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 s' ows clearly the tilted groundways and the angle reached by the tug in striking the water.

The "Patuxent" is an ocean-going twin-screw tug, 148 feet in length, 755 tons displacement, 1,160 horsepower, and estimated speed of 13 knots. A large bunker capacity, twin screws, and unusual speed make her an exceedingly valuable vessel, and she will undoubtedly prove a very serviceable addition to the new navy.

Correspondence.

Electrocution of Animals.

To the Editor of the SCIENTIFIC AMERICAN:

In reference to an article in the July 11 number of your journal, concerning the humane slaughtering of animals, I wish to call your attention to the fact that all the devices offered, at least all those mentioned in the article, for the solution of the problem seem to be of the mechanical order. Why is electrocution not made use of? In slaughtering upon a large scale, it appears to me that electrocution would afford more advantages than the use of any mechanical device, besides being humane enough for the requirements of the A. S. P. C. A. What could be more rapid than the quick application of a high-tension current?

Sherburn, Minn. WALTER ARP.

The Meaning of "Micro-photograph."

To the Editor of the SCIENTIFIC AMERICAN:

Permit me to call your attention to the misuse of the word "micro-photograph" in legends on illustrations on pages 56 and 57 of your July 25 issue.

A micro-photograph is an ordinary photograph minimized to about the size of a pin-head for viewing under a compound microscope.

A photo-micrograph (which is what you show) is a photograph through a microscope of a magnified view of a microscopic object. Of course, I admit there is some "authority" in the misuse of the word as you use it; but in the interests of photo-micrography, I beg you to use the correct or better word. Even if there is sanction of your use of the word, it is illogical. What you want to express is not a *micro*-photograph, but a photograph of a micro-object. The photograph may be as large as the side of a barn.

EDWARD F. BIGELOW.

Stamford, Conn., July 27, 1908.

A Young Girl's Theory of Thunder Storms.

To the Editor of the SCIENTIFIC AMERICAN:

Can a twelve-year-old girl be scientific? Surely not. But I love to think and talk about such things; and who knows but that some day, kicking about in the dust, I may find a nugget as well as a man might. The following notions about the causes of rainfall I think to be new. They are interesting to me, also to some others, among them Prof. Loveland, of our State University, and I surmise they may some time be proved correct:

I, one day, during a thunder storm, said to my father: "What causes thunder?"

He replied: "It is the detonation resulting from a bolt of lightning leaping from cloud to cloud or from a cloud to the earth."

"Yes; we understand that is *what* it is. But what causes it?"

"Well, electricity is generated, in some way not clearly explained, by the condensation of vapor into rain."

"Did you, when a student, see any experiments in which condensation of moisture generated electricity?"

"No; I never did, but I have seen the exact opposite. I have seen water decomposed by electrolysis, i. e., an electric spark passed through water will resolve it into its components, oxygen and hydrogen."

"Then, by the law of conservation of energy would not the reuniting of these component gases into water give back the electric spark that separated them?"

"Yes, I presume it would, though I have never seen any demonstrations to this effect."

"If such prove the case would it account for lightning and thunder?"

"No; not as we understand it. To account for lightning and thunder in this way would involve us in accounting for rainfall by chemical reaction—an entirely different theory from that which now obtains."

"What is the present theory of rainfall?"

"Why, simply this: The point of saturation of cold air is much lower than that of warm air. Hence, when saturated air becomes cooled it precipitates moisture in the form of rain."

"Did you ever see this done in a laboratory?"

"Yes. Often and in many ways. The sweating of a pitcher of ice water in a warm room attests it, also the mist falling from the exhaust steam of an engine on a cold day."

"Did you ever see water recomposed from its constituent gases?"

"Yes. You put them in an inverted bell jar and explode them and water moistens the table. We also see the same in the water dripping from the oxy-hydrogen blowpipe."

"Is the explosion attended by noise?"

"Oh, yes. It cracks like thunder and bursts the bell jar in a thousand pieces."

"Does it give off an electric spark?"

"It may. I never tested for it."

"Could rainfall be accounted for by a chemical reaction like that which bursts the bell jar, lightning being its liberated energy and thunder its detonation?"

"Probably not; though it is a novel and fascinating idea. The soft, thunderless rains of our winter season and those of the Pacific coast are doubtless the result of condensation only, as popularly supposed. But you lead me to think there is room for speculation as to the origin of the thunder shower. At any rate it is an interesting theme. Hunt it down as Kepler did his Laws of Planetary Motion and see if it fits the conditions."

And so I have been, and still am, "hunting it down," and the following is my catechism as far as formulated:

Q. What is the source of the free oxygen in the air presupposed by my theory?

A. All oxygen in the air is free oxygen. Air is a mixture, not a chemical compound.

Q. What keeps up the supply of oxygen if large quantities are consumed in the formation of rain?

A. The exhalation of plants in the process of growth. They inhale carbon dioxide, secrete the carbon, and exhale the oxygen.

Q. Then we would expect more oxygen and more rainfall in districts where vegetation abounds?

A. And such is the case; also more thunder and lightning.

Q. We would also expect fewer thunder showers in winter than during the summer months with their oxygen-exhaling verdure.

A. It rarely thunders in winter, or in arctic latitudes, or after frost has checked vegetable growth in the fall.

Q. Why does a thunder shower seem to follow a watercourse?

A. The vegetation, and hence the free oxygen, are more abundant along the valleys and watercourses. The rain cloud builds itself as it goes, and builds in the channel where the materials exist most abundantly.

Q. In what way does cultivation of the soil and the planting of trees increase rainfall?

A. Besides the physical results usually ascribed, it increases vegetation and the free oxygen which vegetation supplies.

Q. Is oxygen more abundant preceding a thunder shower?

A. Yes. It sometimes becomes so abundant as to compose a new element, ozone or compound oxygen, which is found in the air just preceding and during a thunder shower.

Q. Is there free hydrogen in the air?

A. Yes, but in quantities disappointing to my theory.

Q. Can this dearth of hydrogen be accounted for?

A. Yes. Hydrogen has a density, or specific gravity only one-fourteenth that of air. Hence, free hydrogen in any quantity would be found in altitudes far above the air strata to which man can gain access.

Q. If so far above the earth, how would it get in contact with the oxygen?

A. Air currents would mingle them.

Q. Do winds, then, conduce to rainfall?

A. Most certainly, especially variable winds. This is obvious to all observers.

Q. But gases mingle together freely regardless of specific gravity; and so, if there were hydrogen in the air it would also be present at sea level?

A. It is present in small amounts in all natural atmosphere. Also the free diffusion of gases is only a partial fact. Carbon dioxide, for instance, will accumulate in wells and mines by reason of its greater specific gravity. It may also be poured from one vessel to another in the presence of the atmosphere and only slowly becomes diffused through the air. And yet its specific gravity is twelve times nearer that of atmospheric air than is that of hydrogen gas.

Q. How can we account for the large quantities of hydrogen in the air which my theory presupposes?

A. The only source I can suggest is the electrolysis of water. The force of the average thunder bolt, expressed commercially, is about $1,400, or equal to the oxidation of a thousand tons of coal at mine value—an enormous aggregate force. Water is one of the best natural conductors of electricity. Hence, lightning usually strikes in water or damp soil and its force, probably, is mainly spent in electrolyzing water and liberating hydrogen which would rise to the upper air immediately, while the oxygen would mingle with the air, which is of about the same specific gravity.

Q. My theory would lead us to expect an accelerated precipitation of rain following at each clap of thunder?

A. Yes. This is a universally noted fact. The freshening shower following a clap of thunder is the best and most direct proof of my theory. Some have tried to account for this by the jar imparted to the atmosphere, and in times of drought have bombarded the heavens in a vain and foolish effort to "jar the rain loose."

Q. If my theory be correct thunder is not the result of lightning. Why, then, do the two phenomena occur simultaneously?

A. Neither is the result of the other. Thunder and lightning are the twin results of a chemical reaction. The best evidence of this is the fact that, while occurring simultaneously, their evidences do not reach us simultaneously, for light and sound do not travel with equal velocity. A flash of lightning, however near us, reaches the eye before the thunder reaches the ear.

Q. Is it not more rational to say that the thunder is the snap of the electrical spark, so to speak?

A. Not at all. One sometimes sees the bolt of lightning and hears its snap or crackle, the detonation of the explosion that gave rise to both reaching the ear a second or two later.

Q. These explosions, when occurring near the earth, would be manifest in their damage to life and property?

A. And so they are. People and animals "struck by lightning" as we commonly call it, are often scorched and singed as if by an explosion of gas and are usually killed without being mangled or torn as we would expect if actually struck by a bolt of lightning. Also buildings are sometimes shattered and not fired; and at other times are fired but not shattered. A tree when struck by lightning is usually splintered, but I never saw evidences of burning in the channels cut by the lightning. On the other hand we often see trees inexplicably killed or the foliage scorched and killed without other evidences of lightning—two distinct classes of damage, one purely electrical, the other a shock and burning, the direct result of being within the zone of the oxy-hydrogen explosion.

Q. What of barometric pressure?

A. Since an unusual infusion of either hydrogen or oxygen, or both, would reduce the specific gravity of the air, my theory would harmonize perfectly with the low barometer preceding rain storms. Even though these gases should be present only in the higher altitudes, yet the barometer would record the lower pressure at all altitudes.

I have other questions yet to answer. I should like someone better equipped than I to discover for me the following, all of which my theory requires should be answered in the affirmative, and I ask them to write me what they discover or conclude, viz.:

1. Is there less free oxygen after than before a thunder shower?

2. Does free hydrogen become more abundant in the air as we ascend from the earth?

3. Is oxygen less abundant after a thunder shower on land and more abundant after a thunder shower at sea?

4. Does the explosion of oxygen and hydrogen gas in a bell jar give forth an electric spark?

5. If correct that electrolysis results when a bolt of lightning passes into the ocean, river, or damp earth, in what other way (than the one supposed by my theory) has the hydrogen gas thus liberated during the ages been taken up and the equilibrium of the air restored?

I do not dogmatize on this theory. I am too little gifted and too poorly equipped with knowledge of the commonest things. I expect some chemist or physicist to fulminate some little fact into my theory that will resolve it into gas thinner than those with which it deals. I am entirely willing he should do so. But if he should not? What then? I only ask that he give me notice when he shoots. EDITH E. CUMMINGS.

Beatrice, Neb., June 29, 1908.

The petroleum pipe line between Baku and Batoum worked without a hitch during the year 1907. The only objectionable feature in connection with the enterprise now is, that in view of the decrease in the exports of illuminating oils from Batoum, there is not sufficient oil to keep the pipe line and its costly machinery continually at work, and the undertaking is, therefore, not as remunerative to the State Railway as was anticipated when the scheme for laying the line first came under the consideration of Russian government engineers. Besides this, merchants using the pipe line are subjected to a loss of 2 per cent of oil which the railway authorities deduct for leakages. Considerable loss of oil is also experienced through the tapping of the line by natives, who in many cases have been caught clandestinely drawing off oil. At Elizavetpol, for instance, quite recently a gigantic fraud was discovered. The town having only consumed one tank car of oil during 1907, an inquiry was instituted which elicited the facts that the pipe line had been tapped some miles to the east of the town, that a systematic robbery of petroleum had been taking place all the year, during which as many as from ten to twelve cart loads of oil were nightly drawn out of the pipe and conveyed to the town for disposal at retail during the day.