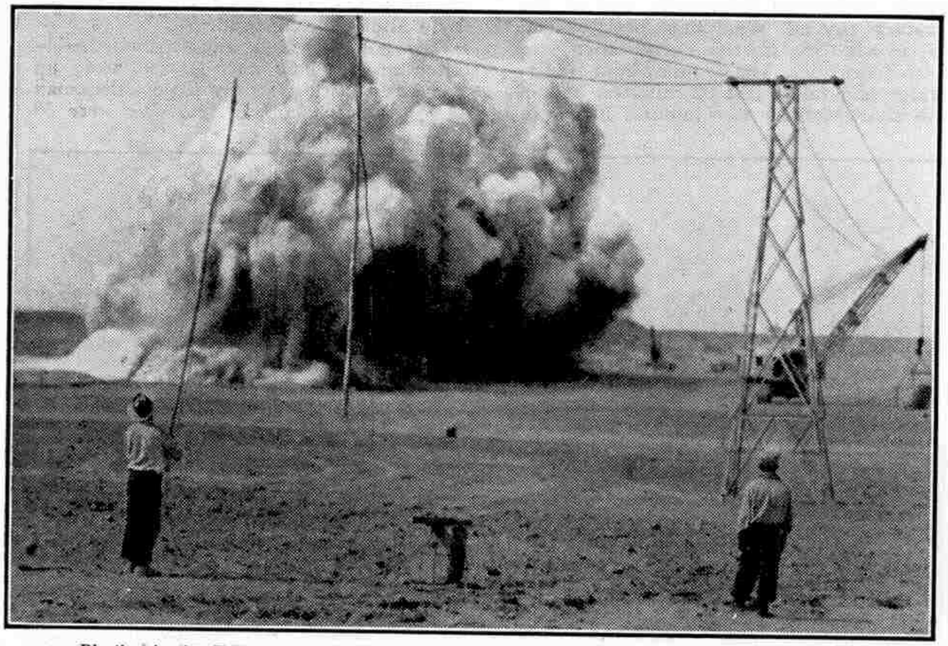


Blasting in the Chilean nitrate fields. The necessary current is supplied through overhead wires.

Fertiliser Found in a Desert

The Romance of Chilean Nitrate

ONE of the laziest substances that we know is nitrogen, the invisible gas that constitutes about four-fifths of our atmosphere. It has a decided preference for living alone and free, and it unites directly with other elements only when driven to it by really extreme measures. For instance, it only forms a union with the oxygen of the air when it is stirred up by a violent electrical discharge, such as a flash of lightning. This reluctance to keep company with other elements gives nitrogen a really sensational place in chemistry. There are various ways of making substances containing the gas, but it is so determined to follow a lone course that many of its compounds explode violently and liberate it on the slightest provocation. Among them are nitro-glycerine, T.N.T. or trinitrotoluene, and nitrogen iodide, the last of which when dry blows up with a terrific roar when a fly walks over it, throwing out clouds of iodine along with the nitrogen set free.

This sluggard element can be made a splendid servant, however. Growing plants need it, and the farmer who wishes to grow abundant crops must provide it for them. Although it is present in the air, within easy reach of the plants, there are only a few of these that have the power of seizing it for themselves with the aid of bacteria in the soil, often attached to their roots, which transform the gas into salts that they can take up. These plants belong to the pea and bean family, and farmers include some of them in their crop rotations in order to increase the quantity of nitrogen in the soil. Other plants have to be fed with nitrogen compounds that dissolve in water so that their roots can absorb them.

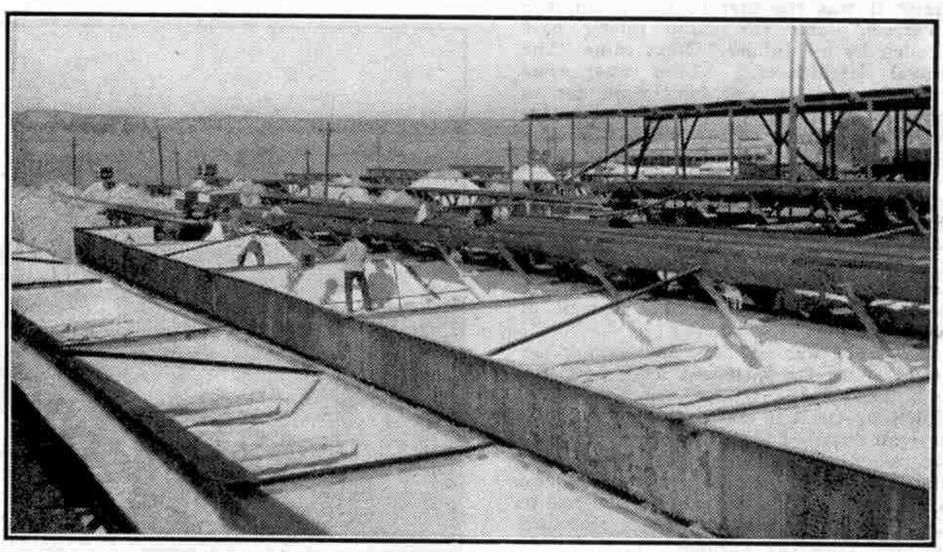
One of the most important of the fertilisers containing nitrogen is Chilean nitrate of soda. This reaches food growers in the form of white crystals or granules, and at first glance there is nothing very mysterious or romantic about it. There is a very interesting story behind its production, however. Chile is a long narrow country on the Western Coast of South America. It stretches from the southern tip of the continent, which approaches the Antarctic, to a point well within the tropics; and a short journey across it by rail carries one from hot coast lands into the icy regions of the heights of the Andes. Its climate therefore offers astonishing contrasts. There are places where the rainfall is heavy, in some places amounting to 200 in. a year; but in the north there is a desert region where years can pass without the fall of a single drop of rain.

This desert region is found on a plateau that forms a kind of step in the sharp rise from the coast to the snow-capped peaks of the Andes. It is a grim and forbidding area where day by day the Sun's rays pour down from a cloudless sky and mirages delude the traveller into the belief that in the distance there are lakes, rivers and marshes. No plants grow there, and wild animal life cannot exist.

There is a tradition that about 200 years ago two Indians travelling across this desert dug a hollow in the ground and in it lit a fire to warm themselves. Suddenly they were startled by blue sparks and flames, and were horrified to discover that the earth around their fire was crackling and sending forth strange lights. In their terror the men ran away to a neighbouring township, from which they returned with a priest, armed with a vessel of holy water to exorcise the devils they had angered.

Later the priest took some of the ground back with him and examined it, to find that it contained what he thought was saltpetre. This he knew to be used in the making of gunpowder, and he was able to reassure the Indians who had summoned him. Then he threw the remainder of the material into a corner of his garden. Some time later he was astonished to find that plants grew with astonishing vigour in the part of the garden where he had dumped the mysterious earth, which clearly was responsible for the improvement. Further trials proved the wonderful fertilising power of the desert ground, and this was the beginning of what eventually became a world-wide trade in Chile saltpetre.

The nitrate in the desert region is concentrated in a strip of land more than 300 miles in length and 12 to 18 miles in width, where it is hidden beneath two layers, one a few inches in thickness, and a thicker one in the form of a hard rocky mass that can only be broken up by means of explosives. The nitrate or "caliche" bed below these layers is normally white or grey in colour, but various impurities may make it violet, yellow, green or red. It varies in thickness from about 18 in. to 12 ft. or 16 ft., and the proportion of nitrate in it is from about 7 to 80 per cent.



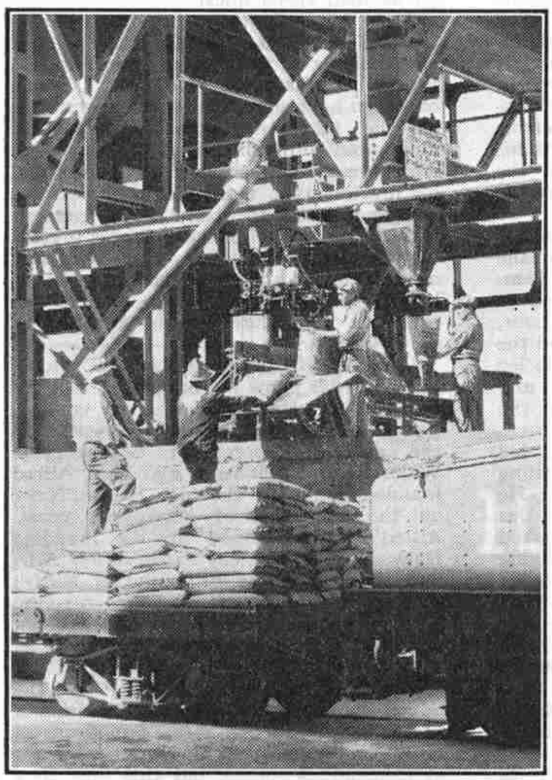
Making preparations to remove Chilean nitrate from the tanks in which it is crystallised. The illustrations to this article are reproduced by courtesy of the Nitrate Corporation of Chile Ltd., London.

It seems strange that such a desolate region as the nitrate fields of Chile can be so full of a material that farmers all over the world use to produce abundant crops. The absence of rain has been a great factor in the preservation of the nitrate, for this is readily soluble in water and would have been washed out of the soil long ago if the rain-bringing clouds sweeping across South America were not deprived of their moisture in their passage across Brazil and the Argentine, and the last upward rush over the towering Andes.

The land was not always arid. At one time it was probably covered by a sea, and it has been suggested that the nitrate was formed by the decomposition of great masses of seaweed left behind when the water evaporated. Seaweed is rich in iodine, and the fact that Chilean nitrate contains a proportion of this valuable element lends support to the belief that the beds were formed in this manner.

One of the most valuable features of Chilean nitrate is that it contains small proportions of rare elements that we now know to be essential to plant growth, although in many instances the proportion required is too small to be detected except by the most delicate of all known tests. For instance, in addition to iodine it contains minute proportions of zinc, which prevent malformation of leaves; of manganese, which banishes what is known as "grey speck" in oats; and boron, the presence of which is necessary to cure certain diseases of the sugar beet.

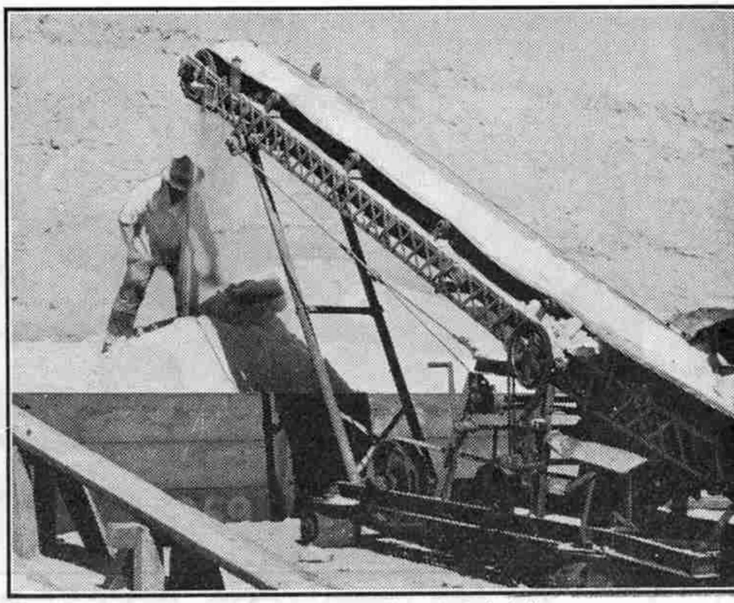
Extracting the caliche is a form of mining. Bore holes are sunk through the protecting layers to a level beneath the caliche itself, and the ground is blasted by means of powder fired by time fuses.



Bagging, sewing and loading granulated nitrate ready for shipment.

The material is then carefully sorted by workmen, who break up large boulders by means of iron bars and by driving steel wedges into them. The pieces of caliche are carefully cleaned, and samples are tested by sprinkling the material in powdered form on the wick of a lamp. The inspectors who do this are so skilful that they can estimate the proportion of nitrate to within two or three per cent. by the extent of the fire from the powdered caliche.

When the caliche is at a depth of 15 ft. or more the open work method of extracting it is not used. Instead it is mined by underground methods, starting from a shaft up which the ore is raised to the surface in buckets hauled up by mule power, using a kind of block and tackle arrangement. Then it is carried on mule carts or motor lorries to the refineries. Formerly the refineries were within easy reach of the nitrate fields themselves, but as the industry has grown, and narrow seams have been worked out, the distance over which the raw material has to be carried has been increased and to-day it may be over 12 to 13 miles.



Loading cars with crystalline nitrate in bulk.

Water is used to extract the nitrate from the caliche. In the refineries producing crystalline nitrate it is first crushed and then dissolved in water in batteries of tanks that hold from 80 to 100 tons each, and steam pipes raise the temperature until the mass boils. After 24 hours the solution is drawn off into tanks where the clay, sand and slime settle, leaving a clear liquid that is pumped or run into cooling tanks. This liquid contains a small proportion of salt and other chemicals, but as cooling proceeds the nitrate crystallises out in comparatively pure form, forming glistening crystals that have been described as "white gold of the desert." These are shovelled on to one side of a sloping tank to drain, after which they are further dried on sloping benches and transferred to the storage yards, which are flat terraces with concrete floors. There they are exposed to the weather, but in perfect safety, for rain never comes.

These methods sufficed when the richer caliche was being worked, but to-day material containing smaller proportions of nitrate is mined and is used in the modern process of making granulated nitrate. Highly mechanised methods are employed. The useless material forming the overburden is drilled and blasted, and then removed by electric drag scrapers. Bore holes for blasting are driven down by means of drills, and as many as 500 to 600 blasts are exploded at the same time. When the overburden has been removed the caliche itself is broken up by further blasting, and electrically-operated shovels, each capable of lifting five tons at a time, load the chunks into 30-ton trucks that are hauled to the refinery by electric locomotives.

Some of these chunks may weigh as much as 3 tons each. They are fed into giant crushers built underground to a depth of 18 ft. The bowl of one of these crushers is about 12 ft. in depth and diameter, and the revolving pestle in the centre itself weighs about 20 tons. Other crushers reduce the small fragments produced, and the final product is carried on a travelling belt to the extraction tanks, passing under a powerful magnet on the way in order to make sure that no fragments of metal remain in it that might damage the machinery. The material dealt with is so dry that over the primary crushers there is always a heavy column of dust visible at a distance of 50 to 60 miles.

In producing granulated nitrate water warmed to a temperature of about 104 deg. F. is used, and the solution is cooled by refrigerating plant. Thus much less fuel is needed than when making crystals, and all the heat required is obtained from the exhausts of the huge Diesel engines that supply power for the plant. This process is carried on in enormous concrete tanks, each holding 10,000 tons of caliche; and the solution from the tanks is circulated through tubes of small diameter surrounded by refrigerating material. The crystals that fall from the tubes are dried and fed into furnaces in which the nitrate is melted and made to flow along a metal channel into heated pots. There pumps throw it in the form of a spray into high chambers built of steel plate and cooled by air circulation, and it solidifies as small round pellets when it meets the cold air.

More than 91 million tons of nitrate have been produced in Chile since 1830. Naturally there have been fears that the deposits would become exhausted, and as long as 30 years ago the prediction was made that they would be worked out early in the present century. Nature has been bountiful, however, and recent surveys have shown that in the nitrate desert there is enough material to supply the farmers of the world for many generations to come.