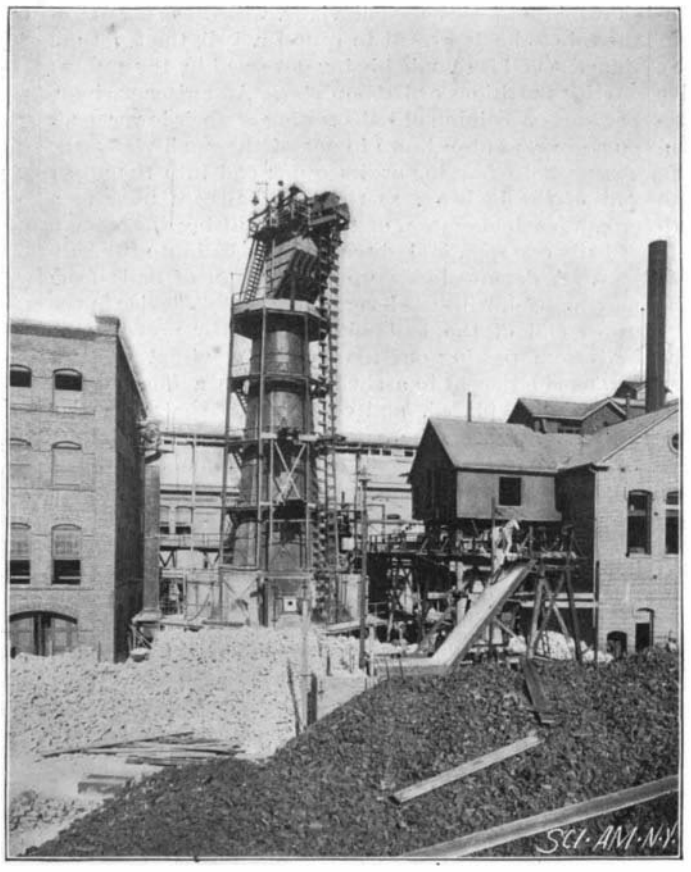
THE MANUFACTURE OF BEET SUGAR.

About midway between Los Angeles and San Bernardino, and well in the center of the famous orange and lemon belt of Southern California, is to be found one of the most promising industrial establishments in this country. It was but a few years ago that the site now occupied by the Chino Valley Beet Sugar Factory and the surrounding beet fields formed part of an extensive stock ranch, but as the result of the decline in the demand for live stock the owner was led some years ago to investigate the quality of the soils for various crops, and discovered that he could raise beets having a high percentage of sugar, and that he could secure a heavy yield of this crop to the acre. This very important discovery led to negotiations which resulted in the erection by the Oxnard Company of the Chino Valley beet sugar factory, which commenced active operations in 1891 and has increased its output steadily ever since. The land in the vicinity is divided up into beet farms of from five to twenty-five acres in extent. These have been purchased from the company on easy terms, and the factory is now the central point in a prosperous community, which has the certain prospect of good crops, convenient market and a steady income.

Before entering into a detailed description of the process of manufacturing sugar from beets, it will be well to draw attention to the fact that contrary to the popular notion that the sugar cane is the source of nearly the whole of the world's sugar supply, it really affords much less than half this amount, more than half or fully sixty per cent of the total being manufactured from the sugar beet. So exclusively has sugar become associated in the public mind with the sugar cane that it is popularly supposed that no other source, such as sorghum, maple trees or beet, can produce the genuine article of the first quality. As a matter of fact the only difference between refined sugar from beets and refined sugar from any other source is in name.

The beet which is used for the manufacture of sugar must not be confused with the common beet with which we are familiar on the dining table, although they have a common ancestry. The sugar beet with its high percentage of saccharine matter is the outcome of long years of careful culture. It is stated that some of the present varieties, which, under favorable circumstances, will produce from fifteen to eighteen per cent of sugar, are instances of what careful culture will do, the same varieties producing a century and a half ago only six per cent of saccharine matter. The improvement of the beet has been carried out on what are known as beet seed farms, of which there are several in Germany and France; and the selection and improvement of the best beets are carried out with a wonderful amount of care and patience. The varieties best known in this country are the Vilmorin Improved and the Kleinwanzleben. The percentage of sugar in the former is about 16, and it will yield from 12 to 16 tons to the acre. The latter is not so rich in sugar, but produces a heavier crop.

From the time the seed is put in the ground to the time when the beets are ready to harvest is from four to four and a half months, the crop which is planted at Chino early in February being ready for harvesting in June. The beets are hauled in wagons from the surrounding farms and are stored in four huge bins or sheds, which have a capacity of 1,500 tons. Between the bins are three elevated driveways for the wagons, and the whole load is dumped into the bins at one operation by lifting one end of a rope net which covers the bottom and is permanently fastened to one side of the wagon. Along the bottom of each flume extends a cement trough, through which a stream of water flows and discharges into the factory. The bins are provided with a sliding bottom, which can be drawn out to allow the beets to fall into the trough, in which they will be floated into the building. A similar flume is arranged alongside the railroad track for handling the beets which are brought in by rail.



THE LIME KILNS.

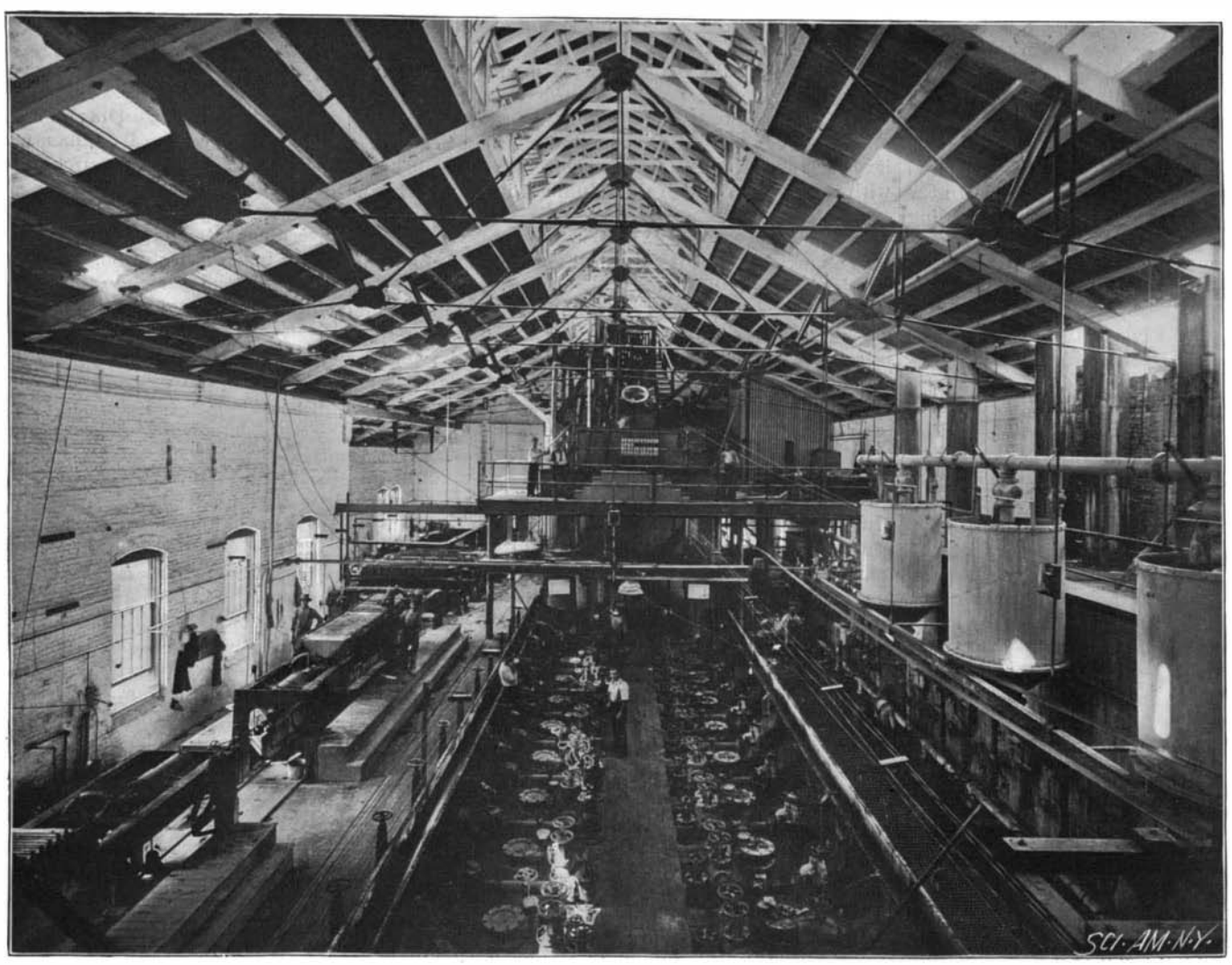
These bins are so constructed that the beets receive full ventilation on the sides and from below; but it is always the aim of the company to use up each day's delivery as it comes, much better results being obtained when the beets are worked up fresh and crisp than when they are run into the factory in a "wilted" or heated condition. The beets are ordered in for daily delivery by the head agriculturist and his assistant in such a systematic manner that the amount brought in is usually a few tons in excess of or below the 800 tons that are worked up in the factory in each twenty-four hours. On floating into the factory the beets are passed into a large trough, where they are freed from the coarser dirt, and then they are carried to the washer, a huge perforated cylinder in which they are spun around and further cleansed.

They are now carried by an elevator to the roof of the building containing the diffusion batteries, etc., and unloaded into the hopper of a large automatic weighing machine, which as soon as it has received a ton of the beets drops them into a slicing machine, in which a number of swiftly revolving, serrated knives cut up the beets into thin and narrow slices which are known as "cosettes." In slicing the beets an effort is made to cut as many as possible of the minute cells in which the saccharine matter is stored. The "cosettes" are now fed into the diffusion battery, which will be noticed ranged down the center of the room below the level of the slicing machine. The battery consists of a series of large vessels in which the juice is extracted from the "cosettes" by passing a stream of water through them. The water passes in at the head of No. 1, is forced down through the mass and passes out through a pipe at the bottom. It is then led to the top of the next vessel, and together with the juices washed out of No. 1, it circulates through the "cosettes" in No. 2. The water with the juices from Nos. 1 and 2 is then drawn off from No. 2 and passes down through No. 3, the process being carried on throughout the whole battery. The solid residue from the battery is then placed in a press, and after it has been relieved of its moisture it is used as feed for cattle.

The juice is now pumped into carbonation tanks, where it is treated with trisaccharate of lime, the lime being precipitated by means of carbonic acid gas. From the carbonation tanks the juice is taken to the filter presses, which are ranged on the opposite sides of the room. These consist of a series of iron frames upon which are hung jute filter cloths. The frames travel upon a pair of steel I beams, and are pressed together by means of a powerful screw. The purified juice passes through the cloths and flows into a side trough, the carbonate of lime and other impurities remaining between the cloths in the form of soft doughlike cakes. A part of this residue is set aside for use as a fertilizer for the next season's crop of beets, and a part of it is placed in transporting scrolls, which deliver it into a drier, from which it is cast into a rotary kiln. Here it is reburned to oxide of lime, and in this form is available for use over again in the carbonating tanks. By this means about two-thirds of the original lime is re-used in the process, a saving of sixty-six per cent of the lime rock.

It should be noted here that the Chino factory is not turning out any molasses; all molasses produced in one day is put through a separate process in which the sugar of the molasses is precipitated by means of powdered lime in the form of a trisaccharate. This trisaccharate is used in place of ordinary lime as a clarifier of the juices of the next day's operations. In this way all sugar of the molasses is returned to the juices, and all the sugar contained in the juices is turned out of the factory as standard sugar ready for the world's markets.

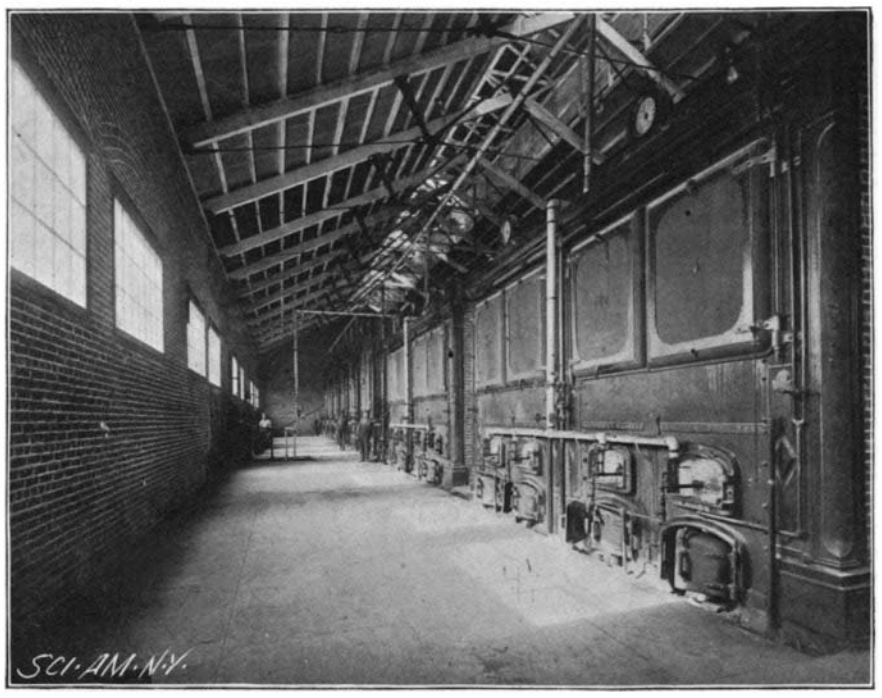
After it has passed through the filter presses, the juice is given a second treatment with lime and carbonic acid gas, and after being treated with sulphur fumes, it is filtered through bags and concentrated in what is known as the "quadruple effect," which is nothing more or less than a set of huge boilers where the surplus water in the juice is boiled off, the "thin juice," of



THE FILTER PRESSES, DIFFUSION BATTERIES AND CARBONATION TANKS.

about 12° Brix, being converted into "thick juice" of about 55° Brix. The thick juice is subjected to a further treatment of sulphur fumes and bag filtration, and the sirup is then ready for crystallization in the vacuum pan. This is a large vessel heated by a coil of copper steam pipe in which the sugar is crystallized, these crystals, together with the uncrystallized sugar, forming a pasty mass known as "masse cuite." From the vacuum pan the "masse cuite" is run into the crystallizers, closed cylindrical vessels provided with a cooling jacket and stirring arms and scrolls. Here it is cooled under constant agitation and allowed to remain a certain length of time in order to permit of a further crystallization. It is then dropped into the centrifugal mixer and from this into the centrifugals, which are quickly revolving baskets with perforated walls in which the "masse cuite" is freed by centrifugal force from the adhering sirup, the sugar crystals remaining in the basket. The crystals are then subjected to a series of washings until they acquire a perfect whiteness, after which they are sent through a revolving drum, heated by steam, and "granulated." From the drum the snowy product is passed through sieves and sacked ready for the market.

Before leaving this very interesting subject, it should be noted that the Chino Valley factory and also that at Norfolk, Neb., are at present the only two factories in existence which are able to turn out all the sugar contained in the beet as standard granulated sugar, and to do this without turning out any other sugars, not even molasses.



BOILER HOUSE—OIL FUEL BROUGHT IN BY GRAVITY FROM DISTANT WELLS.

For the data contained in the present article our thanks are due to Mr. Henry T. Oxnard, the president of the Chino Valley Beet Sugar Company, to Mr. N. R. Cottman, the manager of the factory, and to Mr. W. Baur, of the Oxnard Construction Company.

Salvage Appliances.*

Whenever a large vessel was unfortunately sunk, as in the case of the Grosser Korfuerst and the Victoria, all kinds of wild schemes were propounded for the easy salvage of the vessels, no matter what the weight of the vessel might be or what depth of water it was lying in. In the case of the Victoria, sunk in 70 fathoms of water, it had been seriously suggested to freeze, by chemical means, the water inside her; and in the case of the Vanguard it had also been proposed to lift her by enveloping her in a huge canvas sheet and pumping air inside the vessel, thereby expelling the water and raising her to the surface.

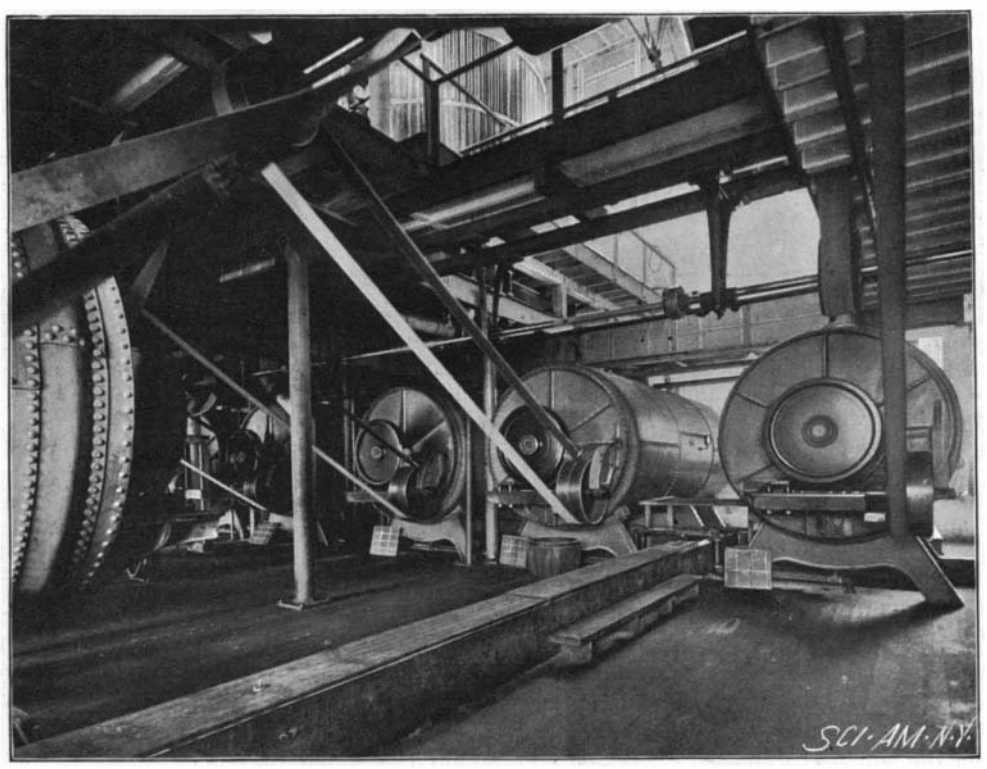
Wreck raising might be classed under two heads, namely, theoretical and practical. Among the former was, first, the plan of lifting with air bags placed inside the sunken vessel, which had been successful with a few small vessels, the Prince Consort, paddle steamer of 607 tons gross, sunk at Aberdeen, being the largest. The remainder of the vessels lifted in this way had not exceeded 200 tons, and many attempts had resulted in complete failure. The air bag system would be an excellent one practically, if all vessels were empty or in ballast, which foundered in divable water, and the decks were built to withstand the strain necessary, and there were no projections such as bolts, beams, etc., or frictional movements, such as were set up by tides or currents, causing fatal injury to the air bags, to say nothing of the rapid deterioration of plant of this description.

Another plan which has been attempted was that of using cylindrical pontoons constructed for the purpose, sinking them to the bottom to lie alongside of the sunken vessel, and having attached the pontoons by chains or wires passing round the hull, the water was pumped out, thus giving buoyancy to the pontoons. This plan would be simple and perfect but for the fact that it was impossible for the divers to do a tithe of the work which this plan imposed upon them.

There were only two methods which had been found practicable, he said, namely, first pumping, and stanking and pumping, which might really be called one plan, as pumps were the main factors; the second, lifting by means of wire ropes and camels. The first of these plans could be, and had been, very successfully applied; and, excepting on the Thames, might be said to be the only way in which attempts were made to salve vessels of any size. The practice was, in the case of a sunken vessel with no great depth of water on her decks, for divers to carefully shore up her decks with stout timber, so that they would withstand the pressure of water from above when the water was pumped out from under them; all hatches and deck openings had to be carefully covered with strong canvas and planking, and holes were cut in the covers just large enough to allow suction pipes to pass into the ship, smaller pipes to admit air, and when all was ready with the pumps on vessels moored above the wreck, the water was pumped out. If everything held good, the vessel came up; but great care was required to prevent her capsizing when she began to lift. If the depth of water should be too great for the above method, the ship had to be stanked—that is to say, balks of timber had to be bolted or secured to her waterways, thick planks had to be fastened to the balks so that they came above water, then a platform or deck constructed across, and the whole made watertight with canvas or oakum—the water pumped out, and the vessel, as she lifted, pulled into shallower water. In this way the Austral and Utopia had been salved, and it might be said to be the only practicable way in which very large steamers could be salved. Of course, it was a costly, risky, and tedious method, and though it was necessary for very large vessels, there was no necessity for applying it to smaller vessels, that is to say, for the vast majority of steamers or of sailing vessels, as vessels up to three or four thousand tons could more expeditiously and cheaply be raised by means of wire ropes and camels than by any other method, and that without the removal of cargoes. In the case of most other methods the cargoes had to be removed.

As regards the method of raising vessels by means of camels and wire ropes, he said that the method carried little or no element of chance with it, and the only difficulty was in getting the ropes under the vessel. He thought, if this method was more generally employed, most of the sunken ships might be recovered, which would result in a saving to the owners, and in many cases would serve to remove obstructions and dangers to shipping. He considered the system of removing dangerous sunken wrecks by means of explosives as barbarous. On the Thames this method was not, however, employed, pontoons being used instead. These pontoons were secured by wire hawsers to the sunken vessel at low water, and as the tide flowed the hawser took the weight off the vessel, the pontoons sank to their displacement, and the cortege was towed to the most suitable place for beaching.

Something better than this plan has been a long-felt want, says the Marine Record, especially in places where the tidal range was small, or nearly absent, and in endeavoring to fulfill this requirement the author's appliances (the models of which were exhibited) had been devised.



A SET OF CRYSTALLIZERS.

Occupations of Americans.

Much interesting data about the occupations of the American people is given in the bulletin of the Eleventh Census recently made public. It shows that the total number of people engaged in occupations of all kinds in 1890 was 22,735,661. Of the whole number of working people the females form 17·22 per cent. Divided by classes the working people of the country are as follows: Agriculture, fisheries, and mining, 9,013,336; professional, 944,333; domestic and personal service, 4,360,577; trade and transportation, 3,326,122; manufacturing and mechanical industries, 5,091,293. Considerably more than four-fifths of the illiterate male population of the country and over one-fourth of the illiterate female population are working. Over 59 per cent of the workingmen are married, over 37 per cent single, over 3 per cent widowed, and one-quarter of 1 per cent divorced. In manufactures and mechanics the carpenters and joiners, numbering 611,482, make up the greatest element, with dressmakers and milliners following, with 499,690. There are a little over 1,000,000 bookkeepers, clerks, and salesmen, 696,658 merchants and dealers, 5,281,557 farmers, planters, and overseers, and 3,004,061 agricultural laborers, 349,592 miners, and only a little over 60,000 fishermen and oystermen. Professors and teachers, aggregating 347,344, form the most numerous of the professional classes. Physicians and surgeons, 104,805, come next; then lawyers, 89,630; clergymen, 88,203; government officials, 79,664; musicians, etc., 62,155; engineers and surveyors, 43,239; artists and art teachers, 22,496; journalists, 21,849; and actors, 9,728.

Sunstrokes in New Orleans.

During the last two weeks of June, New Orleans suffered from an epidemic of sunstrokes different from anything of the kind that has occurred there before. The peculiar feature of the epidemic was the exceedingly large proportion of the deaths to the prostrations, half or more than half the persons affected having died, and a considerable number of them having been found dead in bed in the morning. The total direct mortality from the heat for the week ending June 26, when the temperature was at the highest, was thirty-one from sunstroke and congestion of the brain, and for the entire hot wave, forty-three. This mortality is phenomenal in New Orleans, which is but seldom a sufferer from sunstroke. Not more than once in three or four years do any deaths whatever occur from the malady, and then only two or three.

Dr. Koch on the Bubonic Plague.

Prof. Koch, the bacteriologist, has just made his report giving the result of his investigations into the bubonic plague which has been ravishing India. He says that the bacilli possess but little vitality outside of the bodies of men and animals, and adds that Prof. Haffkines' serum possesses undoubted protective qualities. Prof. Koch states that his report is founded on the results of experiments on fourteen hundred cases.

* Abstract of a paper by Capt. James Bell, Assoc. I. N. A., read before Section G of the British Association for the Advancement of Science.

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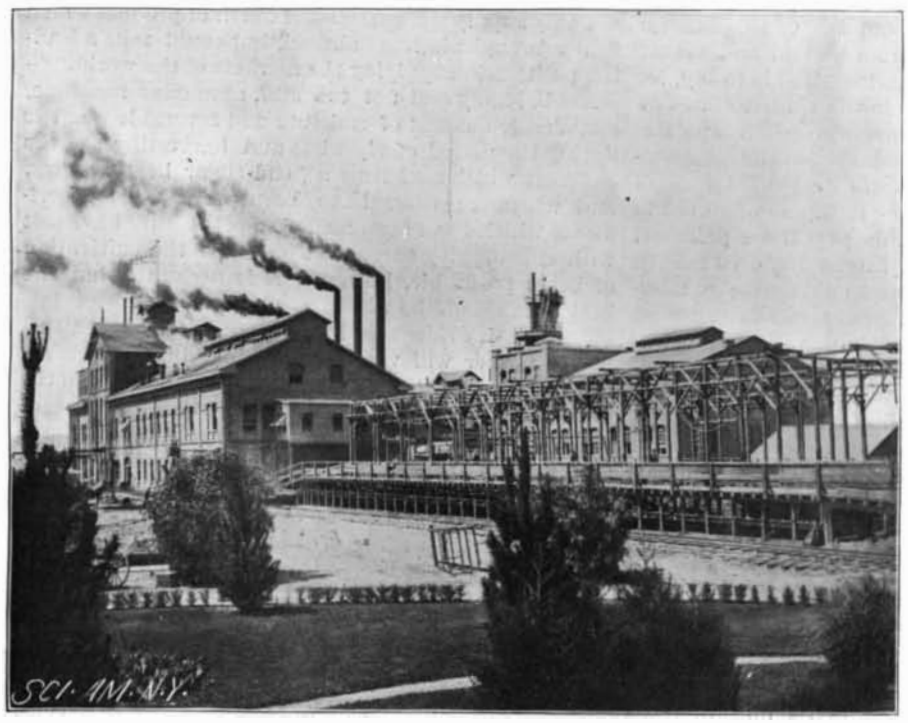
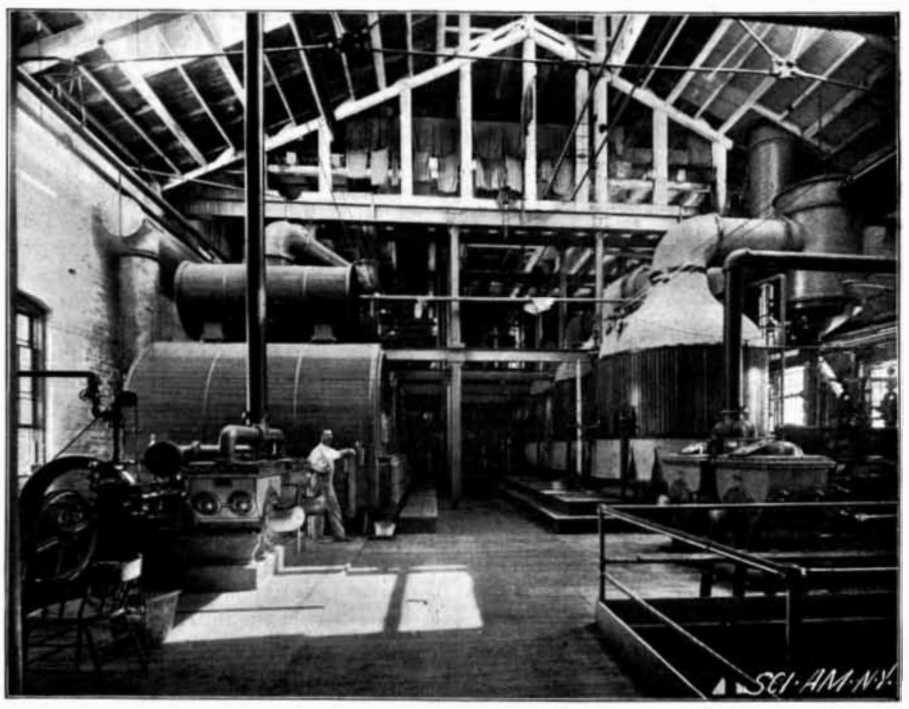
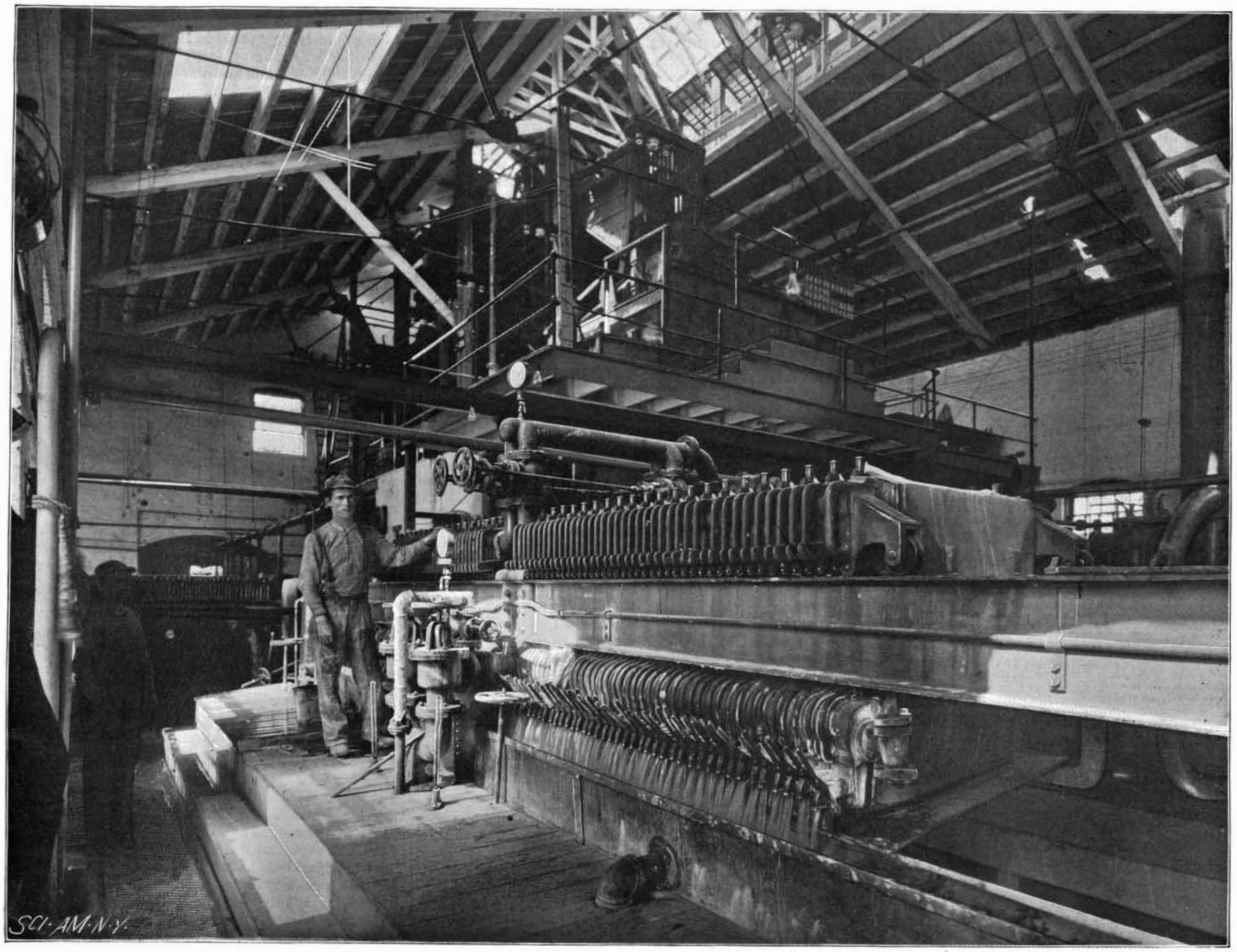


GENERAL VIEW OF FACTORY AND STORAGE BINS.



THE EVAPORATORS.



THE FILTER PRESSES—BEET WEIGHING SCALE AT THE REAR.

THE MANUFACTURE OF BEET SUGAR.—[See page 72.]