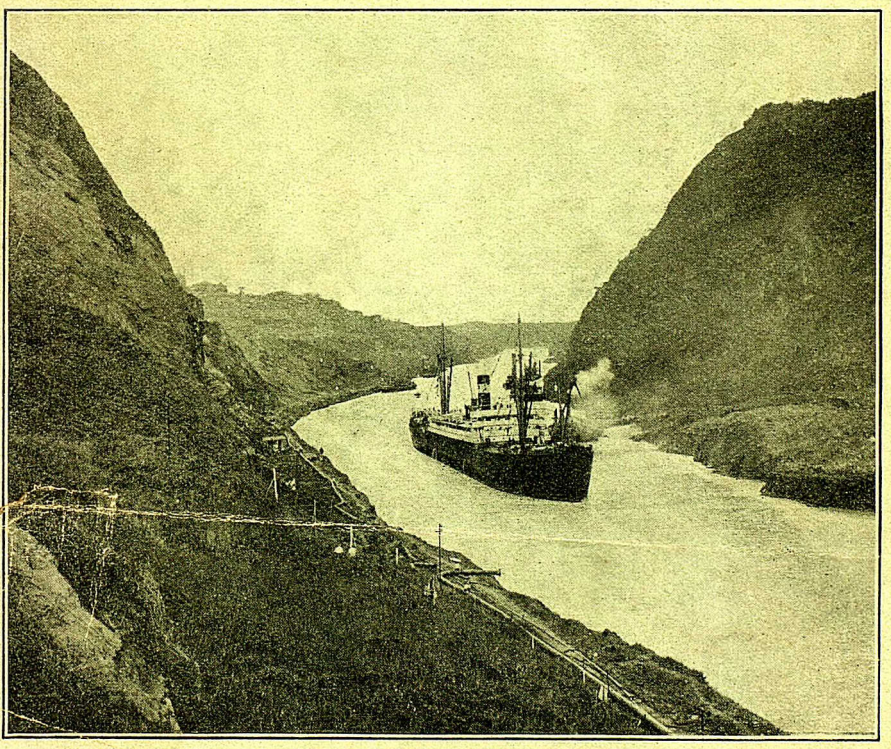
# OFFICIAL HANDBOOK OF THE PANAMA CANAL

1915



S. S. ANCON PASSING CONTINENTAL DIVIDE, AUGUST 15, 1914.

# OFFICIAL HANDBOOK OF THE PANAMA CANAL

1915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1915

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## INTRODUCTORY.

Since the golden age of discovery inaugurated by Columbus the quest for an all-water way from Europe to the Far East, across Atlantic and Pacific, has been a world obsession.

The idea has possessed the minds of navigators, shippers, business men, admirals, and Governments. Dozens of projects for the forcing of the passage have been advanced; thousands of lives have been lost in the efforts.

On May 4, 1904, the Government of the United States took possession of a strip of land 10 miles wide running across the Isthmus of Panama and called the Canal Zone. On August 15, 1914, the Panama Canal was opened to commerce.

This began the era of operation. This is the time of realization of the actual condition to which we have been looking forward so long. To tell something of the canal in operation, how it is managed, the distances it saves, with the resulting economy in operation of vessels using the canal, and the ways the trade is moving, are some of the purposes of this handbook.

OFFICIAL HANDBOOK

OF THE

# PANAMA CANAL.

## DISTANCES SAVED.

From Colon, on the Atlantic side of the Isthmus of Panama, to Balboa, on the Pacific side, the distance by water, around South America, is 10,500 nautical miles. Through the canal that distance is reduced to less than 44 miles.

The difference in length of these routes, 10,456 miles, represents the maximum distance that can be saved to a vessel by use of the canal. This maximum is more interesting geographically than commercially because vessels bound for the Pacific coast by way of the Strait of Magellan would not skirt the entire Atlantic coast of South America, but would strike across the Caribbean, if from the United States, or the central Atlantic, if from Europe, and proceed by the most direct route consistent with commercial advantage. But the saving is not purely hypothetical. The tug *Reliance*, once employed in the Atlantic entrance of the canal, was transferred to the Pacific entrance by way of Magellan. The voyage required 126 days, and the *Reliance* has since several times made the transit from ocean to ocean in one day in passing back and forth between Colon and Balboa by way of the canal.

What counts in the commercial value of the canal is not the distance that could be saved but the distances that are saved by vessels substituting the canal route for the earlier 'round-the-continent route in regular trade. Following are some of the savings on great trade routes, between important areas:

The great United States Atlantic port of New York, for instance, is nearer to the great Pacific port of San Francisco, through the use of the canal, by 7,873 nautical miles. The distance of 13,135 miles by Magellan has been reduced to

5,262 miles by the canal. The water distance between these ports is two-fifths what it used to be.

So far in the use of the canal, over 40 per cent of the vessels which have passed through it have been engaged in the coastwise trade of the United States—each of them saving about 7,800 miles on each trip. If their average speed be taken at 10 knots, they have averaged a saving of over a month at sea on each voyage from coast to coast. Where formerly the round trip of a 10-knot vessel required about 55 days' actual steaming, the time at sea for the same trip for the same vessel is now reduced to about 22 days.

The next heaviest traffic through the canal is between the Pacific coast of the United States and Europe. The canal makes San Francisco nearer to Liverpool by 5,666 miles, a saving of two-fifths of the old journey by Magellan. The distance between San Francisco and Gibraltar has been reduced from 12,571 miles to 7,621 miles, a saving of 4,950 miles or 39 per cent of the former distance.

From San Francisco to Buenos Aires, via Valparaiso and Magellan, is approximately 7,610 miles which is shorter than the route through the canal, by which the distance is 8,941 miles. To Rio de Janeiro, the distance via Magellan is 8,609 miles; by the canal 7,885 miles. To Pernambuco, on the eastern promontory of South America, the distance via Magellan is 9,748 miles; via the canal 6,746 miles. To Para the distances via Magellan and via the canal are 10,852 and 5,642 miles, respectively.

From San Francisco to Freetown, on the west coast of middle Africa, the distance by the most practicable route, using the Strait of Magellan, is 11,380 miles. Through the canal and by way of the island of Barbados, the distance is 7,277 miles. The new route is less than two-thirds of the former.

With reference to the trade between the Atlantic coast of the United States and the west coast of South America, New York is nearer to Valparaiso by 3,717 miles by virtue of the canal; to Iquique, one of the great nitrate ports, by

4,139 miles; and to Guayaquil by 7,405 miles. From New York to Guayaquil the present distance of 2,765 miles is approximately 27 per cent of the former distance—10,270 miles.

As to the Far East, New York is nearer to Yokohama by 3,768 miles than formerly by way of the Suez Canal, but the latter route is 18 miles shorter than the Panama route for vessels plying between New York and Hongkong. New York is 41 miles nearer Manila by Panama than by Suez, and 3,932 miles nearer Sydney by Panama. New York is now, by virtue of the Panama Canal, nearer than Liverpool to Yokohama by 1,880 miles, and nearer than Liverpool to Sydney by 2,424 miles.

The foregoing are typical instances of the changes of routes effected by the opening of the canal. Detailed tabulations of distances are given in the appended tables.

*Reduction (in nautical miles) effected by the Panama Canal in length of all-water routes between ports of the Atlantic–Gulf seaboard of the United States and Pacific ports, American and foreign.*

| To— | From— | | | | | | | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Portland (Me.). | Boston. | New York. | Philadelphia. | Baltimore. | Norfolk. | Charleston. | Savannah. | Jacksonville. | Port Tampa. | Pensacola. | Mobile. | New Orleans. | Galveston. | |
| Sitka | 7,663 | 7,676 | 7,873 | 7,948 | 8,020 | 8,020 | 8,234 | 8,267 | 8,301 | 8,748 | 8,821 | 8,834 | 8,868 | 8,940 | Via San Francisco. Difference between Panama and Magellan routes. |
| Port Townsend. | 7,663 | 7,676 | 7,873 | 7,948 | 8,020 | 8,020 | 8,234 | 8,267 | 8,301 | 8,748 | 8,821 | 8,834 | 8,868 | 8,940 | Do. |
| Portland, Oreg | 7,663 | 7,676 | 7,873 | 7,948 | 8,020 | 8,020 | 8,234 | 8,267 | 8,301 | 8,748 | 8,821 | 8,834 | 8,868 | 8,940 | Do. |
| San Francisco. | 7,663 | 7,676 | 7,873 | 7,948 | 8,020 | 8,020 | 8,234 | 8,267 | 8,301 | 8,748 | 8,821 | 8,834 | 8,868 | 8,940 | Do. |
| San Diego | 7,673 | 7,686 | 7,883 | 7,958 | 8,030 | 8,030 | 8,244 | 8,277 | 8,311 | 8,758 | 8,831 | 8,844 | 8,878 | 8,950 | Do. |
| Acapulco | 7,871 | 7,884 | 8,081 | 8,156 | 8,228 | 8,228 | 8,442 | 8,475 | 8,509 | 8,956 | 9,029 | 9,042 | 9,076 | 9,148 | Do. |
| San Jose de Guatemala. | 8,125 | 8,138 | 8,335 | 8,410 | 8,482 | 8,482 | 8,696 | 8,729 | 8,763 | 9,210 | 9,283 | 9,296 | 9,330 | 9,402 | Do. |
| Honolulu | 6,400 | 6,413 | 6,610 | 6,685 | 6,757 | 6,757 | 6,971 | 7,004 | 7,038 | 7,485 | 7,558 | 7,571 | 7,605 | 7,677 | Do. |
| Guayaquil | 7,195 | 7,208 | 7,405 | 7,480 | 7,552 | 7,552 | 7,766 | 7,799 | 7,833 | 8,280 | 8,353 | 8,366 | 8,400 | 8,472 | Do. |
| Callao | 6,040 | 6,053 | 6,250 | 6,325 | 6,397 | 6,397 | 6,611 | 6,644 | 6,678 | 7,125 | 7,198 | 7,211 | 7,245 | 7,317 | Do. |
| Iquique | 4,929 | 4,942 | 5,139 | 5,214 | 5,286 | 5,286 | 5,500 | 5,533 | 5,567 | 6,014 | 6,087 | 6,100 | 6,134 | 6,206 | Do. |
| Valparaiso | 3,537 | 3,550 | 3,747 | 3,822 | 3,894 | 3,894 | 4,108 | 4,141 | 4,175 | 4,622 | 4,695 | 4,708 | 4,742 | 4,814 | Do. |
| Coronel | 3,086 | 3,099 | 3,296 | 3,371 | 3,443 | 3,443 | 3,657 | 3,690 | 3,724 | 4,171 | 4,244 | 4,257 | 4,291 | 4,363 | Do. |
| Yokohama | 3,353 | 3,435 | 3,768 | 3,938 | 4,116 | 4,116 | 4,575 | 4,649 | 4,771 | 5,585 | 5,658 | 5,671 | 5,705 | 5,777 | Difference between routes via Panama, San Francisco, and Great Circle, and via Suez, Colombo, Singapore, Hongkong, and Shanghai. |
| Shanghai | 1,461 | 1,543 | 1,876 | 2,046 | 2,224 | 2,224 | 2,683 | 2,757 | 2,879 | 3,693 | 3,766 | 3,779 | 3,813 | 3,885 | Difference between routes via Panama, San Francisco, Yokohama, and via Suez, Colombo, Singapore, and Hongkong. |
| Hongkong | [1]—433 | [1]—351 | [1]—18 | 152 | 330 | 330 | 789 | 863 | 985 | 1,799 | 1,872 | 1,885 | 1,919 | 1,991 | Difference between routes via Panama, San Francisco, Yokohama, and Shanghai, and via Suez, Colombo, and Singapore. |
| Manila | [1]—374 | [1]—292 | 41 | 211 | 389 | 389 | 848 | 922 | 1,044 | 1,858 | 1,931 | 1,944 | 1,978 | 2,050 | Difference between routes via Panama, San Francisco, and Yokohama, and via Suez, Colombo, and Singapore. |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adelaide..... | 1,424 | 1,483 | 1,746 | 1,873 | 2,000 | 2,000 | 2,352 | 2,412 | 2,489 | 3,138 | 3,211 | 3,224 | 3,258 | 3,330 | Difference between routes via Panama, Tahiti, Sydney, and Melbourne, and via St. Vincent and Cape of Good Hope. |
| Melbourne.... | 2,448 | 2,507 | 2,770 | 2,897 | 3,024 | 3,024 | 3,376 | 3,436 | 3,513 | 4,162 | 4,235 | 4,248 | 4,282 | 4,354 | Difference between routes via Panama, Tahiti, and Sydney, and via St. Vincent, Cape of Good Hope, and Adelaide. |
| Sydney..... | 3,610 | 3,669 | 3,932 | 4,059 | 4,186 | 4,186 | 4,538 | 4,598 | 4,675 | 5,324 | 5,397 | 5,410 | 5,444 | 5,516 | Difference between routes via Panama and Tahiti and via St. Vincent, Cape of Good Hope, Adelaide, and Melbourne. |
| Wellington.... | 2,283 | 2,296 | 2,493 | 2,568 | 2,640 | 2,640 | 2,854 | 2,887 | 2,921 | 3,368 | 3,441 | 3,454 | 3,488 | 3,560 | Difference between routes via Panama and Tahiti and via Straits of Magellan. |

[1] Distance less via Suez.

*Reduction (in nautical miles) effected by the Panama Canal in distances from European ports to the ports of the west coast of America and to New Zealand.*

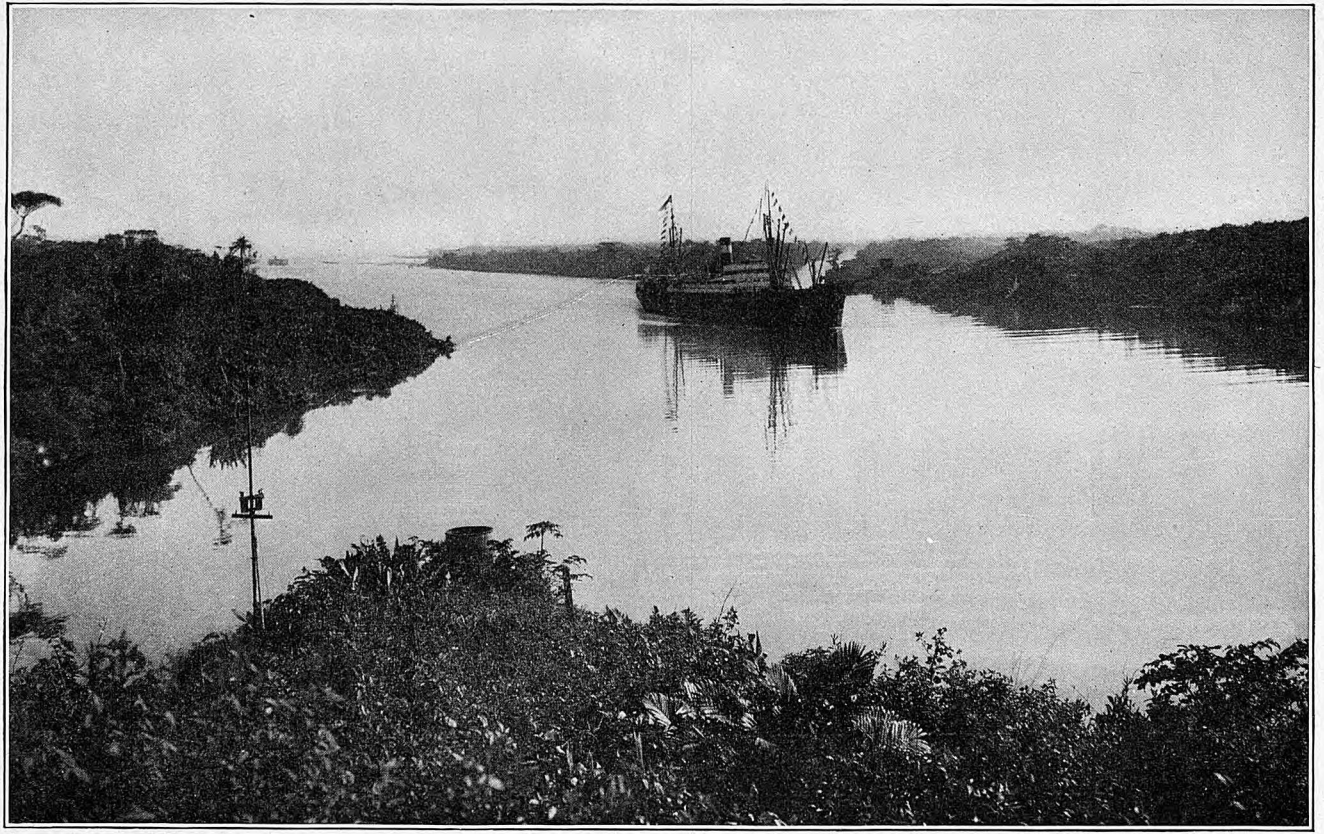
| To— | Via— | From— | | | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Liverpool. | | Hamburg. | | Antwerp. | | Bordeaux. | | Gibraltar. | | |
| | | Distance. | Less via Panama. | Distance. | Less via Panama. | Distance. | Less via Panama. | Distance. | Less via Panama. | Distance. | Less via Panama. | |
| Sitka | Magellan | 14,804 | 5,666 | 15,185 | 5,528 | 14,923 | 5,528 | 14,564 | 5,376 | 13,873 | 4,950 | Via San Francisco. |
| | Panama | 9,138 | | 9,657 | | 9,395 | | 9,188 | | 8,923 | | |
| Port Townsend. | Magellan | 14,272 | 5,666 | 14,653 | 5,528 | 14,391 | 5,528 | 14,032 | 5,376 | 13,341 | 4,950 | Do. |
| | Panama | 8,606 | | 9,125 | | 8,863 | | 8,556 | | 8,391 | | |
| Portland, Oreg. | Magellan | 14,152 | 5,666 | 14,533 | 5,528 | 14,271 | 5,528 | 13,912 | 5,376 | 13,221 | 4,950 | Do. |
| | Panama | 8,486 | | 9,005 | | 8,743 | | 8,536 | | 8,271 | | |
| San Francisco. | Magellan | 13,502 | 5,666 | 13,883 | 5,528 | 13,621 | 5,528 | 13,262 | 5,376 | 12,571 | 4,950 | |
| | Panama | 7,836 | | 8,355 | | 8,093 | | 7,886 | | 7,621 | | |
| San Diego | Magellan | 13,110 | 5,676 | 13,491 | 5,538 | 13,229 | 5,538 | 12,870 | 5,386 | 12,179 | 4,960 | |
| | Panama | 7,434 | | 7,953 | | 7,691 | | 7,484 | | 7,219 | | |
| Acapulco | Magellan | 11,891 | 5,874 | 12,272 | 5,736 | 12,010 | 5,736 | 11,651 | 5,584 | 10,960 | 5,158 | |
| | Panama | 6,017 | | 6,536 | | 6,274 | | 6,067 | | 5,802 | | |
| San Jose de Guatemala. | Magellan | 11,605 | 6,128 | 11,986 | 5,990 | 11,724 | 5,990 | 11,365 | 5,838 | 10,674 | 5,412 | |
| | Panama | 5,477 | | 5,996 | | 5,734 | | 5,527 | | 5,262 | | |
| Honolulu | Magellan | 13,679 | 4,403 | 14,060 | 4,265 | 13,798 | 4,265 | 13,439 | 4,113 | 12,748 | 3,687 | |
| | Panama | 9,276 | | 9,795 | | 9,533 | | 9,326 | | 9,061 | | |
| Guayaquil | Magellan | 10,582 | 5,198 | 10,963 | 5,060 | 10,701 | 5,060 | 10,342 | 4,908 | 9,651 | 4,482 | |
| | Panama | 5,384 | | 5,903 | | 5,641 | | 5,434 | | 5,169 | | |
| Callao | Magellan | 9,980 | 4,043 | 10,361 | 3,905 | 10,099 | 3,905 | 9,740 | 3,753 | 9,049 | 3,327 | |
| | Panama | 5,937 | | 6,456 | | 6,194 | | 5,987 | | 5,722 | | |
| Iquique | Magellan | 9,510 | 2,932 | 9,891 | 2,794 | 9,629 | 2,794 | 9,270 | 2,642 | 8,579 | 2,216 | |
| | Panama | 6,578 | | 7,097 | | 6,835 | | 6,628 | | 6,363 | | |
| Valparaiso | Magellan | 8,747 | 1,540 | 9,128 | 1,402 | 8,866 | 1,402 | 8,507 | 1,250 | 7,816 | 824 | |
| | Panama | 7,207 | | 7,726 | | 7,464 | | 7,257 | | 6,992 | | |
| Coronel | Magellan | 8,502 | 1,089 | 8,883 | 951 | 8,621 | 951 | 8,262 | 799 | 7,571 | 373 | |
| | Panama | 7,413 | | 7,932 | | 7,670 | | 7,403 | | 7,198 | | |
| Wellington | Suez | 12,989 | 1,564 | 13,353 | 1,409 | 13,091 | 1,409 | 12,732 | 1,257 | 11,702 | 489 | Suez route via Aden, Colombo, King George Sound, and Melbourne. |
| | Panama | 11,425 | | 11,944 | | 11,682 | | 11,475 | | 11,213 | | Panama route via Tahiti. |

*Number of days saved, for vessels of different speeds, by the Panama Canal route between the Atlantic–Gulf ports of the United States and Pacific ports, American and foreign.*

| To— | From— | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | New York, for vessels of— | | | | | Charleston, for vessels of— | | | | | Port Tampa, for vessels of— | | | | | New Orleans, for vessels of— | | | | | Galveston, for vessels of— | | | | |
| | 9 knots. | 10 knots. | 12 knots. | 14 knots. | 16 knots. | 9 knots. | 10 knots. | 12 knots. | 14 knots. | 16 knots. | 9 knots. | 10 knots. | 12 knots. | 14 knots. | 16 knots. | 9 knots. | 10 knots. | 12 knots. | 14 knots. | 16 knots. | 9 knots. | 10 knots. | 12 knots. | 14 knots. | 16 knots. |
| Sitka | 35.9 | 32.3 | 26.8 | 22.9 | 20.0 | 37.6 | 33.8 | 28.1 | 24.0 | 20.9 | 40.0 | 35.9 | 29.8 | 25.5 | 22.2 | 40.5 | 36.4 | 30.2 | 25.9 | 22.6 | 40.8 | 36.7 | 30.5 | 26.1 | 22.7 |
| Port Townsend | 35.9 | 32.3 | 26.8 | 22.9 | 20.0 | 37.6 | 33.8 | 28.1 | 24.0 | 20.9 | 40.0 | 35.9 | 29.8 | 25.5 | 22.2 | 40.5 | 36.4 | 30.2 | 25.9 | 22.6 | 40.8 | 36.7 | 30.5 | 26.1 | 22.7 |
| Portland, Oreg. | 35.9 | 32.3 | 26.8 | 22.9 | 20.0 | 37.6 | 33.8 | 28.1 | 24.0 | 20.9 | 40.0 | 35.9 | 29.8 | 25.5 | 22.2 | 40.5 | 36.4 | 30.2 | 25.9 | 22.6 | 40.8 | 36.7 | 30.5 | 26.1 | 22.7 |
| San Francisco | 35.9 | 32.3 | 26.8 | 22.9 | 20.0 | 37.6 | 33.8 | 28.1 | 24.0 | 20.9 | 40.0 | 35.9 | 29.8 | 25.5 | 22.2 | 40.5 | 36.4 | 30.2 | 25.9 | 22.6 | 40.8 | 36.7 | 30.5 | 26.1 | 22.7 |
| San Diego | 36.0 | 32.3 | 26.8 | 22.9 | 20.0 | 37.6 | 33.8 | 28.1 | 24.0 | 20.9 | 40.0 | 35.9 | 29.9 | 25.5 | 22.3 | 40.6 | 36.4 | 30.3 | 25.9 | 22.6 | 40.9 | 36.8 | 30.5 | 26.1 | 22.8 |
| Acapulco | 36.9 | 33.2 | 27.5 | 23.5 | 20.5 | 38.5 | 34.6 | 28.8 | 24.6 | 21.5 | 40.9 | 36.8 | 30.5 | 26.1 | 22.8 | 41.5 | 37.3 | 31.0 | 26.5 | 23.1 | 41.8 | 37.6 | 31.2 | 26.7 | 23.3 |
| San Jose de Guatemala | 38.0 | 34.2 | 28.4 | 24.3 | 21.2 | 40.2 | 35.7 | 29.7 | 25.4 | 22.1 | 42.1 | 37.9 | 31.5 | 26.9 | 23.5 | 42.6 | 38.4 | 31.9 | 27.3 | 23.8 | 43.0 | 38.7 | 32.1 | 27.5 | 24.0 |
| Honolulu | 30.1 | 27.0 | 22.4 | 19.1 | 16.7 | 31.7 | 28.5 | 23.7 | 20.2 | 17.7 | 34.1 | 30.7 | 25.5 | 21.8 | 19.0 | 34.7 | 31.2 | 25.9 | 22.1 | 19.3 | 35.0 | 31.5 | 26.2 | 22.4 | 19.5 |
| Guayaquil | 33.7 | 30.3 | 25.2 | 21.5 | 18.7 | 35.4 | 31.8 | 26.5 | 22.6 | 19.7 | 37.8 | 34.0 | 28.3 | 24.1 | 21.1 | 38.4 | 34.5 | 28.7 | 24.5 | 21.4 | 38.7 | 34.8 | 28.9 | 24.7 | 21.6 |
| Callao | 28.4 | 25.5 | 21.2 | 18.1 | 15.7 | 30.1 | 27.0 | 22.4 | 19.2 | 16.7 | 32.5 | 29.2 | 24.2 | 20.7 | 18.1 | 33.0 | 29.7 | 24.7 | 21.1 | 18.4 | 33.4 | 30.0 | 24.9 | 21.3 | 18.5 |
| Iquique | 23.3 | 20.9 | 17.3 | 14.8 | 12.9 | 25.0 | 22.4 | 18.6 | 15.8 | 13.8 | 27.3 | 24.5 | 20.4 | 17.4 | 15.2 | 27.9 | 25.0 | 20.8 | 17.7 | 15.4 | 28.3 | 25.3 | 21.0 | 17.9 | 15.6 |
| Valparaiso | 16.8 | 15.1 | 12.5 | 10.6 | 9.2 | 18.5 | 16.6 | 13.7 | 11.7 | 10.2 | 20.9 | 18.7 | 15.5 | 13.2 | 11.5 | 21.4 | 19.2 | 16.0 | 13.6 | 11.8 | 21.8 | 19.5 | 16.2 | 13.8 | 12.0 |
| Coronel | 14.7 | 13.2 | 10.9 | 9.3 | 8.1 | 16.4 | 14.7 | 12.2 | 10.4 | 9.0 | 18.8 | 16.9 | 14.0 | 11.9 | 10.4 | 19.4 | 17.4 | 14.4 | 12.3 | 10.7 | 20.5 | 17.7 | 14.6 | 12.5 | 10.9 |
| Yokohama | 16.9 | 15.2 | 12.6 | 10.7 | 9.3 | 20.7 | 18.5 | 15.4 | 13.1 | 11.4 | 25.3 | 22.8 | 18.9 | 16.1 | 14.0 | 25.9 | 23.3 | 19.3 | 16.5 | 14.4 | 26.2 | 23.6 | 19.5 | 16.7 | 14.5 |
| Shanghai | 8.1 | 7.3 | 6.0 | 5.1 | 4.4 | 11.9 | 10.7 | 8.8 | 7.5 | 6.5 | 16.6 | 14.8 | 12.3 | 10.4 | 9.1 | 17.1 | 15.4 | 12.7 | 10.8 | 9.4 | 17.4 | 15.7 | 13.0 | 11.1 | 9.6 |
| Hongkong | ..... | ..... | ..... | ..... | ..... | 3.1 | 2.8 | 2.2 | 1.9 | 1.5 | 7.8 | 7.0 | 5.7 | 4.8 | 4.2 | 8.4 | 7.5 | 6.2 | 5.2 | 4.5 | 8.7 | 7.8 | 6.4 | 5.4 | 4.7 |
| Manila | ..... | ..... | ..... | ..... | ..... | 3.4 | 3.0 | 2.4 | 2.0 | 1.7 | 8.1 | 7.2 | 5.9 | 5.0 | 4.3 | 8.6 | 7.7 | 6.4 | 5.4 | 4.7 | 9.0 | 8.0 | 6.6 | 5.6 | 4.8 |
| Adelaide | 7.5 | 6.7 | 5.6 | 4.6 | 4.0 | 10.4 | 9.3 | 7.7 | 6.5 | 5.6 | 14.0 | 12.5 | 10.4 | 8.8 | 7.7 | 14.6 | 13.1 | 10.8 | 9.2 | 8.0 | 14.9 | 13.3 | 11.0 | 9.4 | 8.1 |
| Melbourne | 12.3 | 11.0 | 9.1 | 7.7 | 6.7 | 15.1 | 13.5 | 11.2 | 9.5 | 8.3 | 18.7 | 16.8 | 14.0 | 11.9 | 10.3 | 19.3 | 17.3 | 14.3 | 12.2 | 10.7 | 19.6 | 17.6 | 14.6 | 12.4 | 10.8 |
| Sydney | 17.7 | 15.8 | 13.1 | 11.2 | 9.7 | 20.5 | 18.4 | 15.3 | 13.0 | 11.3 | 24.1 | 21.7 | 18.0 | 15.3 | 13.4 | 24.6 | 22.2 | 18.4 | 15.7 | 13.7 | 25.0 | 22.4 | 18.6 | 15.9 | 13.8 |
| Wellington | 11.0 | 9.9 | 8.1 | 6.9 | 6.0 | 12.7 | 11.4 | 9.4 | 8.0 | 6.9 | 15.1 | 13.5 | 11.2 | 9.5 | 8.3 | 15.6 | 14.0 | 11.6 | 9.9 | 8.6 | 15.9 | 14.3 | 11.8 | 10.5 | 8.7 |

*Number of days saved, for vessels of different speeds, by the Panama Canal route between European ports and ports of Pacific America and of New Zealand.*

| To— | From— | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Liverpool, for vessels of— | | | | | Hamburg, for vessels of— | | | | | Antwerp, for vessels of— | | | | | Bordeaux, for vessels of— | | | | | Gibraltar, for vessels of— | | | | |
| | 9 knots. | 10 knots. | 12 knots. | 14 knots. | 16 knots. | 9 knots. | 10 knots. | 12 knots. | 14 knots. | 16 knots. | 9 knots. | 10 knots. | 12 knots. | 14 knots. | 16 knots. | 9 knots. | 10 knots. | 12 knots. | 14 knots. | 16 knots. | 9 knots. | 10 knots. | 12 knots. | 14 knots. | 16 knots. |
| Sitka | 25.7 | 23.1 | 19.1 | 16.3 | 14.2 | 25.1 | 22.5 | 18.7 | 15.9 | 13.9 | 25.1 | 22.5 | 18.7 | 15.9 | 13.9 | 24.4 | 21.9 | 18.1 | 15.5 | 13.5 | 22.4 | 20.1 | 16.7 | 14.2 | 12.3 |
| Port Townsend | 25.7 | 23.1 | 19.1 | 16.3 | 14.2 | 25.1 | 22.5 | 18.7 | 15.9 | 13.9 | 25.1 | 22.5 | 18.7 | 15.9 | 13.9 | 24.4 | 21.9 | 18.1 | 15.5 | 13.5 | 22.4 | 20.1 | 16.7 | 14.2 | 12.3 |
| Portland, Oreg. | 25.7 | 23.1 | 19.1 | 16.3 | 14.2 | 25.1 | 22.5 | 18.7 | 15.9 | 13.9 | 25.1 | 22.5 | 18.7 | 15.9 | 13.9 | 24.4 | 21.9 | 18.1 | 15.5 | 13.5 | 22.4 | 20.1 | 16.7 | 14.2 | 12.3 |
| San Francisco | 25.7 | 23.1 | 19.1 | 16.3 | 14.2 | 25.1 | 22.5 | 18.7 | 15.9 | 13.9 | 25.1 | 22.5 | 18.7 | 15.9 | 13.9 | 24.4 | 21.9 | 18.1 | 15.5 | 13.5 | 22.4 | 20.1 | 16.7 | 14.2 | 12.3 |
| San Diego | 25.7 | 23.1 | 19.2 | 16.4 | 14.3 | 25.1 | 22.5 | 18.7 | 15.9 | 13.9 | 25.1 | 22.5 | 18.7 | 15.9 | 13.9 | 24.5 | 21.9 | 18.2 | 15.5 | 13.5 | 22.4 | 20.1 | 16.7 | 14.2 | 12.4 |
| Acapulco | 26.7 | 23.9 | 19.9 | 17.0 | 14.8 | 26.0 | 23.4 | 19.4 | 16.6 | 14.4 | 26.0 | 23.4 | 19.4 | 16.6 | 14.4 | 25.3 | 22.8 | 18.9 | 16.1 | 14.1 | 23.4 | 21.0 | 17.4 | 14.8 | 12.9 |
| San Jose de Guatemala | 27.8 | 25.0 | 20.8 | 17.7 | 15.4 | 27.2 | 24.4 | 20.3 | 17.3 | 15.1 | 27.2 | 24.4 | 20.3 | 17.3 | 15.1 | 26.5 | 23.8 | 19.8 | 16.8 | 14.7 | 24.5 | 22.0 | 18.3 | 15.6 | 13.6 |
| Honolulu | 19.8 | 17.8 | 14.8 | 12.6 | 10.9 | 19.2 | 17.2 | 14.3 | 12.2 | 10.6 | 19.2 | 17.2 | 14.3 | 12.2 | 10.6 | 18.5 | 16.6 | 13.7 | 11.7 | 10.2 | 16.5 | 14.8 | 12.3 | 10.4 | 9.1 |
| Guayaquil | 23.5 | 21.1 | 17.5 | 14.9 | 13.0 | 22.9 | 20.6 | 17.1 | 14.6 | 12.7 | 22.9 | 20.6 | 17.1 | 14.6 | 12.7 | 22.2 | 19.9 | 16.5 | 14.1 | 12.2 | 20.2 | 18.2 | 15.0 | 12.8 | 11.1 |
| Callao | 18.2 | 16.3 | 13.5 | 11.5 | 10.0 | 17.6 | 15.8 | 13.1 | 11.5 | 9.7 | 17.6 | 15.8 | 13.1 | 11.5 | 9.7 | 16.8 | 15.1 | 12.5 | 10.6 | 9.2 | 14.9 | 13.3 | 11.0 | 9.4 | 8.1 |
| Iquique | 13.1 | 11.7 | 9.7 | 8.2 | 7.1 | 12.4 | 11.1 | 9.2 | 7.8 | 6.8 | 12.4 | 11.1 | 9.2 | 7.8 | 6.8 | 11.7 | 10.5 | 8.7 | 7.3 | 6.3 | 9.7 | 8.7 | 7.2 | 6.1 | 5.2 |
| Valparaiso | 6.6 | 5.9 | 4.8 | 4.1 | 3.5 | 6.0 | 5.3 | 4.3 | 3.5 | 3.1 | 6.0 | 5.3 | 4.3 | 3.5 | 3.1 | 5.3 | 4.7 | 3.8 | 3.2 | 2.7 | 3.3 | 2.9 | 2.3 | 1.9 | 1.6 |
| Coronel | 4.5 | 4.0 | 3.3 | 2.7 | 2.3 | 3.9 | 3.4 | 2.8 | 2.3 | 1.9 | 3.9 | 3.4 | 2.8 | 2.3 | 1.9 | 3.1 | 2.8 | 2.2 | 1.8 | 1.5 | 1.2 | 1.0 | 0.8 | 0.6 | 0.5 |
| Wellington | 6.7 | 6.0 | 4.9 | 4.2 | 3.5 | 6.0 | 5.3 | 4.4 | 3.7 | 3.2 | 6.0 | 5.3 | 4.4 | 3.7 | 3.2 | 5.3 | 4.7 | 3.8 | 3.2 | 2.7 | 1.7 | 1.5 | 1.2 | 0.6 | 0.5 |



S. S. CRISTOBAL CROSSING LINE OF OLD FRENCH CANAL ON WAY TO GATUN, AUGUST 3, 1914.

## HOW A VESSEL IS HANDLED THROUGH THE CANAL.

For a steamship owner or agent to send a vessel through the canal is one of the simplest matters in all his business. Practically all he has to do is to make a deposit with the Government to cover the vessel's canal expenses. The Government will attend to everything else,—and return his change as soon as the vessel has cleared from the canal.

There are several ways by which money may be advanced to cover canal charges. The simplest and most direct and the one usually followed is to make a deposit with an assistant treasurer of the United States (there is one in every large port of the United States). The assistant treasurer will, on request, telegraph the Washington office of The Panama Canal which will cable notice of the placing of the deposit to the canal authorities on the Isthmus, who then make all arrangements to give the vessel the quickest dispatch through the canal as soon as it presents itself at either port of entry.

The method outlined above is equally easy for an owner or agent in a foreign country. He can simply direct his bank, which will have connections with a bank or banks in the United States, to have a deposit placed with the assistant treasurer, say, in New York or San Francisco. This done,

the conduct of the rest of the business is in the hands of the Government.

Another method which may be followed in making the deposit, but which is more complicated, is to deposit certain high-grade bonds with the assistant auditor of the Panama Canal in Washington as security and to make payment by draft. Drafts to the accepted value of the bonds will then be accepted for conversion into cash, the value of the drafts being secured to the Government by its tenure of the bonds. This arrangement is supposed to be especially convenient for companies having frequent sailings through the canal.

A third method is to make payment in cash to the collector on the Isthmus. The probabilities are that this method will not be used often, except in cases of yachts and other small vessels, on account of the inconvenience and risk of carrying credit, to apply on future bills.

By whichever method the advance payment is made, it should be amply sufficient to cover the estimated tolls as well as any other probable expenses, such as for fuel, supplies, cable messages, etc. Whatever balance is due the depositor after the vessel's expenses have been paid will be refunded him, by check on the Treasurer of the United States, directly after the vessel has cleared from the canal. If the depositor expressely requests it, any balance due him will be left to his credit, to apply on future bills.

Some owners or agents who may have been unaware of the simple and prompt method by which their business with the canal can be handled, have employed local agents on the Isthmus to look after the interests of their vessels, or have arranged with local banks to pay their bills. Such arrangements are neither necessary nor desirable. The one thing important is to provide the money to pay the ship's bills. That is done most expeditiously through the Government's arrangements, as outlined above, and when it has been done the canal organization handles the ship's business with a minimum of delay. The introduction of a third party in the transaction tends to complicate the situation and actually to delay the transit of the ship, by interfering with the usual

methods of handling business by the canal authorities in connection therewith.

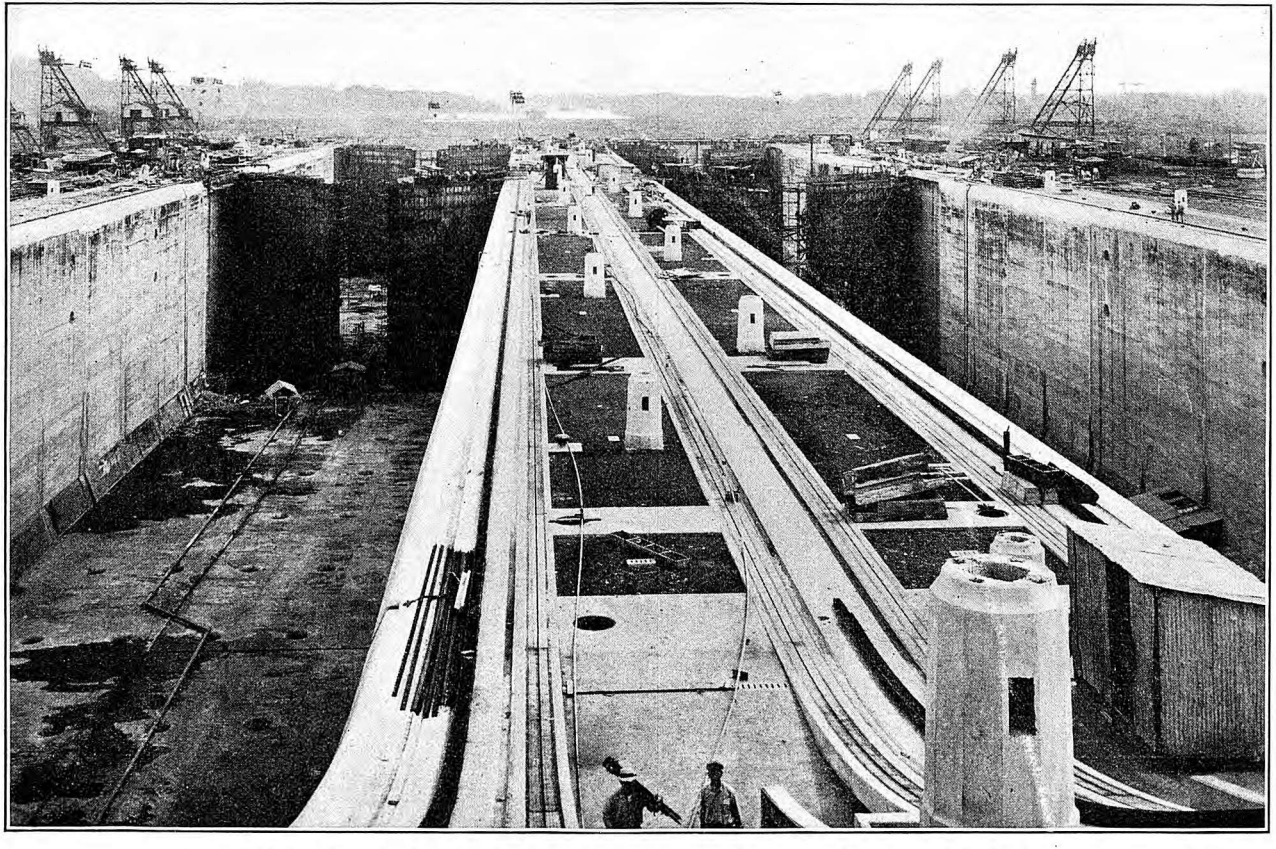
When the ship enters the harbor of either of the terminal ports it is boarded by officers of the canal who examine its bill of health and clearance, see that its certificate of canal measurement is properly made out, and ascertain any of the vessels needs in the matters of fuel, supplies, extra men to handle the lines during the passage of the locks, etc. These matters are immediately reported to the Captain of the Port, who gives the necessary orders to insure proper attendance on the vessel's needs and directs its start through the canal whenever it is ready.

In all stages of its transit of the canal the vessel must have on board a Government pilot. There is no charge for pilotage on vessels going directly through the canal without stopping to discharge cargo or passengers at the terminal ports. The pilot is on board in an advisory capacity and is required to confer with the master of the vessel, giving him the benefit of his knowledge and advice as to the handling of the vessel in the various reaches, but the master, who is best acquainted with the peculiarities of his vessel and her ways of answering the helm, is responsible for the navigation of the vessel, except when she is passing through the locks.

The handling of a vessel during its transit of the canal is like the handling of a railway train on its "run." The course is equipped with all requisite signals, facilities for mooring, like sidings, and a system of communication between points along the line, which includes a special telephone system connecting all the important points of control in series.

As soon as the vessel starts on its transit of the canal, the Captain of the Port at the point of entrance telephones its starting to the other stations along the course. As the vessel arrives and departs from each of these points, the fact is telephoned along the line, so that there is exact knowledge at each station all the time of the status of traffic, and complete cooperation from the several points of control.

The transit of the canal requires about 10 hours, of which approximately 3 hours are spent in the locks. In the sea-



GATUN LOWER LOCKS, LOOKING NORTH FROM MIDDLE LOCKS, MAY 6, 1913.

level channels and Gaillard (formerly "Culebra") Cut the speed of vessels is limited to 6 knots; through Gatun Lake they may make 10, 12, and 15 knots, according to the width of the channel. A vessel may clear from the canal port at which it enters and, after passing through the last of the locks, put direct to sea without further stop.

The handling of a vessel all through the canal, except in the locks, is essentially the same as its handling through any charted channel where observance of signals, ranges, and turns is necessary. The canal channel throughout is very accurately charted, fully equipped with aids to navigation, and governed by explicit rules with which the pilots, of course, are thoroughly familiar.

In the locks, the vessel is under the control of the lock-operating force. As the vessel approaches the locks, the operator in charge at the control house indicates by an electrically operated signal at the outer end of the approach wall if the vessel shall enter the locks, and, if so, on which side; or if it shall keep back or moor alongside the approach wall. If everything is ready for the transit of the locks, the vessel approaches the center approach wall, which is a pier extending about a thousand feet from the locks proper, lines are thrown out, and connections are made with the electric towing locomotives on the approach wall.

The vessel then moves forward slowly until it is in the entrance chamber, when lines are thrown out on the other side and connections are made with towing locomotives on the side wall. Six locomotives are used for the larger vessels, three on each wall of the lock chamber. Two keep forward of the vessel, pulling and holding her head to the center of the chamber; two aft, holding the vessel in check; and two slightly forward of amidships, which do most of the towing of the vessel through the chamber. The locomotives are powerful affairs, secured against slipping by the engagement of cogs with a rack running along the center of the track, and equipped with a slip drum and towing windlass, which allow the prompt paying out and taking in of hawser as required. No trouble has been experienced in maintaining absolute control over the vessels.

The water within the lock chamber proper, beyond the entrance chamber, is brought to the level of that in the approach, the gates toward the vessel are opened, the fender chain is lowered, and the locomotives maneuver the vessel into the chamber and bring it to rest. The gates are then closed, the water raised or lowered, as the case may be, to the level of that in the next chamber, the gates at the other end are opened, and the vessel moved forward. Three such steps are made at Gatun, two at Miraflores, and one at Pedro Miguel.

When the vessel has passed into the approach chamber at the end of the locks, the lines from the towing locomotives on the side wall are first cast off, then those from the locomotives on the approach wall, and the vessel clears under its own power.

Towing is not ordinarily required in any part of the canal, except in the locks, for steam or motor vessels. Tug service for sailing ships or vessels without motive power is at the rate of $15 per hour. If the channel in the Cut has been disturbed by a slide, tugs may be used to handle vessels past the narrow places, but in such cases there is no charge for the service to vessels of less than 15,000 gross tonnage.

## FACILITIES FOR SHIPPING.

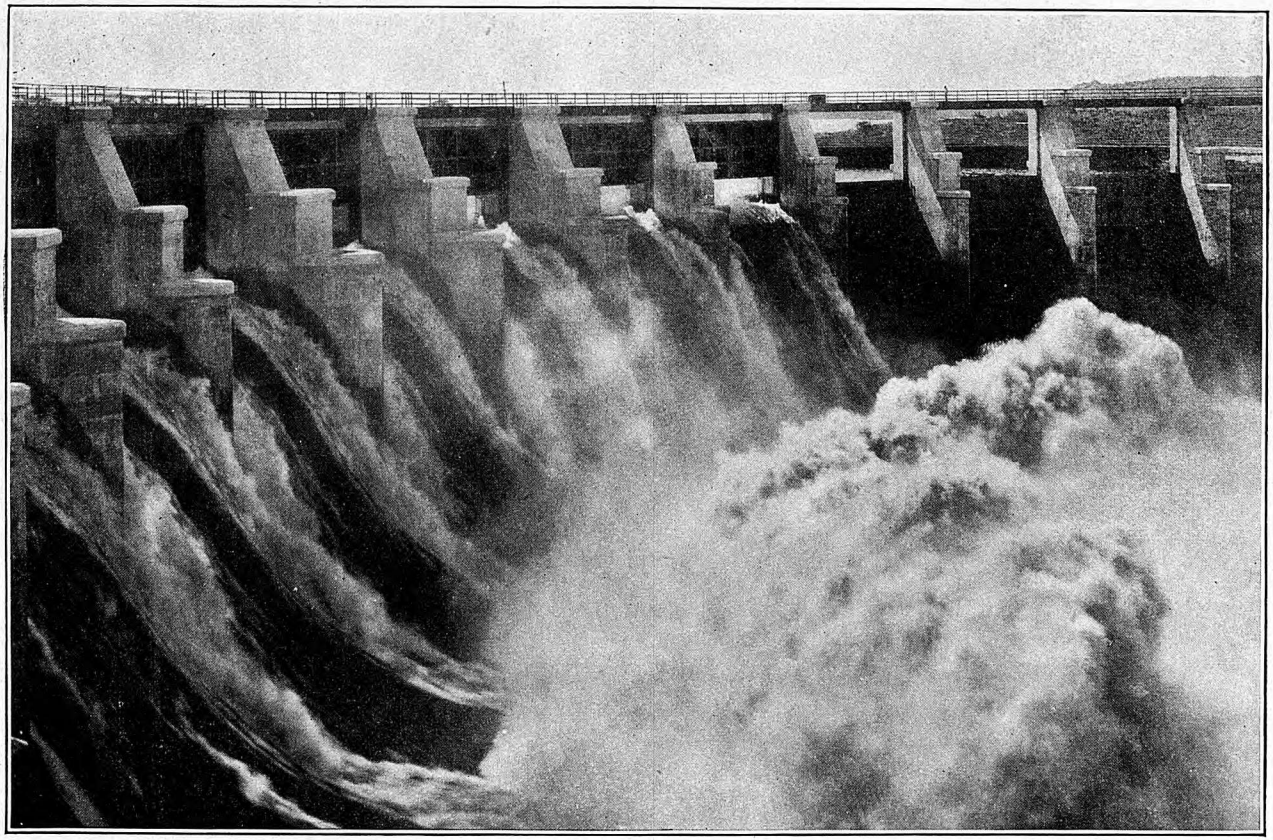
In line with its policy of making the canal thoroughly serviceable in a commercial sense, the Government is equipping it with all requisite facilities to minimize the incidental delays and expenses of vessels passing through it.

The facilities are now ample for the present traffic, except for the lack of a large dry dock. The concrete is now being placed for the permanent dry dock at Balboa, which will accommodate the largest vessels afloat, and is to be finished by the end of 1915.

Extensive fuel-oil handling plants, with which are connected tanks belonging to individuals and companies, as well as those erected by the Government, have been established at both terminals of the canal. Oil can be supplied to ships at the rate of 1,200 barrels per hour to each vessel.

The permanent coaling plants, now under construction at both terminals, will each be able to load coal into bunkers of vessels at the rate of 2,000 tons per hour. The plant at the Atlantic entrance is to have a storage capacity of a little over 400,000 tons, and that at the Pacific entrance will have a capacity of 200,000 tons. Both will be equipped with unloading and loading cranes. These plants are to be completed early in 1916. The present means of supplying coal to vessels are from lighters at the Pacific entrance, and from lighters, or from cars alongside the wharves, or by cantilever crane at the coal wharf at the Atlantic entrance.

Water is supplied from the mains on the terminal wharves and piers. The water in Gatun Lake is fresh, but is not safe for drinking purposes in an untreated state. The water sold at the docks is drawn from the regular water-supply systems and has been purified.



GATUN SPILLWAY DAM. OPENING OF SEVEN GATES, LOOKING WEST FROM EAST ABUTMENT, DECEMBER 30, 1913.

96642°—15——4

## GENERAL SUPPLIES.

As The Panama Canal and the Panama Railroad Company are together operating a large number of vessels of a variety of classes, from tugs to ocean-going passenger and freight vessels, supplies for practically any kind of vessel are kept on hand on the Isthmus. Such supplies are for sale to all ships using the canal, or calling at the terminal ports. The storehouses at Cristobal and Balboa have in stock all standard lubricants, light and heavy hardware, cordage, and miscellaneous ship-chandlery supplies.

Foodstuffs and the general variety of merchandise handled by the commissary department of The Panama Canal may be purchased for ships. The fact that the supply department is supplying regularly most of the food and wearing apparel of approximately 50,000 people is a warrant that its operations are on a scale which can easily include the needs of ships now coming to the canal. Prices are generally lower than the retail prices in the United States, or possibly about 10 per cent higher than the wholesale prices there, and compare favorably with prices in any port of the world.

A large stock of fresh meats, vegetables, fruits, canned groceries, bakery products, etc., is always on hand, and advance arrangements can be made for supplies of any article obtainable in the markets of the world.

Ice may be purchased in any reasonable quantity.

Laundry is handled quickly. No advance notice is required, and ship's laundry can be returned on the same day it is received. A vessel entering the canal can forward its laundry by rail to the plant at Cristobal or the one at Ancon and receive it back by the time it is ready to clear from the other end of the canal. Passengers' laundry can be handled with corresponding dispatch, but it is preferred to have at least two days for the work.

## REPAIRS.

Except for the limitations imposed at present by the absence of a large dry dock, and of lathes for turning the largest crank shafts and longest line shafts of modern vessels, the canal shops can do practically any repair work which

a vessel might bring. Sufficient materials, including heavy billets and all sizes of plates and angles, are kept on hand to meet every probable need. The foundry can make steel castings up to 5 tons in weight, and iron castings up to 10 tons, as well as brass castings of any ordinary size.

The shops at Balboa are equipped with a 540-ton hydraulic forging press, an open-side extension planer with capacity to plane 132 inches wide, 96 inches high, and 24 feet long, lathes large enough for ordinary line-shaft work, and the usual accessories of fully equipped machine, boiler, and ship-fitters' shops. The shops alongside the dry dock at Mount Hope can do small machine work of moderate size, and practically any plate work likely to be required. By submitting to the delay necessary to transport parts to Balboa, all the facilities of the Balboa shops are also available for work at Mount Hope. The Mount Hope Dry Dock can take ships drawing 13½ feet of water and 300 feet long; the permanent dry dock now under construction at Balboa will take any vessel that can pass through the canal.

The Balboa shops contain a plant for the generation of oxygen and acetylene, and both they and the shops at Mount Hope are equipped with tools for all kinds of cutting and welding. Compressed air, steam, water, oil, and electric current are available at the repair wharves in the maximum quantity required. Locomotive and wrecking cranes are available at the wharf side for lifting, and a derrick barge with a lifting capacity of 40 tons may be brought into service if necessary. Two floating derricks of 250-tons capacity have been erected and are practically ready for service.

Contracts for doing repair work at a stated cost can not be made by The Panama Canal, though estimates of probable cost can be furnished from the shops. Charges are made on the basis of actual cost of repairs, plus a percentage to cover overhead expenses, prescribed by The Panama Canal.

### HOTEL AND HOSPITAL ACCOMMODATIONS AND CABLE CONNECTIONS.

The Hotel Washington at Colon and the Hotel Tivoli at Ancon, adjoining Balboa, and the Hotel Aspinwall, on

Taboga Island, are owned and operated by the Government for the accommodation of the traveling public. Reservations can be made in the same way as at privately owned hotels.

Ancon Hospital is equipped with 800 beds. It treats about 35,000 cases a year, in which approximately 7,000 surgical operations are performed. Its staff of physicians and surgeons includes men of marked experience and ability and several experts in tropical medicine. The treatment of cases from neighboring countries and from ships is a part of its regular work.

Direct cable connections extend from the Isthmus to New York and to the west coasts of Mexico, Central, and South America. The radio stations at Colon and Balboa handle commercial business.

### METHOD OF APPLICATION FOR SUPPLIES.

Steamship captains or agents desiring the services of The Panama Canal in the way of supplies, repairs, etc., will receive prompt response on communicating with the Captain of the Port at Balboa or Cristobal. Ships may communicate their wants by radio in advance of arrival. The canal organization, having made ample preparations for serving vessels, is desirous of giving prompt and satisfactory service on a businesslike basis without unnecessary delay or red tape.

The Captain of the Port will furnish information in regard to placing orders, and should be notified of all orders placed, so that he may be able to keep track of them in relation to clearing ship, etc.

Bills for all supplies will be submitted through the offices of the deputy collectors at the ports for collection, or cash may be sent with orders. Bills for supplies furnished ships of regularly established lines will be submitted to the local agents, if desired.

### PRICES OF SUPPLIES.

The following is a partial list of the charges prevailing at present for various services, but they are subject to change from time to time:

*Coal.*—At Cristobal, from lighters, trimmed in bunkers, or from cars alongside wharf, handled by ships' gear, per ton, $5.40; use of steam hoist and crane, per hour, $1. At Balboa the price is $1 more per ton, either form of delivery.

*Fuel oil.*—Regular sales, $1.25 per barrel.

*Water.*—Delivered at dock, 25 cents per 1,000 gallons; minimum charge, $3.

*General supplies, foodstuffs, etc.*—Prices are usually less than retail prices in the United States. Wholesale lists may be obtained from the offices of the port captains.

*Ice.*—At Cristobal, 30 cents per 100 pounds; at Balboa, 35 cents per 100 pounds.

*Laundry.*—The following representative prices will give a fair idea of charges. For passengers: Drawers or undershirts, 10 cents each; socks, 5 cents per pair; collars, 3 cents each. For ships: Waiters' coats, 10 cents each; blankets, 10 cents each; trousers and jackets, 5 cents each; aprons, caps, sheets, tablecloths, napkins, towels, 1 cent each.

### CHARGES FOR SERVICES.

*Barges and lighters.*—With towing machine, 400 tons or over, $2.25 per hour; without towing machine, 400 tons or over, 90 cents per hour; under 400 tons, 30 cents per hour.

The charge for barges or lighters will depend upon the kind and class of service rendered, time in use, and charges in connection with handling freight and cargo.

*Wharfage.*—All steam or motor vessels, per day or fraction thereof, per foot of length, measured over all, 12½ cents. Sailing vessels, 100 feet in length or less, per foot, 5 cents; over 100 but less than 200 feet, per foot, 10 cents; over 200 feet, per foot, 12½ cents.

*Dry docking at Mount Hope.*—For vessel docked alone, $75 for the first day, and $25 for each subsequent day. For a vessel docked with another vessel, $50 for the first day, and $18 for each subsequent day.

*Launches.*—Larger launches, for the first hour, $7.50, and $5 for each succeeding hour; smaller launches, $5 for the first hour, and $2.50 for each succeeding hour.

*Diver's service.*—For the first four hours or fraction thereof from time of arrival at point of diving $60, for each subsequent hour $10.

*Freight.*—Rates for handling freight depend upon the kind and class of services required. Freight is handled at the terminal ports either by the Panama Railroad or the agents of vessels.

*Tugs.*—For harbor work, shifting berths, work around piers or locks, and short tows, $15 per hour. For towing through the canal 4 cents per displacement ton, or 10 cents per net Panama Canal ton; minimum charge for towing through the canal $150.

*Pilotage.*—Charges are based upon the maximum draft; rate per foot or fraction of foot exceeding 6 inches $1. In case pilot is taken on outside of the Atlantic breakwaters an extra charge of $10 is imposed. There is no charge for pilotage when a vessel goes direct through the canal without stopping at either terminal port to take on or discharge cargo or passengers. Through passengers will be allowed to land without affecting the status of the vessel in this respect.

*Tolls.*—On merchant vessels carrying passengers or cargo per net ton (each 100 cubic feet) of actual earning capacity $1.20.

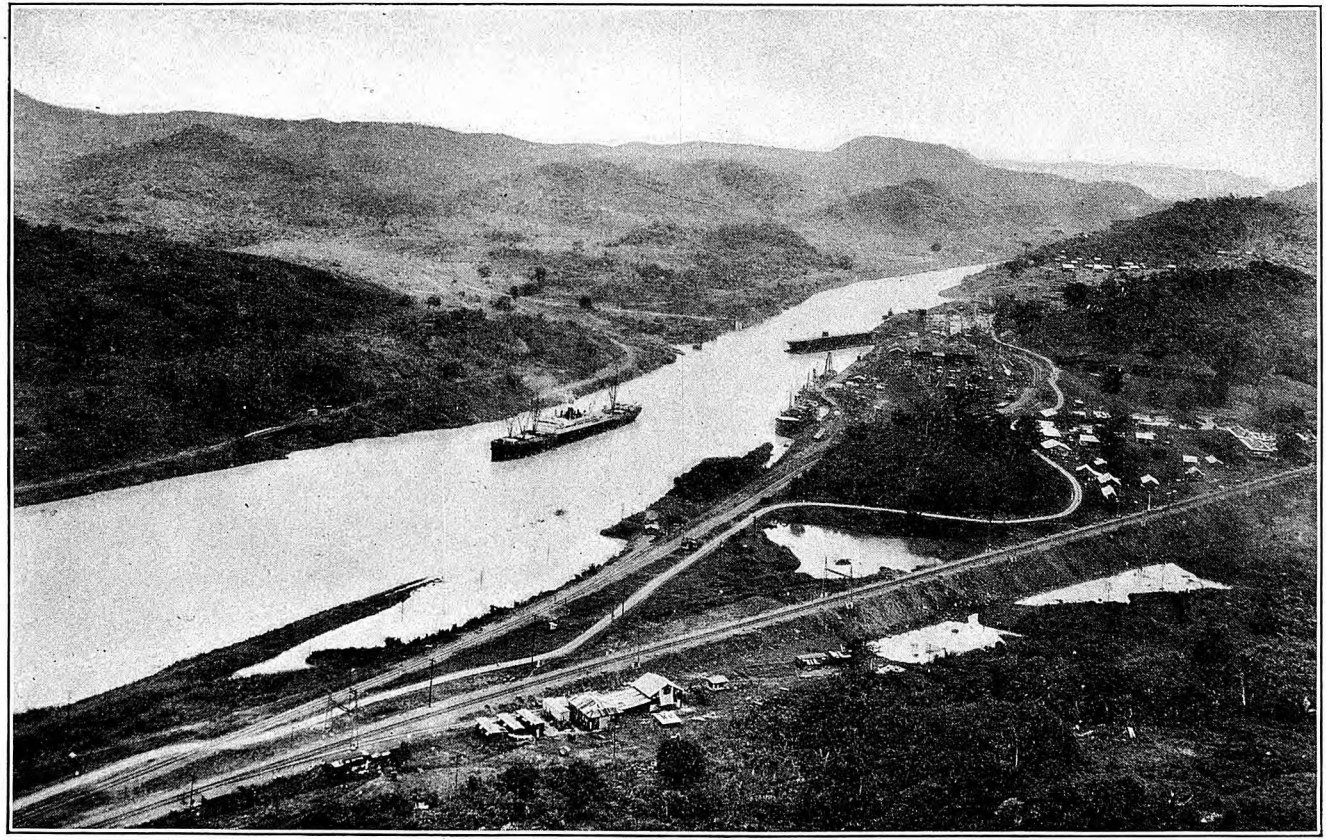
On vessels in ballast without passengers or cargo, per ton, 75 cents.

On naval vessels, other than transports, colliers, hospital ships, and supply ships, per displacement ton, 50 cents.

On Army and Navy transports, colliers, hospital ships, and supply ships, the vessel to be measured by the same rules as are employed in determining the net tonnage of merchant vessels, per net ton, $1.20.

Additional charges are made for deck loads, depending on the space occupied; per net vessel ton, $1.20.

For passengers, no specific charge is made, but passenger space is included in the net tonnage upon which tolls are charged.



OPENING OF THE PANAMA CANAL. S. S. ANCON IN GAILLARD CUT, LOOKING NORTH FROM CERRO LUISA, AUGUST 15, 1914.

## SAVINGS IN COST.

Fundamentally, the saving to a vessel by the use of the canal in place of a longer route is the difference between the cost of the voyage over the longer route and the cost over the canal route, in which latter must be included the canal tolls. The actual cost per day at sea on any route is affected by various factors, chief among which are the cost of fuel and of supplies which must be taken aboard en route; these factors, as may be judged from the description of facilities for vessels at the canal, and the broader influences of weather, conditions at sea, and connections with secondary trade areas, are generally favorable to the canal in comparison with alternate routes. The advantage of quicker delivery of goods is in most cases an appreciable consideration.

For a specific voyage between two ports, by way of the canal or by an alternate route, the cost will vary in any number of vessels according to their individual expenses of operation. All cases can not be covered by exact formula. The following typical instances are, however, illustrative of general conditions:

With reference to the trade from the Atlantic coast of the United States to the Far East, the voyage of the *Penrith Castle*, which passed through the canal on October 22–23 en route from Galveston to Yokohama with a cargo of 3,270 tons of raw cotton, is typical.

By using The Panama Canal, this vessel saved at least 5,280 miles of travel between these ports. The distance via the canal, San Francisco, and the Great Circle is 9,294 miles; via the Suez Canal and the most direct sailing, about 14,575 miles. On a speed of 10 knots this means a saving of 22 days on the outward voyage alone.

The *Penrith Castle* is 361 feet long, 42.6 feet in the beam, 17.6 feet in mean draft, has a net registered tonnage of 2,337 by the rules of measurement of the British Board of Trade. and is propelled by a three-cylinder, triple-expansion engine, with 24, 40, and 67 inch cylinders and 45-inch stroke. The crew numbers 28, officers and men. Its operating expenses may be approximated at $230 per day on this route.

The saving of 22 days at sea amounts, accordingly, to a saving of $5,060. The tolls collected at the canal—$4,101.60 (at $1.20 per ton on 3,418 tons, including 111 tons of deck load)—should not be deducted from the saving, as an equivalent amount would have been collected at the Suez Canal.

If the vessel had elected to go by way of the Strait of Magellan, it would have had to travel approximately 15,071 miles, or 5,777 miles farther than by the canal route, and the cost, on the basis followed above, would have exceeded the cost by the canal, including tolls, by $1,533.40. The Cape of Good Hope route would have increased the voyage about 7,700 miles over the canal voyage and would have cost at least $3,258.40 more than the use of the canal route.

Concerning the traffic between the Pacific coast of the United States and Europe, the following is an approximation based on the transit of 17 vessels of foreign registry laden with grain from San Francisco and Puget Sound to European ports, principally in Great Britain: The distance saved by the use of the canal in place of the Strait of Magellan was about 5,550 miles for each vessel. For a speed of 10 knots, the saving in time at sea was 23 days. The average net tonnage of the 17 vessels—British Board of Trade measurement—was 3,094; the average net tonnage under the rules for the measurement of vessels for The Panama Canal was 4,050 tons, and the average tolls were, accordingly, $4,860. If the average per diem cost at sea be rated at $0.09 per net registered ton, the average saving per vessel by the use of the canal was the average daily cost of operation—$278.46—multiplied by 23, less the canal tolls, or $1,544.58.

In the traffic between the Atlantic and Pacific coasts of the United States, involving over 40 per cent of the movements

through the canal, an idea of the saving may be obtained from the case of one of the American Hawaiian Co.'s liners, the *Arizonan*, for instance: On the basis of a speed of 12 knots, the canal saves the *Arizonan* about 26.8 days at sea on each voyage from coast to coast. The *Arizonan* is a relatively large vessel, 470 feet long by 57.2 feet in the beam, and has carried as much as 11,780 tons of cargo through the canal on one of her voyages. The canal tolls levied on each passage are $7,891.20. The cost of operating the *Arizonan* at sea may be taken at $450 a day. For 26 days this means $11,700, from which the subtraction of the tolls leaves a net saving of approximately $3,808 per voyage.

Similar instances might be cited without end. Those given are indicative of the great element of saving which will be introduced into some of the more important routes.

## TOLLS.

To offset, at least in part, the cost of the maintenance and operation of the canal and the interest on the money invested in it, the Government charges tolls on the vessels which make use of it.

Tolls are levied on the basis of the cargo and passenger carrying capacity of each vessel. The determination of capacity is embraced in a set of rules of measurement of vessels for The Panama Canal, according to which the net tonnage of a vessel is the units of interior space of 100 cubic feet, or 2.83 cubic meters, which may be devoted to carrying cargo or passengers.

The interior cargo-carrying capacity or net canal tonnage is the primary basis on which tolls are levied, but there is additional charge for open space on deck occupied by cargo or deckload.

A vessel may be measured for its Panama Canal certificate by the surveyor of any port of the United States, and copies of the rules for measurement have been sent to the Governments of all the principal maritime countries where duly appointed foreign officials may measure vessels and issue certificates; and the canal maintains a staff to measure vessels which arrive at the canal without a certificate, and to check the certificates issued at other ports. The canal force can measure and certificate vessels ordinarily in from 24 to 36 hours, if the masters furnish the constructor's blue prints and the ship's certificate of national registry, or check a previously issued certificate in an hour unless it contains exceptional errors.

Gross tonnage, according to The Panama Canal rules, includes, in general, the total capacity of the vessel or the cubical contents of all spaces below the upper deck and of all permanently covered or closed-in spaces on or above that deck, excepting spaces specifically designated for exemption from such measurement.

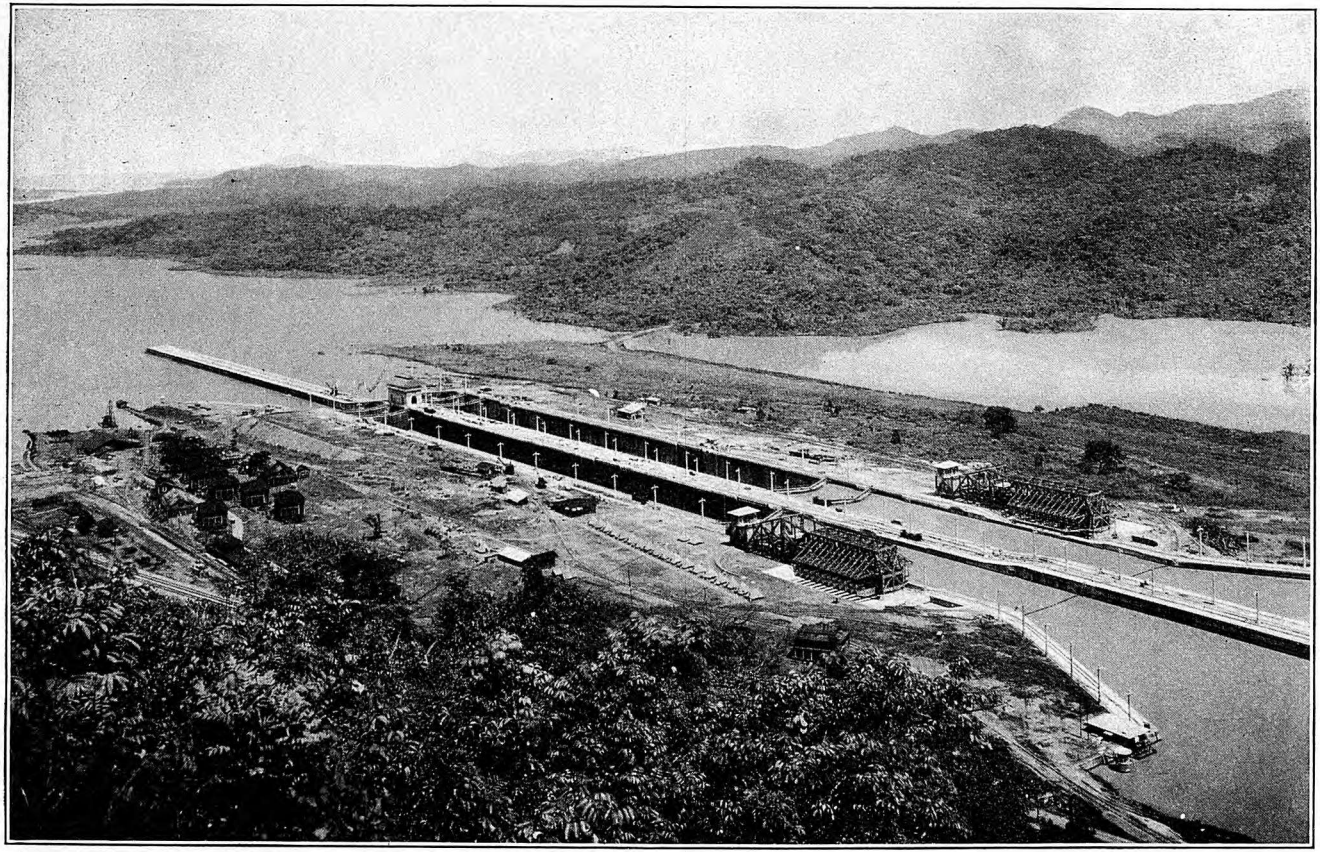
The principal deductions from the gross tonnage for the determination of the net tonnage include, in general, spaces which serve for the navigation of the ship, its propulsion, spaces devoted to the use of officers and crew, for its fuel supply, boatswain's stores, feed-water tanks, and spaces framed in around the funnels for the admission of light and air to the engine and fire rooms. No space not included in the gross tonnage is ever deducted in the determination of the net tonnage.

The canal system of designation of tonnage differs somewhat from the systems in practice in the United States and various foreign nations and from that for the measurement of vessels for the Suez Canal. The classifications of space for registry are at such variance that it was decided to work out a separate plan for the measurement of vessels for the canal which should be fair to all, irrespective of previous registry.

On loaded commercial vessels the toll charge is $1.20 per net canal ton, plus $1.20 per 100 cubic feet of deck load, provided that the sum of these charges shall not exceed an amount equivalent to a charge of $1.25 per net ton on the vessel, as measured for United States registry.

Vessels going through the canal without cargo or passengers—that is, in ballast—will be charged 72 cents per net canal ton, provided that if this amount is not equivalent to the product of the vessel's net tonnage according to measurement for American registry by 75 cents, the larger sum shall be collected.

In commercial operations, steamship agents charge freight on the basis of weight or of space occupied. On the basis of space, they ordinarily rate 40 cubic feet as a ton. Accordingly, the 100 cubic feet called a ton in canal measurement could contain two and one-half tons of cargo, on the com-



GENERAL VIEW OF PEDRO MIGUEL LOCKS FROM LUISA HILL, JUNE 6, 1914.

mercial basis of 40 cubic feet to the ton. In the case of ideally compact loading, the canal toll of $1.20 per ton of canal space would be equivalent to a charge of 48 cents per ship's ton of cargo. As a matter of experience with vessels which have so far used the canal, with great variations in loading, the toll charge has averaged approximately 75 cents per ton of cargo as declared in the ship's manifests. The heavier the loading in proportion to capacity the smaller the cost per ton of cargo. The steamship *Historian*, rated at 5,378 net canal tons, paid $6,453.60 in tolls to pass through the canal on November 14 on the way from San Francisco to London. She was laden with 12,000 tons of cargo on which, accordingly, the cost per ton was approximately 54 cents.

The Panama Canal, however, has no direct interest in the proportionate loading of vessels carrying cargo through the canal, or in the nature of the cargo, other than explosives or other commodities requiring precautions in handling or liable to menace the safety of the canal. Its rates are entirely flat, on the simple basis of cargo-carrying capacity, and there are no complicated tariffs.

The first tolls were collected on May 18, 1914, before the opening of the canal to ocean-going vessels, and were assessed on loaded barges towed through the canal by tugs. The actual collection of tolls (less $11,551.20 refunded) between that date and May 1, 1915, may be summarized as follows:

| | |
|---|---|
| Prior to Aug. 15, 1914 | $11, 610. 69 |
| Aug. 15 to 31 | 98, 066. 19 |
| Sept. 1 to 30 | 263, 220. 00 |
| Oct. 1 to 31 | 349, 986. 48 |
| Nov. 1 to 30 | 349, 382. 15 |
| Dec. 1 to 31 | 395, 169. 57 |
| Jan. 1 to 31, 1915 | 376, 810. 88 |
| Feb. 1 to 28 | 403, 118. 36 |
| Mar. 1 to 31 | 606, 316. 56 |
| Apr. 1 to 30 | 420, 884. 69 |
| Total | 3, 274, 565. 57 |

## SAILING SHIPS.

Prior to the opening of the canal it was widely assumed that the new route would not be used by sailing vessels, and there has been very little discussion of the relations of the canal to sailing traffic.

To date half a dozen sailing vessels have gone through the canal. Something of the cost of handling them through the canal may be judged from these figures on the passage of the schooner *Zeta* and the barkentine *John Ena*, which went through the canal well laden and may be regarded as typical of the traffic:

The *Zeta* is a wooden three-masted schooner 132 feet long, 32 feet in the beam, and 12 feet deep. She is registered at 335 net tons, Lloyds' measurement, and at 313 net tons, canal measurement. Her expenses in transiting the canal were: Tolls, $520.80; tug service, $150; total, $670.80. The vessel was carrying 600 tons of lumber; her expenses in passing through the canal amounted to $1.118 per ton of cargo.

The *John Ena* is a four-masted steel barkentine, 313 feet long, 48 feet in the beam, and 25 feet deep. The registered net tonnage of this vessel is 2,706; the canal measurement rates it at 2,609 net tons. Expenses for going through the canal were: Tolls, $3,130.80; tug service, $302.15; total, $3,432.95. On a cargo of 4,400 tons of petroleum and wax the total expenses prorate at 78 cents per ton.

To date, under conditions of average loading, the tolls on laden steam vessels have been equivalent to approximately 75 cents per ton of cargo carried.

From the foregoing instances it is seen that sailing vessels can be handled through the canal economically, as far as the actual passage of the canal is concerned. A factor of

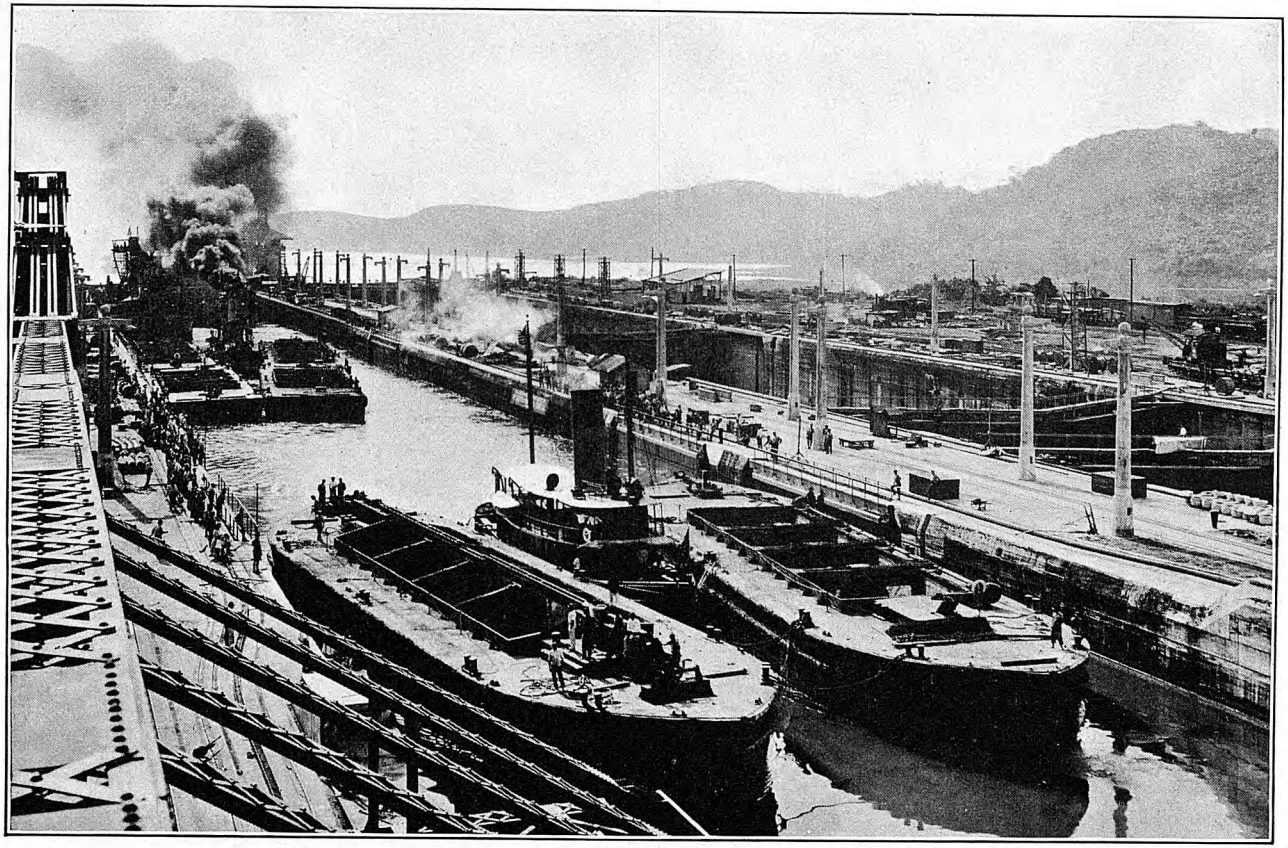
greater importance, admitting of less certainty in its determination, is the relative time which it will take a sailing vessel to reach the Isthmus and its ultimate destination, in comparison with the passage over the longer alternative routes around the Horn or the Cape of Good Hope.

On the Atlantic side, according to sailing directions, the time of transit of an average sailing vessel between New York and the Isthmus may be approximated at 20 days. The time from the English Channel to the Isthmus is reckoned as 30 days for a yearly average; the homeward voyage to Europe is taken at 40 days. Limon Bay is easily accessible to sailing vessels at all times of the year and vessels may generally expect a fair wind for entering.

On the Pacific side vessels may generally expect a fair wind offshore on departing from the Isthmus, light from May to November, and somewhat stronger from December to April. Vessels entering the Gulf of Panama will almost invariably encounter head winds, often very light, and find difficulty in beating up to the canal. Off shore on the Pacific side the regular trades may not be expected until several hundred miles off shore. Sailing directions should be freely consulted by all sailing masters, particularly in regard to the wind and currents on the Pacific side. If due notice be given, tugs may be obtained from the canal authorities.

The average time of a sailing vessel from Panama to San Francisco is considered to be between 37 and 40 days; for the return about 31 days from April to October, and 26 days from October to April.

Accordingly the time of transit of a vessel from New York to San Francisco may be reckoned generally at 60 days, including a day in the canal. The return trip should consume about 57 days in the winter months and 62 in the summer season. The generally accepted average time for sailing vessels to go from New York to San Francisco around Cape Horn is 140 days; the return voyage requires from 110 to 115 days. On this basis the normal time for a round trip between the two ports by way of the canal may be rated at 120 days; by way of the Horn about 250 days.



PEDRO MIGUEL LOCKS. DREDGING FLEET PASSING FROM EAST CHAMBER INTO GAILLARD CUT ON WAY TO CUCARACHA SLIDE, DECEMBER 2, 1913.

The extent to which sailing vessels will use the canal will be dependent on many conditions in the shipping world, but it appears that under normal conditions the canal route is favorable to them. For instance, on the voyage from New York to San Francisco under average conditions a vessel might be expected to save 80 days at sea. Shipowners state that a vessel of 2,000 tons net may be operated at sea at a cost of $75 per day. The charges for passing such a vessel through the canal would approximate $2,700. If these charges be subtracted from the saving of 80 days at sea, at $75 per day, or $6,000, the net saving to the operator would be $3,300.

In the case of such a vessel the saving of 36 days at sea would cover its canal expenses. Between this period and the normal expectation of saving by way of the canal, 80 days, is a leeway of 44 days; that is, if the operator used the canal and then had his vessel arrive 44 days late, as compared to the normal voyage over the route, he would still "break even." If the vessel arrived 30 days late over the normal time, he would be benefited to the extent of 14 days at sea, which, at $75 per day, is equivalent to $1,050.

## THE CANAL AND THE NAVY.

The opening of the canal has greatly increased the effectiveness of the Navy of the United States. It has reduced the distance between the central points of the Atlantic and Pacific coasts from 13,000 to 5,000 miles and greatly reduced the problem of coaling on a cruise from coast to coast. It has made possible the concentration of a fleet at either entrance of the canal which, with a cruising speed of 15 knots, could reach the center of the Pacific coast in 9 days and the center of the Atlantic coast in 5 days.

Where formerly the fleets stationed opposite the middle of each coast were, from a cruising point of view, as far apart as opposite sides of the world, they are now as near as if one were off New York and the other off Buenos Aires.

With regard to the monetary saving to the United States resulting from the availability of the canal for naval use, it is apparent that the distance and time between the coasts have been reduced to less than two-fifths of the former figures. The cost of coast-to-coast movements is reduced accordingly, for though vessels of the Navy pay tolls, such payment is in effect a transfer of money from one branch of the Government to another.

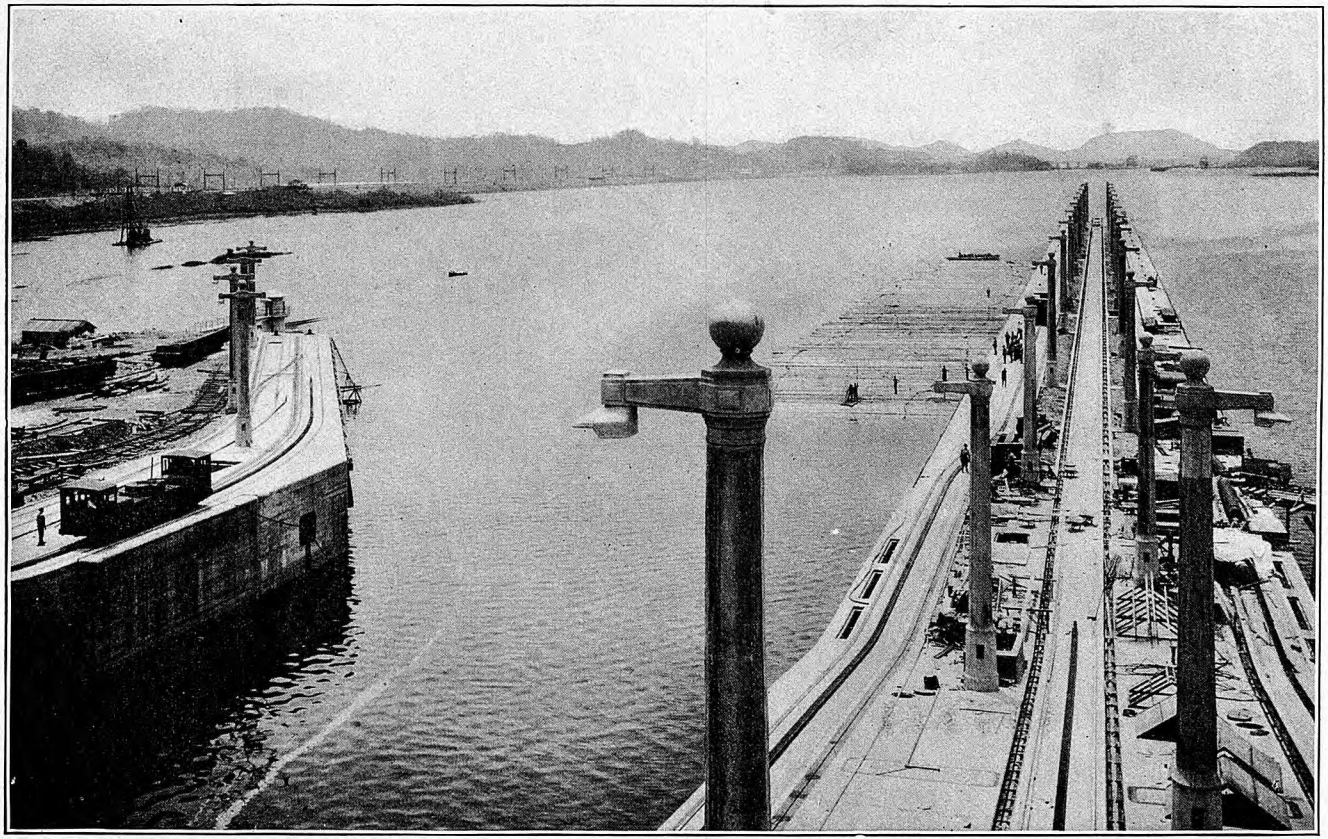
The strategic importance of the canal is inestimable from a monetary standpoint.

## FEATURES OF CONSTRUCTION.

The Isthmus of Panama connects the two continents through an elbow or segment of an arc running almost east and west. The canal runs more nearly north and south than east and west, and the Pacific end of it is east of the Atlantic end. The starting point in Limon Bay lies at latitude 9° 23′ north by longitude 79° 56′ west, and the other end of the canal, in the Bay of Panama, lies at 8° 54′ north by 79° 32′ west.

The distance by air from shore to shore of this narrow part of the Isthmus is about 30 miles. The canal is 43.84 nautical miles in length from deep water to deep water. It passes through a varied and picturesque country, at places rugged, and where Gaillard Cut[1] goes through the Continental Divide the lowest point was formerly some 700 feet above sea level. The route selected has, in general, followed the valley of the Mindi and Chagres Rivers on the Atlantic slope of the divide, and the valley of the Rio Grande on the Pacific slope. Sea-level channels were dredged inward from either end of the canal as far as practicable—that is, from deep water in the Pacific northward to Miraflores, and from deep water in the Atlantic southward to Gatun—and two artificial lakes were formed by damming the waters of the rivers at higher levels, one, the Miraflores Lake, extending between Miraflores and Pedro Miguel, with surface 54⅔ feet above sea level, and the other, Gatun Lake, extending from Pedro Miguel to Gatun, with surface 85 feet above sea level. Gaillard Cut, which is approximately 8 miles long, forms the southern arm

[1] The "Culebra Cut" was renamed "Gaillard Cut" by Executive order of the President dated April 27, 1915.



PEDRO MIGUEL LOCKS. LOCKAGE OF 85-FOOT PILES RAFTED FROM BALBOA TO EAST BREAKWATER, ATLANTIC ENTRANCE, LOOKING SOUTH FROM CONTROL HOUSE, APRIL 8, 1914.

of the Gatun Lake. The locks at Miraflores, Pedro Miguel, and Gatun are used as elevators for raising and lowering vessels between the levels mentioned.

From the initial station in Limon Bay, on the Atlantic side, the canal runs almost due south 7 miles in a sea-level section reaching to the valley of the Chagres at Gatun. Here is the great Gatun Dam, nearly a mile and a half long, closing a gap through the western end of the Quebrancha Range. The dam is an artificial ridge formed by pumping an impervious core of dredged clay and sand between parallel ridges or "toes" of rock and earth. Its construction, across swampy bottoms, was considered the most difficult feature of the canal. The top was smoothed over with earth, and the part of the slope on the lake side, lying between levels 10 feet above and 10 feet below the normal water surface, has been riprapped with hard rock to protect against wave erosion.

As completed, Gatun Dam is about half a mile wide at the base and 100 feet wide at the top, which is 103.5 feet above sea level. It contains 10,728,965 cubic yards of wet fill and 12,229,104 cubic yards of dry fill, a total 22,958,069 cubic yards, which is more than one-sixth of the total excavation from Gaillard Cut to date.

Near the center of the dam is a concrete spillway, for discharging the surplus waters of the lake into the lower channel of the Chagres. The discharge channel is 285 feet wide and 1,200 feet long; and the spillway dam across its upper end is 808 feet long, being in the form of an arc of a circle. The top of this dam is 69 feet above sea level, and is surmounted by regulating gates 20 feet high, the tops of which are accordingly at elevation 89 feet, or 2 feet above the proposed maximum elevation of the lake. The 14 regulating gates are installed between vertical concrete piers and are raised and lowered by means of chains running over sheaves at the top of the piers and down through the piers to the operating machinery in the body of the dam. The operating machinery is accessible by means of a tunnel through the center of the spillway dam, and may be operated by remote control from a switchboard in the hydroelectric station,

which is situated on the east side of the spillway discharge channel. When all the gates are open the discharge of water is greater than any known rate of run-off from the Chagres watershed. Dropping down the 60-foot slope of the ogee and striking against the baffle piers at the bottom, the water makes a turbulent fall which is one of the beautiful sights of the Isthmus.

The hydroelectric station uses water from Gatun Lake for driving three turbo-generators of 2,000-kilowatt capacity each, which supply electricity for the operation of the lock and spillway machinery, the terminal shops and adjacent facilities, and for the lighting of the locks and the canal villages and fortifications. Transmission over the Zone is effected through four substations and a connecting high voltage transmission line which follows the main line of the Panama Railroad.

Gatun Lake, impounded by Gatun Dam, has an area of 164 square miles when its surface is at the normal elevation of 85 feet above sea level, and is the largest artificially formed lake in the world. The area of the watershed tributary to the lake is 1,320 square miles. During the rainy season, from April to the latter part of December, the run-off from this basin exceeds considerably the consumption of water, and the surplus is discharged through the spillway of Gatun Dam. Toward the end of the rainy season the surface of the lake is raised to about 87 feet above sea level, in order to afford a surplus or reserve supply to keep the channel full to operating depth during the dry season, in part of which the consumption and evaporation are in excess of the supply. It is calculated that when this level has been attained at the beginning of the dry season the reserve is sufficient to assure a surface elevation of at least 79 feet at the end of the dry season in spite of the consumption at the hydroelectric station, and allowing 41 passages of vessels through the locks each day with the use of the full length of the chambers, or 58 lockages a day when the shorter sections of the chambers are used and cross filling is employed, which would usually be the case. This is a greater number of lockages than can be made in one day.

The creation of the lake made it possible to have a channel 45 feet deep with its bottom at 40 feet above sea level. By following the valley of the Chagres as far as Gamboa, 24 miles of channel were thus completed with relatively little excavation. At the same time the lake, by backing water far up the valleys of the Chagres and its tributaries, deadens the currents of the rivers before they reach the canal channel and decreases silting to a minimum.

At Gamboa the Chagres Valley turns sharply to the east and the line of the canal leaves it for the heavy cut through the Continental Divide. Gaillard Cut, forming the passageway between the opposite slopes of the divide, is 7.97 miles long, 300 feet wide at the bottom, and from 45 to 65 feet in depth. The great depth of the Cut is responsible for the magnitude of the slides, which are breaks in the banks, due to the pressure of the material. The elementary phenomena of slides are encountered in almost any kind of cutting or trenching through earth; the great depth of the Gaillard Cut has caused similar breaks even in ordinarily firm rock. The slides are responsible for 35,158,225 cubic yards of additional excavation to February 1, 1915. To that date the total excavation from the Cut has been 117,077,044 cubic yards. The Cut is an arm of Gatun Lake and its bottom is accordingly 40 feet above sea level.

At the south end of the Cut, on the Pacific slope of the divide, the waters are held back by Pedro Miguel Dam and Lock. The dam is of earth, protected by rock riprap at the water levels, and is 1,400 feet long, extending from a high hill on the west to the lock, which is set at the base of a high hill on the east.

Below Pedro Miguel Lock and Dam is a small lake, Miraflores Lake, through which the channel passes to Miraflores Locks, which effect the transit between Miraflores Lake and the Pacific entrance channel. The surface is normally 55 feet above sea level. Its area is 1.88 square miles, and it may always be kept at full depth by supplying water, if needed, from Gatun Lake, as to fill it completely from Gatun Lake would lower the surface of the latter less than 6 inches. The length of the canal channel through it is 1.4 miles. The lake

GAILLARD CUT. DEEPEST EXCAVATED PORTION OF PANAMA CANAL, SHOWING GOLD HILL ON RIGHT AND CONTRACTORS HILL ON LEFT, JUNE, 1913.

is impounded by an earth dam 2,700 feet long, connecting with Miraflores Locks from the west, and by a concrete spillway dam to the east of the locks, 500 feet long, on which are mounted eight regulating gates similar to those on the Gatun Spillway.

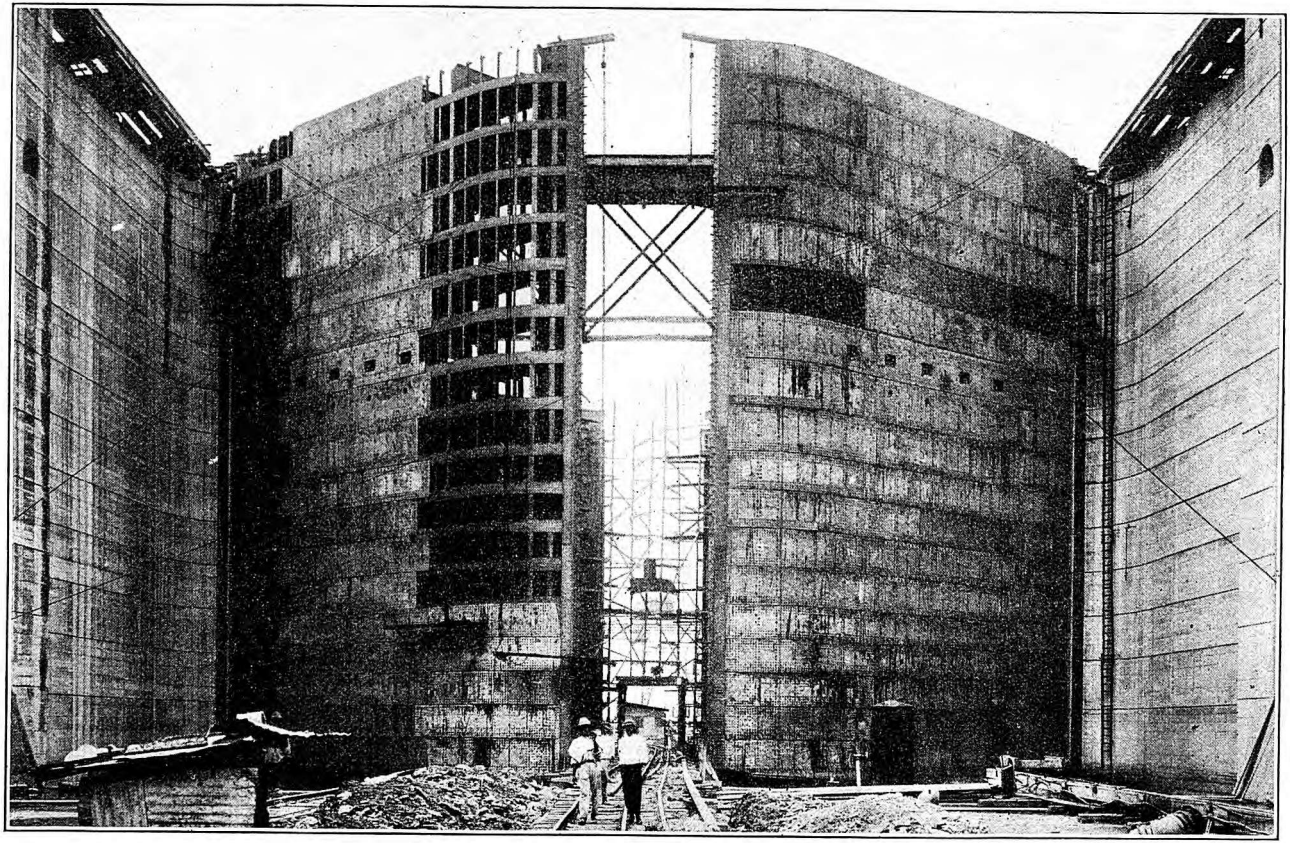
The transits between the several levels of the canal—between the Atlantic and Gatun Lake, between Gatun Lake (Gaillard Cut) and Miraflores Lake, and between Miraflores Lake and the Pacific—are effected by means of massive locks of concrete and gates of steel.

Three sets of locks were built—one set in three successive levels at Gatun, a set with one lift at Pedro Miguel, and a set with two lifts at Miraflores. The differences in levels overcome at the three places are, respectively, 85, 30⅓, and 54⅔ feet, the latter varying according to the tide in the Pacific, the figure given being for mean tide.

Each lock consists of two parallel chambers, which effect a double-tracking of the channel and allow vessels going in opposite directions to use the same flight of locks simultaneously. All of the chambers have the same length, 1,000 feet, and width, 110 feet; the depth of water in the locks varies from approximately 81 feet when a boat is being locked down and 45 feet when a boat is being locked up, and there is always a minimum depth over the gate sill of 45 feet.

At the upper and lower ends of each set of locks the center wall was extended approximately 1,250 feet to form a long pier, against which entering vessels can bring up before entering the chambers of the locks proper; and the side walls were flared out at an angle of 60° to form a funnel-shaped entrance. Both the center-approach walls and the flare walls are fitted with strips of timbers resting on helical springs to form buffers for the vessels, and the outer end of the center wall is fitted with a resilient fender of heavy timbers.

The channels of the lock are blocked by massive steel gates which cut off the flow of water and divide the locks into chambers. The flow of water into and from the chambers is effected through culverts running longitudinally through the bottoms of the side and center walls and feeding



MIRAFLORES LOWER LOCKS. LOWER MAIN GATES, JULY 5, 1913.

into the chambers through lateral culverts running under the floors of the chambers and emptying upward. The culverts are controlled by valves.

In all 92 leaves, forming 46 gates of two leaves each, are used in the three sets of locks. Each leaf is 65 feet long, so that when two are swung together to form a closed gate they meet in the center of the 110-foot width at an obtuse angle. The leaves are so set that this junction always points upstream against the downward pressure of the water; this pressure accordingly forces them firmly together and affords an element of safety, since a gate can not be opened until the water on both sides has been equalized. The leaves range from 47 to 82 feet in height, according to location, and they weigh from 390 to 730 tons each. The 82-foot gates occur only at the lower end of Miraflores Locks, where they are necessary on account of tidal conditions.

The leaves are hinged to anchorages in the walls and are swung back and forth like ordinary gates. They are moved by machines driven by electric motors. In fact, every piece of mechanism in the locks is actuated by electricity, and this has made possible a central control by which an operator at a central switchboard can cause every movement of the lock equipment except the running of the towing locomotives, which are under the control of individual operators riding on them, and the handling of the emergency dams.

## TRAFFIC ROUTES.

During the first six months of canal operation, from August 15, 1914, to February 15, 1915, it was seen that at least 95 out of every 100 ships using the canal were traveling over four great trade routes.

These were the routes of coastwise trade between the Atlantic and Pacific coasts of the United States; the route between the Pacific coast of North America and Europe; a route between the west coast of South America and the Atlantic coast of the United States and Europe (vessels frequently proceeding along one of these coasts and across to the other); and a route between the Atlantic coast of the United States and the Far East, including Australia and New Zealand.

During the first six months 496 ocean-going vessels passed through the canal. The way they were going and the cargo carried by them may be summarized in this manner:

| Route. | Number of vessels. | Cargo tonnage. |
|---|---|---|
| United States coastwise, eastbound | 97 | 499.439 |
| United States coastwise, westbound | 109 | 493,272 |
| United States Pacific coast to Europe | 66 | 444.855 |
| Europe to United States Pacific coast | 16 | 59,516 |
| South America to United States and Europe | 69 | 378.386 |
| United States and Europe to South America | 31 | 128,922 |
| United States Atlantic coast to Far East | 48 | 287,782 |
| Far East to United States Atlantic coast | 2 | 14,500 |
| Miscellaneous routings | 13 | 60,572 |
| Vessels without cargo | 45 | ..... |
| Total | 496 | 2,367,244 |

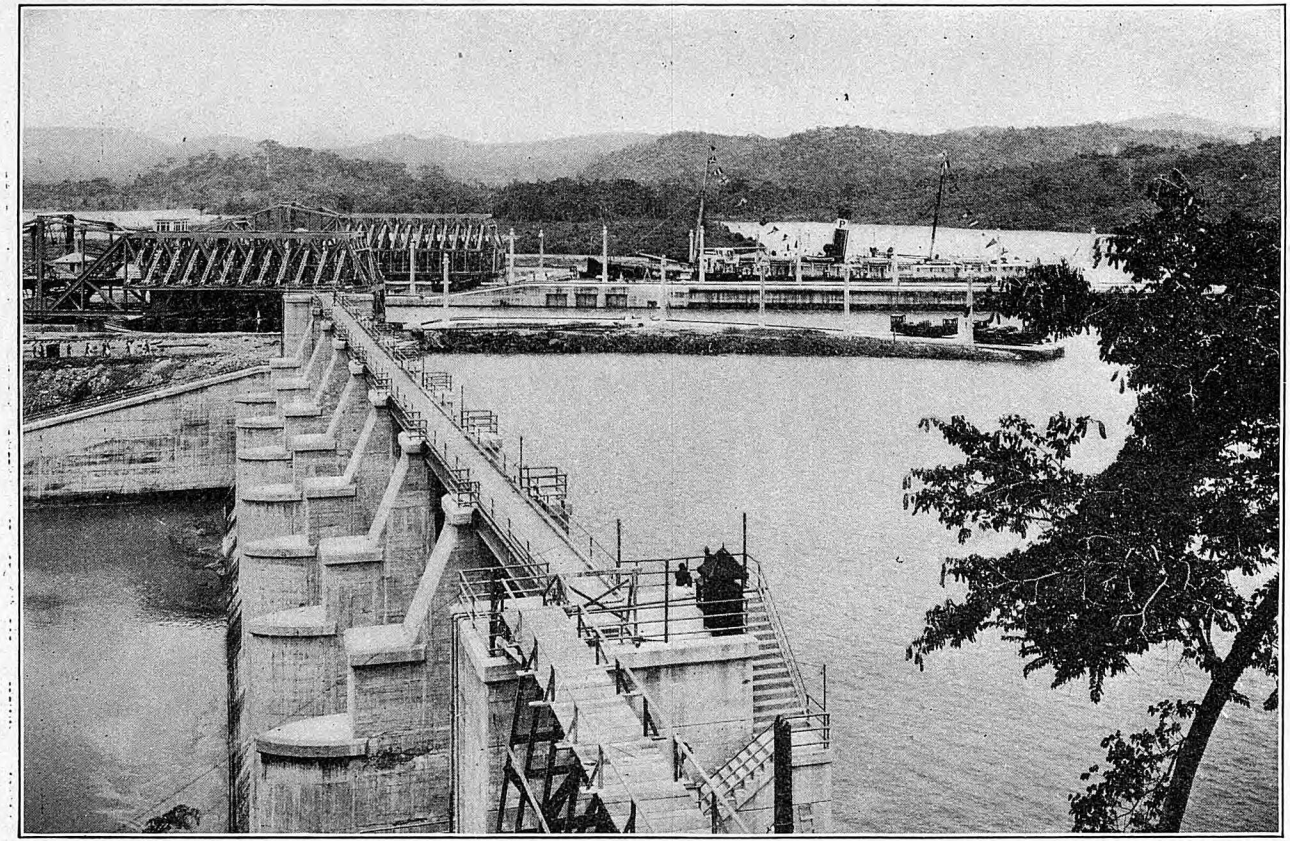
The heaviest traffic, from the Pacific coast to the Atlantic coast of the United States, has consisted principally of

canned fruit and fish, lumber, wine, pineapples, sugar, ores, and other items of the general produce of the west coast and adjacent inland areas. The return leg of this trade, from the Atlantic to the Pacific coast of the United States, has consisted principally of coal, structural iron, machinery, and, above all, a great variety of merchandise. Some idea of it may be gained from the following note, which appeared in the Canal Record of March 24, 1915:

As an example of the great variety of goods carried in the westbound United States coastwise trade, it is interesting to note some of the items in the cargo of 4,500 tons carried by the *Peter H. Crowell* through the canal March 10 on the way from New York to Los Angeles and San Francisco. Among the items listed by the master on the partial cargo declaration form supplied by The Panama Canal were: Battery cells, caustic soda, olives, chemicals, earthenware, glassware, lard, liquors, structural steel, machinery, refined petroleum, vegetable oils, paint, paper and paperware, pianos, rubber goods, salt, soap, stamped ware, textiles, tobacco, wooden ware, marble, starch, and thread; and the declaration was finished with "Balance, 1,189 tons, small lots of various articles."

From the west coast of the United States and Canada to Europe, over half the traffic was in grain, and the balance was in the same sort of general produce which constitutes the bulk of the eastbound American coastwise trade. Forty-four vessels carried western grain to Europe during the first six months of canal operation. They transported 155,146 tons of wheat and 134,145 tons of barley. Expressed in bushels the quantities were 5,752,402 bushels of wheat and 6,170,670 bushels of barley, an aggregate of over 11,923,000 bushels of grain.

The trade from Europe direct to the west coast has been about one-seventh that from the west coast to Europe. The cargo has been mostly coal and those sorts of general merchandise which make up the bulk of the trade from the Atlantic coast of the United States to the Pacific coast. Numbers of vessels have gone through the canal empty or "in ballast" from the Atlantic to load with cargo on the Pacific coast and return. This was especially noticeable at one time in the traffic in grain.



MIRAFLORES LOCKS. S. S. ADVANCE GOING SOUTH ON TRIP THROUGH CANAL. SPILLWAY IN FOREGROUND, LOOKING WEST, AUGUST 9, 1914.

The traffic from the west coast of South America to the Atlantic coast of the United States has had as its largest single item nitrates. Of this item, 204,441 tons were shipped through the canal during the first six months of operation, the greater part going to the United States. Iron ore has been another important item, amounting in the period to 41,300 tons. Other items distinguished by their size were fuel oil and benzene, amounting to 16,799 tons, and sugar, about 18,000 tons, of which 13,360 tons came through in two ships. In addition to these, there was an export of about 100,000 tons of general cargo, a great variety of native produce, in which ores, wool, hardwoods, and grain are noteworthy.

The traffic to South America through the canal during the first six months was less than one-half of the exportations from the west coast which passed through the canal. The 31 laden vessels which made the transit on their way to the west coast carried 128,922 tons of cargo. This was mainly machinery, structural material, clothing, and a great variety of general merchandise.

Shipments from the Atlantic coast of the United States to the Far East included 87,857 tons of refined petroleum and other petroleum products, 38,239 tons of raw cotton, and 162,686 tons of a great variety of manufactured goods, of which machinery, structural steel, railroad material, and textiles have been considerable items. About half of these vessels cleared for Australia and New Zealand, the rest for Japan, China, and Vladivostok. The trade to Vladivostok has been unexpectedly heavy.

During the first six months only two vessels returned through the canal directly from the Far East. Most of the vessels which go out over this route load in the Far East for ports in Europe or return first to the Pacific coast of North America, discharging cargo there and reloading. The cargo coming through the canal from the Far East has included Chinese groceries, matting, antimony, vegetable oils, curios, rattan, bamboo, silk, tallow, tea, wool, etc.

The routes just described were used by all but 13 of the vessels passing through the canal during its first half year.

The 13 miscellaneous vessels not to be classified with the principal routes included 4 vessels of a whaling fleet, on the way from Magdalena Bay to Norway; several stray vessels in the Central American coasting trade, and several vessels carrying coal to undeclared destinations.

The half dozen leading commodities shipped through the canal during the first half year were, in order of their tonnage, grain, nitrates, coal, refined petroleum products, lumber, and cotton. These six commodities together amounted to approximately one-third of all goods shipped through the canal.

Grain shipments amounted to 303,124 tons, of which all but 13,733 tons were shipped from the west coast of the United States and Canada. Of the other 13,733 tons, 6,200 tons were barley shipped from Valparaiso to Great Britain and 7,533 tons were wheat shipped from St. Johns, New Brunswick, to New Zealand.

The grain shipments from the west coast of North America consisted of 155,246 tons of wheat (5,744,000 bushels) and 134,145 tons of barley (6,170,000 bushels), a total of approximately 11,914,000 bushels.

Nitrates shipped from the west coast of South America to various ports in the United States and Europe amounted to 204,441 tons.

Coal, all moving to the Pacific, amounted to 151,745 tons. Of this quantity, 83,081 tons were shipped from the Atlantic seaboard of the United States and 68,664 tons from the United Kingdom.

Refined petroleum and other products amounted to 102,456 tons, of which 87,857 tons were shipped from the Atlantic seaboard of the United States to China, Japan, and Korea, and 14,599 tons were shipped from Talara, Peru, to Great Britain.

Shipments of lumber amounted to 56,078 tons. All but 600 tons (shipped from Gulfport to Panama City) were from the west coast of North America. Of the 55,478 tons shipped from the west coast all were shipped from ports of the United States except 6,891 tons from Nanaimo, British Columbia.

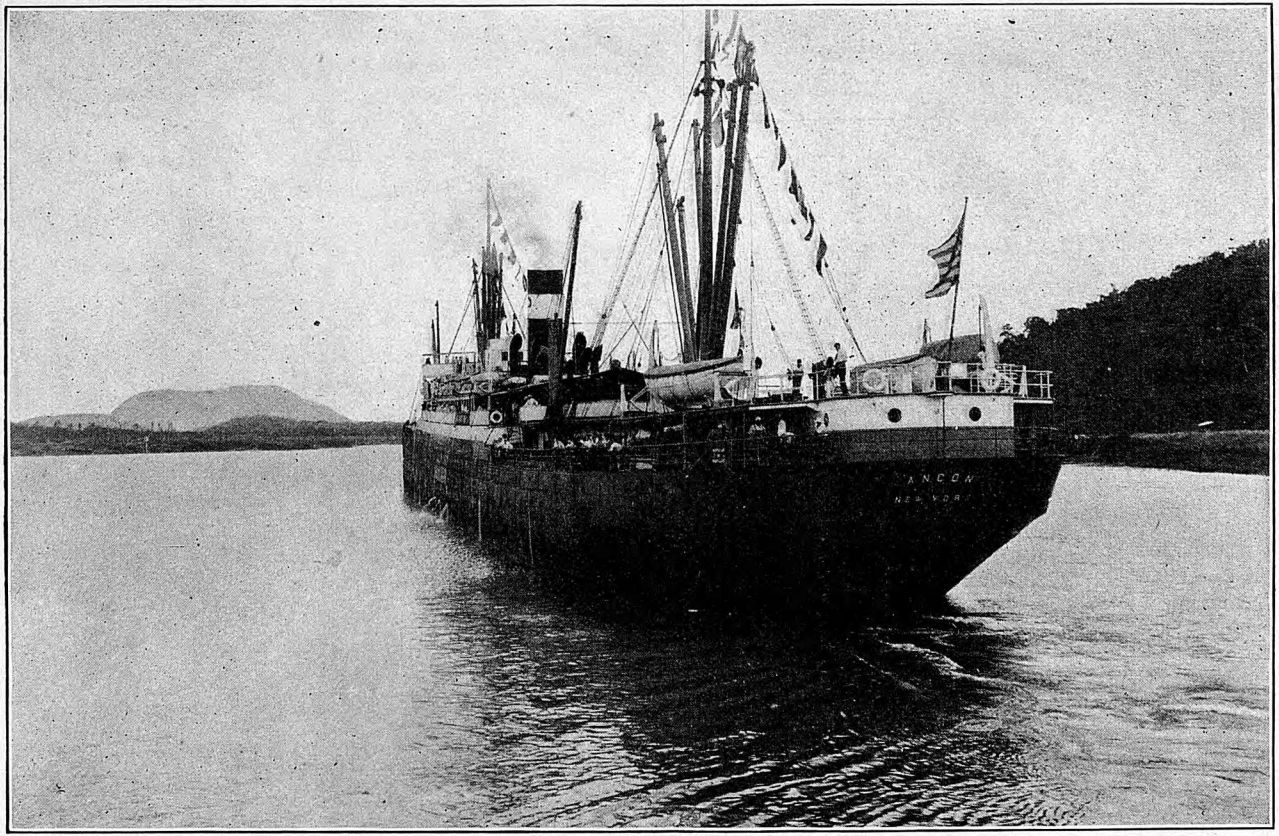
Raw cotton shipments amounted to 38,239 tons, en route from the Atlantic seaboard of the United States to the Far East. Over 70 per cent of the cotton passing through the canal was consigned to Japan.

The total cargo handled through the canal in its first half year was 2,367,244 tons. In the month and a half after February 15 nearly 1,000,000 tons more of cargo went through the canal, and the total up to April 1 was 3,246,019 tons. Its proportionate distribution over the principal routes is about the same, as shown in the following tabulation:

| | Vessels. | Tonnage. | Total tonnage. |
|---|---|---|---|
| United States coastwise, eastbound | 137 | 650,921 | |
| United States coastwise, westbound | 132 | 616,872 | 1,267,793 |
| North Pacific coast to Europe | 83 | 620,988 | |
| Europe to North Pacific coast | 21 | 68,043 | 689,031 |
| South and Central America to United States and Europe | 103 | 593,812 | |
| United States and Europe to South and Central America | 53 | 190,330 | 784,142 |
| Atlantic coast to Far East | 62 | 373,097 | |
| Far East to Atlantic coast | 6 | 45,100 | 418,197 |
| Miscellaneous routings | 16 | ..... | 86,856 |
| Vessels without cargo | 56 | ..... | ..... |
| Grand total | 679 | ..... | 3,246,019 |

Up to April 1, 1915, the canal had been in operation seven and a half months. Through that period the movement of cargo averaged 432,802 tons a month, which is at the rate of over 5,000,000 tons a year.

An expression of this quantity in terms of railway traffic is illuminating. During the fiscal year ending June 30, 1914, the Panama Railroad handled 643,178 tons of through freight between the seaboards of the Isthmus. During that year the railroad was supposed to be handling more freight per mile of track than any other railroad in the world. It will be noted that the through traffic of the Panama Railroad that year was within 9,000 tons of the amount carried through the canal during the month of March, 1915 (which was 635,057 tons); in other words, that the canal has handled in a month almost as much as the railroad did during a year.

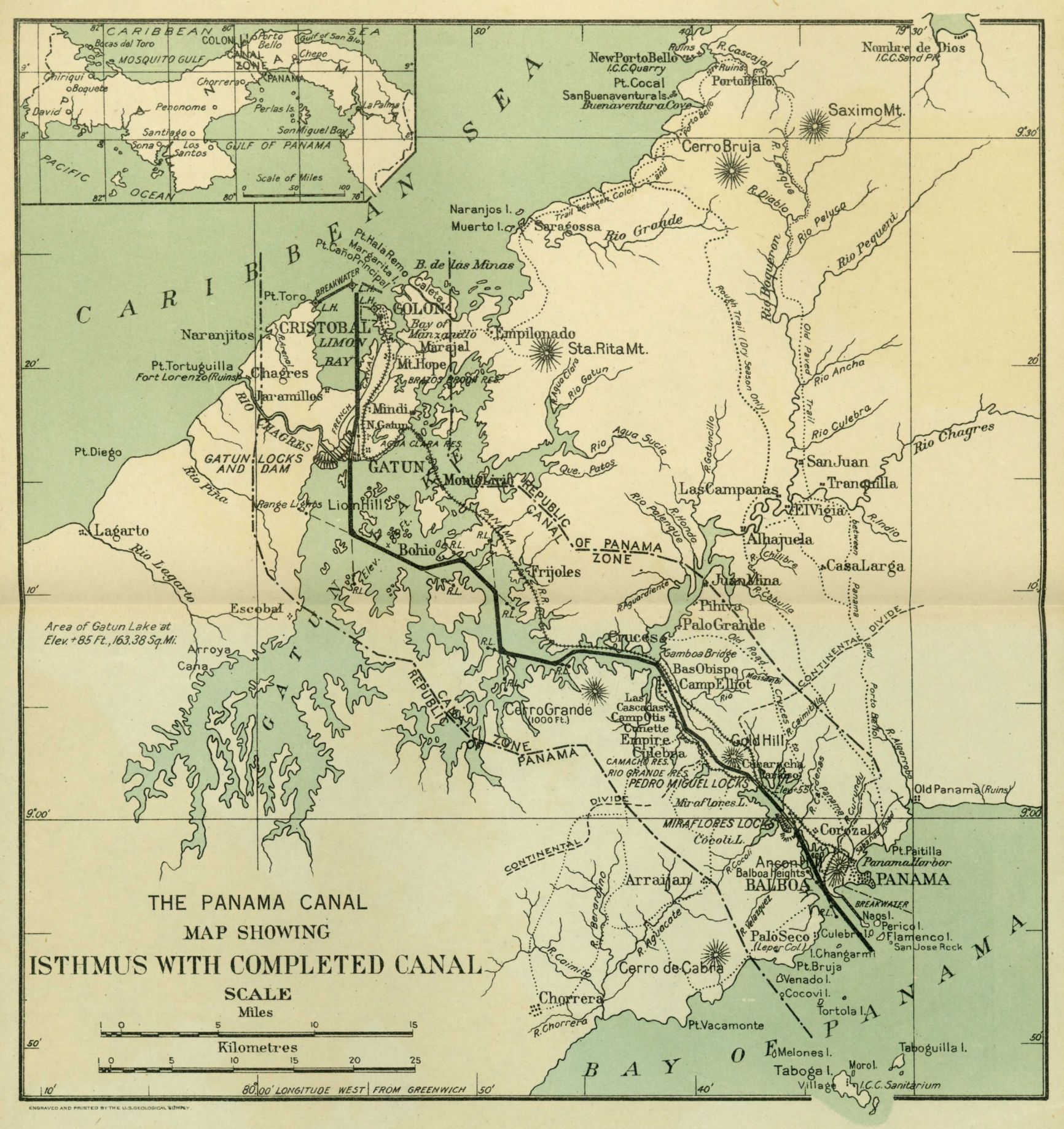



OPENING OF THE PANAMA CANAL. S. S. ANCON IN SEA-LEVEL SECTION OF CANAL SOUTH OF MIRAFLORES LOCKS, AUGUST 15, 1914.

The trains of the Panama Railroad engaged in hauling through freight were made up of from 18 to 20 loaded cars, carrying in the aggregate about 350 tons. To handle 5,000,000 tons of cargo across the Isthmus in a year by rail would require the operation of 39 trains a day. It would mean dispatching a train each way every hour and a quarter, and trains passing a given point about every 40 minutes through every hour of the year. The 14,285 trains necessary for handling this traffic would have, at 800 feet each, an aggregate length of over 2,142 miles, greater than the distance from New York to Colon. In a single train the cars would reach from New York to Chicago and back, or from New York to Chicago and then down to New Orleans, and leave several hundred miles of train to spare.

During the month of March, 1915, the laden vessels going through the canal had an average of 5,040 tons of cargo. Thus the vessels contained, on an average, over 14 trainloads of goods each.

The locomotives and trains of the Panama Railroad are about the average in freight work. A comparison in the maximum terms of railway traffic is afforded by the trial trip made last year by what was called the world's largest locomotive, the "Matt H. Shay," of the Erie Railroad. This was termed "three engines in one," and on its trial trip handled a train of 55 cars of coal, said to have been the heaviest train ever hauled from Baltimore to Philadelphia by one locomotive. This train carried 4,012 tons, which is less than the average load on each ship going through the canal.

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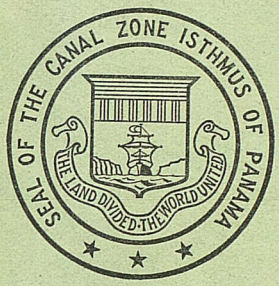
SEAL OF THE CANAL ZONE ISTHMUS OF PANAMA
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