$2,907; at $191.59 per day in 1903, $2,299.08; for the 2,104-ton steamer the tolls would be $2,104, the saving in the first period would be $3,446.40, in the second period, $2,331. In all cases a considerable cash balance in favor of the canal. Had the voyages been shortened but ten days, there would have been a slight cash loss for both steamers at the period of cheaper rates.

The canal route, however, has advantages not shown in the balance struck between tolls paid and time saved. Insurance rates will be much lower for the safer northern route, and the quicker voyage would usually command a higher freight rate than a longer one, for, in most branches of commerce, time is money. In times of high prosperity the profits of $25, $50, $100 or more per day would very materially affect the use of the canal; every dollar of clear profit per day must be added to the canal credit side of the balance. On the other hand, the loss that the ship charterer may sustain does not enter into the balance, because the balance is based on operating expenses. If these losses bring about reduction in charter rates, they then affect the operating expenses of the charterer and influence his decision concerning use of the canal. The balancing of expenses may in times of exceptional depression occasionally omit the element of freight earnings. If the vessel is not on time charter, but is managed by her owner on the single voyage basis, she might have no freight, and none engaged, and be sent to Chile in ballast or in coal cargo in the hope that return freight could be secured later. Such a voyage would be undertaken as the only alternative to lying idle, and might be succeeded by a period of absolute idleness in a South American port. The owner would calculate the cost of that voyage on the basis of actual cash outlay—coal, crew, stores, insurance, etc., omitting interest and earnings, and would decide about the use of the canal accordingly, and probably to the disadvantage of the total canal traffic. Such voyages would rarely occur.

With regard to the Chilean trade under normal circum-
stances, it is evident that the 2,800 miles saved from the nitrate ports to Europe, and the 2,900 miles saved from Coronel to New York, are a sufficient guarantee that the trade between the cities named would use the canal if it were now in operation. The trade between Europe, Valparaiso and Coronel has far less promise of aid from the canal. The distance, time and cash savings above cited for the voyage to Iquique must be divided by two for Valparaiso and by four for Coronel. In both cases the balance goes so strongly against the canal route that full-loaded vessels to or from Valparaiso would probably not use the canal, and it appears that a canal toll of $1.00 per ton would be entirely prohibitive for vessels bound to or from Coronel. Even this fact will not prevent some of the trade of the region around Coronel passing through the canal. It is true that a full loaded steamer going to or from Coronel would in all probability follow the Magellan route, but the trade of the agricultural district, in which Coronel is situated, is not usually carried in full cargoes. It consists of miscellaneous imports of manufactures and varied exports of general produce well suited to the lines of steamers that skirt the coast. These lines load and unload at many ports, and of the export cargo from 50 to 80 per cent. is almost invariably composed of nitrate of soda. The nitrate fields are a magnet attracting all vessels that come to Chile, and they would continue to be so if the canal were in operation, with the probable result that the European liners bound for the south of Chile would pass once along the coast, entering or leaving the Pacific by the Panama Canal and the Straits of Magellan. Whether they entered the Pacific by the Canal and sailed south, or whether they followed the reverse order, would depend upon the relative importance of speed in the delivery of Chilean imports or exports. The result upon routes would be the same—approximately one-half of the tonnage passing between southern Chile and Europe using the canal.

The Panama Canal will have very slight influence upon the trade of eastern South America. There is no regular
Effects of Panama Canal Upon Trade Routes.

present or prospective trade between the Atlantic and Pacific sides of South and Central America. The basis for trade does not exist because the wants of the people and the natural products are the same. There must be difference in production before there is reason for exchange of goods. The possibility of trade between the Pacific states of the United States and the tropic Atlantic countries is largely cut off by the proximity of Chile and the Argentine Republic, both capable of supplying grain, fruit and other temperate zone produce. The only economic want of the Atlantic side of South America that is being supplied, or is likely to be supplied from the Pacific is the demand for soft wood lumber from California and Washington. This commodity is shipped in full cargoes to the River Plate ports and Brazil, and there is likely to be a steady demand for it on the entire east coast. Owing to the eastward projection of the coast of Brazil, there is no economy in using the canal in a voyage from San Francisco or Puget Sound to any port of the east coast below Rio Janeiro. In reaching the Brazilian and other ports to the northward, the canal will be used, but the trade is likely to be only an occasional one.

All tropic America imports temperate zone flour or wheat, or both, and the opening of the Panama Canal may give to the Pacific wheat growers a monopoly of the Caribbean flour markets. The world's wheat price is fixed by the European demand, and the price in any port is likely to be the Liverpool or London price minus the freight rate to those ports. Wheat is higher in New York than in Buenos Ayres, and higher there than in Valparaiso, while the Valparaiso price is higher than that of San Francisco or Portland. The wheat price declines as the stations on the South American trunk route are more widely separated from the central price-setting market. Accordingly, when the South American crops have failed, it was not New York, but California that supplied Brazil with wheat, because the Californian must usually pass directly by the Brazilian ports en route to market in Europe. For the same reasons California
flour is now shipped across the Isthmus of Panama by rail and reshipped to Port Limon on the Caribbean for distribution in Costa Rica. Flour is as cheap, or is cheaper, at Panama than at New Orleans or New York. The opening of the canal will increase the advantages of California and Chile as wheat and flour purveyors to all the Caribbean ports. The canal is the gateway through which these grain producing countries will reach the great world market on the Atlantic, and the Caribbean and West Indian ports are directly upon the route.

The opening of the isthmic canal will work changes in the Mediterranean-Asiatic trunk route, second only in extent to those to be experienced by the South American trunk. The traffic lost to the Suez Canal and to the Mediterranean-Asiatic route will be gained by the Panama Canal and the American-Oriental route. To one accustomed to the Mercator's projection maps it may appear strange that the route from the American isthmus to Asia should be the Pacific Coast-Oriental, the same as that from the Pacific Coast of the United States, but, practically, such is the case. This route will be merely extended to the isthmus. The direct or great circle route to Shanghai follows the coast of Mexico as far as southern California, and then crosses to Japan close to the track followed by San Francisco steamers. This route is fourteen hundred miles shorter than the southern route to Shanghai, via Guam and Manila, and has the advantage of passing near the ports of Japan and the United States with their harbors and freight and coal. The shortest route passes directly by Yokohama and so close to San Francisco that a call can be made at that port by an additional one hundred and fourteen miles, but it requires a deviation of three hundred and sixty-six miles to make a stop at Hawaii. It is, therefore, safe to say that San Francisco will be an important port of call on this route, and that the shipping diverted by the Panama Canal from the Mediterranean-Asiatic route will be transferred to the Pacific Coast-Oriental.
Effects of Panama Canal Upon Trade Routes.

In considering the effect of an isthmian canal upon the South American route, the improved waterway was in competition with the free and open sea route, and the question was one of determining the balance between tolls and distance. The question is a different one with the Mediterranean-Asiatic route, because it involves balancing the advantages of two canals which will probably have different rates of toll.

The consideration of the probable effects of the Panama Canal upon the trade routes of Asia involves, as it did in the case of South America, the pointing out of geographic limits of the canal's influence upon the trade of the United States and of northwestern Europe.

With the trade from the American side of the Atlantic it is evident from the distances saved that the trade of Japan and North China belongs exclusively to the American route, and that of Burmah, India and other points west of Singapore belongs as exclusively to the Suez Canal. Somewhere between these regions is the trade divide.

The distance divide is very close to Manila, the distances being as follows: New York to Manila, via Panama, San Francisco and Yokohama, 11,585 miles; via Suez, Colombo and Singapore, 11,601 miles; via Panama, Honolulu and Guam, 11,642 miles. It is evident that, other things being equal, the navigator would have small choice between the Suez and Panama routes to Manila. But other things are not equal, and it is upon the comparative merits of the other elements that the choice of the route depends.

The first and greatest element of difference will probably be the rate of toll at the two canals. The Suez rate is 8.50 francs per ton, Danube measurement, which amounts to approximately $2.00 per ton net register, English or American measurement. This rate is not likely to be reduced, nor is the American canal charge likely to exceed $1.00 per ton. This difference of $1.00 per ton was found in the case of South American trade to be the equivalent of 2,000 miles or more of steaming.
The American route has a further advantage in the greater amount of freight that may be delivered or collected en route. By comparatively short extensions of the journey, such as line steamers continually find it profitable to make, stops can be made at Hong Kong, Shanghai and Honolulu, while San Francisco and Yokohama are bound to be upon the route if present practice be any guide to predictions of future action. It is possible that a Mexican port may be added to this list, as Acapulco lies directly on the route, and Mazatlan is but a short distance to one side. This succession of ports on the Pacific Coast-Oriental route offers greater commercial advantages than are to be found in going by Suez, where Singapore is the only freight port of the first rank, Colombo being decidedly in the second rank and Aden, beside the deserts, is of still less importance.

The route by the American isthmus will probably have the more favorable coal supply. In crossing the North Pacific there is a long gap between coaling stations, but, on the whole, coal is likely to be cheaper upon the American route. The first station of importance promises to be at the canal, within the reach of barges from New Orleans or Mobile. This cheap form of transportation for coal which is cheaper to start with than the European, will give cheaper coal at the Panama Canal than in the Mediterranean. The Isthmus of Panama is on the route to western South America, the only part of the world from which we import a greater bulk of merchandise than we export. Hence, American coal with the possibility of going out as ballast cargo will be cheap on the isthmus. The increasing coal output of Washington State and British Columbia, furnishes another supply near the route to Asia. At Yokohama Japanese coal is to be had cheaper than the same coal at Singapore, where it is the main dependence of the steamers via Suez. The coal supply of the new route is likely to be further improved by the opening up of the almost limitless coal fields of China.

The greater safety of the Pacific route will secure for steamers following it a somewhat more favorable insurance
Effects of Panama Canal Upon Trade Routes.

rate. The typhoons of the Chinese Seas, the narrow and rocky passages of the Red Sea and the storms of the Atlantic are dangers which the insurance companies can and do estimate in cash, and which the steamers coming to and from New York by the Panama route will largely avoid.

Of the two canal routes from New York to the Orient, that by Panama promises to have the four advantages of cheaper tolls, more way freight, cheaper coal and less insurance. The combined effect will be the removal of the trade divide between the two routes a considerable distance to the westward of the distance divide. It cannot be stated with accuracy how far beyond Manila it will be, but under present conditions for full loaded vessels, it would, in all probability, be between one thousand and two thousand miles. The Panama Canal would certainly have all the Atlantic-American trade with Japan, China, the Philippines and French Indo-China, and probably a large part of that from Singapore, which lies well within the 2,000-mile limit. It is probable that Singapore would become a terminal point for lines coming from both directions, or again it is possible that vessels might come by one route and return by the other. These occurrences are the more likely because of the prominence of steamer lines rather than chartered vessels in the trade of the Orient. The line steamer, in order to balance a voyage and complete a freight service, or keep out competitors, may extend its itinerary to points that a chartered steamer, coming from the same port, would reach by a different route. For example, there are lines of steamers passing from Europe down the east coast of Africa from Aden, and others going up the coast from Cape Town. The services of these lines overlap by about 1,800 miles. Other lines entirely circumnavigate the African continent, and some vessels go one way and some the other. In the same way the completion of the Panama Canal will open a round-the-world route, whereby steamers from New York may skirt the coasts of Asia in both directions, and lines may overlap along southeastern Asia, giving Singapore and ports
to the east a double service to the Atlantic ports of the United States.

For the commerce between Europe and eastern Asia the Panama Canal offers no advantage of distance. The American route has a handicap of nearly a thousand miles from Liverpool to Yokohama and three thousand to Shanghai. From the Mediterranean ports of southern Europe these distances should be increased by three or four thousand miles. Will the commerce of northwestern Europe with eastern Asia be able to utilize the Panama Canal? Under the toll conditions outlined above, it probably will to some extent. The ordinary tramp steamer, passing between Liverpool and Yokohama, could profitably expend four to six days in going the extra nine hundred and thirty-six miles of the American route if she saved her owners thereby one-half of the present Suez Canal tolls. Line steamers would also be very likely to use the same route on the return voyage to Europe. It is the custom for liners going out from Europe to China to end the voyage at Yokohama. But once in Yokohama, the most economical route for the return is by way of America. The steamers could discharge and receive cargo at Hong Kong and Shanghai, and continue from Yokohama to San Francisco. The freight conditions in this part of the world would favor this practice because the trade from China and Japan toward Europe is much lighter than that going the other way. The steamers at Yokohama are, therefore, in straits for freight, and it would be natural for them to seek the abundant freights of California, and thus adopt the practice that is being, and has long been, followed by many sailing vessels that have discharged cargoes in the ports of East Asia. This prediction is further strengthened by the recent establishment of a line of steamers running from England to China and Japan, and then for the sake of a return cargo going on to Portland, Ore., securing nearly a full cargo of wheat, returning thence to Asia, where such other cargo as may be secured is added, and the whole carried westward through the Suez Canal to
Effects of Panama Canal Upon Trade Routes.

Europe. With the Panama Canal in operation it is scarcely possible that these steamers would return to England by the longer Asiatic route. If the Suez Canal tolls should be as low as those at Panama (which is very unlikely) the use of the American route by regular lines from Japan to Europe, would be probable, because the temptation of Pacific Coast freight would continue strong and would certainly, as at present, draw many tramp vessels across the North Pacific.

A natural factor of some importance in the consideration of this round-the-world route is the prevailing westerly winds, which, even to steamers, are an aid in going from west to east, and a drawback in going from east to west. The steamer going from Europe to Japan by Suez and returning by Panama, would be aided over a large part of the distance by the prevailing world winds.

The routes of Australasian trade will be materially changed by the opening of the Panama Canal. There will be a new steamer route worthy to be classed with the world's trunk routes: the Australasian trunk, connecting Australia, New Zealand and the Isthmus of Panama. This new route will draw commerce from four of the existing trunk routes, but none of these will be entirely replaced. The heaviest loser will be the South African trunk route; the Mediterranean-Asiatic route may lose some of the traffic now passing to Australia via the Red Sea; other contributors to the new route will be the American Pacific Coast-Australasian and possibly the New Zealand-Cape Horn branch of the South American trunk route.

Australasian trade is predominantly with Europe, but the trade between the eastern United States and Australasia should, in this connexion, be considered first, because of the greater saving of distance to be affected by the Panama Canal. At present, this carrying trade appears to be in a stage of gradual transition from sailing vessels to steamers. All vessels of both types to both Australia and New Zealand go out by the South African route via Good Hope. With the Panama Canal in operation, two routes are offered across
the Pacific: one from Panama to Sydney, via Tahiti and Society Islands; the other via Wellington, on the straits separating the Isles of New Zealand. The first route is divided into nearly equal parts by the call at Tahiti. This is an advantage in coaling, but coal is bound to be high at such a place, and the route is four hundred and five miles longer than the one by Wellington, which will have cheaper coal and a safer route for navigation. Judged by these general considerations, and by the coaling practice of the steamers on the Good Hope route, it is improbable that the Tahiti route will be used by Australasian steamers going to and from the canal. This discussion is, therefore, based on the supposition that all Australasian steamers follow the direct route from Panama to Wellington. The saving of distance to a steamer using the Panama Canal rather than the present Good Hope route, will be from New York to Wellington, 5,800 miles; to Sydney, 3,800 miles; and to Melbourne and Adelaide, via Wellington, 3,000 and 2,000 miles respectively; from New Orleans the saving is about 1,500 miles greater. These reductions of distance are in competition with a safe, free and open sea route. Will the canal be used?

The answer to this question cannot be wholly reached by an analysis of the distances to single ports. That method is only measurably correct for the tramp vessel in- or out-bound with full cargo, because the coal supply of Sydney causes that port to be visited by almost every steamer that goes to Australia. But the trade of Australia is not very largely a tramp vessel trade, nor does it promise to become so. It is chiefly a line traffic, and is becoming more so with the increase in the use of steamers. Excepting one or two small lines, the vessels to southeastern Australia all go to the three ports of Adelaide, Melbourne and Sydney. The effect of the canal upon these liners is to be understood by consid-

6A direct voyage from Panama to Sydney is of about the same length whether going to the north of New Zealand or through the straits between the main islands
erating the three ports, not as isolated units, but as links in a chain and we must consider the chain in its entirety. The steamer visits all of the ports, and, as she begins at one or the other of the ends of the chain, we must measure distance from the end ports in the chain. By way of Panama, Sydney, the easternmost of the three leading ports is 3,761 miles nearer New York than Adelaide, the westernmost port, is via the Cape of Good Hope. This distance advantage is somewhat magnified by the greater importance of Sydney and its trade, and the desirability of reaching it with cargo as soon as possible. When the voyage is completed at Adelaide, the steamer can return to New York via Melbourne and Wellington with a saving of over 2,000 miles from Adelaide. This saving of 2,000 miles from Adelaide is somewhat under the margin of cash saving necessary for canal use as shown in the analysis of South American trade, but the return ports offer good freight and the coal supply at Sydney is an attraction that draws nearly all steamers visiting Australia. There will be another advantage in the probable cheapness of coal at the Panama coaling station. The winds and currents of the Good Hope route are very unfavorable to returning vessels, and the high value of Australian import and export cargo gives a high value to the time element. Summing up the situation it seems reasonably certain that the trade of the eastern United States with Adelaide and Australasian points lying to the eastward, would go and come by the New Australasian trunk route and the Panama Canal if that waterway were now in operation. If present conditions continue it would be a common occurrence for vessels to return to the Eastern States via the Suez canal with East Indian cargoes, because Australia imports greater bulk of American goods than she pays for in kind, and vessels seek cargo in other countries.

The canal will not offer such advantages for the Australasian trade with Europe. At present the greater part of it uses the South African trunk route, and from New Zealand the return trip is commonly made by the Straits of Magellan,
thus completing a round-the-world voyage. The Suez route gives a saving of less than 1,000 miles from European ports, and it is used only by lines carrying mail or passengers. The Panama route from Liverpool to Wellington is 1,676 miles shorter than the Suez route, and 641 miles shorter than the Magellan route, but to Australian ports it is longer than the Suez; by 2,118 miles to Adelaide, 1,102 miles to Melbourne and 319 miles to Sydney. It is evident that there is no reason for European line steamers going out to Australia by the Panama route. The situation assumes a different aspect when Sydney has been reached and the return is in order. It is desired that the ship with her valuable cargo, passengers and mail reach Britain as quickly as possible. In comparison with Suez, the Panama route has the handicap of 300 miles, less than 3 per cent. of the total distance; it has the advantage of offering more passengers and mail at Wellington, good coal there and at Panama, favorable winds in the South Pacific and North Atlantic and probably a gain of $1.00 per ton register in canal tolls—advantages enough to enable the shipowner to use the route with no loss of time and some gain in money.

During the year 1903 the average voyage for the eight White Star liners plying between New York and Liverpool averaged 5.14 per cent. longer in time going west than east. Expert navigators say that there are so many elements of difference between the east and west voyages that this percentage cannot be cited as a measure of the influence of wind and currents. It is, however, suggestive of some such influence.

The present fast mail route from Sydney to Great Britain is not via Suez, but by fast steamers to San Francisco and Vancouver, express trains to New York and from New York to Queenstown by the trans-Atlantic liners. The competition between this route and the Panama route raises an interesting speculation. The route via San Francisco is longer, but has the advantage of the American train service and the fastest steamers in the world. The Panama route
is nearly 2,000 miles shorter, but cannot afford the fastest of steamers.

The mails from Melbourne, Adelaide and West Australia could not go by the Panama route without considerable loss of time, so the possible adoption of a Sydney mail via Wellington and Panama would not prevent the Melbourne and West Australian mail following the Suez route as at present.

There is no likelihood of the canal route (with tolls at $1.00 per ton) diverting to itself any of the Australian-European freight that goes by Good Hope, for at best the saving is considerably less than 1,000 miles. There is less possibility of attracting the New Zealand freighters that go by Magellan.

The Pacific Coast-Australasian trunk will have its traffic diminished by the diversion to the new Australasian trunk of practically all of the freight that originates in the Mississippi Valley, and is exported through San Francisco. Under the new conditions some Atlantic or Gulf port will surely have this traffic, which is even now of inconsiderable dimensions owing to the competition of the New York steamers.

THE EFFECT OF THE PANAMA CANAL UPON THE MARINE COAL SUPPLY.

The new canal will bring about some changes in the coal supply and the relative importance of coaling stations, but its effects will be much less pronounced in this field than in the routes of trade.

The chief change in the coal supply will be in the enlargement of the field for American coal. The Pacific will be tapped, and as our eastern states now supply the Caribbean, so they will then supply northern South America, western Mexico and possibly California to some extent. The latter region has many champions who maintain that the Puget Sound district has coal that will satisfy in both quantity and quality the demands of the Pacific coast of the United States. An Atlantic coal supply for the Pacific ports within 2,000 miles of Panama is made the more probable by our relatively
heavy imports from that region, and by the feasibility of shipping coal in barges as it is now shipped along the Atlantic Coast from the Delaware and Chesapeake to New England.

Individual coaling stations will, in the main, be affected by the canal only as the different routes are increased or decreased in importance. There will be a few exceptions to this. One of the greatest coaling stations in the world will arise at Colon or Panama, the termini of the canal. It is also possible that a station will be established somewhere on the western coast of Mexico to break the journey to San Francisco. Acapulco and Magdalena Bay are suitable harbors. The latter is a magnificent, but almost unused harbor on the coast of lower California. The freedom of this shore from fogs and storms makes easier the use of coaling stations along the coast. Both of these harbors are immediately upon the route of steamers bound from the canal to San Francisco or the Orient, and the nearness to the mineral and agricultural regions of western Mexico gives promise of return freight for vessels carrying out coal. The canal will probably cause the establishment of a coaling station of secondary importance at Tahiti. As pointed out above, it is not likely to be regularly used by the Australasian steamers, but it will be by some engaged in the Polynesian trade, and by Australasian steamers in cases of emergency.

THE CANAL AND THE WORLD'S SAILING ROUTES.

The Panama Canal will divert steamer traffic from one steamer route to another, and will create new routes for some of the diverted traffic. The existing sailing routes will also lose a share of their traffic, but it will probably be transferred to steamers and steamer routes, rather than to new sailing routes, passing through the canal. Two main reasons lead to this conclusion. The first is the general decline of sailing vessels in the world's trade, combined with the superiority of steamers in short rather than long routes. The canal will substitute short for long
Effects of Panama Canal Upon Trade Routes.

routes. For a comparison of the two types of vessels see the chapter on that subject. The second reason is the peculiar disadvantage of the Pacific Ocean near Panama for sailing vessels.

It should be remembered in this connection that the Suez Canal is not used at all by sailing vessels. The narrow, rocky and calm seas of the Suez route are not duplicated about the Panama route, but the handicaps to sailing vessels are great enough to render unlikely their successful competition with steamers passing through the canal. The Pacific Ocean south and west of the isthmus is a calm sea, and the sailor must have wind. The equatorial zone of calms reaches nearly to Panama, and the trade winds which should blow from the northeast are cut off by the isthmus; but the land is not wide enough to set up an extended land and sea breeze or monsoon wind action. Consequently a large area of the Pacific, including the Bay of Panama is so ill supplied with winds as to be a great drawback to the use of the canal route by sailing vessels (see Chapter IV). They can, with proper towing through the canal, make successful use of the waterway, but will it be profitable and become a factor in international trade? It may to a limited extent, and for a limited time after the canal is opened, but it is the prevailing opinion of hydrographers, sailing masters and ship brokers that the Panama Canal will not be practicable for the use of sailing vessels. In the opinion of the Isthmian Canal Commission also, sailing vessels will play a very limited rôle in the canal traffic. Sailing routes will remain practically as they are, and will have a decreased traffic as a result of the advantage that steamers will derive from the new waterway.
CHAPTER IX.

THE COMPETITION OF THE STEAMER WITH THE SAILING VESSEL IN THE WORLD'S CARRYING TRADE.

In the shipping world a revolution in motive power is in progress and nearing its close. After an undisturbed supremacy of more than a thousand years the sailing vessel is being displaced upon all oceans by the steamer. It is a competition between low costs and low efficiency, and high costs and high efficiency, and high efficiency is winning.

The sailing vessel has free power, cheap construction, a minimum of motor machinery, a maximum of storage space and a small crew. But the free power is uncertain, slow and sometimes fails entirely.

The steamer is more expensive to build and her machinery and coal bunkers occupy about one-third of her capacity in comparison to the 5 per cent. lost space in the sailing vessel. Her repairs and coal are expensive, the crew three-eighths larger in proportion than in the sailing vessel, but she is faster and much more dependable and efficient. "The ratio of four to one being the present measure of the efficiency of steam tonnage compared with sail tonnage." 7

That both types of vessel have been improved is shown by the declining number of men in their crews. For British vessels engaged in the foreign trade the number of crew per 100 tons net register has been as follows:

<table>
<thead>
<tr>
<th></th>
<th>1880</th>
<th>1890</th>
<th>1898</th>
<th>1901</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sailing Vessel</td>
<td>2.32</td>
<td>1.96</td>
<td>1.65</td>
<td>1.61</td>
</tr>
<tr>
<td>Steamer</td>
<td>2.95</td>
<td>2.73</td>
<td>2.32</td>
<td>2.22</td>
</tr>
</tbody>
</table>

The steamer, depending so much upon machinery, has a greater field for improvement. A steamer built in the mid-

Competition of Steam with Sailing Vessels.

By the middle of the nineteenth century and broken up in 1899 was found to have engines that weighed seventeen times as much per horse-power as the best type then being put into new vessels. This mechanical perfection is illustrated in the new American steamers that have been built to replace the sailing vessel line from New York to San Francisco. Some of these vessels can carry 10,000 tons dead weight of freight and 2,500 tons of coal. If the Panama Canal were open it is expected that they would make the 5,000-mile voyage from New York to San Francisco at nine knots per hour with 1,000 tons of coal, or one ton of coal for ten tons of freight. With coal at $3.00 per ton, the coal cost of a ton of freight carried 5,000 miles would be 30 cents. Small wonder that the manager of these steamers exclaimed, when comparing them to sailers, “Oh, the coal is a bagatelle.”

The progress and the effect of these improvements is reflected in the statistics of tonnage in the world’s mercantile marine. Table 1 shows that during a twenty-five year period, from 1874 to 1899, the steam tonnage of all countries increased enormously, the average for the world being 336 per cent., more than 100 per cent. per decade. During the same period (see Table 2) when steam had increased so rapidly the sail tonnage declined relatively and absolutely. The percentage of decline was 40 in the twenty-five years, and Norway was the only country that held its own. In the five years since the close of that period Norway’s sail tonnage has declined one-third.

Table No. 3 shows that the greater part of the decline in sailing vessels has occurred since 1890. At that date sailers outranked steamers by nearly a million tons. In 1903 the proportions were nearly 3 to 1. 16.8 millions to 6.4 million tons, or, of the total merchant shipping afloat but 27.7 per cent. was propelled by sail. From the standpoint of work done, it appears, by using the above given rule of efficiency, four tons of sail equal one of steam, that sailing vessels are now doing but 8.8 per cent. of the world’s ocean carrying.
### TABLE I.—SEAGOING STEAM TONNAGE OF THE WORLD.

<table>
<thead>
<tr>
<th>COUNTRIES</th>
<th>1873-74</th>
<th>Per Cent.</th>
<th>1878-79</th>
<th>Per Cent.</th>
<th>1888-89</th>
<th>Per Cent.</th>
<th>1898-99</th>
<th>Per Cent.</th>
<th>Increase 1873-74 to 1898-99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Britain</td>
<td>2,624,431</td>
<td>60.4</td>
<td>3,465,187</td>
<td>62.4</td>
<td>6,873,552</td>
<td>62.3</td>
<td>10,903,111</td>
<td>58.5</td>
<td>311%</td>
</tr>
<tr>
<td>United States</td>
<td>483,040</td>
<td>11.2</td>
<td>609,101</td>
<td>10.8</td>
<td>535,345</td>
<td>4.8</td>
<td>810,800</td>
<td>4.2</td>
<td>68</td>
</tr>
<tr>
<td>France</td>
<td>310,765</td>
<td>7.4</td>
<td>335,219</td>
<td>5.9</td>
<td>752,028</td>
<td>6.8</td>
<td>952,692</td>
<td>5.1</td>
<td>200</td>
</tr>
<tr>
<td>Germany</td>
<td>204,894</td>
<td>4.8</td>
<td>253,667</td>
<td>4.5</td>
<td>602,331</td>
<td>5.0</td>
<td>1,625,571</td>
<td>8.3</td>
<td>603</td>
</tr>
<tr>
<td>Spain</td>
<td>138,675</td>
<td>3.3</td>
<td>152,708</td>
<td>2.7</td>
<td>305,685</td>
<td>3.5</td>
<td>520,847</td>
<td>2.7</td>
<td>275</td>
</tr>
<tr>
<td>Italy</td>
<td>85,045</td>
<td>1.9</td>
<td>94,421</td>
<td>1.5</td>
<td>276,126</td>
<td>2.5</td>
<td>420,880</td>
<td>2.2</td>
<td>305</td>
</tr>
<tr>
<td>Holland</td>
<td>72,753</td>
<td>1.7</td>
<td>116,144</td>
<td>2.1</td>
<td>197,748</td>
<td>1.8</td>
<td>361,200</td>
<td>1.9</td>
<td>309</td>
</tr>
<tr>
<td>Russia</td>
<td>67,522</td>
<td>1.6</td>
<td>104,702</td>
<td>1.8</td>
<td>163,556</td>
<td>1.5</td>
<td>358,415</td>
<td>1.8</td>
<td>430</td>
</tr>
<tr>
<td>Norway</td>
<td>41,902</td>
<td>0.9</td>
<td>33,331</td>
<td>0.9</td>
<td>160,568</td>
<td>1.4</td>
<td>628,493</td>
<td>3.3</td>
<td>1,410</td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>115,088</td>
<td>1.0</td>
<td>439,509</td>
<td>2.3</td>
<td>394</td>
</tr>
<tr>
<td>All Others</td>
<td>293,466</td>
<td>6.8</td>
<td>420,690</td>
<td>7.5</td>
<td>913,720</td>
<td>8.3</td>
<td>1,773,674</td>
<td>9.5</td>
<td>594</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4,328,193</td>
<td>100.0</td>
<td>5,595,175</td>
<td>100.0</td>
<td>11,045,937</td>
<td>100.0</td>
<td>18,887,132</td>
<td>100.0</td>
<td>336</td>
</tr>
</tbody>
</table>
Competition of Steam with Sailing Vessels.

TABLE 2.—Seagoing Sail Tonnage of the World.

<table>
<thead>
<tr>
<th>COUNTRIES</th>
<th>1873-74</th>
<th>1878-79</th>
<th>1888-89</th>
<th>1898-99</th>
<th>Percentage of Decrease from 1874 to 1899.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Britain</td>
<td>5,320,089</td>
<td>5,556,018</td>
<td>4,215,634</td>
<td>2,070,555</td>
<td>45</td>
</tr>
<tr>
<td>United States</td>
<td>2,132,838</td>
<td>2,075,832</td>
<td>1,913,090</td>
<td>1,285,859</td>
<td>40</td>
</tr>
<tr>
<td>Norway</td>
<td>1,137,177</td>
<td>1,374,824</td>
<td>1,328,206</td>
<td>1,144,482</td>
<td>.6</td>
</tr>
<tr>
<td>Italy</td>
<td>1,126,032</td>
<td>963,025</td>
<td>718,889</td>
<td>463,767</td>
<td>59</td>
</tr>
<tr>
<td>Germany</td>
<td>803,052</td>
<td>614,074</td>
<td>737,026</td>
<td>535,057</td>
<td>49</td>
</tr>
<tr>
<td>France</td>
<td>708,050</td>
<td>595,033</td>
<td>352,418</td>
<td>279,412</td>
<td>64</td>
</tr>
<tr>
<td>All Others</td>
<td>2,807,689</td>
<td>2,796,524</td>
<td>2,370,034</td>
<td>2,073,257</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>14,185,836</td>
<td>14,317,430</td>
<td>11,036,289</td>
<td>8,693,769</td>
<td>40</td>
</tr>
</tbody>
</table>

TABLE 3.—The World’s Merchant Marine.

[Recorded in Lloyds, 100 tons or over]

<table>
<thead>
<tr>
<th>YEAR</th>
<th>STEAM</th>
<th>SAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Net Tons</td>
</tr>
<tr>
<td>1890</td>
<td>11,108</td>
<td>8,295,514</td>
</tr>
<tr>
<td>1893</td>
<td>12,588</td>
<td>9,622,610</td>
</tr>
<tr>
<td>1894</td>
<td>12,907</td>
<td>10,111,769</td>
</tr>
<tr>
<td>1895</td>
<td>13,256</td>
<td>10,573,642</td>
</tr>
<tr>
<td>1896</td>
<td>13,652</td>
<td>11,027,603</td>
</tr>
<tr>
<td>1897</td>
<td>14,183</td>
<td>11,531,829</td>
</tr>
<tr>
<td>1898</td>
<td>14,701</td>
<td>12,073,974</td>
</tr>
<tr>
<td>1899</td>
<td>15,324</td>
<td>12,935,994</td>
</tr>
<tr>
<td>1900</td>
<td>15,868</td>
<td>13,856,513</td>
</tr>
<tr>
<td>1901</td>
<td>16,528</td>
<td>14,874,253</td>
</tr>
<tr>
<td>1902</td>
<td>17,156</td>
<td>16,026,372</td>
</tr>
<tr>
<td>1903</td>
<td>17,701</td>
<td>16,822,466</td>
</tr>
</tbody>
</table>

This decline has been general, not local; it has affected the shipping of all countries, the trade of all oceans and of almost all commodities.

The claim is often made that there are special commodities and particular routes that belong exclusively to the traffic of the sailing vessel. Conspicuous among commodities supposed to belong to the sailor are nitrate of soda from Chile, lumber in the American coasting trade and elsewhere, and wheat from San Francisco. Within the past decade the shipment of full cargoes of nitrate by steam has become common, and several lines of steamers regularly carry it as a
large part of their return cargo. Special steamers have been built to carry Carolina pine to New York and New England, and in 1901, 1902 and 1903 steamers carried many cargoes of Pacific Coast grain to Europe. It was, it is true, done at a loss, but such periods come rather frequently in the shipping industry. It is not being claimed here that the steamer promises immediately to replace the sailer in this trade, but it has already competed for full cargoes. Much more significant is the consolidation of all sailing lines between the two coasts of America, and the sale of these vessels and their replacement by high type steamers. Upon the opening of the Panama Canal the sailer will probably be entirely displaced in the Atlantic-Pacific trade by the apparently impossible task of competing around Cape Horn with a steamer passing through the canal, and saving more than half of the distance.

The route from New York to Australia was claimed by Lieutenant Maury, the great ocean expert of forty years ago, as the perpetual home and exclusive possession of the sailer. The route is long, the winds are fair and coaling stations for the rival steamers are scarce and expensive. In the year 1896 several lines added steamers to their service, and have maintained them for eight years and are shipping a large, if not the greater, part of the freight by them.

It appears from the statistics that there has been a pause in the downward course of sail tonnage. During the five years, 1899 to 1903, the total decline was not much greater than the annual decline from 1890 to 1899. This halt was due largely to the great boom of 1898 and 1899, which made every kind of vessel profitable in the extreme, and produced the greatest increase of steam shipping ever known. Interest has also been attracted by a new type of sailer, the six and seven-masted schooner, with steam sail hoisters and very small crew requirements. This improvement, however, should be set off against the oil-burning steamer, which is a corresponding improvement in the rival type, eliminating much labor, and which is being used much more extensively than the giant schooners.
The extinction of the commercial sailor is not predicted here. For a long period to come there will be some distinctly sailing vessel work, but further decline of tonnage seems evident. She cannot hold her paltry twelfth part. In 1902 the British steam tonnage increased 708,000 tons and the sail tonnage declined 65,000 tons. The traffic upon which the sailing vessel has the strongest hold is some irregular and spasmodic trade, both coasting and foreign, which cannot be organized and handled as line traffic. The beginning of a new trade may be the occasional departure of a sailing vessel. Such a trade is now arising between the Gulf ports of the United States and the La Plata ports. If it grows, a line of steamers will take it over and most of the sailors will be displaced, giving another reduction to sailing tonnage.

There are times when the sailing vessel is desired because the low speed and consequent long voyage enable the shipper to save storage expenses at one of the termini, but the competition of a seaworthy ship as a mere storage warehouse is not a strong foundation for continued prosperity.
CHAPTER X.

GOVERNMENT CONTROL OF SHIPPING.

In the chapter on ocean freight rates much emphasis was laid upon the freedom of the ship to go wherever her navigator wished, and the great and unrestrained freedom in making rates. From port to port the ship is practically free, but within the limits of a port all is changed. Few, if any, forms of commercial activity are so extensively regulated by law as the building, maintenance, loading, departure and arrival of shipping. This great care is needed because of the great risks to life and property, and the numerous interests at stake. Opposed to these is often the immediate pecuniary interest of the owner, who, safe on land, might be willing to jeopardize the lives and properties of others in a ship inadequately built, out of repair and undermanned; accordingly the lives of the passengers and crew are safeguarded by law as is the property of the freight shipper and the public health, which, by the movement of ships is constantly exposed to the dangers of imported diseases. Public revenue being in part derived from tariffs furnishes another motive for the control of the movements of shipping.

Shipping regulations fall naturally into three groups: (a) building regulations; (b) loading regulations; (c) regulations of departure and arrival.

(a) The building regulations are about as thorough as human ingenuity can make them to prevent dangers to life and property that may result from the desire for economy on the part of the carrier. The United States and foreign statutes cover a vast amount of technical detail, and in this country the enforcement of the law and the making of further necessary regulations are lodged in the hands of the Secretary of Commerce, who works through a board of expert inspectors. A few examples will serve to show the
nature of this supervision. The rivet holes in a marine engine boiler must be drilled, not punched, because drilled plates are stronger. Every piece of metal subject to a tensile strain must be inspected, and every boiler plate must be numbered and stamped by its maker, showing his name and the strength of the piece. Further, the inspectors must keep in their books the record of every one of these boiler plates that is used. Passenger steamers must be divided, according to their size, into a prescribed number of water-tight compartments, the legal prescription for the partitions being very minute. The passenger steamer has elaborate and detailed provisions for defence from fire, and for life boats, life preservers and other provision for accidents, and the construction must provide for easy exit for passengers. Air space per capita, light, ventilation and drainage are prescribed for both passengers and crew. Other living freight, live animals, are as carefully legislated for as human beings, in some respects they are more carefully safeguarded. The maintenance of this efficiency is provided for by annual inspections of both machinery (if a steamer) and hull, and along with the power of inspection goes the power of condemnation and prohibition to go to sea. If the hull of a vessel is wood, the inspector may assure himself of the condition of the timbers by boring into them until he is satisfied. All important countries have somewhat similar marine codes.

In the matter of shipping, governments, the protectors of peoples, make every effort to see to it that when a ship is permitted to receive cargo, she promises to be able to carry it in safety. The above mentioned provisions of construction and inspection are but types, and no pretense is made of covering the whole of these subjects.

(b) Loading regulations. A ship at her pier might be loaded with cargo until her decks sank almost to the water's edge and there would be no risk while at the pier, and she might even cross the ocean in safety. So long as the depth of loading was to be decided by personal opinion there was
always the temptation to overload and take risks to gain profits, particularly as the men who load ships rarely ride in them. Sometimes this danger took a more virulent form and a poor ship was loaded, and overloaded, with a trifling cargo and falsely insured, and sent to sea with the hope that she might sink and thereby bring profit to the enterprise through the insurance. The "coffin ships," as they were called, were long a subject of work for the philanthropic legislator, and all countries have now limited the depth to which each ship may be loaded and it is distinctly marked upon her sides. The British mark, a white circle with three lines across it placed amidships, is called the Plimsoll line, and makes different provisions for different seasons and oceans, according to the risk involved. No ship is permitted to clear from port with her load limit line below water.

The marine codes of nations provide that dangerous articles such as unslaked lime, explosives and dangerous combustibles must be shipped under their own names always, and in some cases they may not be taken on passenger ships. Freight must also not be placed dangerously near the engines, nor must it impede their operation nor the free passage of passengers.

(c) Regulations of departure and arrival. After a ship is built according to law, much care is required to maintain her identity and preserve her operation in accord with safety and with the tariff and health laws of the various countries. If a ship bears no marks of identity upon her, she has increased opportunity of unfair dealings, and preservation of identity is, therefore, a strong means of control. This is exercised by the arrangement known as registry, which corresponds closely to the system of giving deeds to real estate. The piece of land for which there is no deed belongs to the state, and the ship without a register is an outlaw subject to heavy fines. Ships are usually registered in the port where the owner, owners or a majority of them live. The power of issuing registers in the United States lies with the
Government Control of Shipping.

collector of the port. A prescribed blank is filled out, containing the name, a full description of the ship, names of owners, and a large number of measurements made by the surveyor of the port. This document, after being approved and recorded by the collector of the port, goes with the ship like the deed does with a house, and must be shown on many occasions. Even the name of the vessel must be approved, a change of name must be approved and change of ownership requires a new register. The ship's name and home port must be painted upon her stern in readable letters.

In the securing of a crew the ship must have the legally prescribed number, and often qualifications of citizenship and technical fitness must be observed. Pressed by the necessity of having a sufficient crew, captains have for ages put to sea with unwilling men secured ("crimped") by force, fraud or under the influence of liquor or drugs. In combination with the practice of advancing pay, "crimping" has enabled sailors' boarding house keepers to make a bargain and ship a boarder, and get pay and over-pay for his indebtedness. To prevent this abuse laws now provide that, in the United States, the only third party who can make a bargain for a sailor, for an American ship, is a government official called the shipping commissioner, or in his absence the collector of the port. These contracts with the sailor must tell where the voyage is to end, the service the man must give and the wages and supplies he is to receive, and there is a penalty for shipping a man without agreement. There must also be proper provisions, medicines and stores for this crew.

When the ship is loaded, and fully manned, she cannot depart without clearance papers, which the captain receives from the collector of the port after he has presented a copy of the manifest of the cargo, giving the articles and value, and if it consists of packages, the number of, and marks on, the same. From these documents come statistics of export trade.

In addition to these regulations, the ship is often compelled
to take a pilot to get from the port to the open sea for the real beginning of the voyage.

In entering a port of the United States, and most other countries, the above list of requirements is reversed and lengthened by the addition of quarantine regulations. The quarantine station is usually between the harbor and the sea. Here the ship must stop, present to the health officer a bill of health received from the health officer of the port of departure, showing the sanitary history of the vessel, and stating that she sailed without cases of contagious or infectious disease on board. The ship is then inspected to ascertain her present condition, and if need be she is disinfected or detained at quarantine, freight, passengers and all. If serious epidemic is threatened, and the conditions seem to warrant it the President may suspend commerce entirely in the interests of public health. If the quarantine officials are satisfied with the condition of the ship, they give a bill of health. With this paper and the bill of health from port of clearance, the vessel is prepared to enter the country, and can do so by presenting both documents to the harbor master, who admits the ship to port and assigns her moorings or anchorage.

Before the cargo can be broken, the captain must present his clearance papers and register to the collector of the port, who holds them, or a consul's receipt for them, until the ship is ready to depart. Thus, the collector, the representative of the custom's authority, keeps the ship under his control during the whole of the time that cargo is being discharged and loaded, and the vessel is, when in touch with the land, always responsible to some controlling authority. Freedom begins when the pilot leaves the ship at the edge of the open sea.
CHAPTER XI.

GOVERNMENT SUPERVISION OF OCEAN ROUTES.

The ship properly built, loaded, equipped and ready for the sea would still be a helpless prey to many destroying agencies but for the aiding and protecting arm of governments. The condition of the ungoverned middle ages would return, and commerce would resume the risks now experienced in polar exploration or by land explorers in savage regions. The unaided ship would be beset by the dangers of grounding on unknown bars, being wrecked on the rocks and shores of any coast, of being tempted there, as of old, by the false lights and bells of wreckers, and the pirate would find the present day commerce of unprecedented richness. But all these dangers the state has taken the pains to reduce or to remove by activities that extend around the world. Chief among these activities are the coast survey, the lighthouse system, storm warnings, ocean pilot charts, the life saving service and the protection of navies.

The approach to a coast is always a dangerous time for shipping. While far at sea, and favored by good weather, the mariner can locate himself by astronomical observations, but when nearing the land the slightest error is dangerous, every possible means must be availed of, and all leading nations have aided navigation by surveying and charting their coasts. These surveys are of the greatest accuracy, and the resulting charts give a minute delineation of the coast line and sometimes a sketch of the topography of adjacent lands; the form of the bottom of the adjacent waters is shown, as are the depth of the water and the character of the bottom as far out as ordinary soundings can bring up a sample; the positions of bars, harbors, channels, and the lights and buoys that mark them; the velocity and direction of currents, the temperature of water, variations
of the magnetic needle, and any and all other information that will aid in the navigation of ships. Some shores, with shifting sands, require almost constant surveying and re-charting. The coasts of United States and Europe have been charted and the charts are usually sold to mariners at cost. Few countries, other than those upon the North Atlantic, have had the energy to survey coasts, but Great Britain, and, to a much smaller extent, other countries, have surveyed wherever throughout the world it best suited their commercial interests. During the fiscal year 1903, United States vessels made surveys in the North Pacific Ocean, in Gulf of California and off the coasts of Brazil, Cuba, China, the Philippines, Hayti, the Aleutian Islands and Samoa. Many of the surveys of distant and unsettled shores have been very hastily and incompletely made, and there is a vast deal of work yet to be done before the combined action of all governments will have given to the mariner accurate knowledge of all shores. The United States is resolutely working away to make charts of the whole world, but it is quite as much a war measure as a commercial one.

The best of maps and charts are useless at night unless the shore is made visible and this the lighthouse does. The buoys upon hidden obstructions and the outlines of coasts are superceded at night by carefully arranged lights that are now maintained by all civilized nations. By keeping in a certain indicated relation to certain carefully described lights it is possible for the pilot to know the exact location of his ship, and follow a narrow and tortuous channel almost as well by starlight as by daylight.

The navigator is informed by charts and bulletins of existent dangers, and through the Weather Bureau he is warned of dangers to come. The exact nature of the weather is hard to predict in advance, but pronounced storms so uniformly announce themselves that during the past six years no protracted storm has reached any American port without being signalled well in advance. The United States Weather Bureau publishes storm warnings on all coasts and
maintains two hundred and fifty displaymen. Messengers are often sent to vessel masters, and the system is so well organized and equipped that a bureau report can reach all vessel masters in the ports of United States within an hour after being sent. The importance of this service may be seen when it is known that there are constantly afloat on the Atlantic and Gulf Coasts of the United States thirty million dollars' worth of shipping and thousands of human lives.

Even in midocean the vessel is not beyond the care and the statutory guidance of governments. A sufficient amount of knowledge has been, and is being, collected to make profitable the publication of permanent and temporary charts of the open sea. Here the chief dangers are those of collision with ice, ships, derelicts (abandoned wrecks) and other floating objects. This danger is infinitely increased in foggy weather. The United States Government publishes charts of the North Atlantic Ocean and of the North Pacific, and owing to the fact that the ice and derelicts never remain in one place and the fogs change with the seasons, these charts become obsolete so rapidly that they are published monthly. The information that they contain is collected by sea captains. Every captain who comes to an American port is expected to report to the officials of the hydrographic office every obstruction to navigation that he has observed. Arrangements have recently been made for these reports to be cabled back to the United States from some foreign ports. By putting together many of these isolated reports, the movement of the ice fields is easily traced, and the derelicts can be followed in their paths across the ocean. Important derelicts, ice floes and even dead whales are put upon the chart of the month, and the trans-Atlantic liners are sometimes delayed in sailing that the captain may have the latest ocean chart. Nineteen hundred voluntary observers are now making reports to our government of weather, storms and fogs at sea, and these elements, too, are represented upon the charts. In addition to the floating obstructions, the chart for any particular month gives the track
followed by a large number of storms that have occurred in that month in preceding years; the relative amounts of fog that may be expected in certain regions, the prevalent wind force and directions, the ocean currents, the variations of the magnetic needle from the true north and, lastly, the exact routes to be followed by both steamers and sailing vessels in making their various voyages across the ocean. The monthly chart has recently been supplemented by a weekly hydrographic bulletin, distributed free of charge, and bringing the information down to the very latest date. Mariners so appreciated this that by their reports it was possible to add to the warnings the exact locations of fifty new dangers per week during 1903. This, along with much other information, is distributed and collected in the United States through the sixteen branches of the hydrographic office located in the leading ports of the country. The captains who make these voluntary reports receive in return free copies of such pilot charts as they need.

If a derelict continues in the paths of ships, and is not rescued for profit by some wrecking company or private individual, a government vessel, usually a revenue cutter, may be sent to find and blow it up with dynamite.

Governments also do real police work. Piracy, probably the greatest bane of ocean commerce from its inception until far into modern times, has practically disappeared through the vigilance of nineteenth century navies. A century ago the Mediterranean was still infested, and pirates yet linger in the China Sea, where the native craft only are selected for victims.

After showing and clearing the way to and across the high seas, governments still have regulations for the actual operation of the ship when far from land. In a fog the vessel must go at half speed, and she must sound a fog horn at such intervals and for such periods as will will show the kind of vessel, and, if a sailing vessel, whether she is tacking to starboard or larboard, or going straight ahead. But the most lengthy regulations are those applying to signalling.
Fifty years ago the problem of communication between ships had resulted in about ten different sets of private signals. From this condition of chaos, order has arisen through the adoption of an international code, made for the British Government by a British commission, and adopted first by France and then, like the postal union, by most of the nations of the world. By a code arranged from twenty-six flags corresponding to the letters of the alphabet, any kind of necessary information can be communicated from ship to ship, or ship to shore, whenever the distance and weather permit flags to be seen. The regulations also provide that by hoisting certain flags in certain places, the vessel shall always give out certain information concerning herself. By this means an observer can tell at a glance if the vessel is about to sail, if she is loading dangerous explosives, if she wants or has a pilot, or if she is in distress. If the distance is too great for flags and colors to be seen, there is a second and less efficient system in which shapes are used, and by arranging squares and circles in certain positions some signalling can be done. By night rockets and lights are used, but owing to the impossibility of variety, the amount of signalling that can be done by this means is very limited.

Lastly, when all regulations and aids have failed, and the ship is driven upon the coast, there is the life saving service to save the passengers and crew from drowning, and, if possible, the property from destruction. The leading European countries maintain life saving stations, but the United States is the only country that also patrols its coast. There are two hundred and seventy-one stations upon the shores of the United States, and thousands of miles of beach are patrolled nightly in all the storms of winter. Upon coasts like those of Long Island and New Jersey, that project far into a much travelled sea and are near a focus of world trade, the stations are only three miles apart, but upon less frequented coasts they are placed only at dangerous points; the Gulf of Mexico having but eight and the entire Pacific Coast sixteen. The patrolman carries lights, and often
safely warns vessels away from dangerous points, and if the vessel is in distress upon the shore the life saving crew, with their life boats, life lines and breeches buoys are such sure rescuers that shipwreck upon the American coast is scarcely more dangerous to life than some hazardous industries. Since the inauguration of the present service in 1871, there have been 13,379 disasters, involving 99,084 persons, of whom 98.9 per cent. or 98,081 were saved. Of the vessels and cargoes, valued at two hundred and one million dollars, one hundred and fifty-eight million dollars worth were saved.
PART III.—Harbor and Port Facilities.

CHAPTER XII.

PORTS AND HARBORS—PHYSICAL EQUIPMENT.

Ports are places where ships transfer their cargo to or from the shore, or ports may be called the connecting points between the trade routes of the land and those of the sea. Ocean vessels are loading and unloading their cargo in such a variety of places, good and bad, safe and unsafe, that it is impossible to give a less general definition of a port than a place where vessels load and unload.

The crudest kind of port work requires some break or unevenness in the shore line, and in some countries the commerce is greatly handicapped because a long, straight and unbroken coast gives the inhabitants of the land no opportunity to establish connections with the sea, except under conditions so precarious that ocean commerce cannot prosper if, indeed, it can exist.

Ports are all alike in that they require some improvement before they can be satisfactorily used for commerce. The extent of this improvement varies greatly, depending as it does upon the nature of the shore, of the commerce, and the amount of money available for harbor works. These artificial aids may be merely wooden landings for row boats, or they may be so extensive as to change an open harbor into a closed one with piers and wharves along which the largest ships may lie and discharge cargo by electricity.

The usefulness of a coast for port purposes, and the amount of labor required to improve it, depend almost entirely upon a simple geologic factor in its history. If the coast has sunk it is filled with harbors. On coasts that have
long been stationary or slowly rising, the rivers and shore currents tend to fill up any irregularities of the coast with materials eroded from the land. On a coast that has sunk, the sea has flowed back into the lower river valleys, and the wider parts of these drowned valleys often make excellent harbors. For instance, New York, Hampton Roads, Chesapeake Bay, the St. Lawrence, San Francisco Bay, Sydney (New South Wales) and all the harbors of Great Britain. If it so happens that, in addition to sinking, a coast has been glaciated, it is so carved up that it makes an almost continuous succession of fine harbors. Examples are found in the coasts of Norway, Scotland, Ireland, Maine, Alaska, southern Chile and New Zealand. These contain enough harbors for the world, but their poor location makes most of them useless to commerce. They are not adjacent to centers of human activity.

All ports may be divided into two classes: (1) open roadsteads and (2) closed harbors.

(1) Open roadsteads are ports which lack the protection of encircling land, where storms from some point or points of the compass may drive the vessels to destruction upon the shore. In such exposed places the water is often rough enough in normal weather to make it inexpedient to bring the vessel alongside a pier, and so piers are not often built. Such ports are to be found below the limit of the ancient glaciers, and below the stormy, cold temperate zones with their uncertain weather. An open roadstead in the North Atlantic would be liable to destructive storms from all points of the compass at any season of the year, and it is far too dangerous and uncertain a place for the accommodation of modern commerce. The open roadsteads usually occur along shores with more settled climate: in the subtropic and tropic zones, where the trade winds and monsoons give the climate a regularity that can be depended upon. Open roadsteads are, therefore, common along the even coasts of South America and Africa, in Central America, southern Asia and the East Indies.
The open roadstead costs little, but labors under disadvantages. In nearly all cases the freight is unloaded, not directly to the land, but into small boats that go out to the ship. This method is troublesome for heavy goods, and under the most favorable conditions it necessitates an extra handling, and merchandise is often injured by sea water and sometimes lost as the small boat attempts to reach the land. In the port of Buenos Ayres, before the recent expensive improvements, the water was extremely shallow, and vessels had to lie several miles from land. Freight was carried back and forth on carts having very high wheels.

The open roadstead is further handicapped because, owing to the roughness of the surf, it is often impossible for a coasting steamer to land the goods at all. The steamer must choose between waiting for good weather or continuing upon her voyage. But waiting means irregularity of service, and irregularity is strenuously avoided by steamship lines. So the small open roadstead port usually misses the call of the steamer when the weather is bad. Sometimes a consignment is carried from New York to Caribbean ports in the same vessel, a second and even a third time, when the trade wind blows strongly, before it can be landed. If the amount of freight is very large the vessel must, of course, wait. During the continuance of rough weather, all loading operations in open ports must stop. The port of Valparaiso is open toward the west, and a strong west wind brings commerce to an absolute standstill. This enforced delay amounted in a recent year to one hundred and thirty-four days, causing a total loss to shipowners of tens of thousands of dollars.

(2) Closed harbors offer by far the best advantages for the growth of trade. A small body of water nearly surrounded by land may be exposed to the wind, but it is safe for ships, because the danger to them comes from the motion and blows of waves, and the formation of dangerous waves requires several miles of unobstructed water. The closed harbors are afforded by bays and river mouths. Considered
merely as safe places for ships the bays are much more numerous than the river mouths. They are usually easier to enter and safer, but most of the great commercial ports are on rivers because a great port must, in addition to a good harbor, also have access to the interior. This is best afforded by the navigable surface and easily traversed valley of a large river.

The value of river mouths for harbors is vitally dependent upon the tide. This influence may be classed under three heads: (a) rivers with little or no tide; (b) those with moderate tide; (c) those with great tides.

(a) Rivers with little or no tide are, at their mouths, constantly on the level of the sea. This permits the river to form a delta, fill its channels with silt and spread out fan-shaped into a multitude of shallow wandering streams. The best example of a tideless sea is the Mediterranean. It has no river harbors, while the north of Europe, with tidal coasts, has river harbors almost exclusively. The rivers flowing into the Mediterranean are all closed. The Rhone, the Po, the Nile and the Danube are in some part navigable rivers, but all are closed by nature to the entry of large vessels. A canal has been cut at the mouth of the Danube to avoid the delta, but it is useful to river steamers rather than ocean steamers, and no important port has resulted. The commerce of the Mediterranean is, therefore, compelled to seek refuge and land connections in bays along shores where suitable bays are scarce. All the leading harbors, Marseilles, Genoa, Naples, Trieste, Algiers and Alexandria were originally open roadsteads that have been protected by costly breakwaters or mole. Similar improvements are planned for Barcelona.

In addition to protecting otherwise open roadsteads the breakwater or jetty is also used to give greater depth to the mouths of rivers having slight tides. The entrance to rivers or lagoons of this class is usually blocked by a sand bar a few feet beneath the surface of the water. The slight tide in running out carries the sediment a short distance beyond the
river or lagoon mouth, and, where the current stops, the earth is dropped in the form of a semi-circular bar. The jetties narrow the opening and extend it out to sea, and the force of the current, being confined within narrower limits, cuts deeper and carries the sediment out to deeper water. This method will require the lengthening of the jetty at intervals as the accumulating sediment forms a new bar. This kind of improvement seems to be particularly applicable in the Gulf of Mexico, where the rise of tide is about two feet. Jetties have deepened the Mississippi from seventeen to thirty feet, and by the same means the shallow ports of Vera Cruz and Tampico, Mexico, have been doubled in depth, and Mexico has entered upon her commercial existence.

(b) Moderate tides, those between five and twelve or fifteen feet, make the best river harbors, because the river mouth is kept open to a good depth, and the rise and fall of the tide is not a serious inconvenience to ships at the wharves or piers. In nearly all cases the water at the entrance is only deep enough for large vessels to enter during two or three hours at high tide, and some dredging is commonly resorted to to make this easy. Harbors of this type are very important in the world's commerce. Among the important examples are the Atlantic ports of United States, Shanghai, Calcutta, Hamburg, Bremen, Rotterdam, Southampton, Glasgow. The streams in which these harbors lie usually require some deepening for the largest vessels, but the cost of dredging is less than that attendant upon the improvement of the rivers without tide or those having great tides.

(c) Great tides are those from fifteen to forty feet, and while they serve to scour out the sand bars, they deposit them further at sea, and it is practically impossible to keep large vessels afloat in the river during low tide. This difficulty was unimportant with the small sailing vessels in use two centuries ago, but the modern steamer has such great size and weight that lying on the bottom would often break the hull. This danger has been avoided by the costly means
of making in the solid earth, along shore, artificial harbors, usually called docks. An excavation is made, enclosed with solid masonry and with water-tight gates like canal lock-gates to hold the water in during low tide. At high tide the gates are opened, vessels come and go and the gates are then closed to hold the water and the ships at the high tide level. Fortunately for the advancement of commerce, great tides are uncommon, and only occur in ports in Great Britain, the English Channel and the Bay of Fundy. There are several exceptions in Great Britain, but the greater part of the foreign commerce of the United Kingdom passes through ports with harbors of this type, as London, Liverpool, Hull, Bristol, Cardiff. Across the channel are other examples in the harbors of Havre and Antwerp, but the latter city has only a part of its harbor within locks, another part being in the river itself, which has become available by the use of modern unloading appliances.

These artificial or dock harbors offer every desired convenience for the handling of freight, the one drawback being the great cost of construction. This is again offset by the permanence of the structure. Piers like those of New York and Philadelphia, standing on piles, must be renewed from time to time, but, according to a New York shipowner, the total cost of building them and keeping them in repair is less than the interest on the capital required for stonework like that in the harbor of Liverpool. That statement is probably too strong, but it is at least suggestive of relative costs.

The ideal commercial harbor probably finds its nearest approach in that of New York. It is a closed river harbor in a renowned valley. It is not obstructed by ice. A great river gives a highway to the interior, and with its deep and widened mouth, half estuary, half bay, holds enough water

---

8 In some of the ports of the Bay of Fundy small vessels are kept at the desired level by being supported on cribs, which are nothing more than strong scaffolds alongside the pier at such a level that at high tide the vessel can float into place. This method of support, if physically possible, would be injurious to vessels of the largest size because of the uneven strain to which the hull would be subjected.
to enable a moderate tide to scour and keep open a sea entrance with but little dredging. Further than this the river is (and for an ideal harbor must be) wide enough to permit piers to be built out into the stream at right angles to the shore. By this means the space available for ships along a given amount of shore line is increased more than fivefold.

If a river, otherwise usable, is too narrow for piers, the vessels must lie in single row lengthwise along the shore. Upon this extravagant use of shore line no commercial city can depend entirely, because the ships that carried its commerce would be compelled to stop miles down stream to find shore space to unload and receive cargo. The Maas at Rotterdam is five hundred and forty yards wide, and the Elbe at Hamburg is little better; while the Hudson at New York and the Delaware at Philadelphia are each nearly a mile in width. A comparison of the maps of the harbors of Hamburg and Rotterdam with New York and Philadelphia will show at a glance the amount of work that man has been compelled to do because of the narrowness of the two European rivers. Instead of piers going into the stream seven hundred feet as in Philadelphia, a single row of ships lies lengthwise along the shore, and artificial harbors hundreds of acres in extent have been dug in the adjacent meadows to enable the shipping to be accommodated within the port.