wall or breakwater. If there are beaches to the leeward the effect on them may be disastrous.

Detached breakwaters should afford protection to the beaches in front of which they have been placed. They should create along those beaches conditions similar to those existing in protected bays and harbors. So far as the protected beaches are concerned, rapid changes due to wave action will be done away with, and the beaches may be extended by dredging and filling if desirable.

CONCLUSION.

It would appear that along each mile of open beach there is a constant transfer of sand from the shore to deep water. When littoral drift is the source from which the supply necessary to maintain the beach is obtained, the quantity of material brought to the section must, in order to maintain the beach, be at least equal to the material carried into deep water plus that carried away by littoral drift.

Assuming a section of beach where the littoral drift is exactly sufficient to replace the wastage, no checking

of the sand at any point will benefit the beach as a whole. The valuable part of water-front property is the part corresponding to the level of the cocoanut grove in Fig. 5, but the value of this portion is somewhat dependent on the existence of a sufficient berm at a lower level. Uplands may be protected by sea-walls and bulkheads, but bathing beaches must necessarily lie outside of such structures.

The writer knows of no means by which exposed sandy beaches for surf bathing may be preserved except by feeding fresh beach material to them as rapidly as the old material is carried away. The rate of growth of Rockaway Point and Long Beach would indicate that many millions of cubic yards per year are required by the beaches of the south shore of Long Island to counterbalance the demands of the littoral drift. There are no data, so far as the writer is aware, by which the quantity of sand carried annually into deep water can be approximated. At all events, it is safe to say that, if the natural supply of beach maintenance material was to be cut off, any attempt to make up the deficiency by

dredging or other artificial means would be a stupendous undertaking.

Along the New Jersey shore north of Asbury Park there remain to-day only a few isolated temporary berms. Along most of that shore the waves are eating into the semi-permanent formations or are battering against the bulkheads. It would seem that the only salvation for many sections of that beach lies in the construction of sea-walls of sufficient strength to combat the waves until such time as new berms are formed, if such time ever comes.

A study of the littoral drift on the south shore of Long Island and the disastrous results to certain beaches that have followed temporary stoppages of that drift would be well worth while. The stoppages in the past have been brought about by natural causes, but the works of Man will play an important part in the future, and we may well take warning while there is yet time and see to it that the interests of the millions who annually visit the beaches of the south shore are properly safeguarded.

The History of Condensed Milk*

With a Note on Its Therapeutical Uses

By Paul Bartholow, M.D.

THE history of condensed milk emerges bit by bit from beneath the records of kindred industries, as, for example, the refining of sugar and the evaporation of fluids and substances liable to decomposition. It deals with important subjects in physics and chemistry which have been stowed away from sight and have therefore been unduly neglected. It is almost essential in understanding the uses of condensed milk that we should know something of the principles upon which it is made, yet this knowledge has hitherto ended at the "curtain" or peroration of the lecturer or manufacturer when introducing condensed milk as a food for children and babies. The mere mechanics of the subject should preserve us from a view so superficial.

Some of the contributions to this science do not demand much notice. The dissertation of Braun, and the brief history of Hosford in the *Milch. Zeitung* several decades ago, come to nothing, or next to nothing, for they describe methods of manufacture that have long since gone to pieces. Mohan, indeed, has given us something more in a brief reference to the patents of Newton and of Green, but it is not clear whether he has read the original specifications or not. For, as to Green's patent, it cannot be stretched to cover any method related to the manufacture of condensed milk.

The invention of the process really originated with Howard, whose vacuum pan recalls some names illustrious in science and trade. It was invented, wrote Maumené in his "Fabrication du sucre," t. i., 3, in 1816. The account of the apparatus was given by Howard's friend, Thomas Thomson, in the *Annals of Philosophy*, 1816, Vol. 8, p. 209, which was translated and published in the *Annales de chimie et de physique*, 1816, p. 373. "In the ordinary way of boiling sugar, the temperature is so high that a considerable portion of the sugar is converted into treacle. Mr. Howard's vessels are globular, and of copper, and connected with an air pump, which is wrought during the whole time the boiling goes on. The consequence is that a vacuum is formed within the boilers. This enables the boiling to take place at a temperature so low that there is no risk of destroying any of the sugar. The vacuum is such as to support a column of mercury from 1 to 4 inches in height. There is a thermometer attached to each boiler, and likewise a mercurial gage to give the degree of rarefaction." (From "A Short Sketch of Mr. Howard's New Process of Refining Sugar.") Manufacturers of sugar and of condensed milk have made full use of this invention. The vacuum pan described in Thomson's memoir is virtually the same as the globular and cylindrical apparatus in use to-day. According to Foster ("Treatment of Evaporation") "the vacuum pan is quite as old, even older than the multiple apparatus . . . it has the same unpractical globular form, low and confined evaporation space, small heating surface."

These passages describe the vacuum pan used in refining sugar and condensing milk; they show that the two industries are inseparably connected. Even the multiple system of Wellner-Jelinek, by which large surfaces of milk or sugar are exposed to evaporation, is used by some manufacturers, in making evaporated milk, which

in this context must not be confounded with condensed milk. It is certainly important that Howard's vacuum pan has given such an impulse to the manufacture of condensed milk.

What must be regarded as the most valuable feature of Howard's system is generally found in the manufacture to-day. In nearly all factories the vacuum pans are worked upon the general principle of Howard's. The air is kept, by the working of an air pump, at such a state of rarefaction that the milk boils at a temperature too low to cause browning, and the other changes incident to exposure to a temperature of 100 deg. Cent. By carefully regulating the supply of heat to the pan, and of cold water to the condenser, the progress of the operation being watched through a glass plate in the roof of the chamber, the condensation is carried on at a rapid but uniform rate until completed. The milk after sugar is added is raised to such a temperature that it may begin to boil immediately when brought into the rarefied atmosphere of the vacuum pan.

Richmond in his "Dairy Chemistry" refers to the multiple evaporation system, without, however, telling us where it is employed. A vacuum pan with a fairly large vapor space is used by the best manufacturers in America. The heat is carefully regulated, as well as the cold water to the condenser, and the milk is boiled at an even, rapid rate until concentration is sufficient, a point easily told by an experienced operator. The pans have a large heating surface, fitted with coils, as in the Wellner-Jelinek system. There is a high vapor space and low boiling level, unlike many pans in which the steam coils occupy most of the space, leaving little or no room for the charge. In a really good and modern pan the full charge is only 0.1 to 0.12 meters above the top row of tubes, which are copper. These tubes are placed in 2, 3 or 4 rows, according to the size of the pan, and heated separately with steam. A high vapor space in the pan is indispensable to the manufacture of a good brand of condensed milk, since it allows the dispersion of gases from the mass of boiling milk. Such a system, however, is in my experience not often seen, the proof being the low standard of condensed in the constituents of the original milk. According to Tibbles, these variations in the composition of condensed milk are so great that it is essential that some standard should be fixed. Now, a medium quality of cow's milk would contain before condensation 3.3 per cent of fat, and condensed to one-third its bulk 10 per cent of fat. Such milk should also contain 8.5 per cent of solids-not-fat before evaporation, and the condensed substance at least 25 per cent of solids-not-fat. It has therefore been an established custom of the British Government to stipulate that it should contain not less than 10 per cent of fat and 25 per cent of solids-not-fat. The Board of Agriculture made the following regulation under Section 4 of the Food and Drugs Act, 1899:

"That any condensed milk (other than that labeled 'Skimmed Milk' in conformity with provisions of Section 2, Food and Drugs Act, 1899) in which the amount of milk-fat is less than 10 per cent, or the amount of solids-not-fat is less than 25 per cent shall be deemed to be so deficient in some of the normal constituents of

milk as to raise a presumption until the contrary is proved, that it is not genuine."

This English rule is a good one and should be followed.

It is now more than 50 years since Gail Borden first manufactured condensed milk on a commercial scale. In 1856 he received a patent for a "process for concentrating sweet milk by evaporation in vacuo, having no sugar or other foreign matter mixed with it." Readers of advertisements naturally conclude that he invented condensed milk; at least that is the impression these advertisements make until corrected. But there is no doubt in the minds of those who have studied the history of condensed milk in detail that it was a Frenchman who first thought of it, and an Englishman named Newton who perfected it. The Frenchman was Appert, who in 1809 published his "L'art de conserver toutes les substances animales et végétales." This little book, which is now extremely rare, was dedicated to Gay-Lussac. At the time Gay-Lussac was a member of the Board of Arts and Manufactures. His opinion of Appert's method is of particular interest. "The Board of Arts and Manufactures," he wrote, "has reported to me the examination it has made of your process for the preservation of fruits, vegetables, meat, soup, milk, etc., and from that report no doubt can be entertained of the success of such a process. As the preservation of animal and vegetable substances may be of the utmost utility in sea voyages, in hospitals and domestic economy, I deem your discovery worthy of an especial mark of the good will of the government."

Appert tells us how he condensed milk, "reducing it to two-thirds of its original volume." He sweetened it with sugar, though sugar, he says, is "hurtful to the patient." Evidently he disliked sugar. Indeed, his opinion on its use for preserving milk might have been written at the present day. I quote it at length: "A second inconvenience is this, that a large quantity (of sugar) is required to preserve a small quantity of milk; and hence the use of it is not only very costly, but even in many cases pernicious."

It is clear that the original idea in condensing milk was to preserve it, and its appropriate uses are equally distinct. Preserved or condensed milk was intended for armies, fleets and hospitals and not at all for children or babies. An English translation of Appert's work was published in London in 1811. Englishmen followed Appert in his process, and a patent for evaporating milk in a vacuum pan, it is stated vaguely by Mohan, was granted to Green in 1813. I have been unable to find this patent in the Specifications of British Patents. But there is a patent that was granted to Green in 1850 for the "preservation of substances liable to decomposition and destructive agencies." (Eng. Pat. 13,420.)

There is no doubt, however, that the process of condensing milk in vacuo was fully developed in 1835 in the patent granted to Newton. (Eng. Pat. 6,787, 11 March.) As the words of the specification tell the story of the original condensed milk, it is worth while to repeat them. (Specifications of British Patents, 1830-1835.) "A method for preparing animal milk and bringing it into such a state as shall allow of its being pre-

*From the *Medical Record*.

served for any length of time with its nutritive properties and capable of being transported to any climate for domestic or medicinal use."

"Taking the milk in a fresh state, as drawn from the animal, having first strained it, if necessary, to get rid of any dirt or other improper matter which may have accidentally fallen into the pail or other vessel while milking, I introduce into the milk a small quantity of pulverized loaf sugar, say, from fiftieth to one hundredth part in weight of the whole quantity of the milk, which quantity may, however, be greater, dependent upon the desired sweetness of the preparation when completed. On the sugar becoming perfectly dissolved I subject the milk to a tolerably rapid evaporation, either by blowing through the milk warm or cold air by means of a suitable apparatus of any convenient form such, for instance, as those at present in use for evaporating syrups, or by means of external heat in connection with a vacuum above the surface. . . . Warmth will best be obtained from hot water or from steam, or heated air. . . . By evaporating the aqueous particles of the milk in this way, its nutritive or essential parts may be concentrated, and its substance reduced to the consistency of cream, honey, or soft paste, or even into dry cakes or powder, and may in the latter states be exposed to the air for a length of time without being impaired, the sugar tending to preserve it. By dissolving the milk so prepared in a proportionate quantity of warm or cold water the original milk is reproduced, with all its properties."

These early methods of making condensed milk proved most expensive undertakings. Though the quality of the produce was good, even superior, the quantity was clearly not great enough for the needs of fleets, armies and hospitals. It is, therefore, no small achievement of Gail Borden to have manufactured condensed milk on a scale meeting commercial conditions and requirements. I am inclined to think that the article he produced in 1857 was of better quality than the present brands. In 1857 a committee of the New York Academy of Medicine published a report on condensed milk after a visit to Gail Borden's laboratory. The details are not complete, but enough is said to make a not unpleasant picture.

In the following words we get the impression of a primitive process, but one which is not tainted by modern arts. "The milk, immediately after leaving the cow, was strained into an ordinary milk can, then placed in a cold water bath until it was entirely deprived of its animal heat. It was then heated to a temperature of 175 deg. Fahr. The milk is now passed through a second strainer, and without delay removed to a vacuum pan, where water is evaporated. This pan consists of a large metallic vessel supplied with a jacket for the reception of steam, by means of which heat is applied." It is not stated whether sugar was added. The uses of this condensed milk are appropriately noted. It "imparts a delicious flavor to coffee, and whenever used in the various departments of the culinary art has given entire satisfaction." At the end of the report the committee publishes letters from the stewards of steamship companies praising the milk as an article of food on long voyages.

The indications for the use of condensed milk are plain. It is both a food and medicine: a medicine for invalids, the sick in hospitals; a food for soldiers, sailors and travelers. Its chief fault is the seductive sweetness that makes such an appeal to children. Again, the saturation of low-graded milk in sugar is a source of profit to manufacturers. At present the conditions of trade are such as to make the original uses of condensed milk more significant than ever. The food crises in Europe have reached such an acute stage as to necessitate the constant production of condensed milk for the armies and adult civil population.

BIBLIOGRAPHY.

1. Maumané: Fabrication du Sucre.
2. Wing: Milk and Its Products.
3. Tibbles: Foods.
4. Willoughby: Milk: Its Production and Uses.
5. Braun: Ueber kondensierte Milch.
6. Hosford: Milch-Zeitung 1877-8.
7. Mohan: Journ. Soc. Chem. Ind., 1915.
8. Crato: Kondensierte Milch aus mager Milch. Veröffentlich. aus d. Gebiete d. Militär Sanitätswesen, Bd. 55.
9. Richmond: Dairy Chemistry.
10. Carrick: The Menace of Skimmed Condensed Milks.

The Propagation of Sound By the Atmosphere

SINCE the beginning of the war the sound of gun-firing in Flanders and France has often been heard in the southeastern counties of England. There can be little doubt as to the origin of the sounds, for the

reports of distant heavy guns have a character which is readily recognized. A correspondent of the *Daily Mail* (July 6) states that at Framfield (near Uckfield), in Sussex, it is easy to identify the particular kind of gun which is being used. The great distance to which the sound-waves are carried under favorable conditions is evident from the letters recently published in the *Daily Mail*. As firing has occurred lately over a great part of the western front, the exact position of the source of the sound is uncertain. But if it were in the neighborhood of Albert the waves must have traveled about 118 miles to Framfield, 150 miles to Sidcup, and 158 miles to Dorking.

Of far greater interest are the form and discontinuity of the sound-area. A remarkable example of the inaudibility of neighboring reports in the face of a gentle wind was given in the last number of *Nature* (p. 385). This is a subject on which many observations have been made since the beginning of the present century, especially in connection with the sounds of volcanic and other explosions. The source of sound is always surrounded by an area of regular or irregular shape within which the sound is everywhere heard, though the source is not always situated symmetrically with reference to the boundary of the area. On several occasions a second sound-area has been mapped, separated from the former by a "silent region" in which no sound is heard. Sometimes this second area partly surrounds the other, sometimes it consists only of isolated patches. As a rule, according to Dr. E. van Everdingen, who has made a detailed study of the subject,¹ the least distance of the second area from the source is much more than 100 km., and the intensity of the sound at this least distance is not less than near the boundary of the inner sound-area.

Dr. van Everdingen refers to several dynamite and volcanic explosions which have been carefully studied from 1903 to 1911. He also adds some interesting observations made chiefly in Holland during the present war. The most important case is that of the bombardment of Antwerp on October 8, 1914. The reports were heard at many places in Holland within 100 km. from the source and again outside a circle of 158 km. radius, but at very few intermediate places. The silent region is bounded by two curves, which are roughly circular, the inner arc being traced for more than 180 degrees and the outer for more than 90 degrees. In some cases of heavy firing at later dates there are also indications of silent regions; in others an increased audibility has been established near the line of 160 km. In no case is there any certain indication of any asymmetrical propagation of the sound.²

Dr. van Everdingen examines the two explanations which have been offered of the existence of the silent region, one of which relies on variations of wind-velocity and temperature with the altitude; the other (von dem Borne's) on changes in the composition of the atmosphere at great heights. On the former explanation we might expect asymmetry, on the latter symmetry, with regard to the source of sound. He considers that both explanations are true and should be applied in combination. In favor of the second explanation, he urges the facts that in recent cases the outer margin of the silent region has always been about 160 km. from the probable source of sound and that no appreciable deviations from the circular form have been observed. The above distance is greater than the limiting distance (114 km.) assigned by von dem Borne, but Dr. van Everdingen shows that it agrees well with estimates made on the supposition that the percentage of hydrogen in the upper atmosphere is much smaller than that assumed by von dem Borne.

There can be no doubt as to the value and interest of Dr. van Everdingen's investigations. It would seem desirable, however, to continue and extend them. Though the existence of silent regions may be regarded as established, many more negative records are required to prove the symmetry of the region with reference to the source of sound. It must be remembered that the deep sounds of these explosions may at great distances be below the lower limit of audibility of some observers. Moreover, the mean radius of the outer margin of the silent region is very far from being constant. In one of the earliest cases in which the silent region was noticed—that of the minute-guns fired during the funeral procession of Queen Victoria on February 1, 1901 (*Knowledge*, vol. xxiv., 1901, pp. 124-5)—the radius was about 80 km.—C. Davison in *Nature*.

¹"The Propagation of Sound in the Atmosphere." *Koninklijke Akad., van Wetenschappen te Amsterdam*, Proc., vol. xviii, 1915, pp. 933-960.

²It may be mentioned that, on October 28, 1914, the sound of the British naval guns that bombarded the Flemish coast was heard at a distance of 280 kilometers, or 174 miles.

An Advertising Toy

A EUROPEAN patent relates to a toy which serves for advertising purposes, in the shape of a transparent ball of some size made of celluloid and containing a separate piece on the inside for the advertisement. Such piece can be made in most varied shapes and is of flat cardboard or any other suitable makeup so as to fit within the ball and remain in position. The ball itself is made in two halves and put together. The advertising piece can consist of a large star with printing upon it, or again as a representation of any objects such as a hat, pair of gloves, etc. As the ball is transparent, the advertisement portion is clearly visible.

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