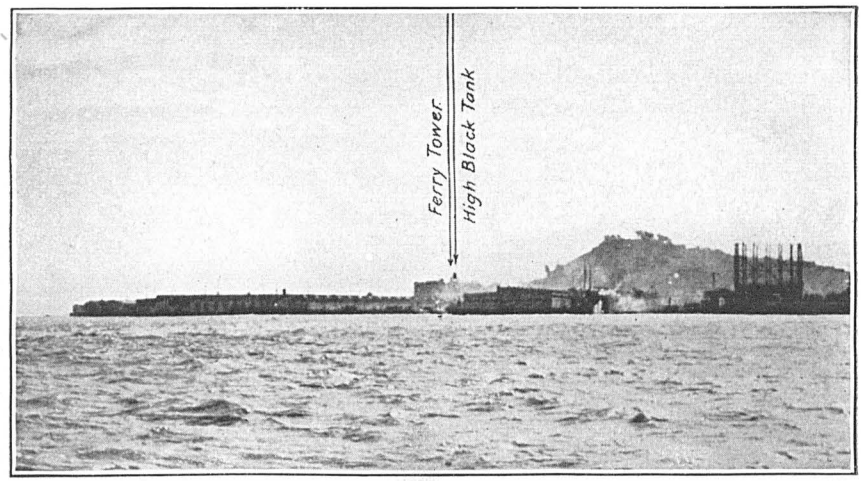
MERCHANTS EXCHANGE.

Front range.



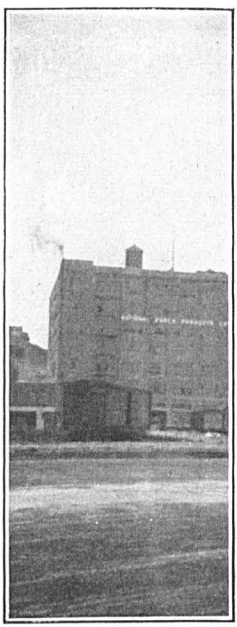
SPRECKELS BUILDING.

Rear range.



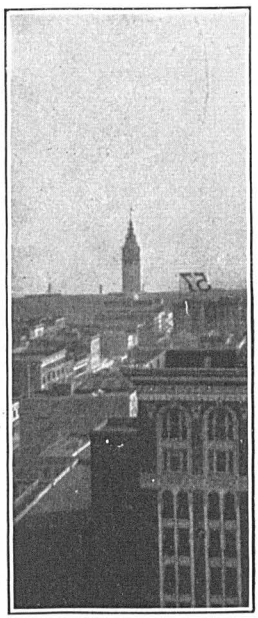
RANGE NO. 11: HIGH BLACK TANK AND FERRY TOWER.

All but the top of the tower and the flagstaff surmounting it are hidden by the nearer building.



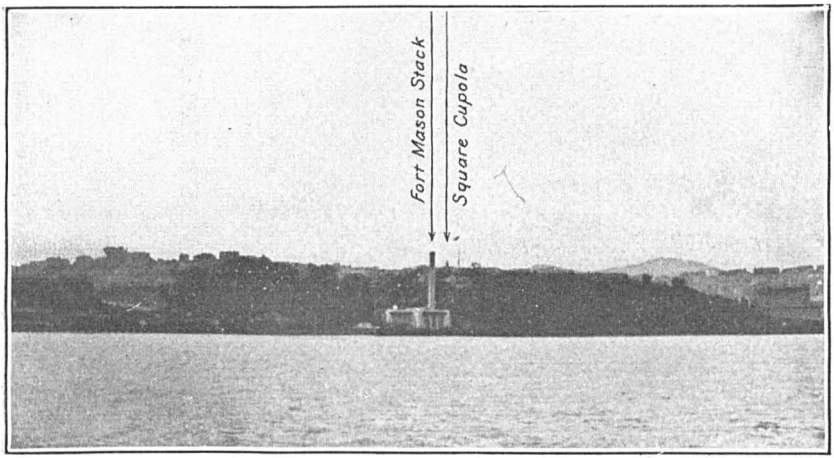
HIGH BLACK TANK.

Front range.

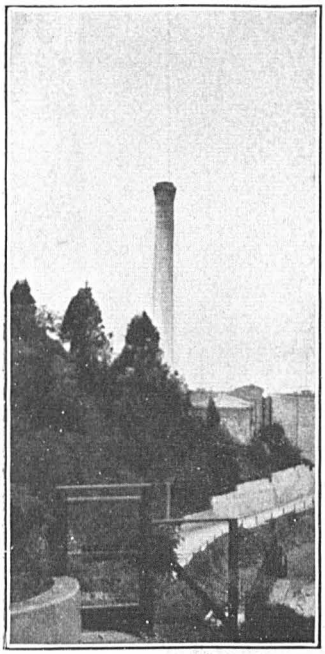


FERRY TOWER.

Rear range.

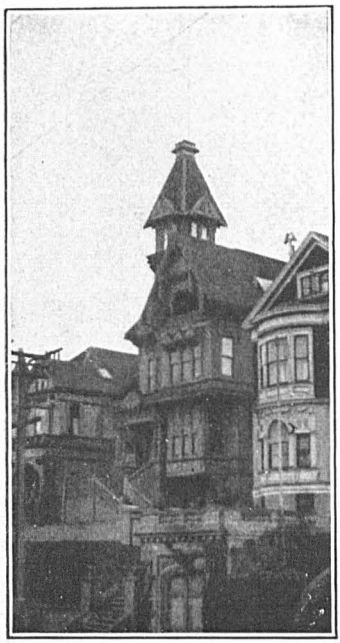


RANGE NO. 12: FORT MASON STACK AND SQUARE CUPOLA.



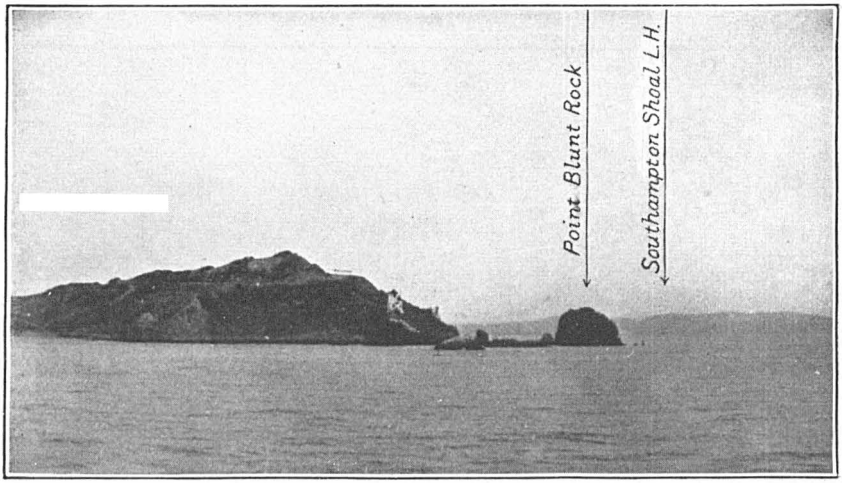
FORT MASON STACK.

Front range.

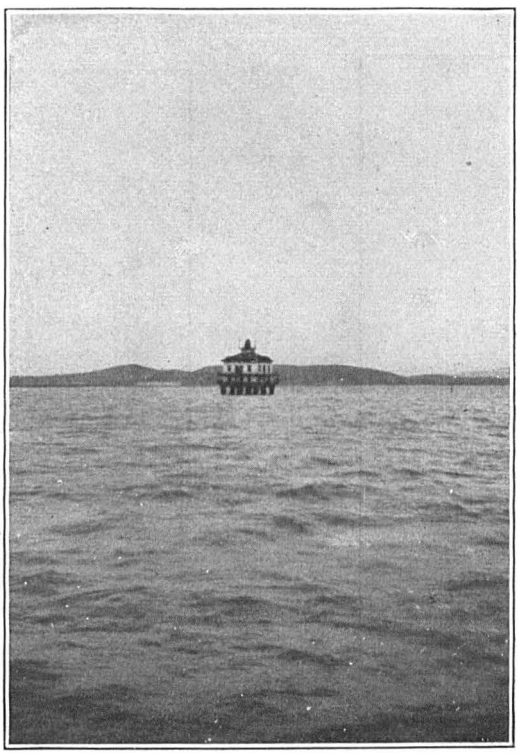


SQUARE CUPOLA.

Rear range.

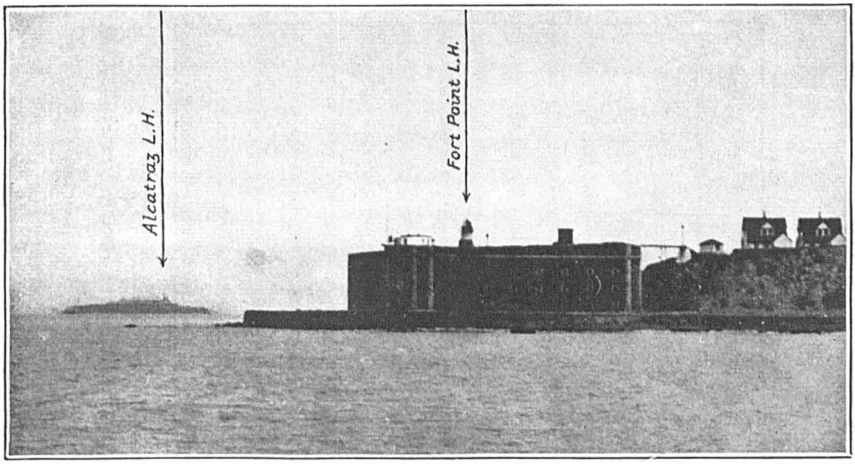


RANGE NO. 13: POINT BLUNT ROCK AND SOUTHAMPTON SHOAL LIGHTHOUSE.



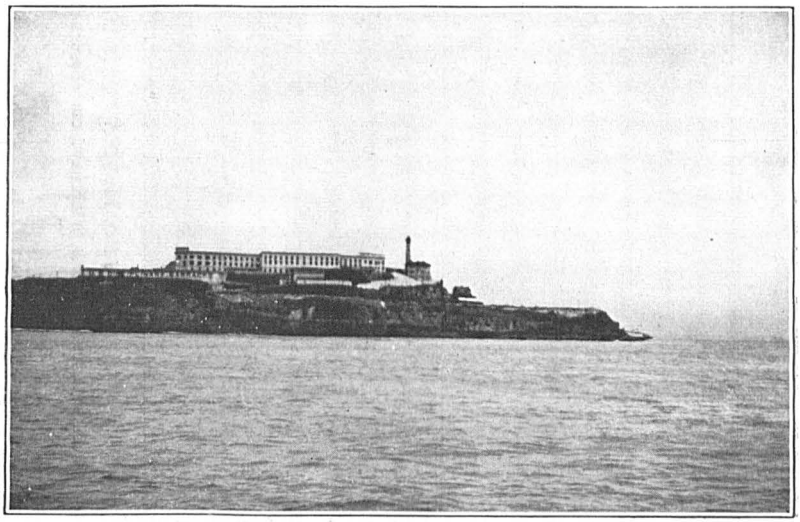
SOUTHAMPTON SHOAL LIGHTHOUSE.

Rear range.



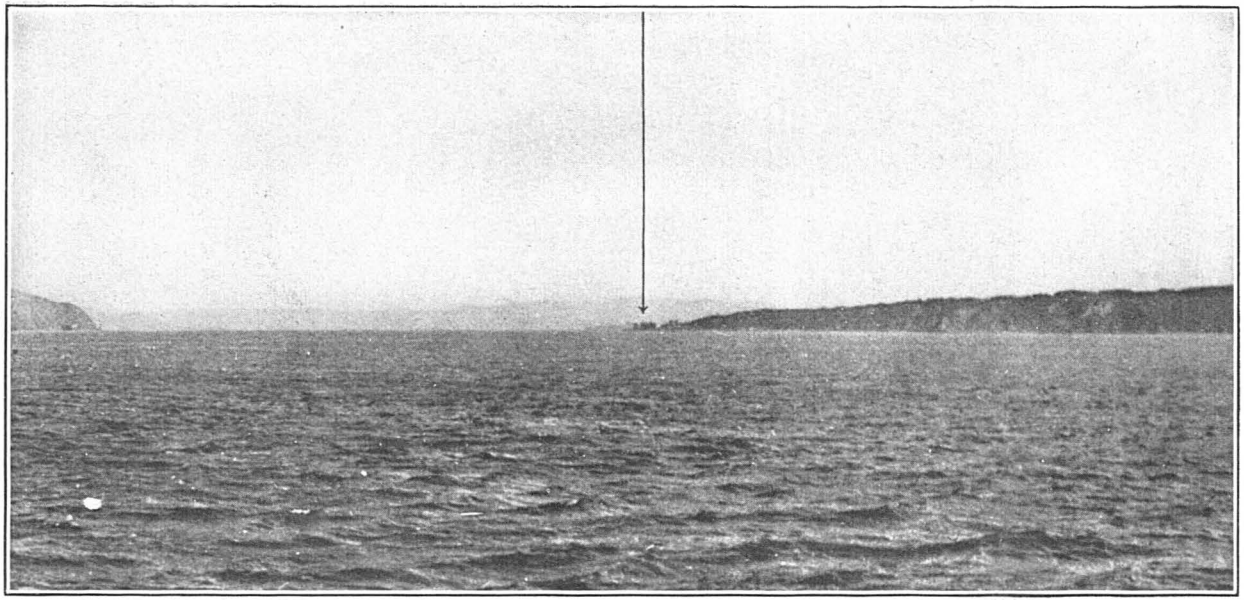
RANGE NO. 14: FORT POINT LIGHTHOUSE AND ALCATRAZ LIGHTHOUSE.

Owing to the difficulty of getting a clear photograph of this range from outside the heads this picture was taken close under the fort, and with the range well open, so as not to obscure any portion of Alcatraz Island.



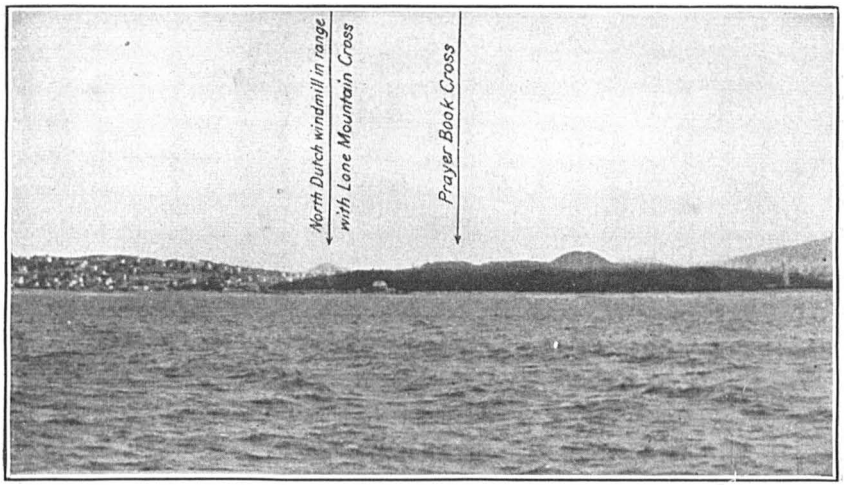
ALCATRAZ LIGHTHOUSE.

Rear range.



RANGE NO. 14: FORT POINT LIGHTHOUSE AND ALCATRAZ LIGHTHOUSE.

There is a tall white stack on the north, or left hand, end of Alcatraz Island, as seen from seaward, that must not be mistaken for the light tower.

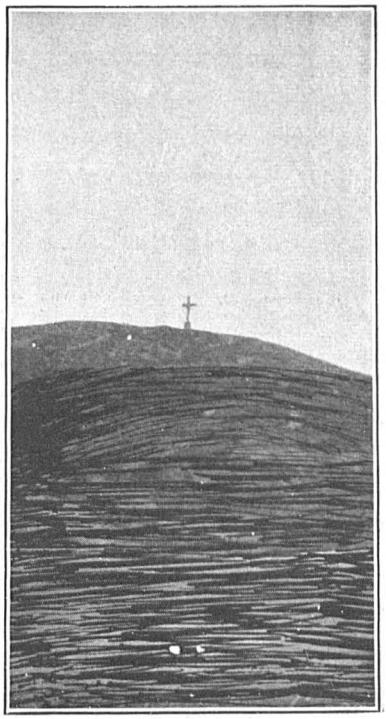


RANGE NO. 15: NORTH DUTCH WINDMILL AND LONE MOUNTAIN CROSS.

This picture also shows the range "Prayer Book Cross and Lone Mountain Cross" well open.

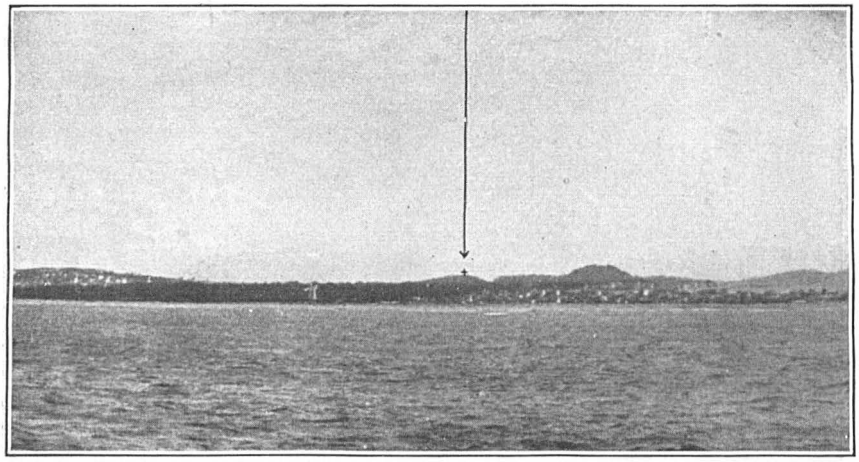
NORTH DUTCH WINDMILL,
GOLDEN GATE PARK.

Front range.



LONE MOUNTAIN CROSS.

Rear range.

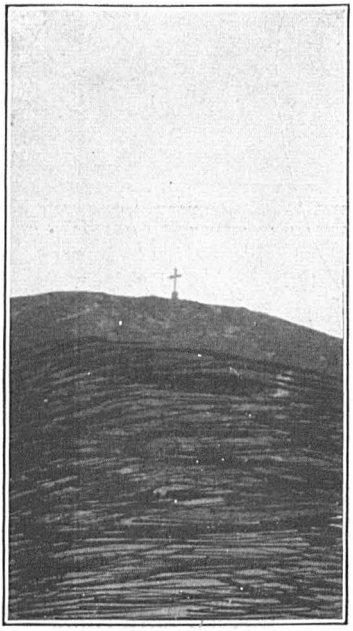


RANGE NO. 16: PRAYER BOOK, OR DRAKE, CROSS AND LONE MOUNTAIN CROSS, IN RANGE.

In passing out the South Channel the summit of Lone Mountain is obscured by the trees on the hill in Golden Gate Park on which the Prayer Book Cross stands. When this range is on, the cross on Lone Mountain is visible above the tree tops.

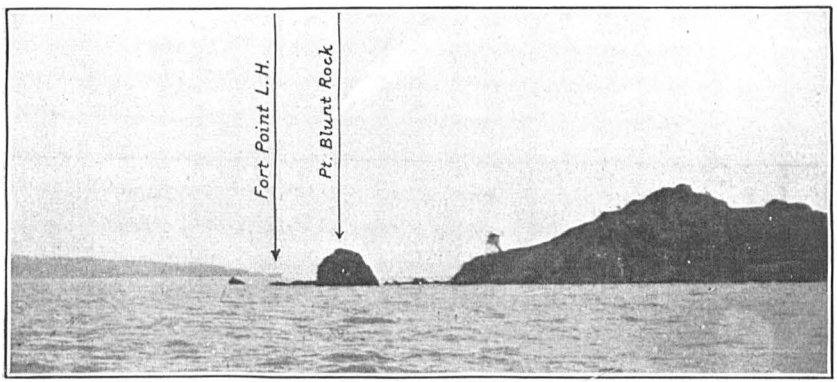
PRAYER BOOK, OR DRAKE, CROSS.

Front range.

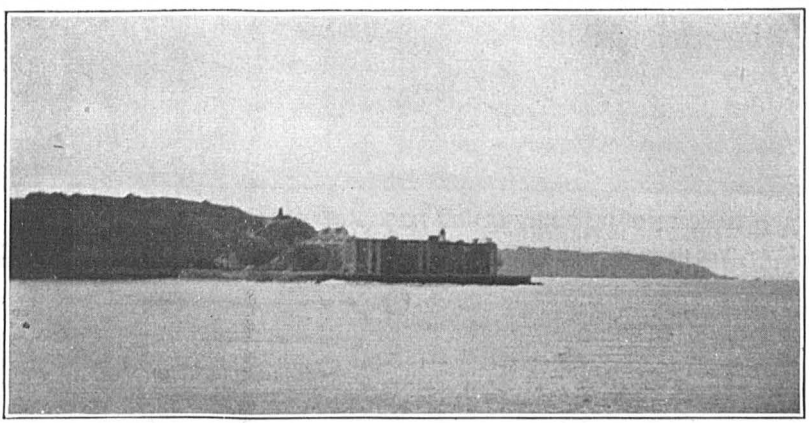


LONE MOUNTAIN CROSS.

Rear range.

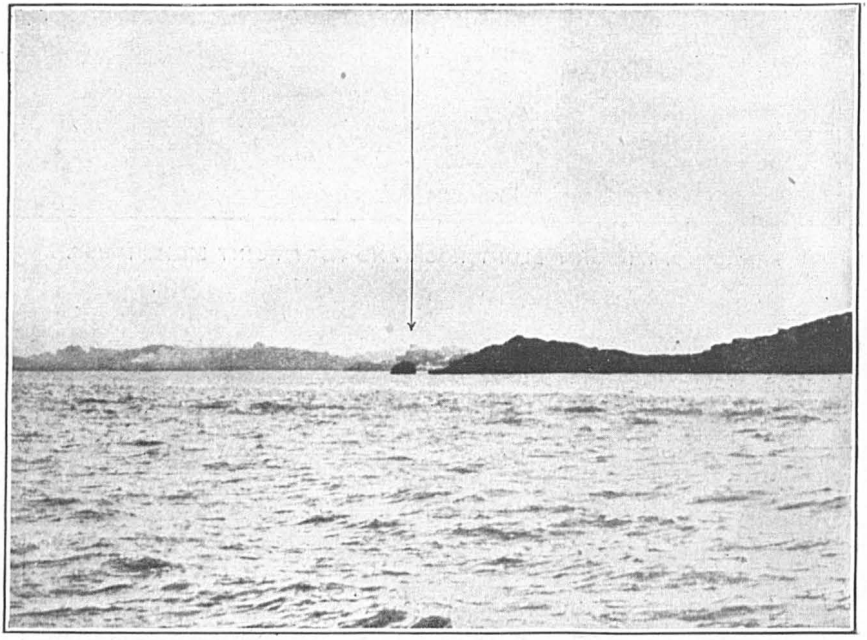


RANGE NO. 17: POINT BLUNT ROCK AND FORT POINT LIGHTHOUSE.



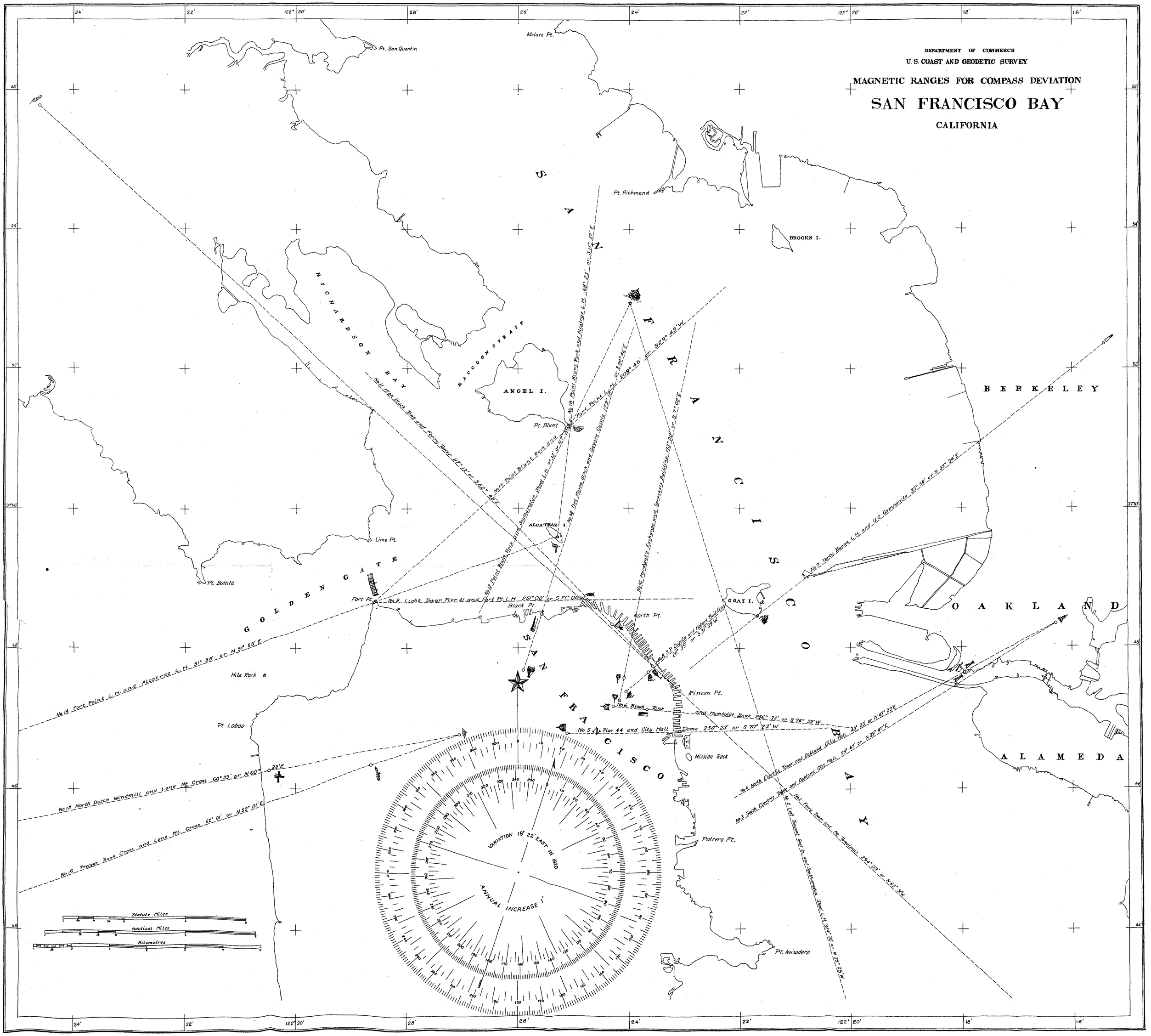
FORT POINT LIGHTHOUSE.

Rear range.



RANGE NO. 18: POINT BLUNT ROCK AND ALCATRAZ LIGHTHOUSE.

The lighthouse shows projected against a grove of trees in San Francisco.


DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
MAGNETIC RANGES FOR COMPASS DEVIATION
SAN FRANCISCO BAY
CALIFORNIA
Pt. San Quentin
Molate Pt.
Pt. Richmond
BROOKS I.
RICHARDSON BAY
RACCOON STRAIT
ANGEL I.
Pt. Blunt
ALCATRAZ I.
Lime Pt.
Pt. Bonita
GOLDEN GATE
Fort Pt.
Black Pt.
North Pt.
GOAT I.
BERKELEY
OAKLAND
ALAMEDA
Mile Rock
Pt. Lobos
Rincon Pt.
Mission Rock
Potrero Pt.
Pt. Avisadero
SAN FRANCISCO BAY
No 11 High Black Tank and Ferry Tower 117° 12' or S 62° 48' E
No 17 Point Blunt Rock and Southampton Shoal L.H. 7° 32' or N 7° 33' E
No 18 Point Blunt Rock and Alcatraz L.H. 68° 23' or S 11° 37' E
No 12 Fort Mason Stack and Square Cupola 179° 18' or S 00° 42' E
No 10 Merchant's Exchange and Spreckels Building 173° 00' or S 7° 00' E
No 9 Light Tower Pier 41 and Fort Pt. L.H. 251° 00' or S 71° 00' W
No 8 S.P. Cupola and Hobart Building 211° 39' or S 31° 39' W
No 7 Yerba Buena L.H. and U.C. Campanile 33° 34' or N 33° 34' E
No 14 Fort Point L.H. and Alcatraz L.H. 51° 53' or N 51° 53' E
No 6 Black Tank and Humboldt Bank 256° 32' or S 76° 32' W
No 5 Pier 44 and City Hall Dome 250° 23' or S 70° 23' W
No 4 North Electric Tower and Oakland City Hall 43° 23' or N 43° 23' E
No 3 South Electric Tower and Oakland City Hall 39° 47' or N 39° 47' E
No 2 Left Tangent Goat Is. and Southampton Shoal L.H. 324° 35' or N 35° 25' W
No 1 Ferry Tower and Mt. Tamalpais 294° 09' or N 65° 5' W
No 15 North Dutch Windmill and Lone Mt. Cross 60° 33' or N 60° 33' E
No 16 Prayer Book Cross and Lone Mt. Cross 52° 01' or N 52° 01' E
VARIATION 18° 22' EAST IN 1920
ANNUAL INCREASE 1'
Statute Miles
Nautical Miles
Kilometres