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(Reprint of an article from the Monthly Bulletin of the International Bureau of American Republics, July, 1908)

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The nitrate fields of South America exported in 1830, the first year of the industry, 8,348 tons of crude mineral. Chile, to which Republic these fields now belong, exported, in 1907, 1,833,800 tons. Between these two dates the history and development of one of the great natural products of the Western Hemisphere must be studied.

The saltpeter, or nitrate, zone embraces the extension comprehended between the Camarones River in south latitude 19° 11′ on the north and parallel 27° to the port of Caldera on the south, a distance of 450 miles from one end to the other. The interval separating the deposits from the coast varies. They never come close to the sea—in the northern part the sea is only 15 miles away, in the southern part it is 93 miles away. These deposits in the Province of Tarapaca occupy the small folds and the gently rising hills extending from the west of the pampas of Tamarugal, but to the south of the Loa River they follow no lode, being found in the midst of the great pampas as well as in the folds of some of the hills. Neither are the deposits found on the lower levels of the western slope of the Andes; they lie at an altitude of from 3,600 to 13,000 feet above the sea. But, fortunately, this is no obstacle to mining or transporting the finished material, because the hills and mountains along this coast come precipitously close to the water, so that, even where railroads are in service,

from the heights at which the nitrate fields are situated the bags containing the commercial nitrate can be shot by the force of gravity to the dispatching warehouses in the harbors. This region, the nitrate zone, is as barren as any place on earth; it is one of the paradoxes of nature's laboratory, because no living thing can find nourishment here, although from these very nitrates nourishment is given to impoverished soils all the world over.

FIG. 2.—Nitrate fields.

The climate, on the other hand, is delightful. Although it rarely rains on the nitrate desert, it is neither oppressively hot nor cold, so that natives and foreigners alike find life agreeable and healthful so long as they trust to nature and the simple foods, which must be brought hither from outside the zone.

Along this stretch of 450 miles of nitrate coast are many of the best-known ports of Chile. First, at the north, comes Pisagua; then Junin, Caleta Buena, Iquique, Tocopilla, Mejillones, Antofagasta,

Coloso, Taltal, with Caldera at the extreme south. The nitrates from the Province of Tarapacá are shipped through the ports of Iquique and Pisagua, while the product of the regions farther south seek the nearest ports. Not one of these offers safe, natural anchorage, but each has been selected altogether on account of its availability as a shipping place for nitrates. Vessels lie in the open roadstead, and the cargoes are lightered out to them in the native way devised many years ago, but which modern mechanical skill will not be able to supersede until breakwaters and piers allow these vessels to approach closer to shore. The cargoes brought to these ports are extraordinarily miscellaneous, because, since nothing is produced in this region, everything must therefore be imported. Coal is probably the larger portion of the freight; but in addition all necessaries like food, both canned and fresh; all liquids, even water to quench thirst and to

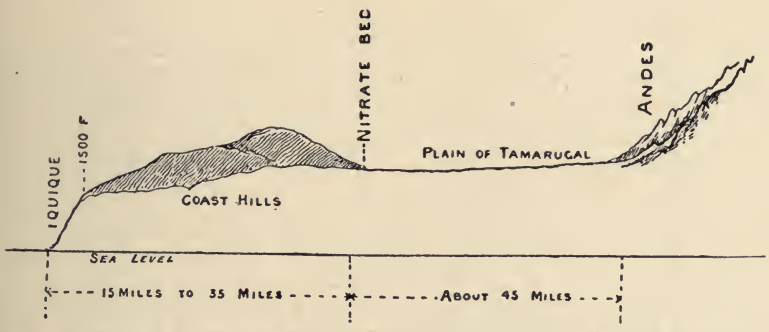


FIG. 3.—General east and west section of the nitrate district of Chile. Vertical scale exaggerated.

extinguish fire; all clothing and building material; all luxuries and decorations; even the soil from which spring the pretty trees and flowers in the plazas and patios, must be imported, both to sustain life and to make it endurable. These are the loads carried into the nitrate ports, and, with the exception of a small proportion of the more precious minerals—gold, silver, and copper—mined also in this zone, nothing is produced that can be carried away but nitrates.

The saltpeter in these nitrate deposits is found mixed with other substances, in which generally common salt predominates, but the conglomeration is usually, besides this, clay, gravel, and sulphate of soda. There are four strata recognized in the fields, although the composition of each varies from location to location. The uppermost layer is called *chuca*, and consists of the surface accumulation of the ages; the second layer is called *costra*, which is firmer in consistency,

thicker than the *chuca* above, and much harder to penetrate. Below this *costra* is found the *caliche*, the real, natural deposit of nitrate of soda, which may be almost pure chemically, but which is considered commercially valuable if it runs above 30 per cent of the salt.

The origin of these deposits of nitrate has been for years a matter of speculation and theory; but no one theory explains with complete satisfaction how or why nature selected such an immense area here, and apparently nowhere else, for such a dense accumulation of mineral wealth. It has puzzled geologists and meteorologists alike, but the owners of the fields and the Government of Chile are content to

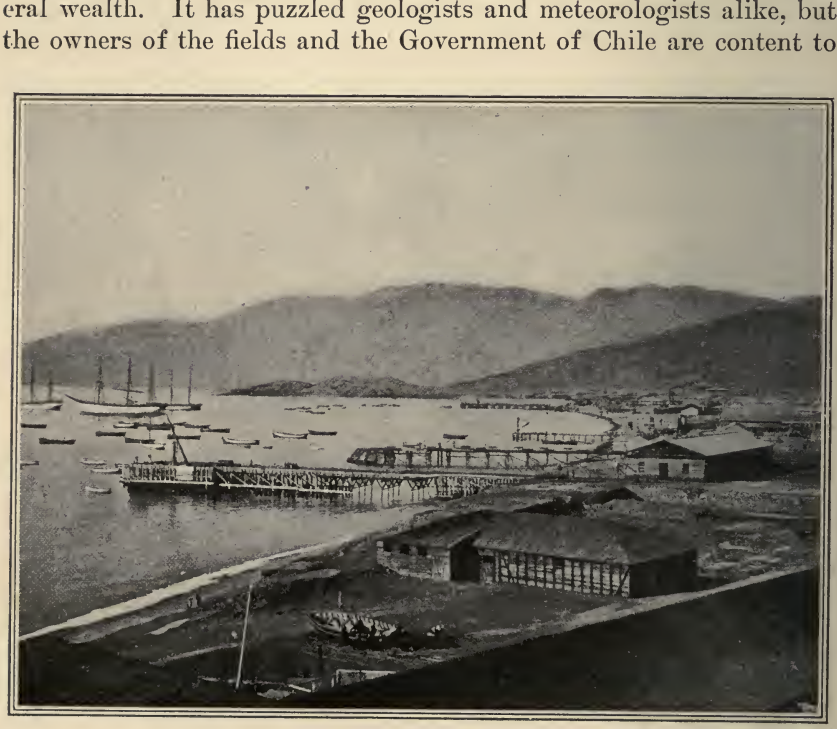


FIG. 4.—The nitrate

accept the facts and to leave the theory to the fancy and imagination of the learned.

Below the *caliche* is the lowest stratum of bed rock called *gova*, from which the first step of the mining operation is conducted. The method of extracting *caliche* is extremely simple when compared with the elaborate machinery necessary in obtaining other minerals. A *cata* or small shaft is sunk through the surface deposits and through the *caliche* to the bed of clay or gravel, the *gova*. Here a hole is scooped out, in which a small boy places a charge of powder or dynamite. This is exploded. The resultant débris is divided into masses

that may be used for building material or such indifferent work, while the *caliche* is collected by itself, placed in mule carts and driven to the factory, or *oficina*.

The *caliche* itself is a combination of nitrate of soda, varying from 14 to 75 per cent or more; sulphate of soda, sodium chloride, iodine salts, small proportions of potash, magnesium, and lime, with insoluble matter. With the exception of the iodine, and in some cases the common salt, these being saved as by-products for other purposes, the entire industry of the *oficina* is devoted to the preparation of the nitrate in such a form that it may be economically exported. The

port of Taltal.

caliche is first crushed, and it is then run into huge boiling tanks, where the salts are dissolved, the sand and other refuse sinking to the bottom. Fortunately, the nitrate has a different point of solubility from other salts, and can, therefore, be precipitated by itself as the water cools. When it has crystallized in large cooling pans or vats, the dry nitrate is put up into bags and dispatched for shipment.

These *oficinas* are establishments thoroughly well equipped with modern machinery and chemical laboratories for the scientific production of nitrate. Each *oficina* stands in the midst of the field from which its *caliche* is obtained; it is a collection of buildings, above

which rises a smokestack, but all, the crushers, the boiling tanks, the settling vats and other quarters, being devoted to a single purpose. An important part of this complicated process, but one subordinate to the main desire to secure as much nitrate as possible, is designed for the preparation of iodine from the nitrate liquor. Iodine is a constituent, in most fields, of the *caliche*, and has a recognizable commercial value, although the demand is limited and the supply can be furnished from other countries than Chile.

An interesting feature of the *oficinas*, as well as of the towns lying within the nitrate belt, is the persistent determination to make them attractively habitable for those who must spend a greater portion of their lives there. In the early days of the industry water was brought in pails by coasting vessels up and down the Pacific; later it was piped from sources in the Andes; but to-day, wherever the supply is too costly or uncertain, water is distilled from the sea. Nothing grows indigenously here, but the traveler will notice plazas, patios, and potted plants, even grass at times, at every port and *oficina*. This miracle is accomplished by the importation of all ingredients for horticulture; the earth itself has been carried here to make a soil foundation, and the people cherish these exotics with the utmost devotion.

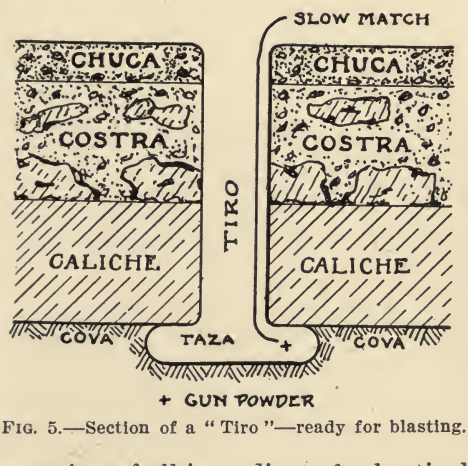


FIG. 5.—Section of a "Tiro"—ready for blasting.

Chile has frequently been dismayed at the fear that the supply of nitrate would become exhausted. This would mean not only a disturbance of chemical conditions throughout the world, but also a disastrous fall in the income the Chilean Government derived from the export tax placed upon this product. Certain calculations made a few years ago demonstrated that, so far as the region of the Province of Tarapacá was concerned, assuming the steady increase in consumption which has marked the spreading knowledge of the use of nitrates, the supply could scarcely last through the next thirty-five years. It was estimated that 100,000,000 tons of nitrate were then unmined; the annual exportation has practically touched the mark of 2,000,000 tons, and is continuously increasing, so that an easy problem in arithmetic shows how close the end is. Yet there are several factors at work to dispel this dismay. The first and most important is the fact that it has been definitely determined that

nitrate is by no means limited to Tarapacá; in the Provinces of Antofagasta and Atacama hitherto unexplored beds of nitrate have been discovered. These beds are said to be capable of furnishing 1,500,000,000 tons additional. This supply, with the fields already exploited, makes available a total of 1,600,000,000 tons, and assuming the world's consumption to be annually 5,000,000, which will probably be the normal demand within a few years, there will be

FIG. 6.—Explosion in caliche bed.

enough to last for over three hundred years. The second factor is the more refined methods introduced by modern chemistry into the industry at the *oficinas*. In early years the crude *caliche* itself was used at home and exported; later, when its value was found to lie in the nitrate constituent, it was found cheaper and more profitable to extract the salt on the spot, even if much of the mineral was lost. To-day, a product of 95 per cent pure nitrate is sent from the *oficinas* to be shipped abroad. This extremely high percentage,

however, came from *caliche* which in itself contained at least 14 per cent and usually not less than 50 per cent of nitrate of soda.

FIG. 7.—Caliche ready for transport to oficina.

Every year new methods are tried and introduced to obtain equally good results from low grade *caliche*. Claims are made that a 7 per

FIG. 8.—Caliche at the crusher.

cent ore can be profitably mined and refined. There is no doubt, therefore, that all the nitrate rock in the Chile desert will, as the

demand increases, be available for commercial uses. The third factor in the nitrate problem is the determination, on the part of Chile as well as on the part of the owners of nitrate concessions and fields,

FIG. 9.—Administration Building.

to do everything reasonable and warrantable to conserve the supply so that demand and output balance each in a normal way.

FIG. 10.—Machinery used in preparing the nitrate and iodine.

The Government of Chile has for years placed a tax upon the export of this natural product. This tax is now at the rate of $0.438 gold per 101.41 pounds. Chile has laid this tax since the year 1880, and

has derived from it the sum of $280,000,000 gold, up to 1904, without taking into account the revenue from iodine or the sale of nitrate

FIG. 11.—Nitrate pans.

lands. In addition to this tax, which naturally Chile is anxious to retain, the Government restricts the distribution of new lands and is

FIG. 12.—Train load of nitrate.

cautious about the lessees or purchasers who are to have the benefit of them. Special laws are issued to protect this one-time wilderness,

and what, eighty years ago, any one could have had for the asking and be laughed at for his pains, is now held so precious that only properly accredited concessionaires can have the privilege of occupying it. With this output restricted by the Government, and allowing for a 10 per cent increase in consumption every five-year period for the next twenty years, the tax will have yielded to the Government by the close of 1923 the sum of $400,000,000 gold, a steady source of income of which any country in the world ought to be proud. This assumes, of course, that nitrate will not be discovered in any other deposits sufficient to offer competition to those in Chile, and that science can not develop some method by which nitrates (or nitric acid) may be derived from some such inexhaustible supply like the at-

FIG. 13.—Dissolving nitrate from crushed caliche.

mosphere. But neither danger is close enough to threaten the industry as established here.

Partly for the protection of its members and partly in support of this enlightened policy of the Government of Chile, the association of nitrate producers has been formed. This Asociación Salitrera de Propaganda, as it is called, has a double purpose. It hopes to keep the production of nitrate within limits set by itself, according to which scheme only just sufficient salt will be annually mined to meet the world's demand at the price best suited to yield a commendable profit. Of the 100 or more *oficinas* in the association, each pledges itself to produce only its quota of nitrate allotted at the beginning of the year by the association. The association attempts thereby to keep the price commensurate with the restricted output. Whether this

method will be successful in the long run is one of the complicated questions of modern finance debated on all occasions by the student of trust economics. The association ended its first five year's compact in 1907, and another has been formed, but the time has been too short to bring a definite decision as to its effectiveness.

FIG. 14.—Machinery in the Oficina.

The subjoined charts illustrate how rapidly the production of nitrate of soda from the Chilean fields has increased. Undoubtedly a much greater quantity could be mined if there were no monopoly or if miners were allowed to rush in indiscriminately to attack the deposits wherever found. At present the industry seems well controlled both by the State and by the association, both making

CRUSHING MACHINERY.

careful studies of the world's markets and future possibilities for consumption.

The second phase of the association's purpose is to spread a knowledge of the sources of nitrate of soda, of the essential value of nitrogen compounds in the arts and in all industrial processes, and especially to extend in every direction among those whose business it is to deal with products of the soil a better recognition of the fact that no soil can forever maintain a highly productive capacity. That is to say, any soil will, after a time, decrease in commercially productive value. Soil must be nourished before paying crops can be grown. If the soil does not find this nourishment from the environment it must be artificially supplied. The three essential soil and

FIG. 15.—Workmen in a nitrate plant.

plant foods are potash, phosphorus, and nitrogen. At present the only available supply of nitrogen is from the nitrate of soda fields in Chile.

The English, at the beginning of the exploitation of the nitrate fields, were the first to learn the practical value of the salt as a fertilizer; they for years absorbed the entire output, and their business men purchased the mines. Germans, who later on, through laboratory experimentation, grasped the situation, dissatisfied at the English control, made purchases for themselves, so that to-day the immense industry is in the hands of these two nationalities. Of course this does not influence the market or the ultimate destination of the

product, because the propaganda must be universal in its significance and application. The absorption has been, for some years, in about

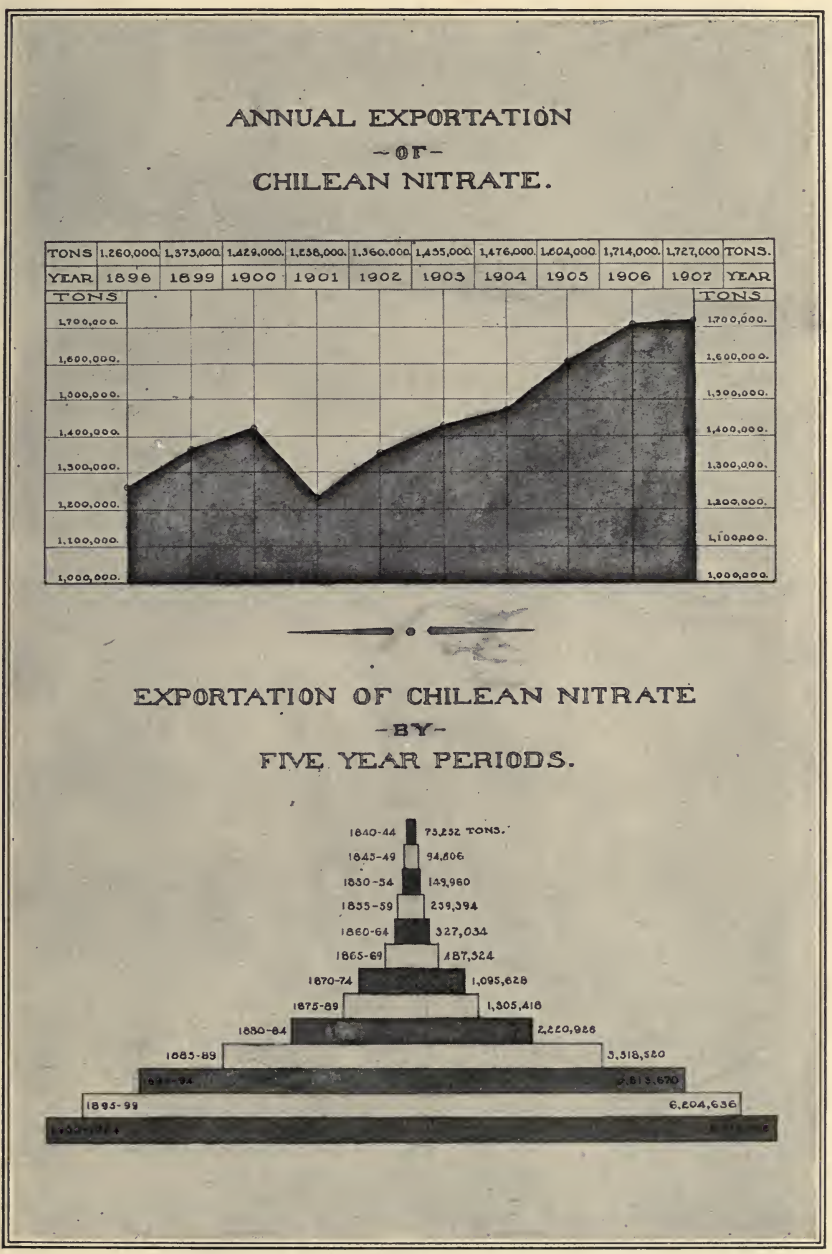


FIG. 16.

the following ratio: England taking 40 per cent of the output; Germany, 20 per cent; the United States, 20 per cent; France, 10

per cent, and other countries the remaining 10 per cent. The consumption in the United States is slowly but steadily rising. The

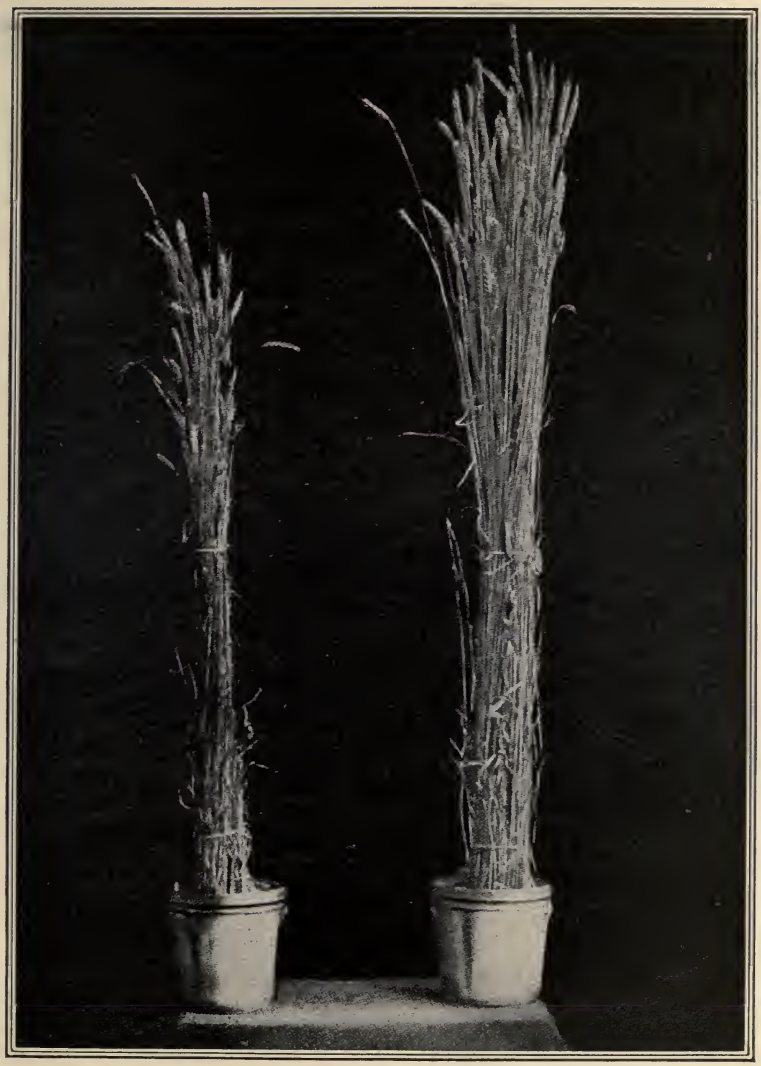
FIG. 17.—Packing nitrate into bags.

Department of Agriculture of the United States, the national and State experiment stations, the commercial fertilizer companies, and

FIG. 18.—Getting ready a nitrate train.

progressive farmers are learning the value of Chilean nitrate. The product is shipped to Egypt, Japan, the Hawaiian Islands, Australia,

Holland, Belgium, Italy, and Spain. The Argentine Republic is beginning to use nitrate on the wheat acres, which it was thought at first never would need fertilization.



(*a*) (*b*)

FIG 19.—Wheat from fields—(*a*) without nitrate, (*b*) with nitrate.

Plants can make use of nitrogen only when it is present in the soil in the form of nitrates. Nitrate of soda is the only fertilizer containing nitrogen in the nitrate condition, and consequently is the most available food of this kind to give to plants. The method

of using it, however, is a matter of careful technique for the agriculturist to learn by both study and experiment. The United States Department of Agriculture has found good results in growing asparagus, tomatoes, cabbage, celery, turnips, peppers, hay, wheat, rye, and forage crops. Various State experiment and agricultural stations have advocated nitrates for sugar beets, onions, the olives, citrus fruits, tobacco, and forest trees. Undoubtedly as knowledge advances the use of nitrate of soda will be extended even further in this direction, and intensified agriculture in this country will be as definite a field of profit as it is in Belgium.

The nitrate salt as exported from Chile has other uses besides that in giving food to plants. Its chief additional value, however,

FIG. 20.—Bags of nitrate ready for shipment.

is in the manufacture of nitric acid, which is an essential in many industrial arts, but especially in the manufacture of nitro-explosives and smokeless powders. About $2\frac{3}{4}$ pounds of sodium nitrate are required to manufacture 1 pound of nitrocellulose. In the United States alone, in 1900, over 3,000,000 pounds of smokeless powder were manufactured, and the total of this product is growing rapidly. It may be seen, therefore, how enormous must be the consumption of the salt, and how dependent the world is upon the supply from Chile.

What effect the completion of the Panama Canal will have on the shipping of nitrate can be determined only when that waterway is actually open to navigation. Iquique, the great nitrate port, is

2,267 miles from Panama, or 4,296 miles from New York, and 7,015 from Liverpool. Approximately speaking, the gain to Europe of the Panama route over that round the Horn is 3,000 miles. Nitrate is "dead freight." The United States merchant marine should apply to this case the lesson of international commerce by sending return freights of merchandise for the nitrates received from Chile.