# An Agricultural Revolution

...By

Herbert Myrick

The Marsden Co
850 Drexel Building
Philadelphia Pa

# A Revolution in Agriculture

## NEW INDUSTRIES

That create a profitable market for hitherto waste products
That may alter naval warfare
And cause far-reaching changes throughout the industrial world

HOW CORN stalks are being utilized so profitably that the farmer may get as much for the formerly despised stalks as for the grain
A romance of modern progress that has laid the foundation for new and successful industries


By....

## Herbert Myrick

Editor of American Agriculturist of New York, Orange Judd Farmer of Chicago, the New England Homestead of Springfield, Mass. Also editor of Farm and Home, Springfield, Mass., Chicago, New Orleans and Montreal. Author of "The American Sugar Industry," "Tobacco Leaf," "The Hop," etc., etc.

**TWO DISTANT VIEWS OF THE MARSDEN FACTORY AT OWENSBORO**

Both pictures are taken from well out in the Ohio river, which is shown in the foreground. In the lower picture observe the steamboat and floating factory, with two barges, used to gather corn stalks from the river landings to which the farmers deliver the stalks. The floating factory is used to put them through the first operation of manufacture, if desired

# New Uses for Corn Stalks.

[Note. For three years The Editor of American Agriculturist and his associates have been inquiring into and closely following the subject here treated. The article below is the final result of all this work. We have published very little on this topic heretofore, because the matter was in a state of evolution. Now, however, the work has gone far enough to warrant a comprehensive, impartial, authoritative and accurate statement, free from bias of any kind. We believe the future will demonstrate that this is a fair review of the case at the present time.]

The application of science to industry has realized greater wonders than were ever dreamt of. The triumphs of science in agriculture are as genuine as her victories in other industries or in astronomy or in electricity. Slaughterhouse by-products, which formerly were wasted, now yield larger profits than the dressed carcass of beef, mutton or pork. The once despised seed of the cotton plant, the accumulation of which was such a nuisance on plantations in former years, is now the raw material for a whole army of industries, and has enabled the grower to make a profit even during the period of phenomenally low prices for cotton.

The grain of the corn plant, formerly used only as food, now affords 20 commercial products. And now the humble corn stalk bids fair to rival all waste products in value.

Such a statement at first looks ridiculous. The western corn grower has been brought up to consider the stalk field of value only for cattle that must "rustle" through severe winters. So lightly is the corn stalk regarded, at least in parts of the great western corn belt, that it is valued at only 60c per acre. The growers of 2632 acres of corn in 96 counties in the eight corn states made exact returns to us of the 1896 crop, showing the value of fodder to average only 59.4c per acre. "The value fixed for fodder was the price at which it would have sold shocked in the field, with no further expense to the owner for hauling or delivery. The value of pasturage in the fields where the ears were husked from the stalk was fixed at the amount for which this privilege could have been sold." The total receipts for the stalks averaged less than 60c per acre. It is true that maize is grown in New England and in certain sections of the southern states even more for its fodder than for its grain. It is also true that the value of this wonderful plant as fodder is becoming better appreciated in the corn belt, yet it is still true that over thousands of square miles of corn fields the stalks have a value of only 60c per acre or even less.

But now come science, invention, discovery and manufactures, uniting in a new industry that offers ten or twenty times that money for each acre of stalks. This new departure establishes a home market at which the farmer may get $3 to $5 per ton for the hitherto despised corn stalk. In other words, it offers $6 to $12 per acre for that which the farmer has heretofore almost thrown away. Even the labor of man and beast in delivering the stalks from field to factory comes at a season when both might otherwise be idle, so that the new industry means also a profitable market for labor.

## WHAT THIS MEANS TO THE CORN GROWER.

The possibilities thus opened up are prodigious. To add only a few dollars per acre to each one of the 80,000,000 acres devoted to maize in the United States each year runs into a sum so fabulous as hardly to bear publication. But if it is assumed that only the fields of the corn belt will be benefited, those eight states, Kentucky, Ohio, Indiana, Illinois, Iowa, Missouri, Kansas and Nebraska, alone average close to 50,000,000 acres under corn. If only $5 per acre is added to the value of the crop in this limited belt, it means the tidy sum of $250,000,000 added to the farmers' income.

And most of it would be net profit, the balance paying for labor in place of enforced idleness. Since the value of the corn (grain) crop in this western belt averages only $6 to $10 per acre, any such cash returns for the stalks alone would practically double the value of the crop. And the corn (grain) produced in the United States each year is alone worth 650 to 850 millions of dollars.

Aside from the flights of imagination suggested by these figures, they reveal the striking importance of the subject. They emphasize what so few people realize, that corn is king, its grain alone excelling in value any other staple crop. Allowing merely a nominal value for the stalks, and King Corn is ordinarily worth over a thousand million dollars to the United States each year. More bushels of maize are produced in the whole world each year than of any other cereal, its total product being exceeded only by the potato. In a season of full average productiveness, the world makes about 4000 million bushels of potatoes, 2750 million bushels of maize, 2600 millions of oats, 2500 millions of wheat, 1300 millions of rye, barley 750 millions of bushels.

Until within a few years, the limitless possibilities of the maize plant were but dimly conceived of. Sir J. B. Lawes, the world-famous agricultural scientist of Rothamsted, England, in a conversation with the writer just ten years ago. referred in part to the commercial development of the corn plant that is now being accomplished, and with an enthusiasm that age could not dampen, concluded: " My chief regret in not having been able to visit America is that I shall die without beholding your millions of acres of what I conceive to be the most superb crop that grows, as it is in itself the most valuable—*Zea mays* or American corn."

### THE FIRST QUESTION

that arises is, can corn stalks be put to uses that warrant paying $3 to $5 a ton for them. We unhesitatingly answer, yes. Why were not these uses

**THE ORIGINAL CORN-PITH CELLULOSE FACTORY**

At Owensboro, Ky. This plant has been in operation since 1896. Here much of the experimental work has been done, which has resulted in establishing a variety of industries based on corn stalk by-products. In this picture, the large building, No. 1, is the cellulose mill, where that article is prepared, treated and packed. The roofs of several other buildings appear, also one of the cutting sheds and the power house. The other illustrations and the accompanying article give a good idea of this new industry.

of stalks discovered before? is often asked. Why was not the present universal application of electricity discovered years before it was? Who can answer either question? But just as the larger use of electricity has so enormously stimulated the use and enhanced the price of copper and zinc, so we foresee how the evolution of uses for the corn stalk may in future years advance rather than reduce the prices now paid for stalks. Here is a list of the products that already have been made on a commercial scale from the maize stalk:

### WHAT IS MADE FROM CORN STALKS.

1. Cellulose for packing coffer dams of battle ships, this preventing them from sinking when pierced by bails or shells.

2. Pyroxylin varnish, a liquid form of cellulose, the uses of which are practically unlimited.

3. Cellulose used for nitrating purposes, for making smokeless powder and other high explosives, for both small and great arms, as well as purposes for which dynamite or all other explosives are required in various forms and degrees of strength.

4. Cellulose for packing, it being the most perfect non-conductor known against heat or electricity, jars or blows.

5. Paper pulp and various forms of paper made therefrom, both alone and mixed with other grades of paper stock.

6. Stock food made from fine ground outer shells or shives of corn stalks, and also from the nodes or joints. The leaves and tassels also furnish a shredded or baled fodder.

7. Mixed feeds for stock, containing fine ground shells or shives as a base, and in addition thereto various nitrogenous meals and concentrated food substances, or blood, molasses, distillery and glucose refuse, sugar beet pulp, apple pomace and other by-products.

8. Poultry foods of two types, namely—type 1, containing a dominant nitrogenous factor for laying hens, and No. 2, containing a dominant carbohydrate factor for fattening purposes.

This is but a bare enunciation of the principal classes of corn stalk products. Each class may be subdivided into a variety of purposes.

### THE VALUE OF THESE PRODUCTS

is unquestionably great. Any one of them is important enough to form a large industry of itself. But to obtain such an array of products from a source never before thought of—the corn stalk—involved an immense amount of original work, experimenting, research and discovery. These scientific problems solved in part, then came the still more perplexing one of handling the stalk and its component parts in such a way that the various products could be made at a cost which would allow of an adequate profit when sold.


**ANOTHER VIEW OF THE OWENSBORO PLANT**

Taken from the top of Mill No. 1, shown on Page 5. Building No. 6 is the baling and storing plant; the excess of large leaves and shucks is baled here. Beyond are work rooms and flats for the help, the managers' and U. S. government inspector's office, other offices and warehouses for machine storage and factory supplies. No. 7 is the cutting plant, from which the cut stalks go through the pipes to No. 6, thence to mills No. 5, 4, 3 and 1. The finished feed drops into No. 3, the cellulose into No. 1.

All this involved the accomplishment in three years of what has taken fifty years to do in many old established industries. Mark W. Marsden obtained the first patent on corn stalk product Feb. 19, 1895, but it has taken the combined genius of many of the most gifted scientists, inventors and manufacturers of America to develop this new industry up to the present state of the art. This has cost enormous sums, too, and would have been impossible but for the almost unlimited capital of The Marsden Company and the unflinching confidence of its president, W. W. Gibbs of Philadelphia, with whom are associated as directors, Thomas Dolan, George Philler, Samuel R. Shipley, Martin Maloney, Edwin S. Cramp, George S. Graham and J. R. Williams—gentlemen whose high standing is recognized throughout the world of finance.

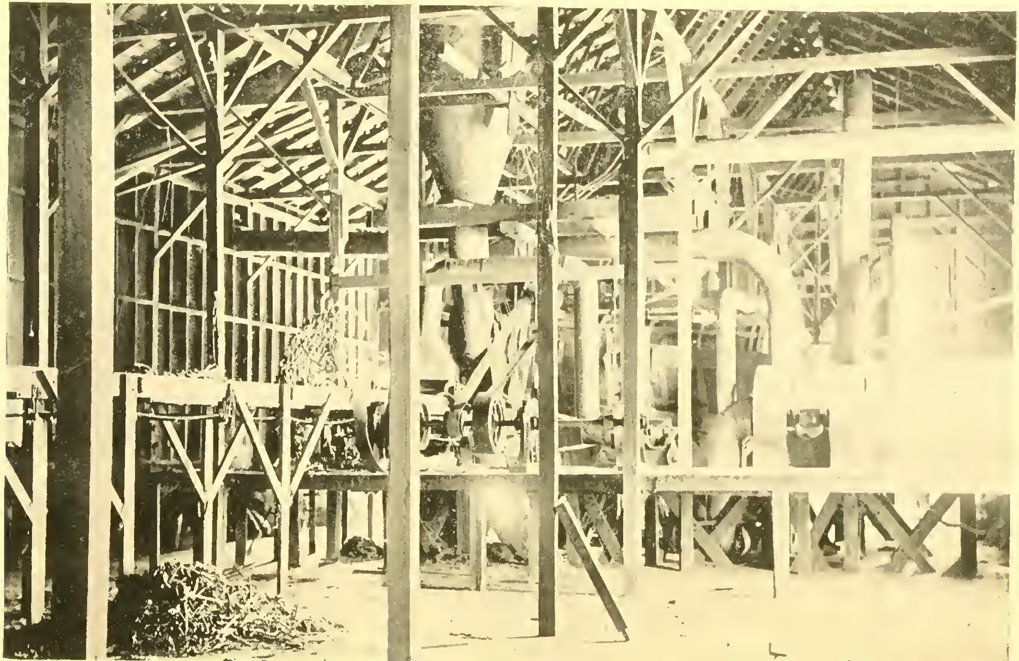
Mr. Gibbs had acquired fame and fortune as a captain of industry in the gas, electric and street railway business before he was sufficiently impressed with the underlying principles of Marsden's ideas to devote almost his entire time and energies to their development. Mr. Gibbs's management has been subjected to the most violent criticism as a financial scheme based on corn stalk impossibilities. His associates have stuck to him, however, Mr. Gibbs has been able to command capital whenever needed and has gone on working out new methods of manufacturing and world-wide markets for these new products until success is assured. This seems to be a case in which the originators or original backers of a new principle have had the faith, the ability and the capital necessary to win momentous victory against what seemed to be overwhelming difficulties.

### THE PROGRESS ACCOMPLISHED.

The problem of extracting these products from the corn stalks involved the solution of new perplexities and untried difficulties in manufacturing that can only be appreciated by those who are familiar with the progress of the work. The latest improvements perfected permit the economical separation of the various products wholly by automatic machinery and methods.

We are satisfied that The Marsden Company is working on correct principles, that its products have a high value and unlimited markets, that these products are being produced of a quality to satisfy consumers and at a cost that affords a wide margin of profit. While affording a profitable home market for a hitherto practically waste product, it is also evident that this concern has at its command the genius, capital and experience necessary to further simplify and perfect its methods of manufacture, so as to still further reduce cost of production and increase its possibilities of profits. The Marsden Company has broad patents covering all the machinery, methods, processes and products of this inviting new industry. In addition, the knowledge it has gained through costly experience is exclusively its own. And this of itself is probably a greater protection even than any patents.

In the light of all these facts, it has seemed to our most conservative judgment that the time was ripe for pointing out the agricultural and



**INSIDE VIEW OF BUILDING NO. 5**

Showing the cutter and first rough separation.

economic possibilities of this new departure. The more so, since, in addition to its experimental works and original factory at Owensboro, Ky., The Marsden Company is now about to build extensive works at Linden, Montgomery county, Indiana, at Peoria in Illinois, and one in eastern Virginia.

## CHARACTER OF THE MAIZE STALK.

To make the matter clear, the nature and composition of the maize plant must first be understood.

The corn stalk consists of joints (also called nodes) at irregular intervals, united by the stalk proper (these uniting sections are called internodes), together with leaves and tassel or flower. In the process of manufacture the leaves, tassels and joints are separated from the internodes, the pith is extracted from the internodes, leaving the shells of the internodes, commonly called shells or shives. It is found that 100 pounds of air-dried Indian corn stalks, when stripped of leaves and tassel, contain about

26 lbs. of nodes or joints.
20 lbs. of pith, coarse and fine.
54 lbs. of shells or shives.

## AMOUNT OF CELLULOSE IN THE STALKS.

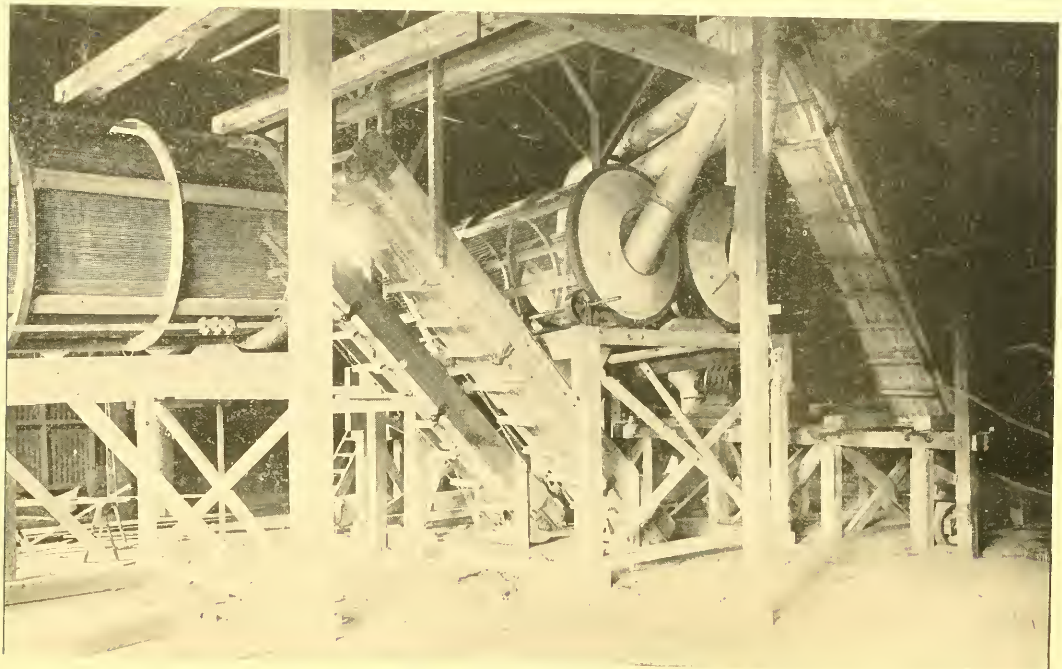
The maize stalk is made up mostly of water, fiber, starchy matters and sugary substances. To speak more scientifically, it is composed chiefly of carbohydrate matter, consisting of ligno-cellulose, pentosan bodies and pure cellulose. The other carbohydrate bodies, except the pure cellulose, can be dissolved by successive treatments with hot acid and alkali. It has thus been found that the nodes contain on the average 33 per cent of pure cellulose, the pith 36 per cent and the shives 40 per cent.

## NEITHER SUGAR NOR ALCOHOL

can be profitably obtained from corn stalks by any method now known. There were some hopes of making alcohol successfully, but this phase of the subject has been carefully gone over by Wiley, who thus summarizes his results for this article:

"Two or three different kinds of sugar may be produced from maize stalks by digestion with hot acid—namely, xylose, arabinose and dextrose. The first and second named sugars are more abundant than the dextrose. The total quantity of sugars produced by hydrolysis with an acid estimated in terms of dextrose is as follows: Nodes 29 per cent, pith 23 per cent, shells or shives 26 per cent.

"These data show that more than half of the material dissolved from nodes and shives by hot dilute sulphuric acid are composed of sugars; while in the case of the pith more than half of the soluble matter consists of sugars.



**REAR VIEW OF CUTTER PLANT IN MILL NO. 5 AT OWENSBORO**

Showing fans and pipes for blowing the shucks, feed and cellulose to the different buildings.

Of these sugars, dextrose is the only one which will yield alcohol on fermentation. The amount of fermentable sugars, however, is very small, since the quantities of alcohol from the three divisions of the stalk with the amount of dextrose corresponding thereto are as follows:

### RESULTS FOR ALCOHOL AND DEXTROSE.

| *Division of stalk* | *Alcohol P cent* | *Dextrose P cent* |
|---|---|---|
| Nodes | 1.36 | 3.40 |
| Pith from internodes | 2.16 | 5.40 |
| Shells from internodes | 1.92 | 4.80 |

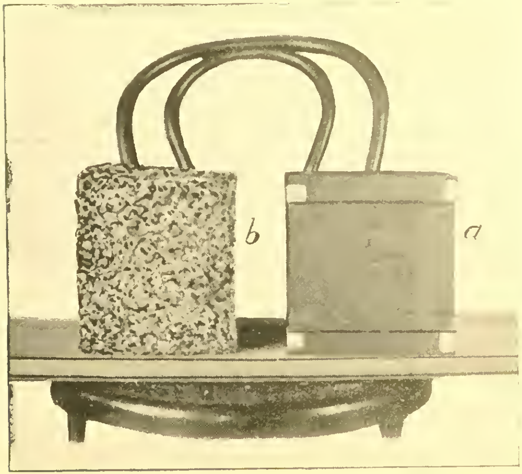
"It has been established that the chief quantity of sugar formed in the above process consists of the quality known as xylose, a sugar which has no commercial value. It is evident that it will never prove profitable to attempt to make alcohol from the maize stalks, since at best they would yield only two pounds of alcohol to 100 pounds of stalks."

### COMMERCIAL USES OF THE MAIZE STALKS.

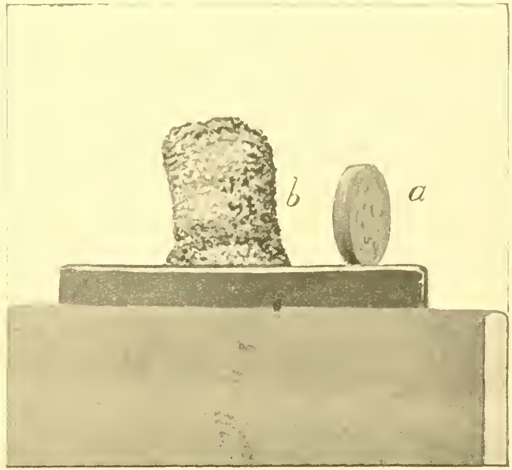
Two important commercial uses have been found for the products of the maize stalk, namely the pith and the shell or shive. In regard to the pith it has been demonstrated by actual trials that it is a perfect protection to battle ships against danger from sinking due to the entrance of water. Coffer dams about three feet in thickness when tightly packed with maize pith and perforated by shells or solid shot are completely impervious to the passage of water. For convenience in packing, the pith, after separation and purification, is pressed into cubes, each side of which is six inches square. These cubes at the factory are packed in paper boxes so that they are kept dry and free from injury in transit. Illustration on Page 13 shows two of these pith cubes, one enclosed in the box and the other removed therefrom to show its general appearance. The corn pith cellulose is rendered fireproof before being used.

When the coffer dam containing this material is perforated by a shot, the elasticity of the tightly packed pith completely closes the hole made by the projectile, so that the water cannot pass through. Naturally some water must enter at the point of perforation, but owing to the great capacity of the pith to absorb water, it being able to hold more than twenty times its own weight when not pressed, the water that first enters is at once absorbed. This causes the pith which is moistened to swell and thus to close more completely the aperture made by the projectile.

Another illustration shows how a block of compressed pith will expand when moistened. Two blocks of pith were prepared in exactly the same way, having the same thickness and the same weight; they were placed on edge in front of a camera and one was moistened by pouring water on it; it immediately began to increase in size and at the end of one minute and









**CORN PITH CELLULOSE IN VARIOUS FORMS FOR SHIPMENT**

*a*, Corn pith cellulose as packed for shipment.

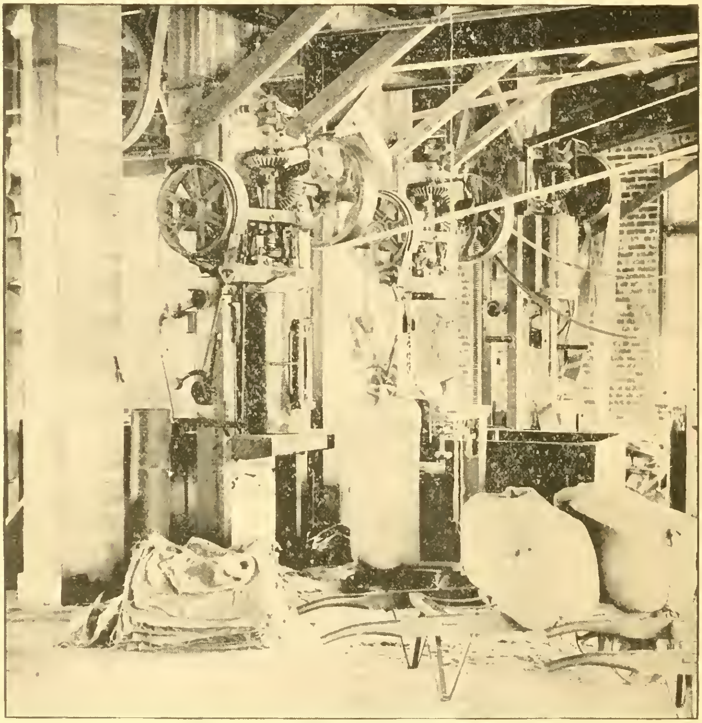
*b*, Same with cover removed. This is the form in which the cellulose is delivered to home and foreign governments for packing warships.

*a*, Disk of compressed corn pith cellulose.

*b*, The same laid flat after water has dropped on it for 1 1-2 minutes, showing its enormous expansive and absorptive power.

thirty seconds after the water was added the photograph was taken. The immense increase in size due to the swelling caused by the water is strikingly shown.

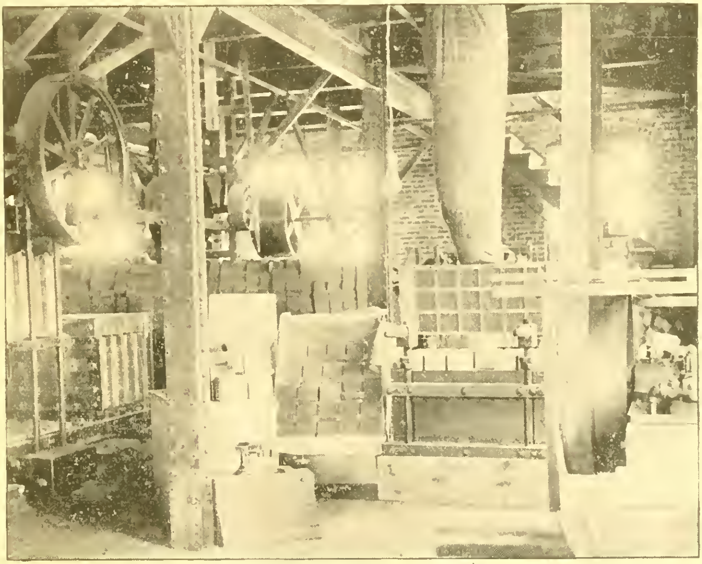
This use of corn pith cellulose long since passed the experimental stage. It was the original object in utilizing corn stalks, and the many



SACKING THE MARSDEN FEED

The new corn product is being sacked by the packer at the right. The machine at the left is for packing finely powdered cellulose.

other products now obtained have grown out of the improvements in extracting the pith for this purpose. The United States navy department early made exhaustive tests of corn pith cellulose, which proved it to be so vastly superior to cocoanut fiber that the latter has been discarded and corn pith cellulose is now used for packing United States warships. This government is so well satisfied with the superiority and cheapness of corn pith cellulose for naval purposes that our navy department officials indorsed it in a report to the Italian government. So successful were the official tests by the admiralty at Southampton and Poligon that the English and Russian governments have placed orders for The Marsden Company's corn pith cellulose for warships now under construction, and the government of France has done likewise.



**PRESSING AND PACKING CELLULOSE**

The corn pith cellulose is pressed into 6-inch cubes 18 at a time on this hydraulic press, with an average pressure of 60 tons to the square inch. The blocks of cellulose are then packed in cartons made from corn shives and then into boxes lined with waterproof paper.

As corn pith cellulose becomes cheaper, it will doubtless come into general use for lining vessels of all kinds, which it is desirable to protect against sinking. A high authority (Lewis Nixon, naval constructor) says this discovery and application of cellulose is of as vital importance to the navy as the development of Harveyized armor and smokeless powder.

## USES OF THE PITH FOR MAKING NITRO-CELLULOSE AND HIGH EXPLOSIVES.

The pith, either directly or after extraction with a dilute alkali, is easily nitrated into all the various forms of material made from cotton, and of course at far less cost. It has many advantages over cotton for nitrating purposes, especially in the manufacture of explosives of all kinds, by reason of its more perfect keeping qualities.

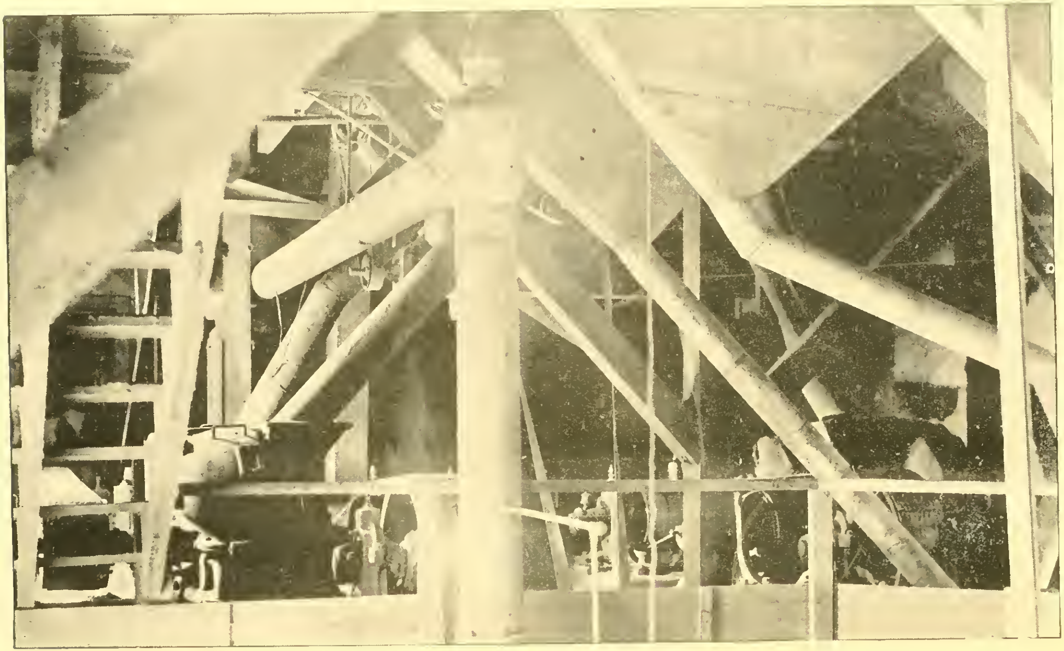
As is well known, the fibers of cotton are hollow and are filled with a mixture of acids during the process of nitration. It is found very difficult to remove these traces of acid by subsequent washing, and therefore the keeping qualities of explosives made from cotton are not of the best. The pith of Indian corn stalks is not open to the objection just urged against the fibers of cotton. It is easily nitrated, easily washed, and makes an excellent


**SHIPPING CELLULOSE BY CARLOADS**

To the United States government. It is sent to the shipyards where naval ships are under construction, and is used in these ships as elsewhere described.

article for solution in amyl acetate or other solvent for the manufacture of varnish of different kinds, and also for making substitutes for gun cotton for the purpose of manufacturing smokeless powder and other explosives.

The best smokeless powders and dynamites are made from this nitrated corn pith. The powders have remarkably permanent qualities, not being open to decomposition and thus being far safer to keep and to use than the ordinary smokeless powders heretofore manufactured. A corporation with ample capital is now constructing great works at South Amboy, New Jersey, for the manufacture of this improved smokeless powder on a large



A PEEP INTO A MASS OF MACHINERY

In The Marsden Company's factory at Owensboro scale. It is to be made in sizes, grades and qualities adapted to every possible purpose.

The corn pith in its natural state absorbs nitroglycerin with avidity, and thus makes an excellent dynamite, the strength of which can be increased almost indefinitely according to the purpose for which it is to be used.

### IN PAPER MANUFACTURE

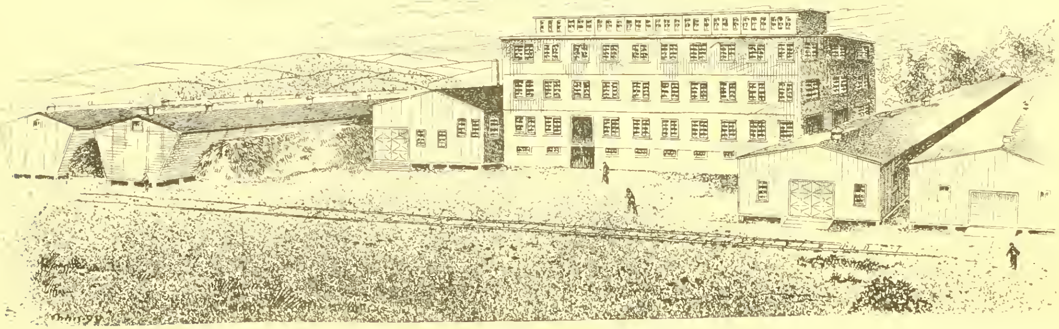
the use of corn pith cellulose is destined to play an important part. The outer shell or shives of the internodes of corn stalk under proper treatment yield a pulp that can be used alone or as an admixture with cheaper pulps for making paper. As Orange Judd Company uses an immense quantity of paper for its periodicals and books, we are specially interested in the claim that the woody covering of corn stalks may yield a substance which will produce news paper of superior quality without materially increased expense. Those most familiar with the experiments under way in application of corn stalk by-product to paper manufacture, predict surprising results in the line of fine book papers at low cost.

It may yet prove true that the humble corn stalk will be a most potent factor in preserving forests. The consumption of forests by wood pulp mills has assumed vast proportions, and already threatens the dire consequences of forest denudation. With corn stalk pulp obtained more cheaply and of better quality than wood pulp, and as an incidental by-product of other manufactures, instead of being the sole product, as in wood pulp mills, the possibilities of the pulp feature of corn stalk utilization are certainly immense.

### IN THE ARTS.

Other manifold uses of cellulose in the arts afford an attractive field for corn pith. The liquid form of cellulose, better known as pyroxylin varnish, is a most remarkable substance that can be utilized in a thousand ways. Practically everything made from wood pulp can be made still better from pyroxylin varnish, which may also be applied as a coating for all exterior surfaces and used for many other purposes. The name " pegamoid " has been applied to a similar but far more costly preparation made from cotton, which has made a great sensation in the world of manufactures and the arts, but the corn pith pyroxylin varnish seems to be in every way superior and much cheaper.

The coarser cellulose product from corn stalks is coming into general use for packing purposes. As one of the best non-conductors of heat, it is employed in lining refrigerators of all kinds. For refrigerator cars it is peculiarly popular, because the jarring of the car in transit expands the stuff and makes it fill space even more thoroughly than when first packed, thus increasing its efficacy. Other preparations, on the contrary, settle and leave large open spaces and their non-conductivity of heat is thus gradually destroyed.



**THE NEW CORN STALK MANUFACTORY**

Of The Marsden Company at Linden, Montgomery Co., Ind. These works embody the fruits of all the company's experience up to date. Similar works are being built in the vicinity of West Point, Virginia, and at Peoria, Illinois. At the left are shown two of the ten cribs for cut stalks. Each crib is 500 ft. long, 30 ft. wide at top, 25 ft. high and has a capacity of some 10,000 tons of clean cut stalks. Between the cribs, the stalks are piled from the farmers' wagons or the railroad cars, ready to be cut. Next on the right is a large stalk-cutting building 70 ft. wide and 150 ft. long. Then comes the large main building, 150 ft. long and 70 ft. wide, three stories high, with basement and windowed roof. Beyond it are two immense warehouses, one for cellulose in various forms, the other for the different kinds of Marsden feeds.

Corn husks afford a desirable quality of " excelsior " for upholstering. The leaves, tassels, etc., make a shredded fodder of good feeding value. Practical farmers will be most interested, however, in

## THE NEW CORN PRODUCT FOR FEEDING PURPOSES.

It has been shown that the fine ground shives or shells of the stalk, from which the pith has been removed, make an excellent base for cattle food. Extensive experiments were made with this food at the Maryland agricultural experiment station and published in Bulletin No. 43 of that station, also at the New York station, Geneva. Feeding experiments were made under controlled conditions, in which it was established that the fine ground shive contains eleven pounds per hundred more digestible matter and two pounds per hundred more digestible protein than the shredded corn fodder. It was further shown that the material was superior to timothy hay in food value.

Similar views of the feeding value of the new corn product have also been officially expressed by leading European experts, including Daforb of Vienna, Thomas of Lige, Wieland of Berlin, Peffert of Paris. Their experiments and reports have been partly responsible for the keen export demand for this feed. It has also been successfully used by many practical feeders in this country. Some stock do not take kindly to it at first, but after getting used to it eat it with avidity and with satisfactory results compared to more costly feeds.

As a base for mixing with other foods, this new corn product is found most excellent in every case, giving results of the most favorable character. The most important function of this material, however, is found in the fact that it is the best absorbent for blood and molasses of any substance which has ever been tried. The food value of blood and molasses has long been recognized all over the world, blood by reason of its high content of protein, and molasses by reason of its content of easily digestible carbohydrates. The sugars contained in molasses have high fattening properties, and are especially suited to preparing animals for the market.

The mechanical defects, however, attending the feeding of blood and molasses in their natural state are so great that such food is impracticable, but fine ground shives of Indian corn stalks will absorb from three to five times their weight of blood and molasses, and after being spread for a day or two in a dry place will be suitable for packing and transportation. If artificial drying be employed even larger quantities can be absorbed.

Advantage has been taken of this fact for mixing the finely ground shive with various other food products in order to make a cheap and yet well balanced ration. It is just the stuff to mix with distillery slop or other forms of swill, vast quantities of which are wasted or lost by methods of feeding now in use. Mixed with apple pomace, the combined feed is more relished and gives better results.

**BEET PULP CORN FEED.**

Mixed with wet pulp from beet sugar factories, the bran-like material absorbs the water and produces a mixture that can be handled readily and fed to great advantage. It has been so successfully used for this purpose by beet sugar manufacturers in Germany, also to utilize their vast stores of


**A COLLECTION OF CORN STALK PRODUCTS**

Now displayed at the national export exposition at Philadelphia, by The Marsden Company, whose headquarters are in the Drexel building, Philadelphia, Pa. This large case, only one of its four sides being shown above, contains a complete array of the large variety of products made from corn stalks. Each part of the plant is shown, also the husks made in excelsior for upholstering, corn-pith cellulose in a variety of forms and conditions, a line of cattle foods in simple and compound form, mixed rations for all classes of stock made with Marsden base, poultry foods of different kinds, pyroxylin varnish, smokeless powder in variety, and high explosives, charcoal and gunpowder, paper-pulp stock and paper made therefrom. A still larger exhibit of these products will be made at the Paris exposition.

waste molasses, that the export demand will take at $12 per ton every ton of the 120,000 tons that the company will be able to make during the coming year.

An economical method of converting the wet but nutritious pulp from sugar beet factories into a form readily handled and fed, is much needed. This new corn product, fine and dry and of unprecedented absorptive power, besides being a good feed of itself, is just the substance for mixing with this wet pulp. The product should possess high feeding value, must be extremely palatable, and in a condition admitting of transportation with facility and of storage without deterioration.

Such beet pulp corn feed should be sold at a price that, in view of results obtained, should make it one of the cheapest of feeds for all farmers within moderate distance by rail or road of the factory. Even at such a price this would afford a profitable market for the vast quantities of pulp that now are practically wasted by every beet sugar factory in America. Possibilities in this direction will be tested on a large scale at a number of beet sugar mills this fall.

If the new corn product thus converts to valuable uses the pulp and molasses from beet sugar manufacture, such a result, along with other by-products from beet sugar mills that are being developed, will have a profound influence in maintaining the superiority for profit of the beet sugar industry over cane sugar. Indeed, the complete utilization of beet by-products may eventually render the industry independent of tariff in competing with the cane sugar made by coolie labor in the tropics.

### AS A BASE FOR POULTRY FOOD

the fine ground shive seems to have no superior. Two types of poultry food have been developed from this material, one for laying hens, containing large percentages of nitrogenous materials, and the other for fattening broilers for the early market, containing a considerable excess of carbohydrates, derived principally from molasses. These rations have been thoroughly tried at the Maryland agricultural experiment station.

Young chicks just from the incubator, having been fed exclusively on this food from the beginning, these chicks not only grew with remarkable rapidity, but the pullets began laying at an earlier day than any others of which a record has been made. The purpose in mixing the poultry food is to make it complete, so that chickens could be fed upon glass plates without access to any material except that contained in the food and yet thrive perfectly.

Chickens eat the poultry food with avidity, especially the type containing the excess of molasses. The type containing the excess of nitrogenous matter is not so palatable at first, but soon becomes so if fed at first with a little sprinkle of maize meal. The poultry food is pressed into flat cakes, making it easier for transportation; before feeding it is broken into fragments and moistened, preferably with hot water; in this condition it is eaten with great avidity and with most profitable results.

## AS A FOOD FOR STOCK

of all kinds, the new corn product has given very satisfactory results. Not only beef cattle and dairy cows, but young stock, horses, mules and hogs have done well on this feed in place of hay or roughage. Owing to its compressibility, large quantities can be transported in a comparatively small space, making it useful for teamsters, army purposes and the like. Pigs do well on it, and the results with poultry are remarkable.

**ANOTHER VIEW OF THE CORN STALK PRODUCTS**

Now on show at the national export exposition, Philadelphia, by The Marsden Company.

Further accounts of the value of the food for feeding purposes are found in Bulletin No. 51 of the Maryland station at College Park postoffice, and Bulletin No. 141 of the New York station at Geneva.

These practical demonstrations of the feeding value of the new corn product simply confirm its theoretical or scientific value for this purpose. It appears that of the protein in the nodes 60 per cent is digestible; in the pith 68 per cent, and in the shells 72 per cent. Each of the three portions of the Indian corn stalk described above has been subjected to a careful chemical examination by Wiley, with the following results:

| | *Nodes p cent* | *Pith p cent* | *Shives p cent* |
|---|---|---|---|
| Moisture | 6.52 | 7.01 | 4.95 |
| Crude fiber | 37.94 | 41.44 | 46.01 |
| Ash | 2.11 | 2.80 | 1.94 |
| Fat | .94 | 1.17 | .78 |
| Proteids | 4.38 | 3.50 | 2.44 |
| Carbohydrates other than crude fiber | 48.21 | 44.08 | 43.88 |

New and more perfect methods of manufacture give a product of still higher feeding value. This is emphasized by the following comparative analysis made by W. H. Dean:

| | *Oat hulls P cent* | *New shive No. 22 P cent* |
|---|---|---|
| Water | 1.56 | 2.92 |
| Ether extract | 1.15 | 1.78 |
| Crude protein | 1.72 | 6.15 |
| Crude fiber | 34.[illegible]3 | 41.34 |
| Ash | 4.76 | 10.36 |

**THE MANURIAL VALUE**

of this new feed must not be lost sight of. Containing as it does the more solid parts of the stalks, its percentage of ash is very high. Since 100 pounds of pure ash of the maize stalk contain some thirty-six pounds of potash and nearly fifteen pounds of phosphoric acid, not to mention about ten pounds each of soda, lime, magnesia and silica, it will be seen that the manurial value of the prepared shives is important. The new preparation is also remarkably rich in protein or nitrogenous matter and this adds still more to its manurial value.

Compared with other feeds, the Marsden new corn feed now made warrants the comparison expressed in the following table. Its digestibility is figured on the average results at the Maryland station. The "values expressed in money" are necessarily somewhat arbitrary, but are the same as used in Myrick's feeding charts and tables, and are quite as intelligible and useful to the ordinary farmer as the chemical analysis and artificial co-efficients of digestibility.

ANOTHER VIEW OF THE MARSDEN EXHIBIT

FEEDING AND MANURIAL CONSTITUENTS COMPARED.

| | *Marsden feed* | *Dry corn fodder* | *Timothy hay* | *Wheat bran* | *Corn meal* |
|---|---|---|---|---|---|
| Water | 2.9 | 42.0 | 13.0 | 11.0 | 15.0 |
| Dry matter | 97.7 | 58.0 | 87.0 | 89.0 | 85.0 |
| Including ash | 5.1 | 2.7 | 4.4 | 5.8 | 1.4 |
| Protein, total | 6.2 | 4.5 | 5.9 | 15.4 | 9.2 |
| Protein, digestible | 3.7 | 2.5 | 2.9 | 12.0 | 7.0 |
| Fiber, total | 41.3 | 14.3 | 20.0 | 9.0 | 1.9 |
| Fiber, digestible | 25.2 | 9.4 | 15.4 | 2.3 | 1.1 |
| Sugar, starch, etc. | 37.5 | 34.7 | 45.0 | 53.9 | 68.7 |
| Sugar, etc., digestible | 24.8 | 24.0 | 28.4 | 36.7 | 63.2 |
| Fat, total | 1.8 | 1.6 | 2.5 | 4.0 | 3.8 |
| Fat, digestible | 1.6 | 1.2 | 1.4 | 2.9 | 3.3 |
| Feeding value per ton | $12.12 | $8.16 | $10.48 | $13.76 | $16.98 |
| Nitrogen per cent | 3.1 | 1.8 | 1.3 | 2.7 | 1.6 |
| Phosphoric acid | 1.1 | 0.5 | .5 | 2.9 | .6 |
| Potash | 1.8 | 0.8 | .9 | 1.6 | .4 |
| Manurial value | $10.84 | $6.53 | $5.03 | $12.19 | $5.69 |
| Total value | $17.54 | $11.43 | $13.00 | $19.86 | $19.83 |

The feeding value per ton is obtained by estimating the digestible fat and digestible protein as worth 2c per lb., and digestible fiber and carbohydrates (sugar, starch, etc.), at 1c per lb. Manurial values are expressed in money by estimating nitrogen at 15c per lb., phosphoric acid 5c, potash 4c. The total value in money is the feeding value plus one-half the manurial value, on the assumption that half the plant food elements are lost by the time the solid and liquid excrement is used on the farm. The "values" thus expressed in money have no necessary relation to what either feed costs in market, nor to their feeding value or effect in making flesh or milk.

**THE MARSDEN PROCESSES OF MANUFACTURING VARIOUS PRODUCTS FROM CORN STALKS.**

The exhaustive exposition above of the industries that are being developed from corn stalks, has led to a loud demand for some account of the various processes of manufacture. The following is the first complete and authoritative description of these processes ever published, but of course omits the secret methods and machinery that are The Marsden Company's exclusive property. This description is of the methods in vogue at the factory at Owensboro, Ky., and will be still clearer by reference to the illustrations printed herewith.

The corn stalks as received from the farmers, tied in bundles, are thrown upon the carrier, shown in one of the photographs, along which the bundle is conveyed to the cutting machine, wherein the stalks are cut into lengths of about one-half inch. A considerable quantity of the leaves and husks are not cut by this machine, but passed through in their original form. All of the stalk, however, is cut up, and in cutting a considerable portion of the outside hard shell is broken loose from the pith.

The material in bulk then passes up the elevator in front of the cutting machine and is thrown into the first pair of large revolving reels, which are clothed with mesh cloth of sufficient size to permit the pith and shell and small particles of leaf and husk to pass through it. The coarser portions of the leaf and husks pass over the reel, tailing from its end, are caught up by an exhaust fan and conveyed through pipes to another part of the plant, where they are shredded and baled ready for the market, furnishing an excellent rough fodder for cattle feeding, equal in nutriment to the best timothy hay.

The material passing through the meshes of these reels is elevated and thrown into the second pair of reels, shown in another photograph. These reels are clothed with longitudinal wires, and by revolving the same at a high rate of speed, the flat pieces of shell, leaf and husk escape between the wires, thus performing the second cleaning operation on the pith. Falling in the hopper, shown under these reels, this material is drawn up by exhaust fans and carried direct to large attrition mills, not shown in any photograph, and is there ground to a fine meal, thus making the new corn product.

### SEPARATING THE CELLULOSE.

The pith tailing over the longitudinal reel is also caught up by exhaust air and carried to the top of building No. 4, shown in the photo-

STARTING A CORN STALK CRIB

From a photograph taken at Linden, Indiana. Huge piles of stalks at either side.

graph, where it is discharged into a grading machine. This consists of reels clothed with four different size mesh cloths, the object being to separate the sizes to facilitate separation from whatever shell and leaf that may remain mixed with the pith at this point. From the grading reels each sized material falls upon another separating device, which consists of a series of inclined upward moving canvas curtains, and not shown in photograph.

The material being delivered at the top of the curtain, the round or short pieces of pith roll rapidly down the curtain, while the flat pieces of shell and leaf are drawn upward and backward over the curtain, falling into an exhaust chamber, whence they are conveyed to the same mills that grind the fine cattle feed.

The pith from these several curtains is now entirely free from leaf, husk and loose dirt, but may have more or less of the hard outer shell closely adhering to it. The pith from all cleaning machines is concentrated by the means of gravity pipes to a belt conveyor, which runs under the entire length of building No. 3, shown in photograph, and is there admitted to an elevator boot, which carries it to the top or fourth floor of the main factory building. The pith is then ground in a mill similar to the mills which grind the feed. This operation breaks loose every particle of shell yet adhering to the pith. The ground mass is then graded into four different sizes, each size consisting of pith, fiber and shell of equal size, though of different specific gravity.

The material then passes to the machine wherein the pith is separated from all foreign material that it may have been mixed with. This is done entirely by air, and the machinery consists of certain special devices. The fiber and shell obtained by this process are carried back to the grinding mills in No. 4 building and are mixed with the feed, the pith in this pure state being again concentrated on a belt conveyor, which carries it to the department wherein it is treated chemically for fireproofing. This operation consists in mixing with the cellulose certain chemicals whereby it is rendered fireproof.

## GOVERNMENT INSPECTION.

At this point of the manufacture, the government inspector, who is stationed continually at the works, passes upon the material. He takes samples of about one half peck each, places it in an iron pan with a perforated bottom and drops on the cellulose an iron rivet heated to a thousand degrees. The government specifications require that under this intense heat the cellulose shall only char and that no flame shall be shown. After the inspector is satisfied that the material meets the fireproofing requirements, it is passed on to the pressing and packing department, shown in the photograph. The government requires that the material shall be packed in six inch cubes to a density of from eight to nine pounds per cubic foot, thus each of the six-inch cubes will weigh from sixteen to eighteen ounces. Each of these cubes is then packed in a pasteboard box, and 128 of these boxes are then packed in a stout packing case, which is first lined with waterproof paper. The box is then closed, the government inspector puts his official stamp on it and it is then practically the property of the United States or some foreign government.

## THE FEED BY-PRODUCT.

After passing through the attrition mills, the cattle feed is all sifted to a uniform size, any coarse particles it may contain being returned to the

**BREAKING GROUND FOR THE NEW PLANT AT LINDEN, IND.**

**FURTHER ALONG IN CONSTRUCTING THE CRIBS**

At Linden, Indiana. From a photograph taken in September. There are ten of these cribs each 500 ft long.

mills for further reduction. From the sifting device, the feed passes into the packing machines, shown in photograph, where it is packed in packages, as shown, to a density of about thirty pounds to the cubic foot.

We have now followed the corn stalk from the time of its delivery to the factory in its original form up to the point where it is ready for the market in the form of cellulose for packing war vessels and cattle feed for general use. The many other uses to which the cellulose is put, such as smokeless powder, dynamite, sponge-making, etc., begin at the point where it is chemically treated for fireproofing. This process of manufacture will be carried out in the new plants at Linden, Peoria and Newport News. From the time the corn stalk starts on the carrier up to the time the feed reaches the packing machines and the cellulose reaches the cellulose press, it is not touched by anyone, the process being continuous and the machinery entirely automatic.

## MORE ABOUT THE OWENSBORO FACTORY.

The first factory in the world for working up corn stalks was established at Owensboro, Ky., in 1896. The location was at the center of a large corn-growing region, accessible by water, railroad and highway to all points. The plant is located immediately on the south bank of the Ohio river, not far from the heart of the city. The river front is a high bluff and the federal government has lately completed rip-rap and mason work to protect the bank from water current during high water.

There are nine separate buildings in use: No. 1, brick, four-story, 56 x 158 feet, which contains the greater part of the reduction machinery; No. 2, brick, one-story, 48 x 126, engine house; No. 3, one-story frame, 40 x 94, machinery; No. 4, frame, three-story, 39 x 46, machinery; No. 5, 48 x 132; No. 6, 84 x 132; No. 7, 50 x 130; No. 9, 132 x 132; No. 11, 25 x 125. Nos. 5, 6, 7, 9 and 11 are all frame and one-story, and are used as storage sheds, but with stalk cutters occupying part of 5 and 6. Buildings Nos. 1 and 2 are substantial brick structures. The others are somewhat inexpensive frame buildings covered roof and sides with corrugated iron. The photographs herein give a good idea of the plant.

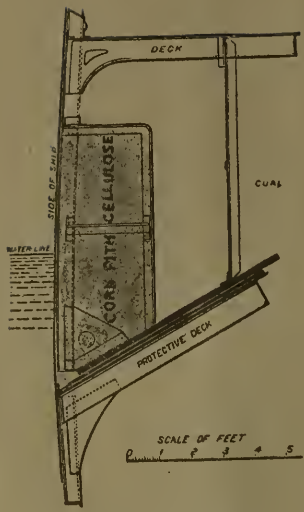
Up to the time of our visit, the stalks used have been drawn from the surrounding country, and delivered at storage sheds by farmers' wagons. There is a stalk yard at a point a little distance out in the country where surplus could be stacked, but not under cover. Being located on the river, stalks can be drawn from a considerable distance at little cost. The company has good docking facilities, and owns a small steamer which it proposed to utilize to tow a fleet of barges. These barges will be taken to convenient points along the river, and stalks may be hauled and delivered to them instead of hauled to central plant. A small cutter will be on each barge, so that by the time they reach the central plant, the stalks will be cut into short pieces, and thus advance the first steps in manufacture. This facility for cheap water transportation for raw material was one reason for locating at Owensboro. The double illustration on Page 2 shows two of these barges finished and others being built. The present will be the first season that barge transportation has been used. For transporting stalks longer distances by rail to The Marsden Company's factories in Virginia, Indiana and Illinois, large railroad cars are specially constructed that carry immense loads. The size of these cars is limited only by the curves of the rails and the hight or width of bridges. Such cars are loaded with cut stalks, the cutting being done at cutting stations conveniently located along the railroad.

Medium-sized stalks are preferred, and experience of farmers who have been furnishing them is that average production is about two and one-half tons per acre. The price paid has been from $3 to $5.40 per ton, according to condition and dryness, delivered at the plant when desired. Contracts are made providing for a sliding scale of price for delivery in different months, in such case grower to shelter stalks and deliver well dried. December delivery was paid for at $3.50 per ton, January $3.75, February $4.50, and ten cents additional each succeeding month to November, when the price for old stalks in prime condition is $5.40. Experience indicates that the amount of dry matter obtained in a ton of stalks at these prices costs about the same. Stalks left standing in the corn field may be cut and delivered at the farmers' convenience during the winter at $3.50 per ton. The shredded corn leaves, one of the first by products in the manufacture, are eagerly bought up by local feeders at a price competing with hay, and are preferred to hay because of the results obtained from feeding the same.

Of the corn stalk, the cellulose is about half the bulk and one-eighth the weight, the residue being one-half the bulk, but seven eighths the weight. Therefore, in a ton of average corn stalks, as taken from the field, there are about 250 pounds of cellulose and 1750 pounds of residue—nodes, shives or shells, leaves and tassels—all nutritious matter. This explains how it is that the Marsden corn feed is so much more concentrated than the stalks from which it is made. So much of the spongy pith or cellulose is removed that the resulting feed is quite concentrated and of higher feeding value than clear corn fodder. This result may be compared to gluten feed or gluten meal, which is so much more concentrated than the clear corn grain from which it is made, because so much of the starchy matter is extracted that the remainder is proportionately rich in protein.

When the factories now under construction are completed this fall, The Marsden Company will be able to work up 300,000 tons of corn stalks. This should yield about 200,000 tons of the various forms of Marsden feeds, besides the other and more valuable products. This is but a beginning, as the company contemplates building a large number of factories throughout the corn belt in future. The market for the products of these factories seems to be unlimited, and offers every inducement for a development of this industry on broadly comprehensive lines.

HARVESTING THE CROP




**COFFER DAM OF CELLULOSE**

on a war ship. If a shell from the enemy pierces the side of a ship below the water line, and passes through three feet of corn-pith cellulose into the ship, the cellulose will swell up so quickly that no water will get into the ship. "For keeping out water a cellulose belt of 3 ft may be said to be about as efficient as a 6 inch belt of steel, so that the ship's stability can be protected with 100 tons of cellulose where we should require 1000 tons of steel." The naval ships Columbia, New York and Olympia are thus protected, and cellulose is being used on most of the new ships.