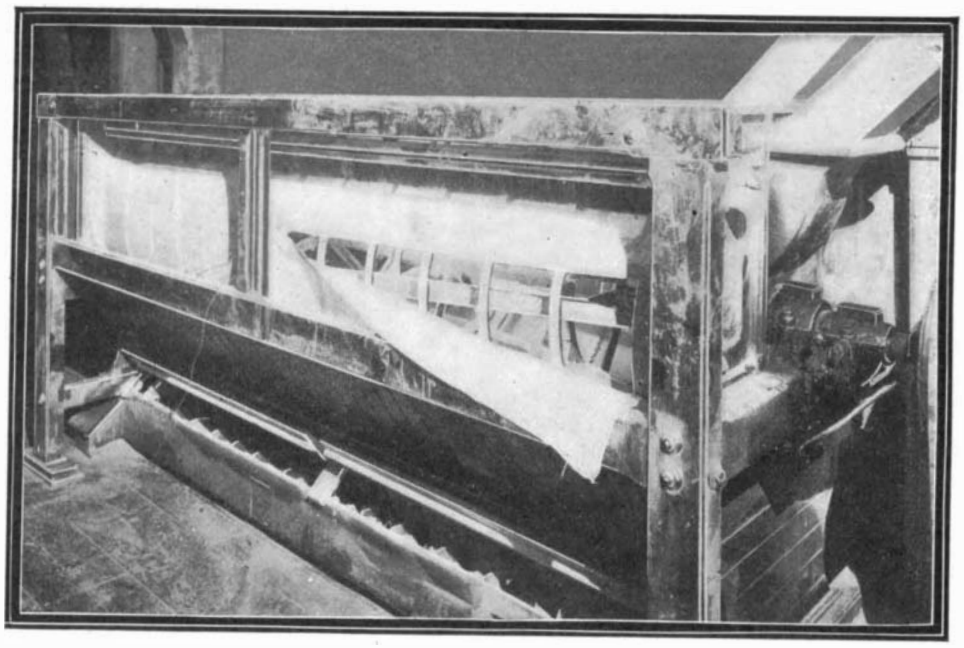
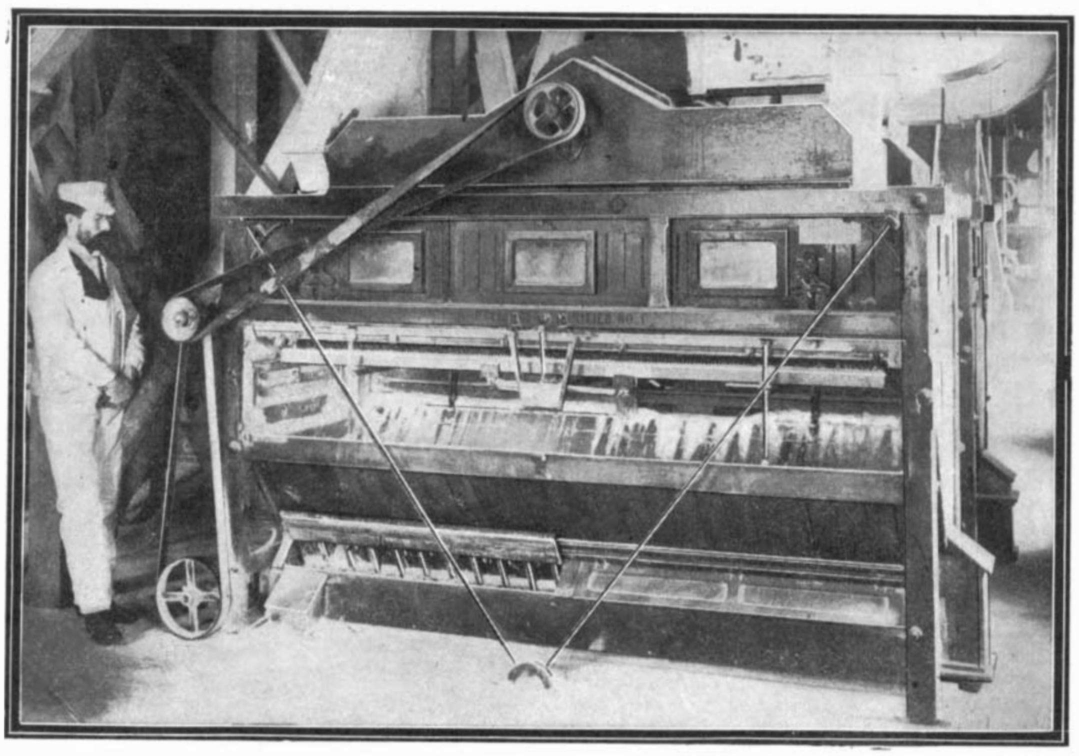
MODERN FLOUR MILLING.

IF it were asked what is the commonest article in daily use, the answer would be "bread;" and its supreme importance is indicated by the fact that in all ages it has been considered as the symbol of food. The milling of cereals is of great antiquity, and it is to Egypt, that great granary of the ancient world, that we owe the manufacture of flour, which was first brought to comparative perfection in the Nile Valley, and we know that in Roman times it was the great center of the world's supply. Strange to say, it is only within the memory of those still living that any substantial improvement was made.

Having described in several articles the wheat farms of the West, where the most powerful agricultural machinery in the world is at work, it is time to consider how the vast acreage of wheat is made useful to man by producing a manufactured article—flour—from the raw material—wheat. We have selected the largest mills in the world, those of the Washburn-Crosby Company, of Minneapolis, Minn., which have a daily capacity of 30,000 barrels of flour, consuming 125,000 bushels of wheat a day, or over 135 carloads, the product of 10,000 acres, or 15 square miles. Before beginning the consideration of the somewhat complicated subject of milling, it would be well perhaps to consider the grain of wheat in the abstract, and the real nature of flour, concerning which there is much misinformation. Wheat is sown early in the year, as it is a peculiarly hardy grain, thriving even in the cold Northwest. The seed is forced into the plowed and harrowed ground by a "seed plow," and in a short time the germ in the kernel begins to vitalize, and shortly we see the small green shoot, indicative of the round of nature's processes. From April to August its young life is menaced by many dangers, but it is hardy, and battles with its foes—heat, cold, humidity, and insects—until at last it ripens and invites the sharp snip-snip of the reaper and binder. The threshers follow, separating the beautiful kernels from the yellow straw, thus reducing an enormously bulky crop to one which can be easily stored and transported by mechanical means at low expense. It is retained in elevators or sent directly to the mill. All wheat is not worth the same price; some farmers allow the tares to grow up, and stunt the rugged growth of the grain, or other kernels may become mixed with it. The chemist now comes in and analyzes the samples, and decides what shall be bought and the "market" fixes the price.



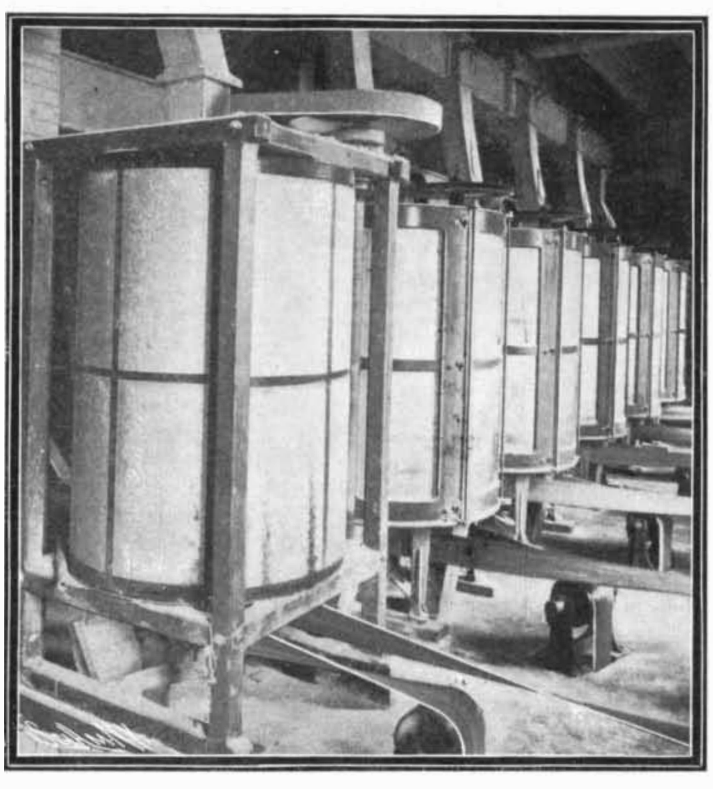
Bolting Reel for Separating the Flour from the Bran.



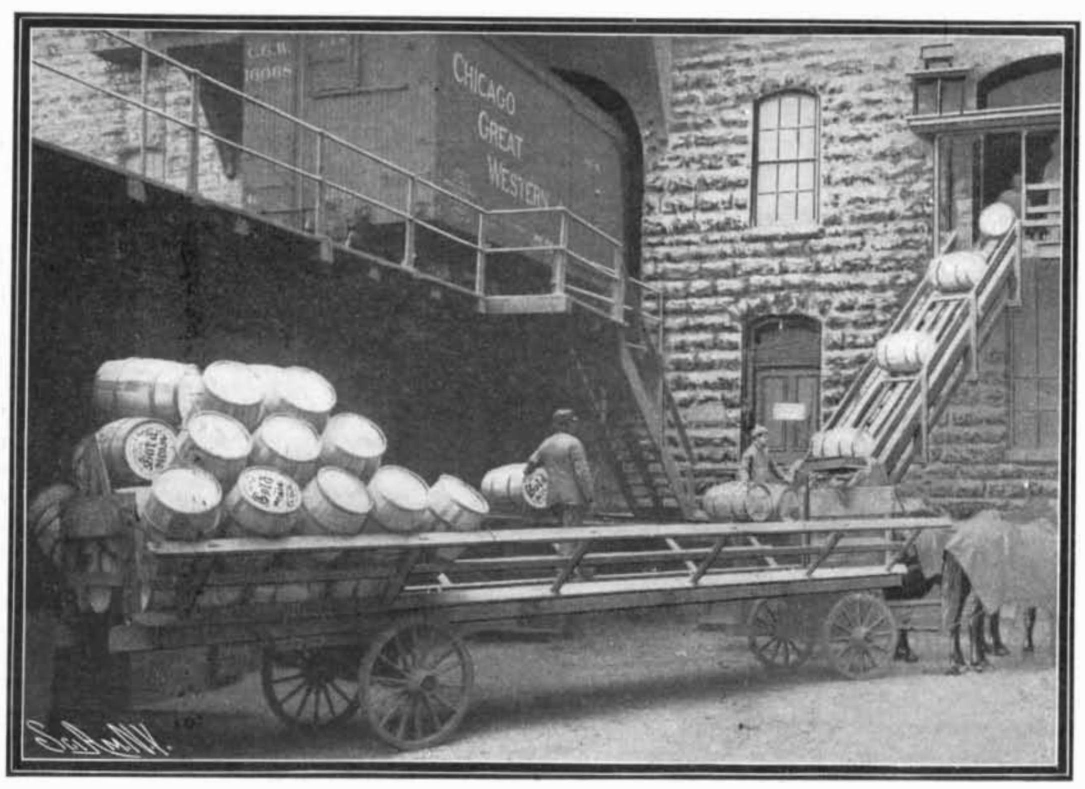
Middlings Purifier for Taking Impurities from the Crushed Grain.

The great elevators, which we have already described, may store the grain of thousands of farmers, but sooner or later the carefully-graded kernels arrive at the mills in carloads containing 700 to 1,200 bushels each. The grain doors are torn down, and with the aid of steam shovels it is precipitated into a chute, whence it is transported to the top of the mill, where it is weighed in large hopper scales by a deputy State weigher. It is then elevated into storage bins, where it is blended to secure an absolutely uniform product.

Now the wheat grain is peculiar, and is more complex than is generally supposed. Its outer hull or cellulosic coat is composed of five layers, and beginning with the outside is known as the epidermis, epicarp, endocarp, testa, and inner coat of bran. Leaving these botanical considerations to the botanist, the miller takes upon himself the entire separation of these coats from the inner starch and gluten producing cells inclosed. The "germ" is useful as a breakfast food, but not for milling, as it impairs the keeping qualities of the flour. Besides the starch cells there are gliaden and glutenin cells; the latter two when combined with water form gluten, which gives the flour much of its value as a food. The milling processes must now remove the bran coats and crush the gluten and starch to a soft powder of great fineness, and this is only accomplished by a series of operations which are interdependent. At this point, however, it might be well to call attention to a popular error. Flour is not dust or pulverized wheat; it really consists of *sharp* granules of uniform size, composed of starch and gluten, all impurities having been removed. The thought might arise as to what is known as "whole wheat" flour, which created such widespread interest a few years ago, on account of its alleged great nutritive value over white or "patent" flour. It is perfectly true that the germ and bran have food value, and if the human stomach were capable of performing all the operations of the miller, this could be utilized. There is more nutriment in the skin of the potato than in the body of it, but who can eat an equal weight of the former without the stomach's rebelling? A nutritive substance is not always a digestive one. We give flour to men and women and bran to cattle, and all thrive, but a man is no stronger than his stomach. Milling is not done to make a white flour, but to make a food product which will be easily assimilated. We left the graded and blended grain in storage bins. It



Bran Dusters.



Unloading Barrels.

MODERN FLOUR MILLING.

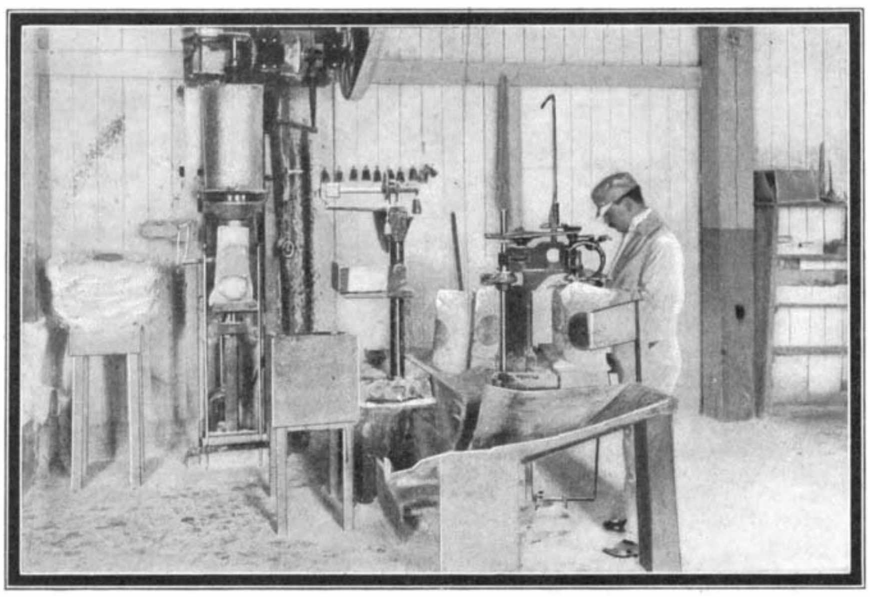
now goes into a separator, which in brief consists of two sieves of perforated metal, those in the upper one being large enough to allow the wheat to pass through, while the largest seeds, such as barley, oats, etc., which are larger than the wheat, are retained as "screenings." The perforations in the lower sieve are smaller than the wheat kernel, so that all the small seeds, such as wild buckwheat or mustard seed, can pass through, the wheat being retained. The wheat then passes into a scourer, which consists essentially of a perforated cylinder, inside of which are beaters revolving rapidly around a vertical shaft. The wheat being fed in at the top is caught by the beaters, and brushed against the cylinder.

In order to get the grain to a uniform temperature, it is run through wheat heaters, which are of several types, the wheat passing over coils heated by steam. It is then stored in tempering bins, which equalize the heat. From there it passes through an automatic registering scale, and to the first set of rolls.

Millstones were formerly used, and still are for some grades of flour. These burr stones, as they are called, are about four or five feet in diameter, and consist of a bed stone and a top stone or "runner." The upper stone revolves on a spindle, and the stock is fed in between the two stones and is *crushed*—which is the trouble. The entire wheat kernel does not want to be crushed, but the interior contents must be shelled out, crushing the hulls as little as possible. This can only be done by a gradual reduction of the wheat between corrugated steel rolls. The roller mill consists of a frame carrying two pairs of steel rolls, one roll of each pair being revolved in a direction opposite to the other. The rolls run at different speeds by means of differential belts. The prepared grain is fed between the rolls, striking the slow rolls first, and is then cut by the fast roll, so as to shell out the contents. The broken kernel is then elevated to a sieve machine called a "scalper," which consists of a flatwise sieve, which allows the granular material, which is called "middlings," to pass through the meshes, while the coarser part of the kernel passes over the sieve to the second set of rolls. This process is repeated five times (the grinding and sifting operations). The next process is the dividing of the middlings into various grades according to the size of the granules. The middlings from these five siftings are delivered to a grader, which may be either a reel or a sifter machine. These grading reels are covered with silk bolting cloth of various degrees of fineness, the finest section being near the head of the reel, and graduated toward the tail of the reel. It is a mistake to suppose that these grades differ in value; they relate entirely to size. Each grade of middlings is now put through a machine termed a middlings purifier. The introduction of this machine has revolutionized the practice of milling. The stock is fed in at one end of the sieve, and is advanced by the end motion of the sieve, which is covered with silk bolting cloth. A

Packing Flour in Barrels.

current of air is drawn up through the sieve by a fan located in the upper part of the machine; this carries off any fine dust into the dust collector, where it settles. The dust collector consists of some form of cloth tubes. The air forces the dust to the walls of the tubes and passes through the mesh, leaving the dust



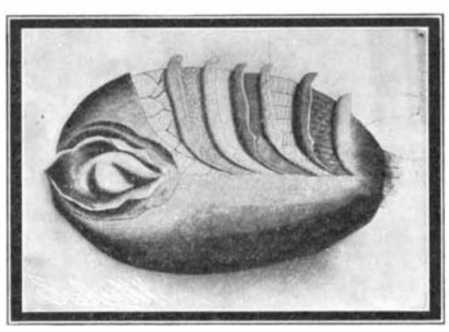
Sacking Flour and Sewing up the Tops.

on the inside. The particles of bran that are with the middlings whose specific gravity is less than the interior of the kernel are kept from going through the meshes by the upward current. The bran is held in suspension until the end of the sieve is reached, when

the air current is cut off, allowing it to fall into a separate conveyor. The purified stock which passed through the sieve is delivered by means of conveyors to a second purifier, whose action is the same; brushes moving at right angles to the motion of the sieve serve to keep the meshes of the cloth open. Each grade of middlings goes through the same process of purification. After the middlings are thoroughly purified, they go to the smooth rolls, where they are partially crushed, but not powdered. The life of the flour is killed if it is pulverized. From there it goes to the bolter, which is made in many forms, but for purposes of illustration we will consider a round reel or "flour dresser," as it is called. The reel is covered with fine silk bolting cloth, which may cost as much as $4 a yard. What flour is fine enough to go through the meshes of this reel is sent to the flour bins, and is ready for packing. What is too coarse to go through goes to the rolls and is recrushed and rebolted, and this process is repeated until all the middlings are crushed fine enough to go through the meshes of the cloth. The bolting cloth is kept free from clogging by a revolving brush, and the stock is thrown against the inner side of the cloth by beaters revolving around a horizontal shaft. Each grade of middlings goes through the same process, and then all the flour from the first two or three crushings is combined to make the first grade of flour.

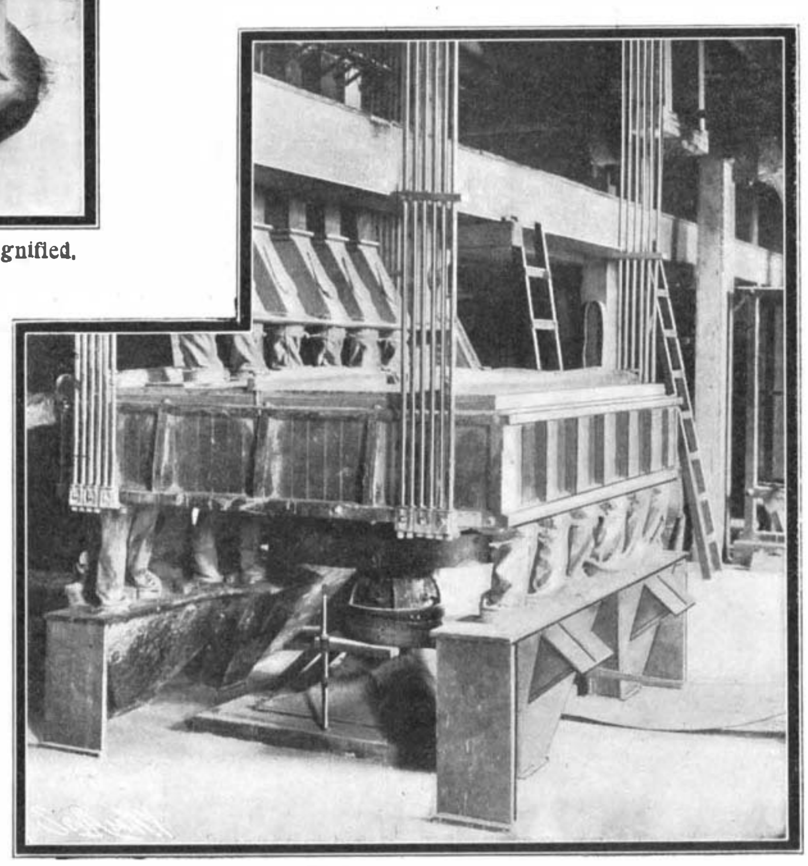
The flour from the various grades of middlings is blended so as to produce, in the judgment of the miller, a flour of standard quality. The various streams of flour are constantly under inspection, and wet and dry tests are made every few minutes. The sample of flour to be tested is smoothed on a board with a sample which is standard; a portion is wet and baked in an electric oven, thus giving a most valuable color test. The grade of flour is always kept at or above the standard, but is never lowered. It is a mistake to suppose that lower grades of flour are made from inferior wheat; it is only the poorer stream of materials developed in the milling process, which contain too much of the branny material to go into the high grades, which are used for low-grade flour.

The flour is now ready for packing in barrels of 196 pounds and bags which range from 3 to 280 pounds. The barrels are placed on a machine located beneath the bin, and adapted to supply a large volume of flour, which will approximately fill the barrel; the supply is automatically cut off when the proper weight is reached. The weight of the barrel is then checked on another pair of scales, and any difference in weight adjusted with a scoop. A number of augers on an upright shaft within a broad iron tube serve to force the flour downward into the package, and prevent clogging in the tube. The barrels are now headed up and branded, and are rolled on board the cars which line alongside the packing room. An average box car will hold from 200 to 275 barrels. Last year the Washburn-Crosby Company shipped from their Minneapolis mills alone over 6,000,000 barrels of flour. A considerable proportion of the



A Dissected Wheat Kernel Magnified.

Raising and Baking Miniature Loaves of Bread for the Miller.



A Plan Sifter at Work.

MODERN FLOUR MILLING.

flour milled is shipped in bags for family use or for export. Cloth bags are preferred, and are filled by machines working on the same principle as the barrel filler; they are sewed by sewing machines, are then run down inclines, and are carried on trucks to the cars. Bags are largely used for export purposes by the Washburn-Crosby Company, as barrels do not pack well, and the American flour sack can now be found in all parts of the world. American foodstuffs, on account of their purity and uniformity, have taken a prominent place in the markets of the world, and Minneapolis is now in the lead as a base of supplies.

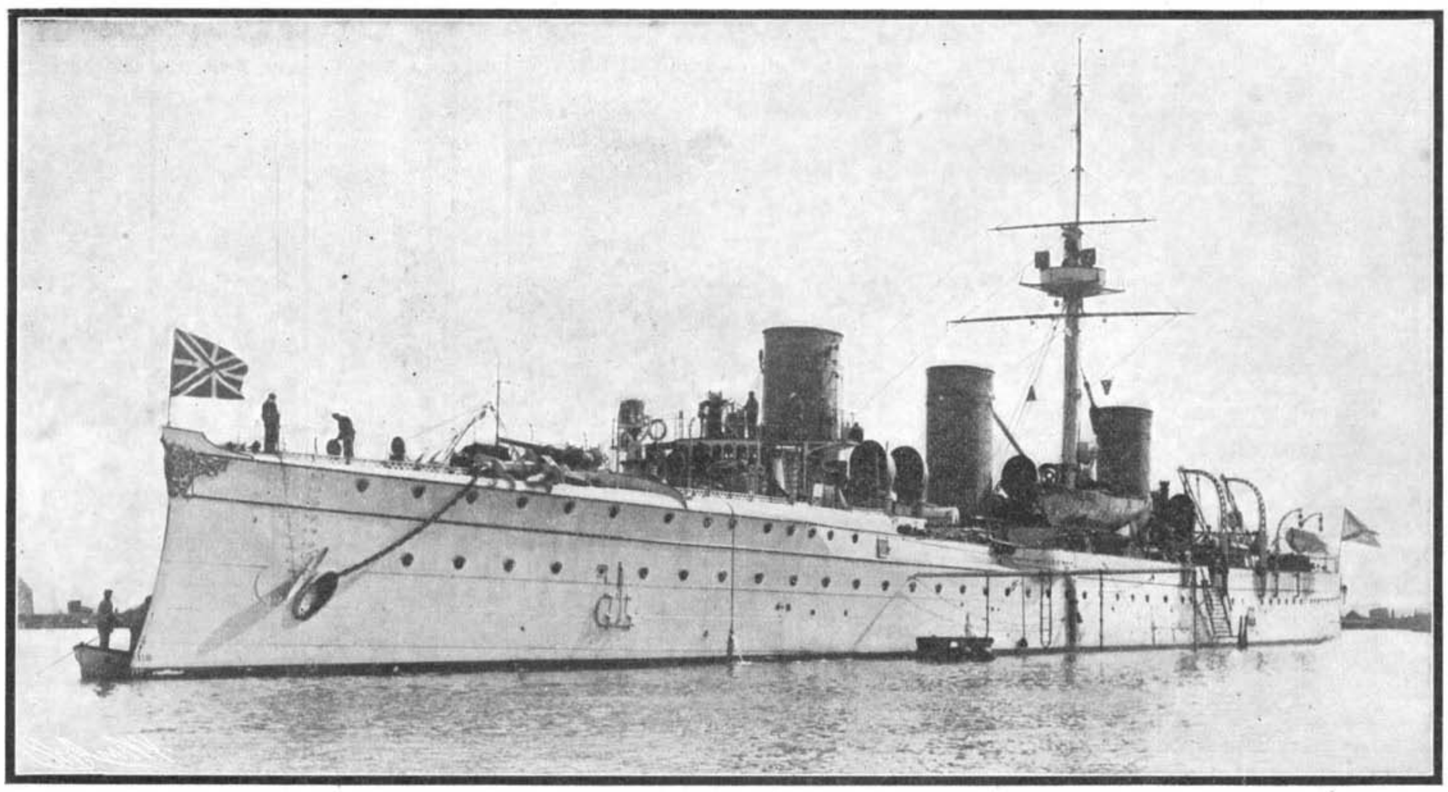
THE DISABLED RUSSIAN CRUISER "NOVIK."

Among the vessels that fell a victim to the attack of the Japanese guns and torpedoes at Port Arthur was a vessel (the only one of its type in existence) which has attracted a great deal of attention in the naval world. We refer to the fast cruiser "Novik," of which we present an illustration. It was shortly after the close of the Spanish-American war that the Russian Admiralty sanctioned the announcement that they were about to build a fleet of several extremely fast protected cruisers, which were to have a speed far in excess of the fleetest vessels afloat at that time. Originally these boats were to have been of a little less than 3,000 tons displacement and 25 knots speed. The contract for the first of them, the "Novik," was given to Schichau, the well-known torpedo-boat builder of Elbing, Germany. She was launched in 1900, and delivered to the government in 1902. Her destination, like that of all the latest and best warships of Russia, was the Pacific station.

The "Novik," as constructed, is somewhat larger and faster than the vessels contemplated in the first designs. She is 347 feet in length, 39 feet 4 inches in beam, and on a draft of 19 feet displaces 3,000 tons. For a vessel of her size the engine and boiler room equipment is extremely powerful, consisting of twelve Thornycroft boilers, and triple engines with a combined indicated horse power of 18,000 to 20,000. On trial she developed a speed of 26 knots an hour, and therefore she is by about 2 knots the fastest cruiser in the world. So much being given up to motive power, the protection is confined to a 2-inch deck with a glacis of inclined armor above the engine hatches 3 inches in thickness. There is also a protection of 1¼ inches on the conning tower. All of this armor is treated by the Krupp process. In addition to her scouting duties, for which by virtue of her high speed she was admirably suited, the "Novik" was designed for the important work of chasing and sinking torpedo boats and torpedo-boat destroyers. For this work she was armed with six 4.7-inch rapid-fire guns, one 3-pounder, eight 6-pounders, and two 1-pounder rapid-fire guns. She also carried one above-water torpedo tube in the stern, and two above-water on each broadside.

In the meager accounts of the Port Arthur engagement, the "Novik" was mentioned as having been very active, maneuvering on the outskirts of the Russian fleet. It is probable that she was doing her best to sink the Japanese destroyers with her 4.7-inch guns, a single well-placed shell from one of which would have meant the complete disablement of any boat that was struck. Whether the "Novik" was disabled by torpedo or by gun fire is not very clear; but it is probable that it was the gun that put her out of action.

In addition to the "Novik," four other fast cruisers of the same type have been completed or are now under construction, while two others are proposed. Of the four, one, the "Almaz," is identical with the "Novik," having the same high speed; the "Boyarin," launched in 1900 at Copenhagen, was sent to the Pacific station, and two others, the "Jemtchug" and "Izumrud," launched in 1903, are now approaching completion. The last three cruisers, while of the same general dimensions as the "Novik" and carrying the same armor and battery, are not so fast by two or three knots, the contract speed being 22.5 knots for 11,500 indicated horse power. The "Boyarin," it would seem, must be added to the list of those Russian ships at Port Arthur that have fallen a victim to the deadly torpedo. It will be remembered that the first intimation of her loss came in the form of a dispatch from Port Arthur stating that the torpedo transport "Yenisei" and the cruiser "Boyarin" had been sunk by coming accidentally in contact with one of the submarine mines in the harbor. A day later came the announcement that the Japanese torpedo-boat destroyers had made another dash at the Port Arthur fleet in a driving snowstorm, that they had discharged their torpedoes, and thought that they had hit a couple of ships. Then followed a statement from Tokio, Japan, that these torpedo boats had succeeded in sinking the "Boyarin" and another vessel. The probabilities are that the last report is correct, and if so, the torpedo boat has added still further to the immense prestige it had already acquired in the present war.



Displacement, 3,000 tons. **Speed,** 26 knots. **Coal,** 500 tons. **Armor:** Deck, 2 inches. **Guns:** Six 4.7-inch; eleven smaller rapid-fire guns. Five torpedo tubes above water.

RUSSIAN CRUISER "NOVIK," THE FASTEST CRUISER EVER BUILT. DISABLED AT PORT ARTHUR.

Death of Prof. Charles E. Beecher.

On February 14, Prof. Charles Emerson Beecher, who occupied the chair of palæontology at Yale, died suddenly at his residence in New Haven. Prof. Beecher was forty-eight years old. A graduate of the University of Michigan of the class of 1878, he pursued a post-graduate course at Yale which earned for him the degree of Ph.D. Shortly after his first appointment to a position on the University staff, he was made professor of historical geology. He succeeded Prof. Marsh as curator of the geological collections and professor of palæontology.

His most important contributions have been to the knowledge of the development and structure of the trilobites and brachiopods. Several papers on the ontogeny and phylogeny of these and other classes of animals were collected in one volume entitled "Studies in Evolution," which appeared in 1901 as one of the Yale bicentennial publications. He also published "Brachiospongidae: A Memoir on a Group of Silurian Sponges," Memoirs of the Peabody Museum of Yale University, Vol. II., Part I., in 1889. In 1899 he became a member of the National Academy of Sciences.

The Current Supplement.

The current Supplement, No. 1469, opens with a most instructive article by Charles H. Stevenson on the dressing and dyeing of aquatic furs. The article is well illustrated by engravings, which clearly show the processes involved. "Natural Products and Scientific Industry" is the title of an article written by Dr. Otto N. Witt, the well-known German chemist. From the mechanical standpoint, by far the most important article in the paper is a thorough discussion of the evolution of watch escapements. The article is very elaborately illustrated. The sleeping sickness, of which we hear so much in these days, is analyzed in a competent way. The walls of ancient Troy are illustrated and briefly described. William Ackroyd writes on "A Principal Cause of the Saltness of the Dead Sea." The usual electrical notes, engineering notes, and consular information will be found in their accustomed places.

The Commerce of the Far East.

The value of the commerce of the countries fronting upon the scene of hostilities in the Orient aggregates about 600 million dollars per annum, and the value of the commerce of the United States with those countries aggregates over 100 million dollars per annum. While the prospect of war resulted in the placing in the United States of orders from Japan for flour and from Russia for meats, the general trend of exportation to the four countries fronting upon the scene of hostilities has been downward during the period in which this subject has been actively discussed. To Japan the exports from the United States during the month of December, 1903, were $2,263,245 in value, against $2,811,589 in December of the preceding year, and for the entire calendar year 1903 were about one million dollars less than in the preceding year. To Asiatic Russia the exports from the United States were $716,274 in 1903, against $898,711 in 1902 and $1,013,320 in 1901. To China our exports during 1903 were materially below those of the preceding year, being for the month of December $841,373, against $1,857,733 in December, 1902, and for the entire year $14,970,138, against $22,698,282 in 1902. This reduction occurs chiefly in cotton cloths, of which our total exportation to China in December, 1903, was but 3,665,364 yards, against 20,582,544 yards in December of the preceding year, the value being $230,546 in December, 1903, against $1,074,463 in December, 1902. For the entire year the value of the cotton cloth exported from the United States to China was $8,801,964, against $16,048,455 in the calendar year 1902. This reduction in exports to China is not peculiar to the United States, as the official reports of the Chinese government show a general reduction in its imports during the past year, up to the latest period covered by the reports.

To Russian China our exports show an increase, being in 1903 $846,310, against $421,163 in 1902. To Korea the exports of the year also show a slight increase, being valued at $370,566 in 1903, against $257,130 in 1902. To Hongkong, which is sufficiently far removed from the scene of existing disturbances to be less affected, apparently, by such conditions, the exports from the United States show an increase, being in December, 1903, $1,705,436, against $1,417,736 in December of the preceding year, and for the entire year $9,792,193, against $8,751,779 in 1902.

As to the trade of the United States with Manchuria, it is not separately shown in the general statements of the commerce with China. The Department of Commerce and Labor, through its Bureau of Statistics, however, has recently compiled some figures which show that the imports of Newchwang, the principal port through which Manchurian commerce now passes, amounted in 1902 to about 18 million haikwan taels, against 17 millions in 1901 and 8 millions in 1900. The value of the haikwan tael in 1902 was 63 cents, so that the value of the imports of Manchuria, stated in dollars, would be, in 1902, about $11,000,000. The official report of the Chinese government does not specify all classes of merchandise received into Newchwang from the United States, but does specify the four principal articles—American jeans, drills, sheetings, and kerosenes. The total value of these four articles of American production reported as brought into Newchwang in 1902, either coming direct from the United States or from other ports of China, was 6,118,920 haikwan taels, which at the official valuation of the haikwan tael in 1902 would make the total value in United States currency $3,854,920.

A Medal for Prof. Hale.

Prof. George E. Hale, director of the Yerkes Observatory, has been awarded a gold medal by the Royal Astronomical Society.

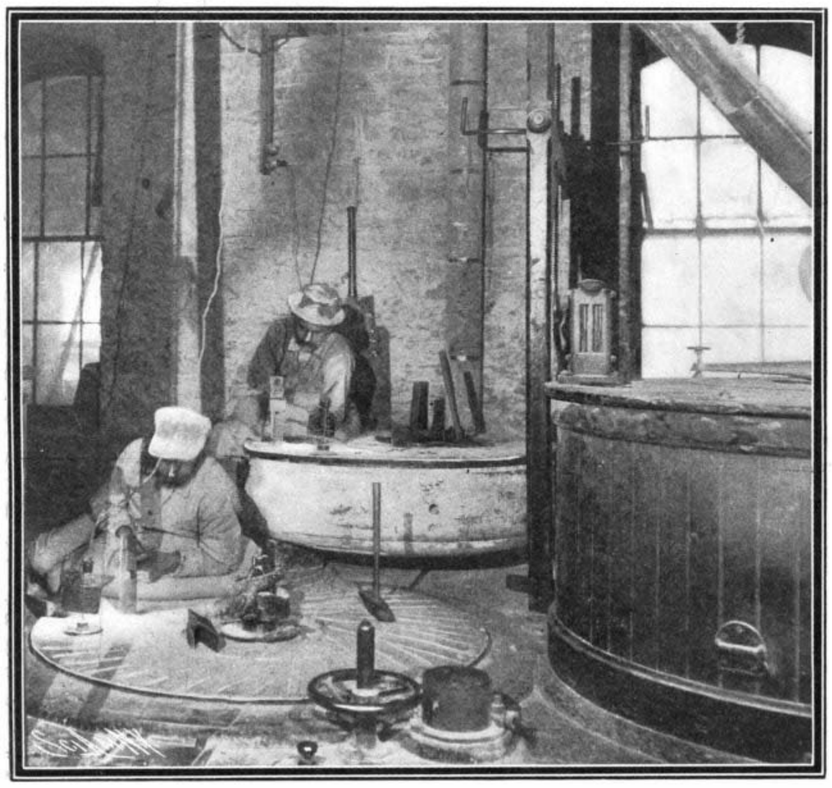
SCIENTIFIC AMERICAN

[Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1904, by Munn & Co.]

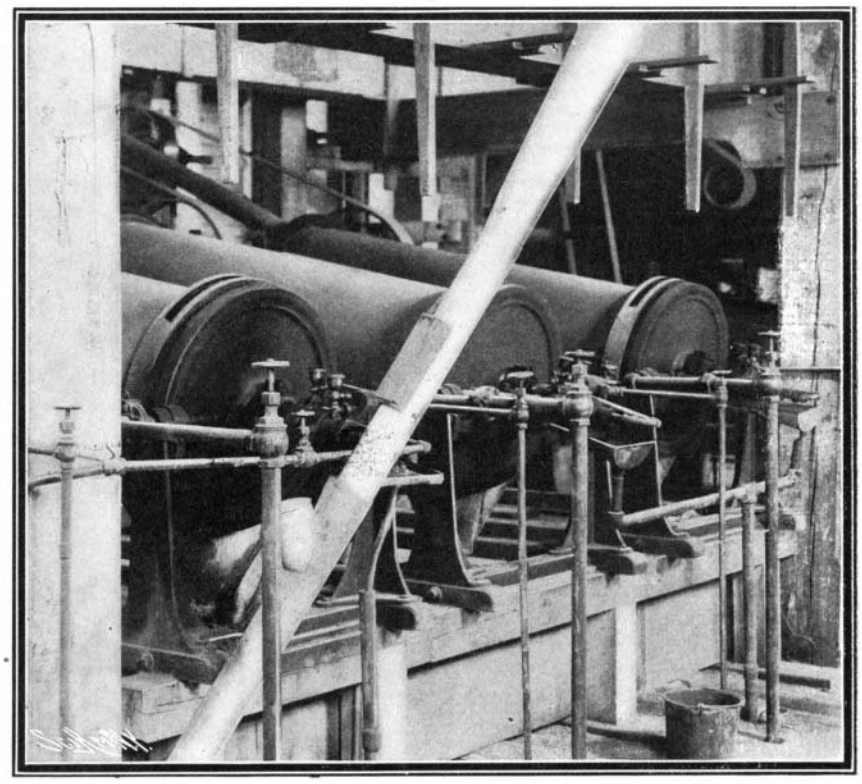
Vol. XC.—No. 9.
Established 1845.

NEW YORK, FEBRUARY 27, 1904.

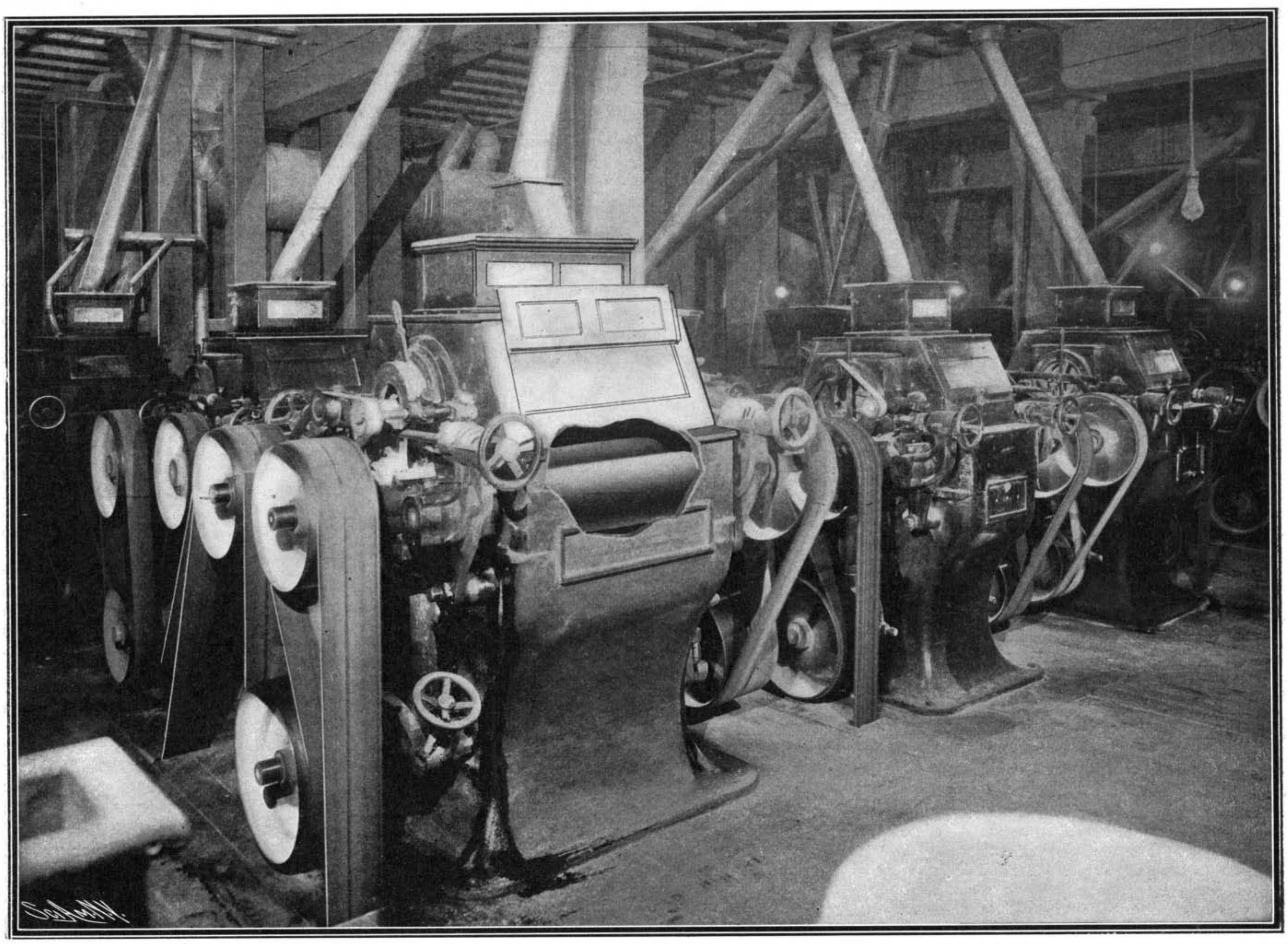
[8 CENTS A COPY
$3.00 A YEAR.]



Roughening Burr Stones.



Heating the Grain in Rotary Heaters.



The Roller Mills Making "Patent" Flour.

HOW BREADSTUFFS ARE MADE IN QUANTITY.

FLOUR MILLING AS CONDUCTED IN THE LARGEST MILLS IN THE WORLD. CAPACITY, 30,000 BARRELS A DAY.—[See page 176.]