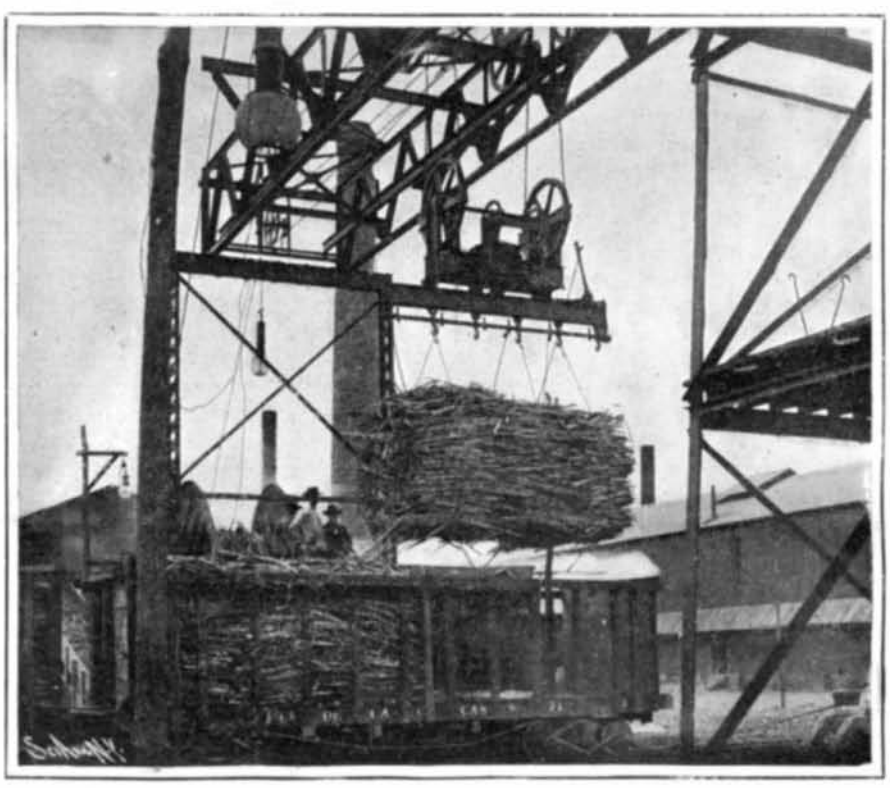
SUGAR MAKING IN CUBA.

BY DAY ALLEN WILLEY.

One result of the increase of American interest in Cuba since the close of the Spanish war has been the development of the sugar industry on a very extensive scale. In fact, the number of sugar plantations and mills operated by people from the United States, and the enterprises projected, indicate that the annual tonnage of sugar manufactured on the island will be greatly increased in the near future, and that it will far exceed any other country in the production of this staple. Since 1902 the increase in the output has been no less than 30 per cent. At the present time it is contributed by 179 estates or plantations, of which two have an annual production of over 25,000 tons each, six ranging between 20,000 tons and 25,000 tons, seventeen between 15,000 tons and 20,000 tons, and fifty-eight between 7,000 tons and 15,000 tons.

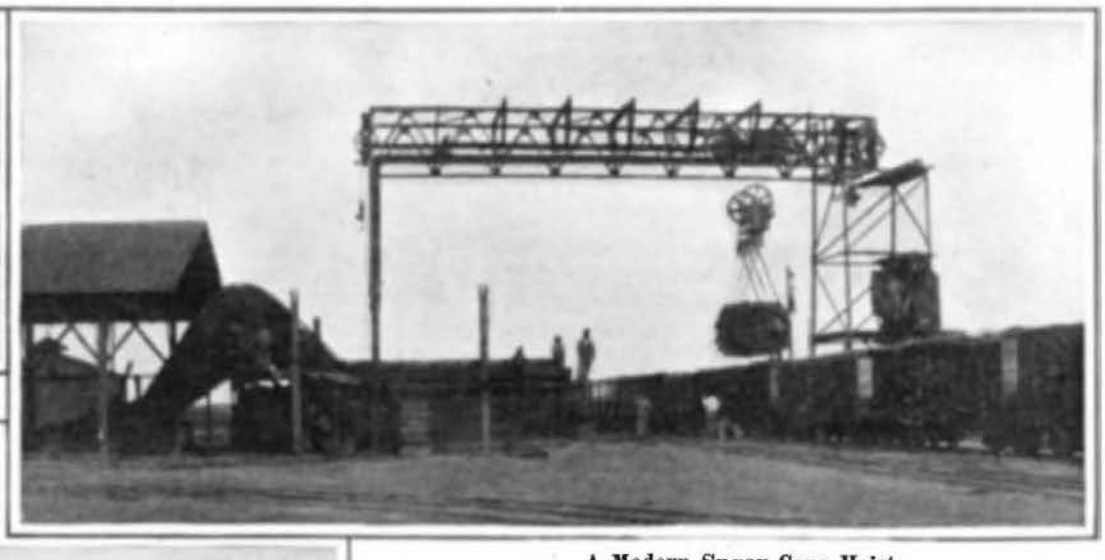
General View of a Sugar Estate Owned by Americans in Cuba.

Cane Lowered Into the Mill.



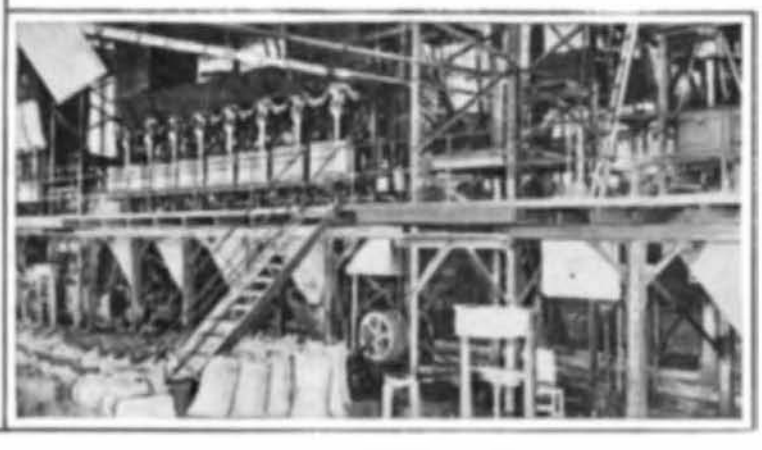
Lifting Cane From the Car.

Loading Cane on Ox Carts.



A Modern Sugar Cane Hoist.

Francisco Sugar Mill. One of the Oldest of the "Centrals" in Cuba.



The Centrifugal Separators.

According to statistics compiled by the Cuba Review in every part of the republic, the province of Havana contains nineteen estates with an annual capacity of 181,000 tons; Pinar del Rio, six representing 28,000 tons; Mantanzas, fifty-two with 362,500 tons; Santa Clara, seventy-one with 537,000 tons; Puerto Principe, three with 35,000 tons; and Santiago, twenty-eight with 265,000 tons. The total output for 1906 will exceed 1,000,000 tons. These figures indicate how widely the industry is distributed, showing that the sugar planter has begun operations practically in all parts of the island.

One factor of superiority is the soil. It is of such fertility, that the cane field is planted at the present time only about once in ten years. Experienced American growers say that there is no necessity ever to plant more than once if care is taken in cutting the cane at harvest time, not to pull up any of the roots, as the new cane will immediately sprout from these. The Cuban cane is of such a size, and contains such uantity of saccharine matter, that ten tons are ulated to produce one ton of sugar if treated by latest mechanical processes. Consequently, a igle plantation of 1,000 acres may yield 3,000 tons the commercial article under fairly favorable conditions.

Compared with other countries producing cane sugar, it is claimed by experts in the industry that where modern methods of agriculture and manufacture are employed, the yield of a given area in Cuba will exceed that of a similar area in any other district, owing to the fertility of the soil, and especially to the fact that the climate here permits the continuous cutting of the cane and the extraction of the juice for a period ranging from 150 to 200 days—a longer sugar-making season than elsewhere. Consequently, at the larger "centrals" or sugar houses, equipped with modern machinery, the cost of production has been reduced to such a figure that, including the cost of the cane and all other expenses, it is actually less than 1½ cents a pound for the centrifugal sugar of 96 degrees standard. These figures are based upon the actual operation of one of the largest estates on the island.

The mechanical processes which have so lowered the cost have been greatly improved in recent years, so that by the present system all of the work is done by machinery at a modern "central," from the time the cane is loaded upon the plantation cars until the sugar is bagged for the refinery and the liquid residue run off into casks or into the hold of the tank steamship. In the old days of the industry the cane was unloaded and carried by hand to the crushing rolls, or transferred by means of what might be called slings operated by hand. As the refuse cane is used for fuel, and the mill must receive a certain supply continually when in operation in order to get the best results, a new device has been invented for handling the cane. It is the invention of Mr. H. J. Kiely, and consists of a trolley passing along an aerial way, from which is suspended a series of chain slings to which are attached automatic trip hooks. As the train of cane cars is moved along the track under the device, the bail of the hoisting machine is lowered over the top of the load, and the chain slings are introduced under the bottom of the cane and fastened with the trip hooks. The bottom of the car is provided with wooden strips spaced four inches apart, which form grooves through which the chains are passed under the load. The load is then raised clear of the top of the car, and while moving in the direction of the receiving hopper is automatically half turned, in order that the cane may be delivered end down instead of lengthwise. When the load is suspended over the hopper it is lowered to within a foot of the bottom of the hopper, and the attendant by controlling the machinery automatically opens simultaneously all the slings under the bottom of the load, which falls into the hopper. The slings are then raised by power, and the carriage travels back to take up another load in the same manner. The device works so rapidly that only three minutes are required to sling, raise, and discharge six tons of cane, including the operation of the trolley along the aerial way.

Thus the raw material is fed continuously to the mill through the receiving hopper or directly to the conveyor serving the crushing rolls. The "trapiche," as the Cubans term the grinding mill, is usually equipped with eight rolls, the first being corrugated. They are set at distances ranging from one-half to one-eighth of an inch apart, each roll being from six to seven feet in length and forty inches in diameter. When at full speed they make about two revolutions per minute. By this system the cane is generally crushed or macerated to such a degree that it is necessary to pass it between the rolls but once, as fully 75 per cent of the juice is extracted. The refuse or bagasse is then taken to the furnaces by means of an endless conveyor. The grinding mill is driven by steam power, the same engine actuating the cane and the bagasse conveyors, so that a uniform speed is maintained.

At present, by means of improved furnaces, or "bagazo burners," the material is burned green, or just as it comes from the conveyor. The introduction of these furnaces, and the consequent saving of time and labor, mark one of the great epochs in the progress of economical sugar making, second only in importance to that of the "triple effect" apparatus. Economy in firing the boilers is one of the greatest considerations, as will be realized when it is stated that the large centrals require for their operations batteries of boilers of from 1,000 to 5,000 horse-power.

The juice flowing from the "trapiche" is pumped either directly into receptacles called defecators, or is first passed through an intermediate apparatus called the "calentador," or heater. The object of this heater is to raise the temperature of the juice from about 80 deg. Fahr., as it comes from the mill, to 100 or 112 deg. by the utilization of waste heat, before delivering it to the defecators. The latter are cylindrical copper vessels, with semi-spherical bottoms, placed in cast-iron jackets, which leave a space between them and the copper bottom. Into this space steam is admitted and the juice heated. The defecators vary in size, having generally a capacity of from 1,000 to 1,300 gallons each, and are arranged in line. A capacity of 1,300 gallons (nearly 180 feet) is sufficient to treat the juice obtained from 100 tons of cane ground in the twenty-four hours.

While the defecators are being filled to within a few inches of the top, steam is gradually admitted. Before reaching the desired level, a solution of lime is added, and the whole is thoroughly agitated. The lime used must be of the finest quality; about 7 to 15 pounds are necessary for a defecator of 1,000 gallons capacity. The best temperature at which to introduce the lime is about 190 deg. Fahr. It takes about twenty minutes to fill a defecator, and, with steam of 55 to 60 pounds pressure, in fifteen minutes more, or a total of thirty-five from the commencement of operation, scum, or "cachaza," begins to form on the surface and the steam is shut off. The juice is thus separated into three layers, the lowest being very thick and turbid, composed of precipitates of insoluble salts, earthy matter, lime, etc. The volume of these substances varies much, according to the quality of the cane and the manner in which the defecation has been conducted, amounting generally to from ¼ per cent to 2 per cent of that of the crude guarapo or syrup. On the surface are albumen, lime, and woody matter. Between these two lies the purified juice, clear, transparent, and of golden color. The solution is allowed to remain ten or fifteen minutes, after which a cock is opened, which allows the turbid fluid at the bottom to be drawn off into a receptacle. When this is done the direction of the cock is changed, and the purified juice is drawn off into a different receptacle until the scum is reached, when that also is drained away separately. The defecator being now empty is ready to receive another charge, and the routine is repeated. The entire round of operations consumes about one hour for each charge.

The scum and turbid residue still contain a considerable portion of juice, of which it is desirable to extract as large a percentage as possible. To this end the scum is led off to scum kettles—rectangular iron tanks furnished with serpentine steam pipes. In these the scum is subjected to a defecation similar to the first, with certain modifications. The clear juice derived from this second treatment is added to that obtained from the first. The remaining scum is then passed through a filter press, and nearly all of the remaining juice is squeezed out and also added to the previous product.

The grosser impurities of the juice, amounting to about 40 per cent of its total weight, having been eliminated by the defecation, the next step in the treatment is concentration by evaporation. This is accomplished in the triple or multiple effect apparatus, which consists of three or more cylindrical vessels, into which the purified juice is delivered from the defecators. In these vessels a vacuum is formed by means of a condenser and air pump. Into the first vessel exhaust steam from the engines and pumps is admitted, this containing enough heat to cause the juice to boil, as atmospheric pressure has been removed. The hot vapors produced by this ebullition are passed over to the heating surface of the second vessel, causing the juice which it contains to enter into ebullition also. The vapors from this second vessel are, in turn, passed over to the heating surface of the third, or fourth, with the same result. This series of operations recalls that of the triple-expansion steam engine, the object in both cases being the economy of heat.

There are several indispensable accessories to this process, the most important being the air pump. This is a heavy and powerful machine, and is built in both vertical and horizontal designs. The condenser, by means of which the vapors from the last vessel are condensed, is another important adjunct. Other pumps are also required—one to raise the defecated juice from the defecators to the multiple effect, and another to remove the condensed vapors and accompanying hot water produced by the action of the condenser from the hot well and deliver them to the cooling tower. These pumps may be independent horizontal engines or worked from the engine of the air pump.

After being evaporated the syrup is sometimes subjected to a clarification, but opinions differ regarding the advantage of this process. When it is practised, the syrup is run into a clarifier, where it receives another boiling and addition of lime, by means of which more scum is separated and removed by skimmers. Either with or without this clarification the syrup is ready, on leaving the evaporators, to be introduced into the vacuum pan to be crystallized. There are many forms of vacuum pans, all founded upon the same principle of concentrating the syrup by further evaporation, and then adding more syrup of lower temperature to produce crystallization. This addition of colder syrup is continued until the vacuum pan is filled with crystals of sugar, containing also certain impurities and about 10 per cent of water. The whole is called the "masa cocida" in Spanish, and "masse cuite" in French. It consists of: Sugar, 75 per cent to 87 per cent; foreign matters, 15 per cent to 5 per cent; water, 10 per cent to 8 per cent.

The final operation is purging the "masa cocida," by placing it in a suitably designed machine called the "centrifugal," where, by rapid revolution, from 20 per cent to 30 per cent of the total mass, consisting of the water, impurities, and some uncrystallized sugar, is separated and thrown off as molasses. Before charging the "masa cocida" into the centrifugals, it is first delivered to the "malaxar," or mixer. This consists of an iron vessel traversed by a shaft upon which are blades. As this revolves, the hot mass is stirred up and prevented from becoming set. The mass is either delivered by pumps directly from the vacuum pans to the mixer, and fed thence, still hot, to the centrifugal, or it is allowed to stand and cool for two or three days before being placed in the mixer. In this latter case the solidified mass is first broken up in a special machine called the "triturador" before being placed in the mixer. This process is called "cold purging."

When the mass is charged in the centrifugal, the latter is made to revolve, at first very slowly, but more and more rapidly up to 1,000 or 1,500 revolutions per minute. By this rapid motion all the molasses is thrown off in from one to fifteen minutes, according to circumstances, and the motion is then gradually arrested. The sugar that remains is known as "first sugar," of 96 per cent polarization, and can be placed at once in bags for the market. It may amount to about 65 per cent of the total "masa cocida." The residue is placed again in the vacuum pans, and subjected to a treatment similar to that already carried out, with certain modifications. This results in the production of "second" or "molasses sugar," after going through the centrifugal again. This second sugar will be of from 85 per cent to 90 per cent polarization. In some plants the second residue is passed again through the vacuum pans, but generally it is distilled into rum. The result of the whole treatment may be as follows: "First" sugar, 65 per cent; "second" sugar, 9 per cent; molasses, 26 per cent.

As we have intimated, some of the most extensive plants in the world for manufacturing "raw" sugar are now being completed in Cuba. The principal one, and by far the largest, is located on Nipe Bay on the northeastern coast. It was designed by American engineers, equipped with American machinery, and is owned entirely by American capitalists. When all its machinery is in operation, it will have a maximum grinding capacity of 5,000 tons of cane every twenty-four hours—nearly double the capacity of any similar plant. To serve this mill 800,000 tons of cane will be required in a season. The company owns 130,000 acres of land, of which 30,000 acres will be cultivated exclusively to supply the Central, whose annual output is estimated to be at least 80,000 tons of sugar, not including the molasses and other by-products which will be secured by the processes employed. To operate the several divisions of the works, 9,000 horsepower will be necessary. It will be supplied by a battery of fifteen units of 600 horse-power each. To serve the mill and adjacent estate, fifteen miles of railroad are being constructed, to be provided with one hundred and seventy-five cane cars and seven locomotives. The cars will be loaded as well as unloaded entirely by power appliances.

Comparing boiler explosions in England and the United States, Consul Halstead stated that during the twelve months ending June 30, 1905, there were 14 persons killed and 40 injured from British steam plant accidents; in the United States 383 persons killed and 585 injured. The number of steam boilers in the United States does not exceed by more than 50 per cent those in Great Britain, so that, in comparison, the actual percentage is ten times as great in the United States as in England.