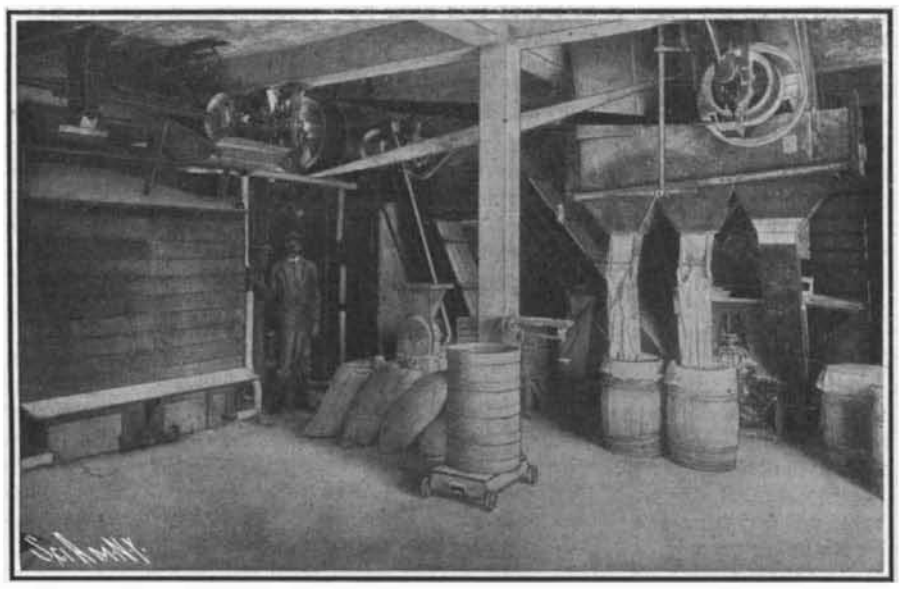
restoring capillarity where plowing has arrested it. A smoothing harrow next follows, leaving a pulverized layer on top, which prevents the moisture from below from reaching the surface and evaporating.

The constant care and working of the soil on which the crops are to be raised is said to be equally important with the rainfall itself. The pulverized ground must not be allowed to pack or break in any event. To avoid this, the harrow is run over it after each rain. The working of the soil begins several months before seeding, and must also be continued after seeding.

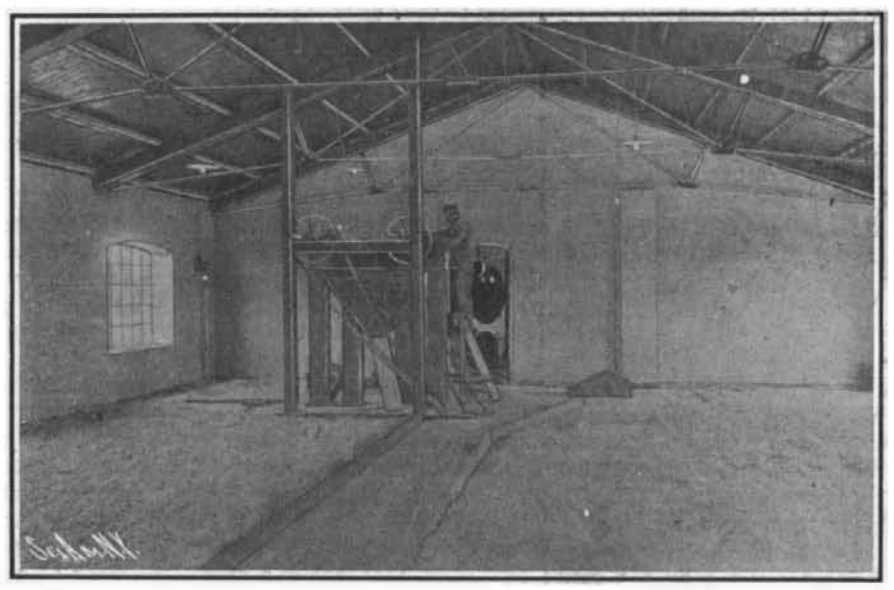
A great many people, cultivating their land under the new system, aim to raise but one crop from the same ground in two years. They divide this land into two equal parts, and use one part for crops one year, and the other the next. This admits of what is known as "summer culture" on the part not in use, and the storing of a season's rains in the soil reservoir. Again, it may be feasible to allow the land to produce crops for two years, and alternate one year of "summer culture." Where crops are planted every year, plowing must quickly follow the operation of harvesting, the aim being to save all possible moisture in the ground and simultaneously prepare the soil for the next rains.

It is confidently expected that the time will come when land on which but a ten-inch rainfall is now recorded will be made to blossom as the rose. This will be accomplished by further advances in scientific discovery. At present, districts having less than fourteen inches rainfall are not regarded as profitable. An educational movement for the scientific study of "dry farming" has already been talked of. Not all attempts at "dry farming" are a success, nor will be, until the mass of the people using it understand the principles on which it must be carried out. The rainfall varies in different years, and this emergency must be met in a scientific way. Conditions differ also in different localities.

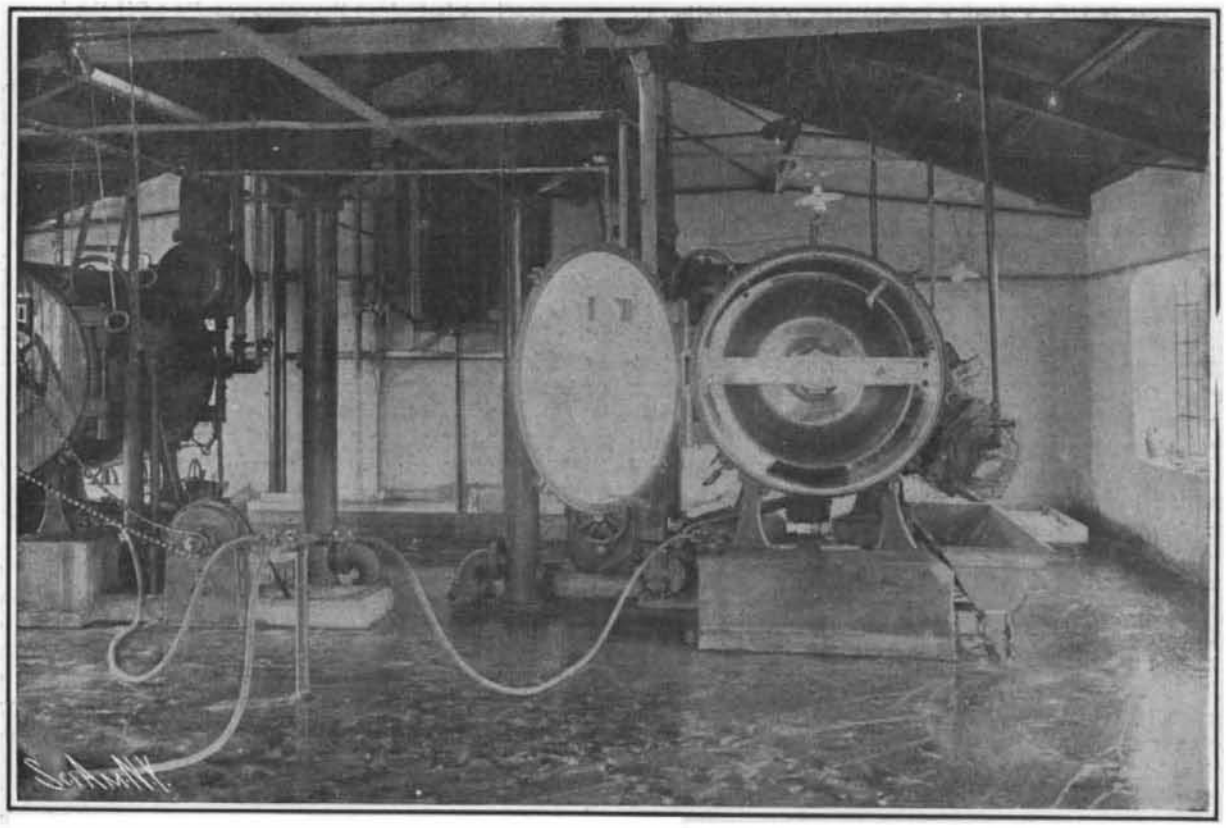
The establishment of more government experiment stations will greatly assist different sections. Several are to be established, it is understood, this year. At Cheyenne, Wyoming, the Board of Trade not long ago established an experiment station, assisted by the government and the railroads. It was here found that, although Cheyenne is at an elevation of 6,000 feet above sea level, wheat, rye, barley, oats, alfalfa, field peas, and sugar beets can be grown profitably. As a result of the experiments the ranchmen in Wyoming are buying thousands of dollars' worth of farming machinery, and are breaking up large acreages and sowing alfalfa and other grasses and grains. Ranches are also being sold for colonization purposes.



Part of the Plant Where Milk Powder is Ground and Sifted to the Consistency of Wheat Flour Ready for Packing.



Cooling the Dry Milk and Feeding the Conveyor Leading to the Milking Plant. The Powdered Milk on the Floor is Yellow in Color and Brittle in Texture.



The Milk-Drying Room, Showing the Exsiccator Devised by Dr. Ekenberg for Drying the Milk under Vacuum with Exhaust Steam.

One exsiccator is shown open, upon the interior nickeled surface of which the milk powder is deposited. The supply of milk from the feed tanks is maintained through flexible pipes from the standpipe in the center.

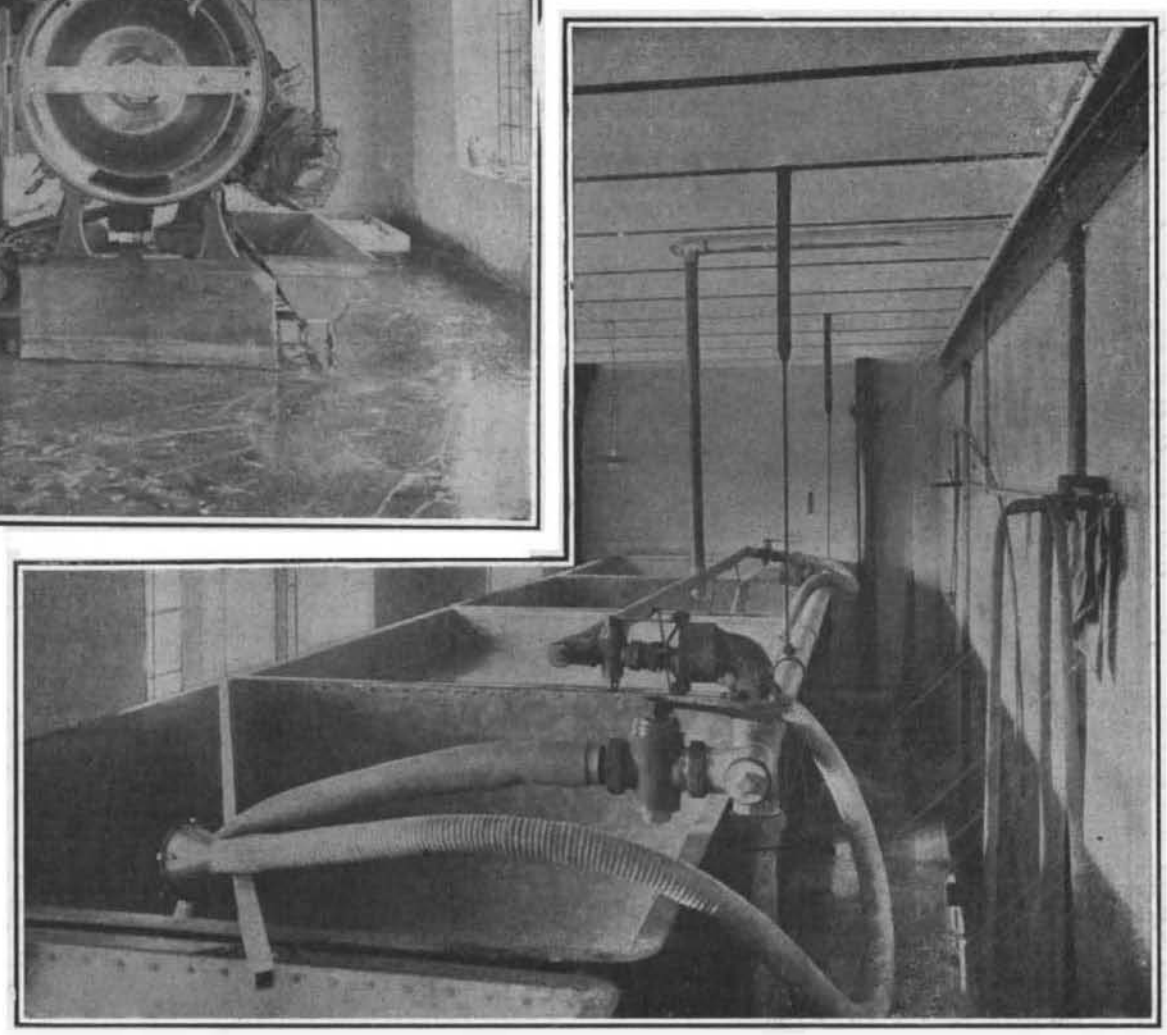
THE EKENBERG PROCESS FOR MANUFACTURING DRIED MILK.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Some five years ago we briefly referred in the pages of the SCIENTIFIC AMERICAN to a lecture delivered before the Royal Academy of Agriculture in Stockholm by Dr. Martin Ekenberg, the eminent Swedish scientist, relative to the production of dried milk, in which he tersely described a system he had then recently evolved for the production of this substance upon an entirely new basis, and in which the constituents of the liquid even when condensed were perfectly retained. Since that date several improvements in the process have been effected, and at the present time there are several factories in Sweden and other countries where the production of the milk powder is being carried out upon an extensive commercial scale.

While there is no food which can take the place of milk in its various uses, there is at the same time no dietary article which is more difficult of distribution, as it is extremely sensitive, and liable to rapid changes and sour fermentations. The reason is that the liquid is composed of 88 per cent of water, in which the solid food substances are dissolved and suspended; and among these latter substances there is one most subtle class, i. e., the albumenoids. It is clear that the great amount of water present renders the milk remarkably susceptible to the propagation of bacteria, while at the same time its bulk militates against cheap and easy transportation.

Numerous efforts toward preserving the solid sub-



The Tanks into Which the Milk is Pumped from the Delivery Room.

THE EKENBERG PROCESS FOR MANUFACTURING DRIED MILK.

stances present by the elimination of the water have been made since the early years of the past century, but the difficulties encountered in entirely extracting the water and the inefficient mechanical means then available were such that the attempts toward producing powdered milk were perforcedly abandoned, and the production of the milk in a condensed form perfected. In this process the milk is converted into a thick liquid which, especially in the presence of cane or beet sugar, has keeping qualities sufficient to render it an article of commerce easily transportable. But although the milk is considerably decreased in bulk by the process of condensing, exploration in the tropics, and long sea and land expeditions, when all requisite food supplies have to be carried from the very start, rendered it apparent that a further diminution in the bulk was desirable, not only in regard to weight but also in order to obtain a better keeping quality, since it is imperative with the condensed product that the can in which it is carried should be absolutely air-tight. Furthermore, condensed milk is somewhat monotonous as a daily food owing to its extreme sweetness. Consequently the old question of reducing the fresh milk to a dry powdered form again impressed itself upon scientists, and numerous experiments to overcome the obstacles which had proved insurmountable to the pioneers in this direction were carried out, among them being Dr. Ekenberg's.

In these renewed efforts the investigators were appreciably assisted by the entire revolution that had taken place in the dairy industry by the introduction of the centrifugal skimming or separating machine, which rendered the practical utilization of the resultant skimmed milk a question of vital importance, since the milk, being deprived of the greater proportion of the cream, was rendered unmarketable in the usual manner, so that it became somewhat of a by or waste product. But at the same time, although the separator made it possible for inland dairies, whence transportation of the raw fresh liquid was difficult, to produce a salable and remunerative article in the form of butter, yet the bulk of the milk—skimmed milk—containing the most valuable parts from a physiological point of view, was left behind.

The operation of extracting the water and converting the milk into a powder appears at first sight to be somewhat simple, but in such a process care must be observed that the resultant product has none of its original and valuable properties destroyed or impaired. The powder generally known as "dry milk," although made from milk, is in reality no longer milk, nor can it be re-converted into milk, though owing to its nutritious value it is used extensively as an emergency food. In the Ekenberg process, however, the powdered milk, as it is termed, is actually dry milk easily soluble in water, and which, when re-constructed into its liquid form by the correct proportionate addition of water, becomes in every way similar to the original substance. Dr. Ekenberg discovered his process in 1899, but during the ensuing years many important improvements have been effected whereby the cost of producing the powder is now quite nominal, so that the product can compete commercially with either the fresh or condensed milk.

The feature of the Ekenberg process is that the heavy percentage of water present in the fresh separated liquid is rapidly evaporated at a low temperature under vacuum, the temperature at no stage of the operations being much higher than luke-warm. Upon arrival at the factory, the cans of milk are emptied into a small reservoir on the ground floor and then pumped to the receiving tanks located in the floors above. In Sweden, owing to regulations concerning milk, it is pasteurized at the dairies before being dispatched to market, so that at the milk factory this preliminary process is avoided. In other countries, however, where such regulations do not obtain, pasteurization is carried out before the elimination of the water is proceeded with. All empty cans are carefully and thoroughly sterilized with steam before being returned to the dairies. The milk is first filtered through a cotton medium whereby all foreign substances in suspension are arrested. It is then cooled by means of refrigerators to a point just above freezing and is kept at this temperature during the day's work.

The process of converting milk into powder consists in quickly drying the milk at the temperature of the blood or approximately 100 deg. F. For this operation a specially constructed apparatus evolved by the inventor and known as the "Exsiccator" (milk dryer) is utilized. In the majority of processes for extracting the water the milk is passed over or between rollers heated to a very high temperature, the powder being deposited upon the external surface of the rollers, from which it is subsequently removed by scraping devices. In the Ekenberg system the powder is deposited upon the inner face of a vacuum vessel. The exsiccator comprises a large, horizontal, cylindrical drum which is caused to revolve. The internal face of this drum is of nickel, which has been proved to be the most suitable metal for the purpose. The milk enters the exsiccator department through a floor standpipe, to which flexible pipes extend from each exsiccator, it being possible to provide as many supply pipes from this central source as there are machines for drying the milk. The supply is maintained by gravitation, the capacious tanks containing the raw milk being placed at suitable points above. The heating medium employed for evaporating the milk is exhaust steam, which is admitted to the interior of the drum when closed. In order to obtain high efficiency and rapid treatment the ends of the drum form bowls, dished outward, in which evaporation of the water to an extent of about four-fifths of the o iginal amount takes place; here an evaporation effect of 160 to 180 kilogrammes per hour per square meter (295 to 330 pounds per square yard) is obtained, which is a higher result than has hitherto been possible, since a locomotive boiler, for instance, evaporates only 40 kilogrammes and a sugar vacuum from 60 and 80 to 100 kilogrammes per hour per square meter. This high evaporating efficiency is obtained by maintaining the milk in constant circulation. The solids of the liquid are deposited upon the nickel surface of the drum and are removed by means of German silver knives and deposited in a special receptacle close to the drum, this vessel being arranged for a periodic discharge of its contents either by hand or by a mechanical device. Upon the removal of the dry milk powder from the exsiccator it is submitted to a crystallizing process in a special chamber at a temperature ranging from 80 to 100 deg. F. It is left within this chamber for approximately one hour or until the sugar of milk has thoroughly crystallized. In this crystalline state the substance is of a very brittle nature and is now submitted to grinding and sifting operations in a mill in precisely the same manner as wheat flour, after which it is ready for packing in either tins, boxes, or barrels.

The exsiccators of the size in general use at the factories now in operation have a drying capacity of from 800 to 1,000 liters (211 to 264 gallons) of milk per hour, or about 15,000 liters (3,962 gallons) per day and night, allowing sufficient intervals for cleansing and emptying the machine. The consumption of steam is low, 100 liters (26 gallons) of milk requiring from 90 to 93 kilogrammes (198 to 205 pounds) of steam for complete drying. The cost of producing the powdered milk is also sufficiently low to render it commercially practicable, the cost of extracting the solids from one gallon of milk amounting to one cent, inclusive of wages, coal, steam-raising, depreciation of plant, and other establishment and maintenance expenses. This low price is furthermore reduced by the economy effected in the transportation of the dried product, owing to its greatly reduced bulk, which is one-tenth of the liquid milk. Powdered milk prepared on this system is therefore not dearer, but cheaper, than the fresh liquid article to the consumer, especially in view of the fact that the fresh milk can be obtained from those parts of the country where it is locally very cheap but where the difficulties and cost of transportation render it impossible to be dispatched to the markets of the great cities for profitable disposal. Moreover, the low cost of production renders it possible for machine-skimmed milk, which is in itself a perfect food and is perhaps purer than the whole milk (in skimming by means of the mechanical apparatus the greatest part of the natural impurities in the raw milk are removed and remain in the separator), to be made available for the masses in the large cities.

If required, the milk powder can be easily reconverted into its original liquid condition by the addition of about nine parts of water to one of the powder. The product of skimmed milk is easily soluble in cold water, in which it is widely divergent from the majority of dried milks, which only with difficulty dissolve in warm or hot water. In this process no foreign substances, to facilitate the conversion of the liquid milk into a stable substance, or preservative are added, and the fact that the skimmed milk and milk with a low percentage of fat are perfectly soluble in cold water is solely attributable to the vacuum treatment adopted, and which constitutes one of the most vital features of the Ekenberg process. It is thus possible for any one under varying conditions, such as soldiers and explorers, to obtain supplies of perfectly natural milk so long as they have access to fresh water. The only difference between the restored and the natural milk is a slightly boiled flavor such as is noticeable when the housewife in hot weather pasteurizes her ordinary milk by scalding it. This effect is attributable to the preliminary process of pasteurization and does not arise from the treatment of the milk in its conversion into powder, and it is only perceptible to an experienced palate. The purity of the restored milk is further testified by the slight sediment which is observable after it has been left standing for more than two hours, this sediment consisting of the albumen coagulated during the pasteurizing process. The experiences of later years have demonstrated the fact that such sediment cannot be avoided without the addition of chemicals, and pasteurized and dried milk must yield some such slight sediment. If such a result is not noticeable after two hours' standing, then chemicals must have been added to the milk at some time or another and in such a case the whole constitution of the milk is altered and no cheese can be made from the restored milk. In regard to these sediments it is to be remembered that the natural milk consists of a serum in which the casein and the fat globules are suspended; it is therefore truly remarkable that this milk powder can be dissolved in water and the milk reconstructed with its casein in its natural condition. However, this sediment is not of sufficient importance to prevent the utilization of the milk powder in the various commercial uses for which it is eminently adapted, such as bakery and confectionery operations. With the Ekenberg dried milk powder it was quite practicable to make cheese, which testifies to the fact that the inner construction of the milk is in no way altered by the drying process.

In comparison with the condensed milk which has now such an extensive vogue, the milk powder has a marked advantage. The ordinary condensed milk with sugar contains from 8 to 12 per cent of milk fat, depending on the quality of the brand, whereas the milk powder contains more than double the quantity, or about 25 per cent of milk fat. In the former, again, the percentage of dry milk substance aggregates some 40 per cent, the balance being sugar and water; the powdered milk contains 98.5 per cent of milk substance, the remaining 1.5 per cent being free moisture. One pound of condensed milk will yield 1.6 quarts of restored milk according to the usual directions for use, while the same quantity of milk powder will give 3.5 quarts. Whereas the condensed milk must be carefully stored in air-tight tins hermetically sealed under special precautions (since any puncture of the vessel will result in leakage and the ultimate fermentation of the contents), with the milk in powder no such apprehensions need be entertained, as a puncture of the tin can result in no serious harm, and it will keep in all climates and retain its sweet and pure qualities under all conditions. Furthermore, while the condensed milk is available only for the sweetening of fluid foods, the powdered variety is applicable in all dry food preparations appealing to domestic use, such as custard powder, cereal preparations, and so forth, as in its raw condition, owing to the milling and grinding operations to which it is subjected, it is of the same consistency and nature as the ordinary wheaten flour, while the absence of added sugar does not sweeten the preparations but gives the same results as if the housewife simply added the preparations desired with ordinary fresh milk.

In regard to the presence of bacteria in the Ekenberg milk powder the various analyses and severe tests to which samples have been subjected show the preparation to be free from such contaminations. Prof. W. Booth, of Syracuse, N. Y., who has made a thorough examination on this subject, found that even after a week's exposure to a temperature of 60 and 65 deg. F. no colonies of bacteria in suitable strata were mixed with the powder. This immunity is probably due to the bacteria-destroying influence of the serum-enzymes of the milk during the concentration in the vacuum, whereby the enzymes are kept in full activity.

SIDE LAUNCHING OF THE U. S. S. "PATUXENT."

We present on the front page illustrations of the side-launching at the Norfolk navy yard of an ocean-going tug, the "Patuxent." While the weight involved was small, the launching was in many respects unique, as it involved a side launching, together with a bodily drop of the ship of about five feet upon reaching the ends of the ground ways. Side launchings are a matter of frequent occurrence, particularly on the Great Lakes; but in practically every instance the ways are continued under water to insure the vessel being waterborne (i. e., supported entirely by water) before leaving them.

The Norfolk navy yard is not equipped with a building slip, nor with any modern means of handling materials over a ship on the stocks. Nor was the allotment of money for building the tug sufficient for cutting through the granite sea wall and laying the usual ways. Accordingly, as the cheapest way of building the vessel, she was erected close to the sea wall, the keel being parallel to the same. This involved laying the launching ways on the top of the granite wall. To insure the vessel being waterborne, the ways would require to extend a hundred feet beyond the sea wall. The expense of piling, and the obstruction of a narrow river, made this impossible, and dropping the vessel off the end of the ways was determined upon.

There were six ground ways, each extending 12 feet beyond the sea wall. Each ground way was cut just beneath the packing, and as the vessel passed the edge of the sea wall, the groundways lifted, and formed a fender which prevented the vessel from rolling backward, recoiling, and doing herself damage against the granite wall. A photograph was fortunately secured by Naval Constructor Battles, which is here reproduced, which shows clearly the tilted groundways and the angle reached by the tug in striking the water.