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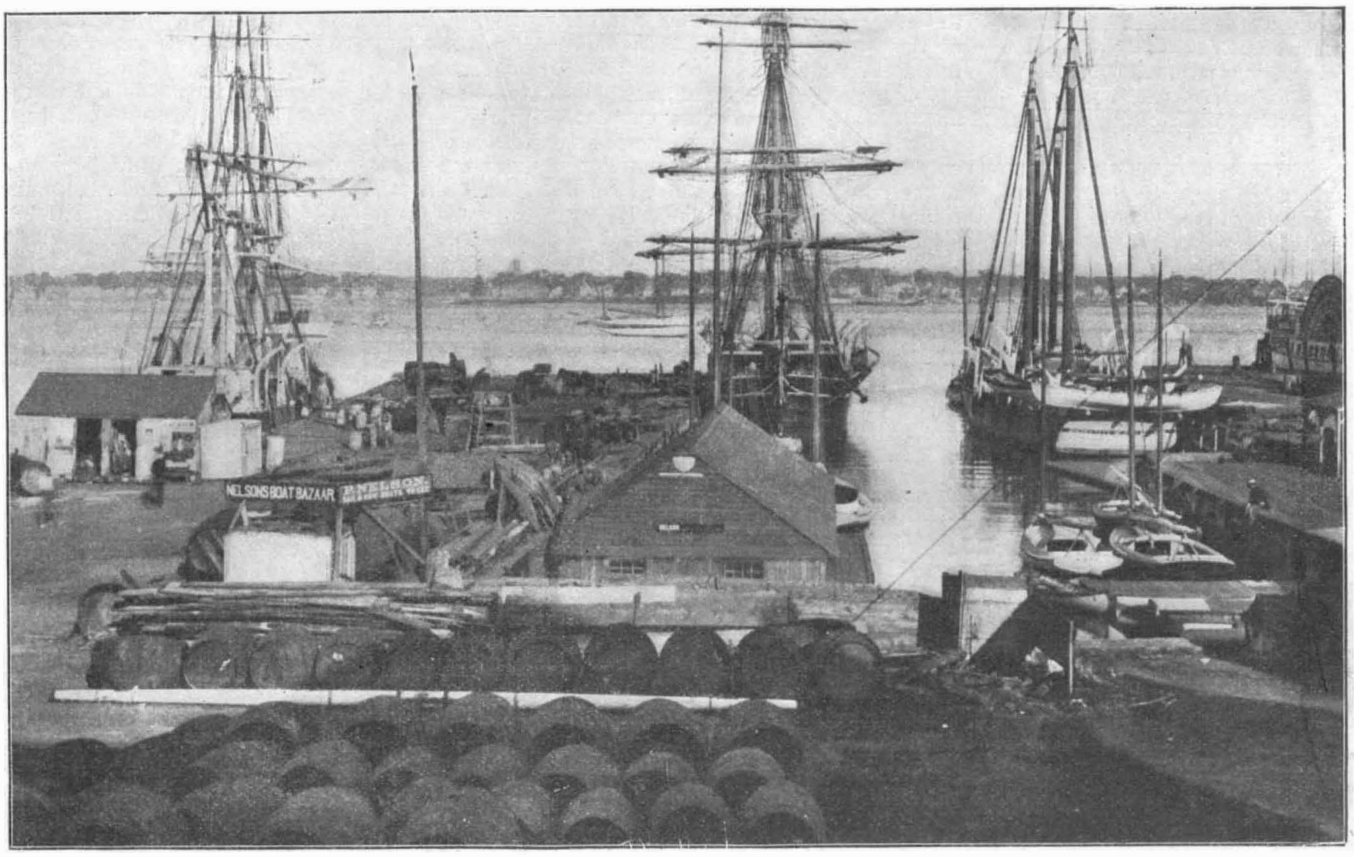
WHALE OIL.*

By Charles H. Stevenson.

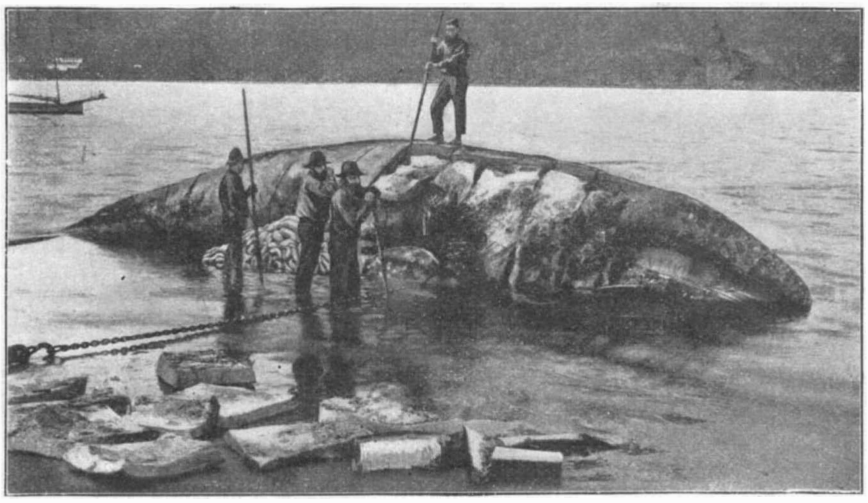
The use of whale oil appears to be of ancient origin. Doubtless it was first obtained from whales accidentally stranded on the shores, a more frequent occurrence during the early abundance of the cetaceans than at present, when their numbers have been so greatly reduced by excessive fisheries. As the demand for the oil increased beyond the supply available from stranded whales, individuals sighted from the shore were attacked and beached. Owing to the frailty of the boats and equipment, this was a more daring attempt than might be supposed.

Just prior to the Revolutionary war, according to Starbuck and other authorities, there were 183 American vessels in the right-whale fishery of the North Atlantic waters, and 125 were engaged in cruising for sperm whales from Newfoundland to the coast of Brazil. The Revolutionary war and the war of 1812 interfered with the fisheries; but during the period of peace following 1815 they increased greatly in extent until 1846, when the fleet numbered 678 ships and barks, 35 brigs, and 22 schooners, a total of 735 vessels, with an aggregate tonnage of 233,189 tons, and a value of $21,075,000, exclusive of outfits and supplies. The entire capital invested in the fishery and its associated industries at that time approximated $40,000,000, and 40,000 persons derived from it their chief support. During the same year the whaling fleet of all Europe numbered but 230 vessels. The crude value of the American catch from 1840 to 1860 averaged about $8,000,000 annually. The greatest value was in 1854, when 2,315,924 gallons of sperm oil worth $1.48¾ per gallon, 10,074,866 gallons of whale oil worth 59⅜ cents per gallon, and 3,445,200 pounds of whalebone worth 39 1-5

* From United States Fish Commission Report for 1902.

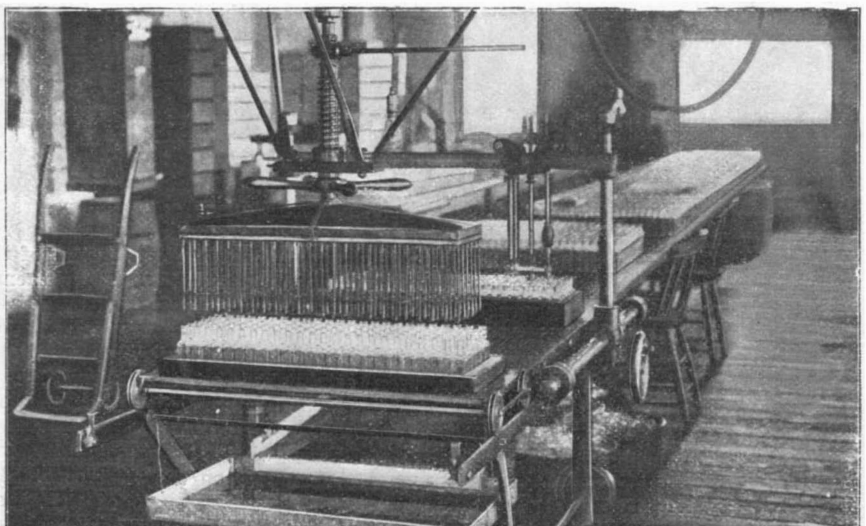


WHALING VESSELS AT NEW BEDFORD, MASS.

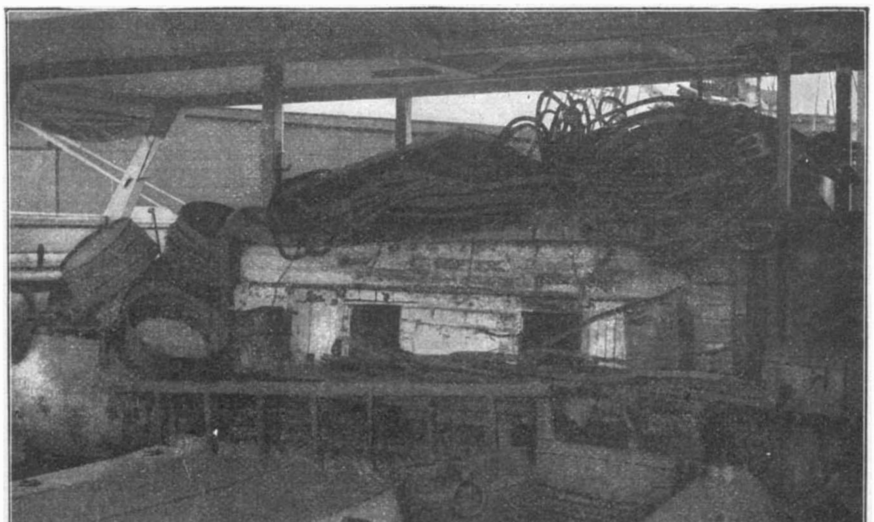


REMOVING BLUBBER FROM WHALE BEACHED ON CALIFORNIA COAST.

GRINDING AND PRESSING CRUDE SPERMACETI FOR REMOVAL OF TAUT-PRESSED OIL.



INTERIOR OF OIL REFINERY. FILLING BOTTLES WITH SPERM OIL.



TRY-WORKS ON MODERN WHALER, LOOKING AFT.

WHALE OIL.

cents per pound were secured, the total value being $10,802,594. In the preceding year, 1853, the total product was 3,246,925 gallons of sperm oil, 8,193,591 gallons of whale oil, and 5,652,300 pounds of whalebone, the whole valued at $10,766,521.

Sperm oil and whale oil then served nearly all the diversified uses for which oil was required, the chief exception being leather-dressing, for which neatsfoot and cod oils were largely employed. The principal uses were as illuminant, lubricator, in cordage-manufacture, screw-cutting, and steel-tempering. The streets of the principal cities were lighted with the oil, and theaters and public buildings were lighted with gas made from the foots. A stock anecdote at the time referred to foreign sailors climbing up the posts of the New York street lamps to drink the whale oil, thus leaving the city in darkness.

The extent of the fisheries soon began to tell on the abundance of the whales, necessitating much longer and more costly voyages, and consequently higher prices for the products. With the increased price came the active search for substitutes, and colza oil and lard oil were largely employed. The competition, however, had little effect on the market for whale products until the adoption of petroleum as an illuminant, and subsequently as a lubricant. Its dangerous qualities at first greatly checked its use, but as improved methods of refining were introduced it was quite generally adopted and proved most influential in decreasing the profits of the whale fishery.

The restricted market and the reduced price resulted in a gradual decrease of the whale fishery. Various agencies accelerated this decrease, while others retarded it. Among the former may be mentioned the destructive influences of the civil war, including the sinking of 36 vessels in blockading Charleston Harbor, and the burning of 46 vessels, with outfit, supplies, and cargoes by privateers; also the loss of 33 ships in the ice of the Arctic Ocean in 1871, and a similar abandonment of 12 vessels in 1876. Among the agencies tending to retard the decrease in the fishery is the greatly enhanced value of whalebone, which increased from 13 cents per pound in 1833 to $7 per pound in 1891. Indeed, it is the whalebone market alone which sustains the present right-whale fisheries of the world. The table showing the annual product of sperm oil and whale oil from 1860 to 1902, inclusive, presents a fair idea of the gradual reduction in extent of the American whale fisheries. Owing to the decreased extent of the fishery, sperm whales are increasing in numbers and are apparently more abundant at present than at any time since the fifties. The bowhead and right whales, however, are doubtless more scarce than at any time since their capture became an object of commercial pursuit.

In 1901, the 20 sperm-whalers cruising in the Atlantic Ocean met with good success, especially those on the Hatteras and Charleston grounds, securing 12,550 barrels of oil, according to the Whalemen's Shipping List, an average of 627 barrels to each vessel. The same season in the Arctic and North Pacific, however was the poorest for many years. The fleet there consisted of 11 steamers and 6 barks. Three steamers were lost, and the total catch was only 43 bowheads and 13 right whales, as compared with 80 bowheads and 14 right whales in 1900. The yield of oil approximated 2,870 barrels, and of whalebone 105,150 pounds. Five barks were employed in sperm-whaling off the coast of Japan, taking 4,100 barrels of oil. The market for sperm oil in 1901 opened at 55 cents per gallon, but gradually increased and closed the year at about 68 cents per gallon. The price of whale oil at San Francisco was 32 to 38 cents and in the Eastern markets 38 cents per gallon.

In 1902 the whaling fleet of the United States consisted of 8 steamers, 18 barks and brigs, and 12 schooners, aggregating 8,366 tons. Of these, 11 barks and 10 schooners were sperm-whale fishing in the Atlantic Ocean, 8 steamers in the Arctic, 6 barks in Okhotsk Sea and off the coast of Japan, 2 schooners in Hudson Bay, and 1 brig at Desolation Island.

The total whale-oil product of the world at present approximates 3,000,000 gallons yearly; of which 750,000 gallons are produced by the United States fisheries, 900,000 by those of Norway, and the remainder by Scotland, Russia, Japan, Newfoundland, and other countries.

THE BLUBBER AND ITS YIELD OF OIL IN DIFFERENT WHALES.

The blubber is a layer or blanket of fat lying between the skin and the flesh or muscles and encompassing the bodies of all cetaceans and likewise of most of the other aquatic mammals. It varies in thickness from 1 to 22 inches, according to the species, size, and condition of the animals. The blubber of right whales is thicker, on an average, than that of the cachalot or sperm whale, although an individual of the last-named species has afforded fat 22 inches thick. The blubber of most species is tough and elastic, but that of the humpback is soft and yielding, and the ropes and chains encompassing it tear out easily. The blubber of poor whales is hard, compact, and tenacious; but when the animals are fat it is softer and yields oil readily, even when handled. In color it varies from a yellowish or dirty white to a somewhat unusual pinkish or reddish cast. The whitish blubber is usually found on young whales, more especially sucking calves, and is of a milky appearance. That of old whales has a coarse grain, and yields or gives out the oil freely; hence it is not so difficult to boil as is the fat of young whales, from which it is almost impossible at times to extract the oil, the texture being so fine and close.

In case of the baleen whales the blubber from all parts of the animal is commingled and boiled together. With the sperm whale, however, the process of saving the oil is different. The most valuable oil of this species is found in a large cavity or reservoir known as the "case," situated anterior to the cranium, which yields clear oil and spermaceti, in equal quantities. These products are known as "head matter." Lying beneath the case is a wedge-shaped mass of pinkish fat, composed of oil, seprmaceti, and "white horse," the last being an extremely tough and sinewy blubber-like substance found about the head and neck, as well as upon other parts of the whale. The lower anterior portion of the junk, known as the "nib end," is similar to the body blubber and devoid of spermaceti. Spermaceti is also found on certain parts of the body, especially in the core of the "hump" and about the "ridge," situated along the back toward the "small," but not in so great abundance as in the case. The yield of the head averages about one-third of the total oil product of the sperm whale. Instances have been reported, however, in which it has been 50 per cent and even as high as 60 per cent of the total.

The following parts in the sperm whale are utilized as an oil-yielding product: The body blubber, case, junk, hump, ridge, lower jaw, head skin, scalp, small flukes, vertebræ, and fin bones. The bones of all whales are porous or spongy in texture, and the cavities are filled with more or less oil. The small bones, such as the fin bones and the vertebræ, as well as the "pans," or broad posterior extremities of the lower jaw-bone, are chopped up with axes and boiled out. The cranium, or, as it is known to whalemen, the "scalp," is generally thrown overboard, but sometimes it is chopped up and boiled. The "head skin," or the great mass of fat covering the scalp, may be rendered if whales are scarce, but when they are plentiful its utilization is not profitable. Some of it is exceedingly tough, and the small quantity of oil it contains is difficult of extraction.

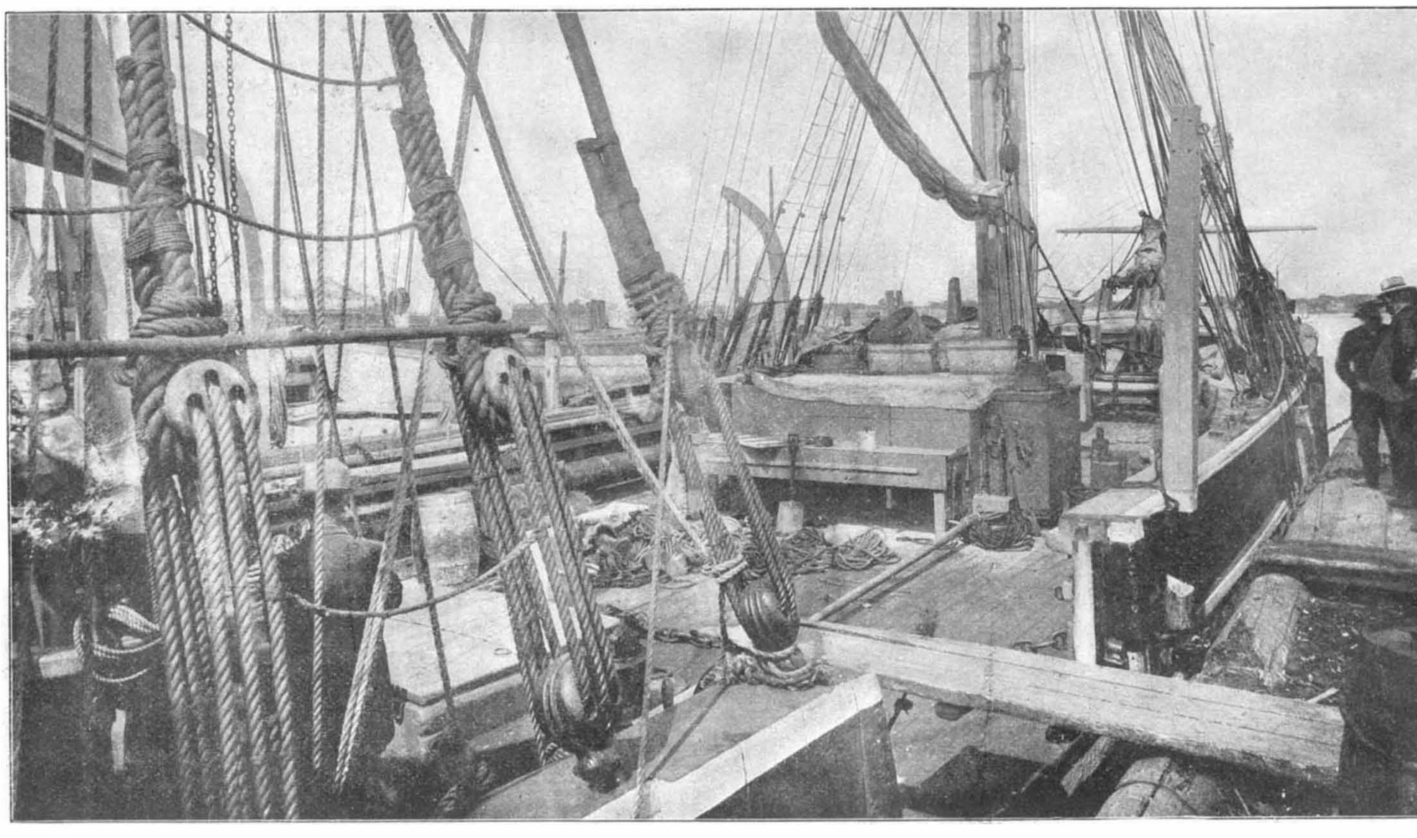
Whales are generally rated by the amount of oil which they yield rather than by the size or length. The yield is expressed in barrels, and an animal may be a "40-barreler" or a "100-barreler." In appearance they are often deceptive, the largest ones not always yielding the greatest amount of oil. Usually the whalemen approximate the produce with remarkable accuracy, but sometimes their guesses miss the mark widely. Blubber yields about 75 per cent of its weight in oil, 4 tons of blubber producing about 3 tons of oil, each containing 252 gallons wine-measure. Sperm whales yield from 5 to 145 barrels of oil, averaging about 25 or 30 for the cows and 75 to 90 for the bulls.

The oil-producing parts of the right whales are the body blubber; the tongue; the head gear, comprising the head, scalp, throat, lips, and head skin; and the blubber on the fins. The right whales yield a larger quantity of oil than the cachalot, and the bowhead or Arctic whale yields a larger quantity than the right whale of temperate waters. In 1861 the "General Pike," of New Bedford, took a right whale on the Kadiak ground which stowed down 274 barrels of oil. The schooner "Lizzie P. Simmons," New London, killed a bowhead whale on October 28, 1882, in Cumberland Inlet, which yielded 2,550 pounds of whalebone and 6,000 gallons of oil, the value of the former being $7,687 and of the latter $3,500, a total of $11,187 from a single animal. According to whalemen, the right whales now captured are not so large as formerly, but the sperm whales seem to average about the same.

The humpback whales and the finback whales of all oceans are frequently captured by deep-sea whalemen and often by shore whalemen, especially in the Finmarken fishery. Since both of these varieties usually sink when killed, they are rarely hunted except "on soundings." The oil-yielding portions of the humpback are the body blubber; head skin; lips, which are small; tongue; entrail fat, the source of a large percentage of the oil, and the striated folds of fat on the breast and abdomen. The entrail fat resembles very closely in appearance the corresponding fatty substance of the ox; its oil is of the same grade as that of the blubber of this species, which is equal in grade to the oil of right whales.

Not only are the oil and whalebone yielded by finback whales much less in quantity, but they are also inferior in quality to those obtained from the right whales. For this reason, and also on account of their great activity and the difficulty of capturing them by harpooning, they were formerly neglected by whalers; but since the employment of steam vessels with bomb guns and explosive lances an extensive fishery for them has been established on the Norwegian and Newfoundland coasts and minor fisheries on the coasts of Russia and Japan.

The California gray whale is occasionally taken in the lagoons of Japan and on the west coast of the United States. The oil-bearing parts of this species which are utilized are the body blubber, head skin, throat, lips, flukes, and entrail fat. According to Capt. George O. Baker, of New Bedford, during several years following 1866 a brig from New Bedford, Mass., made quite a business of catching California gray whales for the food markets of Japan.



DECK OF MODERN WHALER, SHOWING TRY-WORKS, SCRAP HOPPER AND UTENSILS EMPLOYED IN TRYING-OUT OIL.

WHALE OIL.

The bottle-nose whale, so called from the peculiar shape of its head, yields on an average about 12 barrels of oil. The principal places where this species is caught are along the edges of the ice fields of northern Europe, between Bear Island and Iceland, the fishery being prosecuted principally by Norwegians hailing from Tönsberg and Sandefjord. Like the sperm whale, the bottle-nose possesses a quantity of oil in the cavity of the head, which yields spermaceti in the process of refinement. The blubber oil of the bottle-nose comes next to sperm oil in quality. It gives no residuum, and is therefore employed for lubricating small machines, spindles in mills, etc.

Besides the above, a number of minor cetaceans are occasionally utilized for their oil; among them the orca or killer whale, the narwhal, the beluga or white whale, the black-fish, and the porpoise. These have a coating of blubber ranging from one-half to 4 inches in thickness, and, although not extensively sought after, many are taken in various parts of the world.

The beluga is plentiful in the Arctic seas and in the North Pacific and comparatively numerous on the Labrador coast and in the St. Lawrence River, where it forms the object of a small but profitable fishery. The steam-whalers sometimes pursue and capture it in great numbers in the Arctic, but only when the Greenland whale can not be found, for the yield of oil is small and the animal is so swift and active that it is not readily captured. The adult is from 10 to 15 feet in length, and of a creamy white color. The blubber is about 2 inches thick, and each animal yields from 20 to 100 gallons of oil excellent in lubricating qualities.

The orca affords a good variety of oil, but owing to its aggressiveness it is not often attacked by the whalers. It has occasionally been captured on the New England coast, and has also been taken on the west coast of Africa, especially off Walfisch Bay. The blubber is 2 or 3 inches thick, and similar in color and texture to that of the sperm whale.

The narwhal yields a small quantity of oil, which is used considerably by the Eskimos and Greenlanders. It is ordinarily very pale in color, in fact almost colorless. The narwhal is not usually an object of pursuit by our whalemen, as its capture is surrounded with many difficulties, owing to its retreats in the ice floes. The valuable black fish and porpoise oils are discussed in a separate chapter.

The following tabulated statement of the yield of oil from the several species of cetaceans has been prepared with much care after consultation with the most experienced whalemen of various ports:

	Yield of oil in barrels of 31½ gallons. Variations.	Average
Right whale, Pacific	25 to 250	90
Right whale, Atlantic	25 150	75
Bowhead	30 250	100
Sperm whale	5 145	45
Humpback, Pacific	10 110	42
Humpback, Atlantic	10 100	40
Finback, Pacific	10 70	35
Finback, Atlantic	20 60	38
California gray whale	15 60	30
Bottle-nose whale	4 25	12
Orca or killer whale	1 6	2½
Beluga or white whale	2/3 3	1 1/3
Black-fish	1/6 4	1 1/3

The methods of cutting-in and removing the blubber have already been described by numerous writers, and especially by James Temple Brown,* rendering unnecessary any extended description in this paper.

Suffice it to state that the whale is attached to the side of the vessel, and by cutting in a spiral line and at the same time rolling the cetacean, the blubber is removed in a helical strip 5 or 6 feet wide, and this is boarded in lengths of 12 or 15 feet, called "blanket-pieces." The manner of doing this and of boarding the head gear is germane to nautical engineering rather than to the subject of oil-rendering.

CONVERSION OF THE BLUBBER INTO OIL.

The following notes on the present methods of converting whale blubber into oil are the results of inquiries and investigations made by the writer during the last four years, and especially in October, 1901, when many practical whalemen were interviewed. Especially are we indebted to Capt. George O. Baker, Capt. Charles H. Robbins, Capt. James Avery, and Mr. W. R. Wing, of New Bedford, Mass.

The reduction of oil from the solid mass of blubber, though tedious in detail, is an operation of simple character, requiring merely that the substance shall be exposed to heat. The blanket-pieces, 12 or 15 feet long and 5 or 6 feet wide, are first "leaned," consisting in removing the pieces of muscles which cling to the fat during the process of cutting in. By means of spades they are cut into smaller sections, called "horse-pieces," about 2 feet long and 6 inches wide. These are passed to the mincers. If the blubber is too thick, say over 12 inches, it is sometimes split before it is minced.

Two methods of mincing the blubber are employed, viz., by hand and by machinery. The former was the first adopted and is generally used at the present time. It is extremely laborious, but most whalemen prefer it, since the pieces are minced more uniformly and consequently the oil boils out more freely. The horse-pieces are laid lengthwise and with the flesh side downward upon a bench called the "mincing-horse," and are scored or cut into slices varying from one-fourth to three-fourths inch thick, called "minced horse-pieces." The knife cuts through the skin, but is stopped within about an inch of the base, so that the slices are held together like the leaves of a book, and in this condition they are pitched into the try-pots.

The try-pots are built of brick athwartships between the foremast and the mainmast. The usual dimensions are 8 or 10 feet long, 7 or 8 feet wide, and about 4½ feet high. The first course of bricks, or the base, is laid in openwork, forming channels through which the water may freely circulate. The fireplaces, or "arches," as they are known aboard a whale ship, are strengthened by pieces of iron and are furnished with sliding doors. Two large metallic try-pots are placed within the try-works, with their bottoms resting upon the arches or furnaces. These are shaped like the old-fashioned 3-legged pots so intimately associated with the domestic hearths of our forefathers. They range in capacity from 120 to 200 gallons each.

While boiling the blubber, the fires are kept up day and night. Naturally, the fuel supply is an item of no small consideration to the whalemen. A quantity of cord-wood, each stick sawed into two pieces, and all kinds of refuse wood are included in the vessel's outfit and relied upon for starting the fires. But when fairly under way the highly combustible residue of the fat, known as "scrap," is mainly depended upon. Once in a while a whale is secured so fat that the scrap is not sufficient to keep the fires going and the "fat lean" and similar materials are burned, and sometimes even a part of the rich blubber is consumed as fuel in order to save the remainder.

It is well known that the boiling point of oil far exceeds that of water. So intense is the heat at times that the solder upon the implements used about the pots is melted. It is important that all water should be expelled in order that the oil may not become rancid when barreled. It is equally important that every precaution should be taken to prevent water from getting into the pots during the process of boiling, the action of the oil under such circumstances depending upon the quantity of the extraneous fluid which is suddenly brought in contact with it. If the pots are not sheltered heavy rain may cause the oil to foam up, and when the vessel ships a heavy sea or when a very heavy rainstorm occurs, the contents of the pots are apt to throw up an immense cloud of steam and scatter the seething oil. Communicating with the fire, the oil is ignited with a flash, and the streams of burning liquid pour out upon the deck, sometimes with disastrous effect. As soon as the contents of the pots show a tendency to boil over, pieces of fresh blubber are pitched in, and if this is not sufficient the fire is immediately banked.

To prevent the vagrant pieces of lean which have accompanied the blubber from clinging to and burning the side and bottom of the pot and thus darkening the oil, the boiling mass is vigorously stirred. This is one of the most important duties in the process of oil-rendering.

Instruments are never used on a whale ship for testing the heat or culinary condition of the oil; the men rely mainly on their experience as to the best time for removing it, judging either by the color of the scrap or by spitting into the boiling mass, this producing a peculiar crepitating noise when the blubber has been sufficiently cooked.

As fast as the pieces of blubber are resolved into oil, the residuary fragments are transferred to a rough box called the "scrap-hopper" or "strainer-cooler." Its size depends upon the dimensions of the try-works, but usually it holds from 1 to 1½ pots of scrap. It consists of two compartments, the upper portion, or hopper, for the scrap and the lower part for the oil, the two separated by a wooden partition containing numerous holes, so that the oil may readily drain from the material.

The best and most economical way of utilizing the scrap has always been an important problem to the whalemen. The body of the sperm whale usually boils out freely, and consequently the scrap is dry, contains little oil, and is valuable only as fuel. The refuse of the right whale, however, retains considerable oil, and the whalemen are averse to burning it until after they have extracted the oil by compression. The scrap from both the sperm and the right whales is regarded as an important fuel supply and is economically saved at each fare during the voyage and used for boiling the blubber of whales taken subsequently.

Although the oil may be thoroughly cooked when the first scrap is removed, it is not bailed off, the usual plan being to fill the pot with fresh blubber and again boil it down until the pot is full. In this manner the hot oil melts the cold blubber and the latter reduces the temperature of the oil already rendered.

The bones of cetacea contain more or less oil, but they are utilized in oil-rendering only when whales are scarce. On a good voyage the endoskeletons are thrown overboard as fast as the coating of fat is removed, provided they are not required for fuel.

The blubber of the "small" and the lobes of the flukes are cut into horse-pieces and boiled out with the body blubber, being of the same nature. The entrail fat of the humpback whale may be boiled by itself or with the blubber, whichever is more convenient, the oil of the fat and that of the blubber being of the same grade. The fins of the sperm whale are cut up with spades; the fatty covering is boiled with the body blubber, and the bones with the fat-lean. The oleaginous covering of the fins of the right whale is cut into horse-pieces and boiled with the body blubber; the fin bones of this species are rejected. The head skin, or the fatty covering of the crown of both the right and bowhead whales, and, indeed, the "head-gear" of both, are cut into horse-pieces and run through the pots with the body blubber.

The tongue of the bowhead as well as of right whales is also reduced to horse-pieces and boiled out. The tongue blubber is close-grained, or of much finer texture than that of the ordinary blubber, and is usually boiled out last. When "green" its oil is extracted with great difficulty, if, indeed, this can be accomplished at all when cooked by itself, unless very finely minced; hence it is sometimes laid aside and run through the pots in easy stages with the body blubber of the next cut. A muscular, fibrous substance known as "plum pudding" permeates the blubber of the tongue of these two species of whales, extending longitudinally through the central part and in greater abundance near the roots. Most of it is utterly worthless and is thrown overboard when detached from the fat of the tongue. At times, however, when the fat predominates, the "plum pudding" is saved and boiled out with the tongue or the refuse of the whale. It is almost impossible to render it when cooked alone.

The "ginger rolls," or plaited folds on the throat and breast of the humpback, are cut into horse-pieces and rendered with the body blubber; but the intermediate substance, resembling "white-horse" in some respects, is extremely tough and elastic, and is absolutely worthless as an oil-yielding substance.

In trying out a sperm whale, either the body blubber or the head matter, including the junk and case, may be boiled out first; but they are never cooked together, since it is not policy to mix the oils, the head oil being worth a cent or two per gallon more than the body oil. The manner of preparing the case and junk for the pots being different, they will be described separately.

If the body blubber is tried out first, the head matter is deposited in junk casks as fast as it is whipped or bailed from the case. The junk is reduced to horse-pieces, placed in similar receptacles, and held in reserve with the head matter until the body blubber has been disposed of. The junk casks are ordinary oil casks with one head removed, and vary in capacity from 100 to 300 gallons each. They are also used to hold the scrap which is saved as fuel. Instead of the casks some of the larger vessels have one or two tanks between decks, which are used as temporary receptacles for the head matter and also for storing the oil.

When ready to boil out the head, the try-pots are well scrubbed, greater care being taken than when boiling the body blubber. They are next about half filled with some of the head matter as soon as it is bailed from the case, the remainder being stowed away as just mentioned. With legs and feet bare, men get into the pots and, standing in this odorous compound, squeeze out the soft pieces of fat. The oil flows freely between their fingers into the pots, while the refuse, called "twitter," is thrown into another receptacle, called the deck-pot, or perhaps into scrap-tubs. Notwithstanding the many improvements that have been made in the oil industries, no process of eliminating this membranous texture from the crude sperm oil has yet been discovered except the one just referred to—that of squeezing by hand. It is necessary to remove these fibers to prevent them from charring and darkening the oil. The case being carefully squeezed, the fires are started and the cooking then commences. The pots are spaded constantly to prevent the small but sometimes numerous particles of twitter, which have not been removed, from burning against the sides and bottoms. Meantime other men are squeezing out the remainder of the head matter deposited in the junk cases, and this is kept in scrap-tubs and poured into the pots as soon as the first installment has been properly cooked and bailed off, this operation continuing until all the head matter has been boiled out.

While the case is boiling, some of the crew cut the junk into horse-pieces somewhat larger than the body-blubber horse-pieces, and these sections, after mincing, are pitched into a pot of thoroughly cooked head matter. The hot oil of the case soon dissolves the junk, the two mingling most intimately, being of a kindred nature. Sometimes the case and the junk are boiled separately.

White-horse in considerable quantity ranges through the junk in streaks. It is tougher and whiter in large whales than in small ones. The fatty substance found between these layers, or strata, is soft—about the consistency of butter—and is of a pinkish cast, resembling somewhat in color the meat of a watermelon. The white-horse of large whales, especially of an aged male, is remarkably tough and is detached by means of sharp cutting-spades and thrown overboard. There is little oil in it, and its extreme toughness prevents it from being minced. If attempts are made to boil it out with the junk, it usually soaks up more oil than it yields. But the junk of small whales, more particularly the cows, including both the white-horse and the fat, may be cut into horse-pieces, minced, and boiled out together. The process of mincing the pieces of junk and pitching them into the try-pot is identical with that previously described in connection with the body blubber. While some of the men are cutting out the white-horse and preparing the junk for the pots, others are scraping up the oil, which flows out profusely during the operations.

The hump and ridge of the sperm whale are cut

* Fishery Industries of the United States, Vol. 2, Sec. 5, p. 278.

into horse-pieces and boiled out with the head and with the fat secured from the jaws.

The term "twitter," which has been previously referred to as applied to the thread-like or membranous substance ranging through the contents of the case, is also applied to the lining of that reservoir. This is from 2 to 3 inches thick, glutinous, and extremely tough. In decapitating the sperm whale, especially in severing near the bunch of the neck, a very sharp spade is required to cut through this tough and elastic formation. Although it is very difficult to manipulate, an economical whaleman never throws this substance away. Since it can not be boiled out with the case, for the reason above given, it is saved and run through the pots with the fat-lean after the case and junk have been cooked.

There are two kinds of "lean," the "clear-lean" and the "fat-lean." The clear-lean, as the term signifies, is composed almost entirely of muscles, and is rejected as utterly worthless to the uses of whalemen. The fat-lean is composed of fat and lean so intermixed that separation by means of knives is impracticable. It is obtained principally about the jaw, as well as from other external parts of the whale. A large portion of it is cut from the blanket pieces during the process of leaning. When whales were abundant, the fat-lean was thrown away, but at present many, if not all, of the whalemen convert it into oil after the oil from the head and body blubber has been boiled out and bailed off. The fires are then drawn, the try-works cooled down, and the fat-lean is pitched in. This is a delicate operation, and if not performed in the proper manner there is danger of cracking the pots. Water is usually placed in the pots first and the fat-lean is pitched in until the pots are about two-thirds full, and then the twitter and lipperings are added. The fires are started, the admixture brought to the boiling point, and the works are again cooled down. When cold the oil floats upon the surface and the water and cracklings remain at the bottom. If the process has been skillfully conducted, the oil may be almost as light and clear as any obtained from the better and purer parts of the whale. As a rule not more than two pots of this substance are boiled down, for the oil obtained from it is generally more or less sour—a result probably from either mixing it with water when boiling, or because it had become tainted through decomposition, or it may be due perhaps to both causes. This oil is usually barreled separately.

The oil obtained from the fat-lean of one whale is sometimes mixed with that obtained from the blubber of the next capture, this being effected by putting a few gallons of it into the cooling tank every time a pot of the subsequent fare is bailed off. Notwithstanding the importance of keeping the different grades of oil separate, some whalemen adulterate the blubber oil to a greater or less degree by the addition of fat-lean oil, yet they are prudent enough to save several casks of the latter grade to show on their return that the fat-lean has not only been economically saved, but also that its product has not been mixed with oils of higher grades.

The slivers, or small pieces that have been cut and hacked from the blubber while reducing it to horse-pieces and mincing it, are also saved and boiled with the blubber. The "slumgullion" and "lipperings" or "dreenings" of the blubber—consisting of a mixture of the blood which issues from the fat-lean and the salt water and oil which flows from the blubber while the men are handling it as they hoist it aboard ship, stow it away, and prepare it for the try-pots—though discarded in the palmy days of whaling, are now carefully husbanded and amalgamated. Like the sweepings of the floors of mints, this liquid refuse of the catch is refined in the whaleman's crucible in order that nothing may be lost. After the solid matter has been disposed of, both the deck lipperings and the blubber-room lipperings are usually deposited in barrels or tubs and there scalded with hot oil. The oil thus obtained is raked off and transferred to the cooling tank. In case the lipperings are not clean they are cooked with the fat-lean.

"Slush" is the skimmings from the tops of the pots, and is usually saved by the cook, who is commonly entitled to one-half of it. On arrival home it is sold to makers of soap, and it is even clarified and mixed with lard. At sea the whalemen sometimes eat the slush as a dressing in the form of gravy on sweet potatoes, etc., but it is doubtful if they could be induced to eat it ashore, although it is quite clean and nutritious.

The different varieties of oils are barreled separately. A cask that has contained whale or humpback oil should be thoroughly cleansed before putting sperm oil into it, but a cask that has been used for sperm oil need not be cleansed should it be necessary to use it for whale oil; the small quantity of whale oil that might be left in the cask would perhaps make the sperm oil somewhat heavy, but a little sperm oil would not injure the whale oil. The casks of a ship engaged solely in right-whaling are not marked at all; should the vessel incidentally catch sperm whales, the casks containing oil from this species are marked S O, and the other casks are supposed to contain whale oil. Casks containing right-whale oil taken by a sperm-whaler are marked W or W O. The head oil of the sperm whale, unless the quantity be very small, is always kept in separate packages, which are marked H; those containing the body oil of this species are marked S O or Sp O. The packages of fat-lean oil bear the initials F L O, and black-fish oil B F O. Except when large catches are made, black-fish oil may be kept in meat barrels. The lettering is done in white paint, on the heads of the casks. When the oil is shipped home by another vessel the name of the ship is also branded on the cask, the impression being made with an implement called the "ship's marking iron," and the casks are numbered consecutively.

(To be continued.)

A NEW TYPE OF RAIL.

In times of peace and tranquillity the greatest possible care is bestowed upon the safety of railroad transportation throughout the entire traffic. To a marked degree the importance of this care is increased at the outbreak of a war, where the system is taxed to its extreme capacity for the transporting of an army to the front or the transferring of it to other points threatened by the enemy. This high degree of safety is secured, not only by having the most intelligent and reliable employes, by the most careful preparation of exact time tables, and the use of faultless rolling stock in sufficient quantity to accommodate all kinds of traffic with comfort, but above all by the excellent condition of the roadbed itself and the superstructure laid upon it, in which the kind of rail employed plays an especially important part.

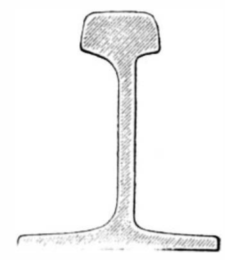


FIG. 1.—ALTERNATIVE WEB RAIL.

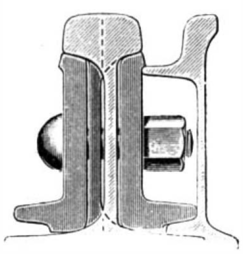


FIG. 2.—ALTERNATIVE WEB-LAPPED JOINT. END VIEW.

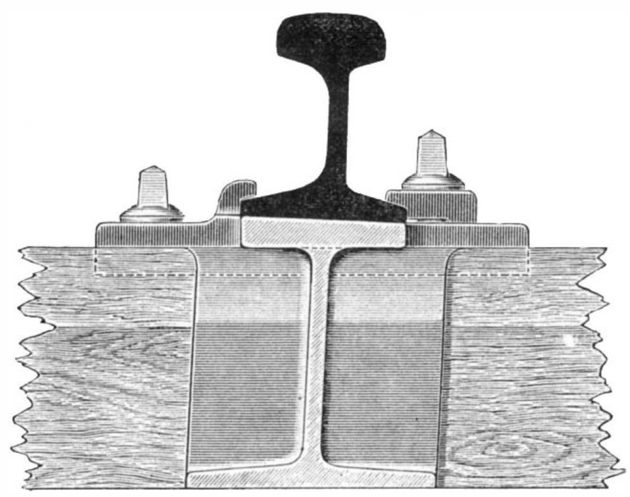


FIG. 4.—JOINT BEARER FOR WOODEN TIES.

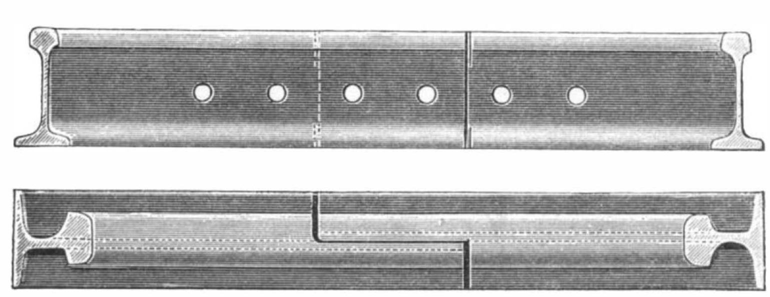


FIG. 3.—ALTERNATIVE WEB-LAPPED JOINT. LONGITUDINAL VIEW.

The directorates of our railroads use their utmost endeavors, financial and technical, to supply our roads with heavy rails, which adds considerably to the safety of transportation. And this safety will be greatly increased if a practical butting of the rails be adopted. It is especially interesting to note the change of opinion concerning the proper joining of the rails, which has recently come over the technical world. The present form of butting, in which the two squared ends of the rails are placed opposite each other, with only sufficient space between them to allow for the expansion due to the heat of summer, has proven itself to be not only a great detriment to the rolling stock, but there is no longer a doubt that the safety of the transportation is considerably lessened thereby. That it is a source of discomfort to the passengers, who are annoyed by the continuous noise and vibration of the car as it passes over the joints, may be a secondary consideration, but from the incessant hammering of the wheels upon the rail ends there results considerable wear and tear, which is the first germ in the difficulties of maintenance as well as danger in the system. The total abolition of the present form of joint would indeed be a radical remedy for its great disadvantages. In the United States electric welding of the rails has been tried, and recently the experimental fusing of the ends of street rails has been effected in Germany by the use of thermite, a combination of aluminium and chromoxide.

It is, however, apparent that insurmountable obstacles stand in the way of the employment of either system when the entire network of rails throughout the country is considered. In his important work upon the railroad track Mr. A. Haarman has this to say upon the butting question:

"The practical working out of the idea would, even for straight stretches, most likely meet with natural obstacles, since the friction of the two halves of a continuous rail four hundred meters in length would hinder the expansion of the middle section to such an extent that a permanent warping of the rail could hardly fail to result. When it is considered with what care the technical department works incessantly toward the production of uniform and faultless pieces for all the parts of the superstructure, it is easy to comprehend wherefore, wholly irrespective of other technical difficulties of management, and in the face, too, of the introduction into the rail, by means of the welding process, of the unavoidable dangers of warping and rupture, one would rather forego a track constructed in that manner, especially since it is by no means cheap.

"Since, then, for the present, the openings between the rail ends cannot be wholly eliminated, means must be sought, and, where possible, provided, for rendering the change from one rail to another as harmless as possible. It is rather fortunate that the joining of the rails into a smooth track free from the jar incident to the change is to-day within the reach of railroad technics; indeed, it can be effected in a mechanical way and at cold or ordinary temperature."

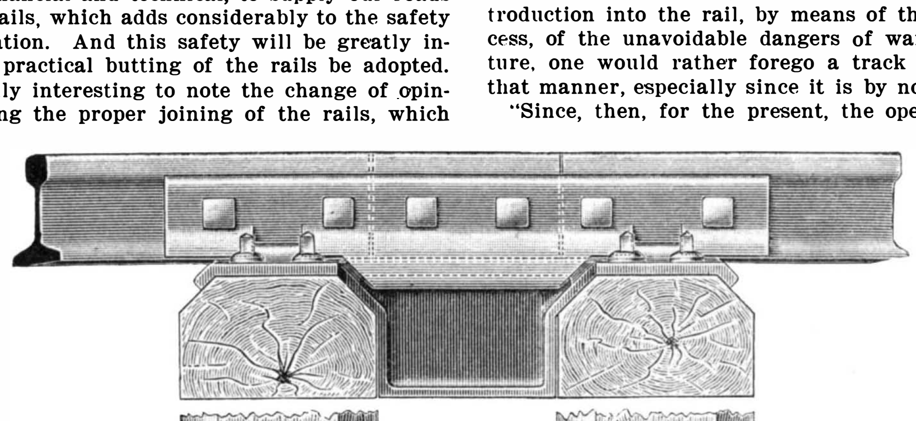


FIG. 5.—TWO VIEWS OF LAPPED JOINT WITH JOINT BEARER ON WOODEN TIES.

The removal of the hammering on the track, which

has such a detrimental effect upon the safety of transportation, can be accomplished by the lapping of the rail ends, for which purpose the so-called alternative web rail, shown in Fig. 1, is peculiarly adapted. The lapping is accomplished by cutting out a portion of the head and foot of the rails on opposite sides, leaving a small part of the web still standing. The center lines of the two lapped rail ends must coincide, as shown in Figs. 2 and 3. Where wooden ties are used, an iron joint bearer has been invented, which acts as an armor

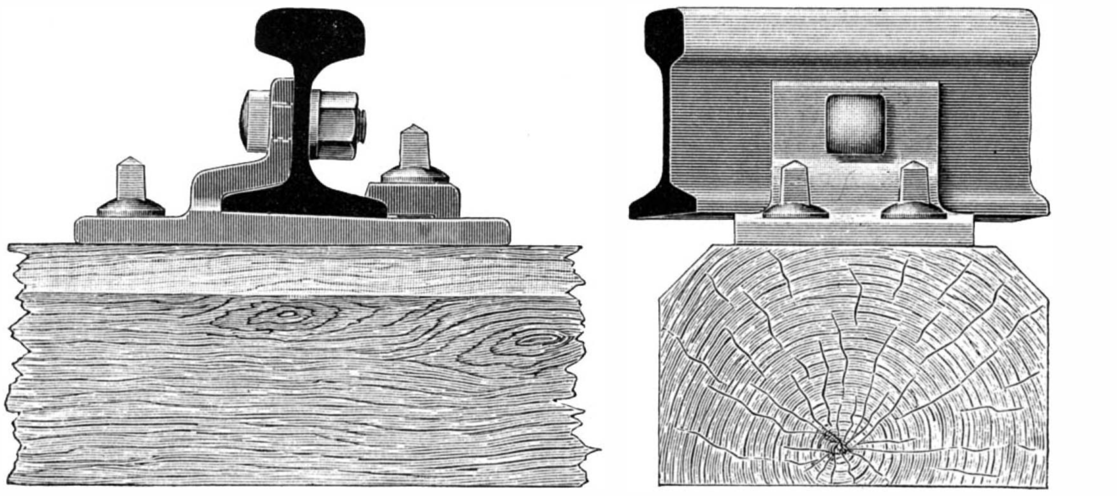


FIG. 6.—TWO VIEWS OF PLATE CHAIR FOR PREVENTING LONGITUDINAL CREEPING.

for the wooden ties, providing them with a solid and in every respect safe fundament for the joint, and this joint bearer (Figs. 4 and 5) represents the latest advance in the direction of abolishing the disturbing and detrimental hammering. In Fig. 5 we give two views of the joint-bearer, the joint, and the fishplates—a side view and a view as seen from the top. Especially constructed plate chairs are used with this joint formation, and we show an end and a side view of such a chair, with its retaining bolts, in Fig. 6.

Thus, with small initial cost and a considerable economy in tractive force, there results a great saving

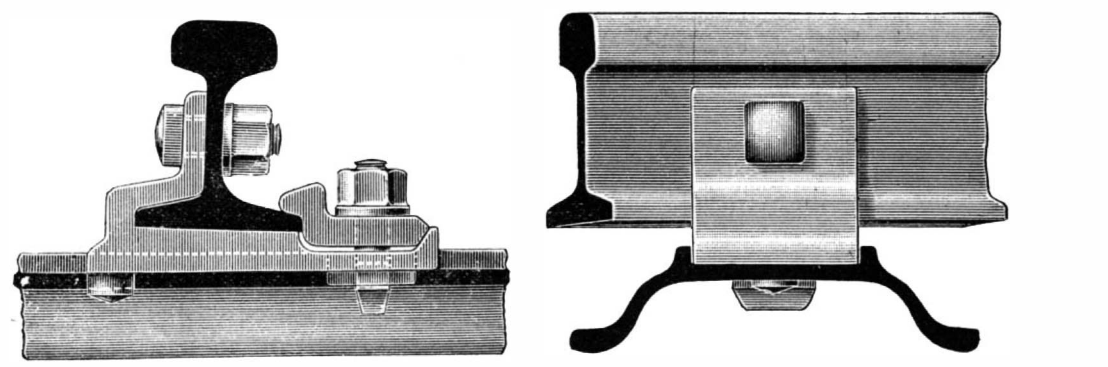


FIG. 7.—TWO VIEWS OF PIVOT CHAIR FOR PREVENTING LONGITUDINAL CREEPING.

in the wear and tear on the rolling stock and maintenance much below the ordinary, which is particularly important in the transportation of men and military stores during the strategic movements of an army.

If, in place of the common wooden sleeper, vaulted iron ties be employed, then a specially constructed pivot chair is preferably used to prevent the longitudinal displacement. Of such a pivot chair we give two views in Fig. 7. A peculiar method of fastening the pivot plate by holes drilled in the tie, together with the use of the joint bearer tie-frame, makes this construction by far the best and most perfect system of completing the superstructure of a road. This ar-

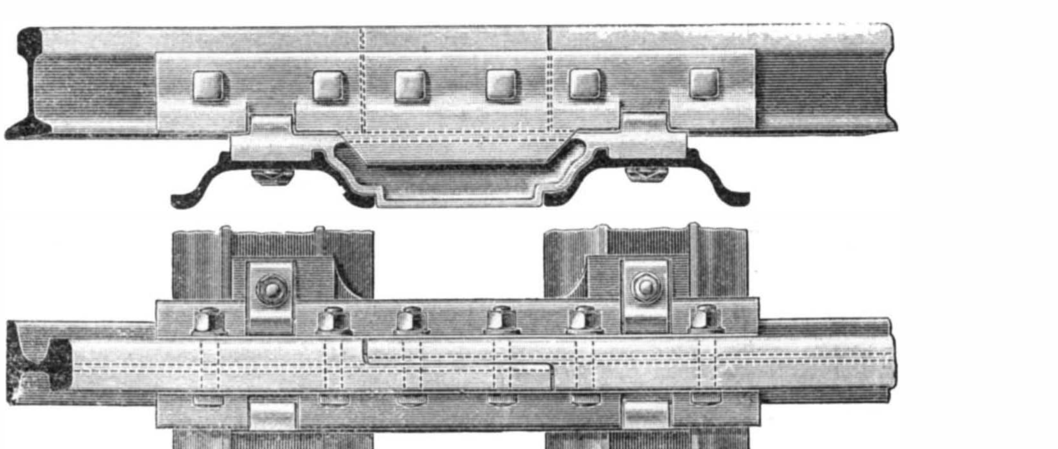


FIG. 8.—TWO VIEWS OF LAPPED JOINT WITH VAULTED IRON SLEEPERS AND JOINT BEARERS COMBINED.

rangement for the butting is well exhibited in our cut shown at Fig. 8. No less than with the wooden ties, we attain here also a low maintenance and a greater protection for the rolling equipment, accompanied by economy in tractive force and the greatest possible safety in running. At the same time, this construction permits of increase in speed, which is again a great desideratum in the transportation of an army over a railroad in war times.

To secure perfect safety in railroad transportation, not only is a perfect superstructure requisite, but also a faultless roadbed.

This should be porous to a degree, consequently free from particles of earth; the separate parts must be able to withstand the frost, and at the same time develop the greatest possible friction the one upon the other—in other words, possess sharp edges, so that the strokes of the tamping bar may press them tightly and solidly under the tie, where they will remain for the longest possible period. For this purpose the best material is broken stone of the hardest sort, the next best is coarse gravel, and a third very serviceable bed can be formed of rubble made of hard-burnt brick. On the stretches far removed from quarries, the slag from blast furnaces may also be used, but this is not so serviceable as either of the above-mentioned materials. The substructure, or foundation, should also receive proper attention. It must be able to carry the superstructure, consisting of rails, ties, and bed, with perfect safety; the most important part of this is the quality of the earth employed, for all underpinning, bridges, viaducts, and similar works are constructed with a view to the greatest safety.

In the matter of earth filling, the shape of which must be well studied and fixed according to the condition of the ground upon which it is to be laid, drainage plays an important rôle, to prevent sliding, which is a most difficult matter to combat.

Cases are not rare where it has been necessary even to search out the subterranean streams or lesser veins of water, and by means of deep spade-drains, tunnels, shafts, or other similar artificial means, draw off the moisture, in order to leave the foundation as dry as possible. At the present moment, the line which offers every conceivable means of safety is the royal military railway between Berlin and Zossen, upon which the recent high-speed tests were made with the electric motor cars built by Siemens & Halske. For these speed tests the whole track has been relaid with new and heavy rails; and in the immediate vicinity of the Dahlwitz station of the Berlin-Dresden road, in the very middle of the test stretch, that is, where the highest speed was attained, the above-described superstructure was laid for 250 meters. No appreciable effect of the very rapid rate of 130 miles per hour has been discovered upon this part of the road; it has remained as faultlessly intact as the trial stretch on the line between Cologne and Hamburg, where a short stretch between Hasbergen and Osnabrück has existed for three years, and where also a stretch of 4.34 miles in length with heavy grades and curves has been laid the past autumn between Vehrte and Osnabrück.

When all our trunk lines have been provided with this novelty in construction, we may then hope for not only greater security in transit by rail, but greater comfort and higher speed for the every-day traveler, not to mention the effect it will produce upon the rapid movement of troops to or from desired points.

DETAILS OF THE NEW CONSTANTINOPLE-BAGDAD RAILWAY.*

THE Bagdad railway, which is to run from Constantinople to the Persian Gulf, is one of considerable length, and will be of importance both from a commercial and political standpoint. Work upon the construction of the railroad is soon to be begun. The idea of connecting Constantinople with the Gulf goes as far back as 1888, when the Ottoman Company of the Anatolia Railroads, which was formed by the Deutsche Bank, received the concession from the Turkish government for a line running from Ismidt to Angora (292 miles), forming the continuation of the already existing Haidar Pacha (Constantinople)-Ismidt railroad (55 miles). After the new section was opened in 1893, the same company, which is under German control, obtained the concession for a branch line running to Koniah (266 miles) which was finished in 1896. This gave a total length of about 620 miles to the system. An agreement was made in May, 1899, between the above company and the Compagnie Française, who operated 320 miles of railroad lines in Anatolia, stipulating that all new railroad enterprises should be carried out in common.

The concession for the present line to Bagdad and Bassorah, which will join the first section at Koniah, was obtained in December, 1899, from the Porte by M. Siemens, president of the Deutsche Bank, acting for the Anatolia Company. The agreement stipulated that the line should be built and put in operation within a maximum of eight years. The enterprise is to be guaranteed by the Turkish government, and the company is not to cede the present railroad or any new lines to other companies. The Turkish government reserves the right of purchasing the Koniah-Bassorah section. To compensate for this transaction, Russia obtained soon after (according to the German press) the option of building a railroad on the shore of the Black Sea. By the Imperial decree of April 7, 1900, the Turkish government pledged itself to accord only to Russian capitalists the right of building and operating a railroad system on the Black Sea, within certain prescribed limits. This concession is to be remarked as the first which the Turkish government has granted to Russian promoters.

As to the new Bagdad line, two different trajects were proposed. The first, which was explored and recommended by Major Von Moltke, started from Angora, passed by Sivas, Diar-Bekir, and followed the valley of the Tigris to Bagdad and Bassorah. The second traject started from Koniah, crossed the Taurus at the Olon-Kichla Pass, and after reaching Aleppo, followed the left bank of the Euphrates to Bassorah. The first traject lies nearest the Russian frontier, which is a disadvantage. The second lies farther away, but is nearer the sea, bringing it within reach of British influence from Alexandrette. The traject which was finally adopted is a combination of the two. The line is to start from Koniah (44,000 inhabitants), passing by Karaman and Eregli along the south of the Salt Desert; it then traverses the high plateau region of Karamaine, crossing the Taurus at 3,000 feet altitude, and reaches Adana (45,000 inhabitants). This latter town is already connected with the sea by a narrow gage railroad. From Adana the new railroad will pass by Hamidia, Killis, and Tell Habesch. From the latter point it runs a branch of 36 miles to Aleppo (127,000 inhabitants). The line continues eastward, crossing the Euphrates, and passes by Harran, Ras-el-Ain, and Mossoul (61,000 inhabitants). From here a branch road 20 miles long runs to Orfa. From Mossoul the road follows the right bank of the Tigris, passing by Tekrit and Sadija (from which a branch will lead to the Persian frontier), then reaches Hanekin and Bagdad. From here the road passes through Nedjef and Zobeir and finally reaches Bassorah, which is the terminal point. From Zobeir a branch will lead to a point on the Persian Gulf.

The new railroad, with its four branches, will have a total length of 1,500 miles. The existing Anatolia railroad leaves Constantinople from Haidar-Pacha, which lies 1.2 miles south of Scutari on the bank of the Marmora Sea, and this will now be the head of the new Constantinople-Bagdad line. Boats will run from here to the main depot in the city. As to the other terminus at Bassorah, the branch from Zobeir to the Persian Gulf will run to a point which is yet to be fixed, but no doubt Koweit will be chosen, seeing that it is one of the most important ports on the Gulf, and is a commercial center for the Arabian region. The Nomads send the products of the region to Koweit, consisting of horses, wool, skins, etc., in exchange for cereals, rice, coffee, and tobacco, as well as for European cloths and other manufactured articles. The

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

port equips more than 120 sailing vessels which are engaged in the fisheries near Bahrein. Koweit has about 25,000 inhabitants. It has an excellent natural port which will take the largest vessels.

The Bagdad line, leaving aside the political phase of the question, will have a considerable importance from an international point of view. It establishes a direct connection between Europe and India. The mail which is carried from London and goes by railroad to Brindisi or Naples and then continues by sea to India, passing through the Suez Canal, takes 14 days 16 hours on an average to reach Bombay. When the new railroad is built, it can make the trip in 11 days, with a gain of nearly 4 days. It is probable that the 220,000 passengers which pass yearly by the Suez Canal (1899) will tend to follow the shorter route to India or the Persian Gulf, and so avoid the long sea voyage.

THE TYPICAL COLLEGE COURSES DEALING WITH THE PROFESSIONAL AND THEORETICAL PHASES OF ELECTRICAL ENGINEERING.*

AT the Chicago meeting of the American Institute of Electrical Engineers held eleven years ago, I presented a paper relating to the subject now under discussion. The proposed subject then apparently created some consternation among the members of the committee on papers, who seemed to fear that it was not of sufficient interest to the society. The old prejudice still held against "college men" in the minds of so-called "practical men" who had grown influential in engineering practice without having had experience of college life and training. Happily the foundation for this prejudice has ere this been destroyed through the influence of the industrial results achieved by college men. The old prejudice so far as it now exists, has more particularly drifted into the way of criticism of the engineering schools rather than their graduates, and the character of the schools and the training they afford are subjects of eager discussion in engineering circles.

This extended interest now manifested in the work of the engineering schools produces a situation which may be of great usefulness to the schools. The character of a college may be that which its alumni determine, and any engineering school may be improved by thoughtful suggestion and broadly considered criticisms emanating from its alumni and others who have its best interests at heart.

Two fundamental propositions must be held clearly in view in all such criticisms, if they are to be of service to the educational administration of the engineering colleges:

1. That it is the business of these colleges to train young men into fertile and exact thinkers guided by common sense, who have a profound knowledge of natural laws and the means for utilizing natural forces for the advantage of man. In other words, it is the business of the engineering colleges to produce, not finished engineers, but young men with a *great capacity for becoming engineers*, the goal being obtained by the graduate only after years of development in the school of life.

2. The problem to be met by the engineering colleges is more particularly a problem in *how to properly train* to the stated purpose. The names attached to the subjects taught are not so important as the results produced by the teaching—namely, the effect impressed on the students' powers. This is a teacher's problem—a question of pedagogy, rather than of the engineering profession. It must be met with all the directness and power of the engineer's best efforts, but it cannot be solved as solely relating to the engineering profession. Much error on this point lies in the minds of many who assume the part of critics of the curricula of the engineering schools.

In this connection I may be permitted to point out that proposals set up as apparently new in the presidential address one year ago, by President Steinmetz of the American Institute of Electrical Engineers, have for many years been largely included within the ideals of numerous American colleges of engineering. It must be admitted that only a few of the engineering schools are living up to their better ideals. This is partially due on the one hand, to personal or institutional ambitions which foster the sensational or spectacular and thereby inevitably ruin good teaching, and, on the other hand, to the meager support in both encouragement and funds which I have noticed is the lot of the engineering schools attached to many universities. The latter, like the former, is often the result of personal prejudices or ambitions.

Most of the faults which are so trenchantly and indiscriminately charged to engineering colleges by many engineers should, so far as they are real, be laid to the pedagogical inexperience and faulty ambitions of the authorities of the many colleges; and exception should be made of the few of the first rank, in which, it is safe to say, the ideals are high and well centered and the administrative organizations hold the ideals continuously in view.

The query here naturally arises: Of what do these ideals properly consist and how fairly should they be met by the college before its course in electrical engineering may be approved as of first rank?

Electrical engineering demands industrial engineers—men with an industrial training of the highest type, competent to conceive, organize, and direct extended industrial enterprises of broadly varied character. For the highest success, these men must be keen, straightforward thinkers who see things as they are, and are not to be misled by fancies; they must have an extended, and even profound, knowledge of natural laws (more particularly of those relating to energy which rest on the law of conservation of energy), an extended knowledge of the useful applications of these laws, and an instinctive capacity for reasoning straight, from cause to effect. Moreover, they must know men and the affairs of men—which is sociology; and they must be acquainted with business methods and the affairs of the business world. Briefly, to reach his highest influence, each man must combine in one a man in the physical sciences, a man in sociology, and a man of business. All engineers cannot reach this high mark, but the engineering college course should start each of its students toward that degree of attainment which his individual powers will permit.

Michael Faraday (whose conservatism and intellectual clearness are proverbial) said that it requires twenty years to "make a man" in the physical sciences. The engineering school must put each student in the way of becoming, so far as his mental and physical powers warrant, not only a man in the physical sciences, but a man in sociology and a man in business as well; and this must be done within the narrow limits of four years. It is clear that only the foundations of "the man" may be laid in the prescribed time, and the engineering college must, therefore, rigorously hold itself to the fundamentals. The engineering college faculty, which is contented to deal out so-called "information courses" on the narrowly empirical side of engineering practice, deals a wrong to its students which they may not recognize at the moment, but which will ultimately tell heavily against their success.

The students that enter the engineering schools of the West, and I presume likewise of the East, are from among the most vigorous minds of the high schools and preparatory schools; and yet it must be admitted that they ordinarily possess little power of clear thinking, power of initiative, regard for accuracy, or understanding of continuous and severe intellectual effort, as these important attributes are understood in industrial circles. They are not yet mature in body and are less mature in mind (the latter being, I think, in accord with the natural order of development). But they commonly are well equipped with physical vigor and latent mental strength. Their preparatory schooling has given them a defective acquaintance with the construction of the English language and the spelling of English words, a still more defective acquaintance with French or German or a fairly good grounding in elementary Latin, a smattering of civics and history, a training in the elementary principles of arithmetic, geometry, and algebra from which the factor of accuracy in application has often been omitted, and perhaps an enthusiastic interest in the physical sciences.

This enumeration of the attainments of the students entering the engineering colleges may perhaps be interpreted as reflecting on the secondary school teachers, but I wish vigorously to deny the validity of any such interpretation. I can truthfully say that, considering all of the conditions, there is no more painstaking and right-wishing body of people than these teachers.

Many of the faults in the preparatory training of our engineering college students are caused by a doubt which is now apparently agitating educational circles on account of the question whether the high schools shall be the "people's colleges" or remain in the station of secondary or "preparatory" schools. This doubt is apparently not yet resolved in the minds of the molders of educational thought; but the traditional old-time secondary school training, which produced men who could spell and cipher and who had received a thorough and accurate drill in the details of one language, is certainly to be preferred as a preparation for an engineering college course. In my own estimation, when accompanied with history and a year spent in civics and natural science, it is not only to be preferred as a school course for preparing the student for college, but also a course for those numerous students who can not go through college.

Taking the students as they come and may be expected to come for the present, the electrical engineering course must include the following branches of learning which are preparatory to the more strictly professional studies:

1. That fuller training in the construction of the English language which is requisite to clear thinking and clear writing, preferably accompanied by an additional language for added strength.

2. The collateral art of expression in drawing.

3. Mathematics through an appropriate amount of calculus, including the integration and solution of equations involving derivatives and instruction in the use of coplanar vectors, and perhaps quaternion quantities, all of which should be taught as applied logic, with special emphasis laid on interpreting the meaning of equations.

4. The science of chemistry, soundly taught.

5. The science of physics, soundly taught, with particular emphasis laid on the elementary mechanics.

6. Applied mechanics.

Mechanics—the philosophy of matter, force, and energy—is the backbone of the electrical engineer's college training.

Instruction in the science branches should be accompanied by well-conceived and properly conducted laboratory work, mostly of quantitative character, accompanying and illustrating the class-room instruction; and all instruction whether in natural science, mathematics or languages, should be under the direction of men who are engineers or in full sympathy with the aims and ideals of engineering.

A limited amount of manual training may well accompany these studies, and likewise, if time can be found for it without over-burdening the reasonable physical powers of the student, a limited amount of proper instruction in surveying (including the use of the compass, transit, and level) will always prove a force for quickening the student's perceptions and at the same time put him into possession of processes of probable future value.

In a few of our engineering colleges which rigidly demand the best preparatory work from the high schools, and which are, at the same time, best manned in their faculties, not less than two years are required to cover the ground above described, if the work is done in a reasonably satisfactory manner. But the above ground can not be covered with anything like reasonable success in much or any less than three years in the larger number of engineering schools that are usually accorded high rank. After covering these branches, it seems to be the tendency in many colleges to fly off into superficial or descriptive courses, relating to engineering practice, during the remaining time of the allotted four years. This is especially apparent in those colleges where the faculties are ambitious to see their graduates take an *immediate* place of considerable responsibility in the world. This is a fault that destroys much of the ultimate advantage which the students may derive from their engineering course. It is a fault, also, which casts just suspicion on engineering education alike in conservative academic circles and in well-informed industrial circles.

A resort to mainly descriptive courses of instruction during the latter portion of the students' life in college, largely neutralizes the advantage flowing from the instruction in the fundamentals heretofore described. The students are yet to be taught many things relating to engineering life. They must learn something regarding the forms and formalities relating to the affairs of business life. They must learn the characteristics and use of materials, their correct application to the building of actual structures, the meaning of kinematics and the processes of designing and using real machinery. They must also learn to reason regarding the special principles of hydraulics and thermodynamics, and the way in which they enter into the design, construction, and operation of machines, and the manner in which they modify the usefulness of machines and the efficiencies of numerous industrial operations. Again, they must learn to reason clearly and rationally in regard to the specific principles relating to applied electricity, including its widely diverse factors, and the way in which these principles enter into every-day practice. And they should learn something of the history of the development of engineering and of the lives of its great men, for the stirring of proper ambitions.

The electrical engineering department should be divided into not less than four subdivisions comprising respectively: Applied electromagnetism, which includes the principles relating to electromagnetic machinery and apparatus; the theory and practice of alternating and variable currents, which include the principles relating to all those numerous phenomena which accompany variable current flow; applied electrochemistry and electrometallurgy; and electrical installations, which includes the applications in engineering practice of the numerous principles to the design, construction, operation, and testing of complete installations and the component parts thereof.

The teaching force of the department should afford a competent expert engineer for the head of each of these subdivisions, and such additional well-trained force as may be necessary to adequately carry on class-room and laboratory instruction for the particular numbers of undergraduate and advanced students which attend the college. The head of such a department should spend much of his time in supervising the teaching in class-room and laboratory which is performed by his various subordinates.

But through all of this professional instruction of the latter part of the course, it is still *principles, principles, principles*, and rational methods of reasoning which must be taught, if full justice is done the students, until each student becomes a man of open mind, keen observation, analytical thinking, and accurate powers of inference. This instruction should be kept close to the tenets of good practice, and the senses of the student should be constantly stimulated by illustrations and problems drawn from practice. The drill in reasoning can undoubtedly be best gained through rational instruction in the useful applications of scientific principles and laws; and no criticism can be justly passed, even by the most conservative educational circles, because the graduate is enabled to earn his living as a result of this training; but the purely descriptive should ordinarily be avoided except in a few cases where it has a specific function in improving the understanding of an application of principles or is adopted as a desirable auxiliary to stimulate the sustained interest of the students and thus add vitality to the teaching. Indeed, except for the purposes here defined, the introduction of the purely descriptive into the electrical engineering course wastes the students' time and injures their training, thus abridging their prospects of ultimate breadth and power.

The typical courses in electrical engineering which are to-day advertised in college catalogues, belong to

* Paper read at the joint session of the American Institute of Electrical Engineers and the Society for the Promotion of Engineering Education, held at Niagara Falls on July 3, 1903.

three classes or combinations thereof. Only the third of these may be acknowledged to fairly meet the proper ideals in such a course. It is to be remembered that I speak of professional engineering. No one possesses a fuller sympathy with the ideals of schools for training men for the mechanical trades short of engineering and bordering thereon, but these schools are not considered in my present discussion.

First, are courses in which predominate the old-time instruction in physics with far more to do with the illustration of the beauties of nature than with the great underlying natural laws. The teaching of mathematics, mechanics, and like ground-work studies is not ordinarily well supervised in colleges that maintain such courses in electrical engineering, because the administrative authorities are out of touch with the industrial world and mistakenly put the superficial and spectacular in science into the place of that sound instruction only through which an engineering course may be rightly maintained. It is needless to add that the average graduate from courses of this type is ordinarily of less value in engineering than the average graduate from an old-time classical course where at least thoroughness is a requirement; and electrical engineering courses of this type are rapidly disappearing through a merging into one of the following types.

Second, are courses in which the ground-work studies (English, mathematics, chemistry, physics, mechanics) are perhaps reasonably well taught through the earlier years, but in which the latter part of the course is diverted to the training of inexperienced students for immediate "jobs" where the students may find some responsibility and proportionate pay immediately after graduation. These courses do not teach engineering in the sound sense. They are likely to injure the future of promising students by occupying time in teaching them the handicrafts in college which they could better learn in the factory or field, or in teaching empirical methods of practice which change almost before they can be put to useful account by the graduates.

The students in these courses frequently gain the impression that the highest type of engineering practice is no more than an advanced artisanship, and that a graduate from the electrical engineering course is the equivalent of a journeyman. The most serious injury flows from this, through the undesirable narrowing of ideals and ambitions. This unfortunate result occurs the more readily because the popular usage of the word engineer makes it denote either an engine driver (a man of purely manual calling) or a man skilled in the principles and professional practice of engineering.

Third, are courses following the ideals which I have herein earlier described. Incompetent students who enter these courses are soon discouraged and drop out. Those whose calling is to artisanship go elsewhere, either to a different school or directly to an apprenticeship. Those who complete the course, as a rule, are competent men; but they are not likely to enter immediately into positions of much responsibility, but rather to go into the so-called "cadet" positions or "student" positions of great industrial enterprises, for the purpose of gaining that experience in the crafts which may enable them to make the most extended use of their training in principles. Here they gradually "find themselves" and ultimately reach the influence in the industrial world for which their caliber and training fit them. These men, if properly taught, have clean-cut ambitions and high ideals as well as the ability to think well and do wisely. Their earnings and perhaps their usefulness to their employers, may be not so great for a short interval as those of the men who are taught more of empiricism and artisanship and less of rational science during their college courses, but the advantage soon flows in a strong current toward the scientifically trained.

The men who are responsible for this third type of electrical engineering courses may reasonably cry to be delivered from judgment upon the success of their work, which is based on the average earnings of the graduates during their first year out of college. The medical schools and law schools are judged by the attainments of their graduates reached in a decade or even in a quarter of a century, and this also should be the basis upon which to judge the work of the electrical engineering courses of this third and highest type.

Do not believe for a moment, however, that I would teach all theory and no practice. The earlier parts of this paper prove the contrary. In truth, right theory and the best practice are one, and practice which is out of accord with right theory is mere rule of thumb and can be bettered. The best college course in electrical engineering is the one which so teaches the fundamentals that right theory may be fully grasped, and which constantly illustrates the bearing of theory by examples derived from good practice. The administration of such a course requires thoughtful, clear-headed men, who are acquainted with the principles and right practice of pedagogy as well as trained in the principles and experienced in the practice of engineering.

My discussion of the subject makes it clear that there is a wide variance between the methods of the colleges which support electrical engineering courses. Complete unity is not only impossible but would undoubtedly be undesirable, since scope for individuality is as essential here as in the control of industrial enterprises; but the cause of sound college training for electrical engineers would be advanced by any action which clearly places the true aims of the college courses in electrical engineering before the authorities of all of our colleges which support such courses. And I may add that many of the greatest weaknesses of electrical engineering courses are due to the fact that the executive heads of the colleges or universities do not always understand what engineering truly stands for, and they equally often have no fair conception of the soundness of training that is required for its practice. DUGALD C. JACKSON.

University of Wisconsin.

CONTEMPORARY ELECTRICAL SCIENCE.*

RADIUM IN EXTREME COLD.—Sir William Crookes and J. Dewar have made some interesting experiments to determine whether the scintillations produced by radium on a sensitive blende screen are affected by cold. A "spintheroscope," a small screen of blende with a morsel of radium close in front, was sealed in a glass tube. On dipping the whole into liquid air, the scintillations grew fainter and soon stopped altogether. To test whether this was due to a cessation of the radio-activity or a cessation of the sensitiveness of the screen, two different cooling tubes were constructed, in one of which the radium salt adjoined the wall exposed to the liquid air, while in the other the screen was in that position. It was found that in the former case the scintillations remained as vigorous as before, while in the latter case they soon ceased. Hence the disappearance of the scintillations is due to loss of sensitiveness of the screen and not to loss of radio-activity. On introducing a drop of water into the tube and producing saturated aqueous vapor, the scintillations remained. On condensing the water with liquid air, the scintillations were, if anything, brighter and more vigorous than before. The highest vacuum obtainable by the action of cold did not diminish the scintillations. The authors also succeeded in distilling an "emanation" from the anhydrous radium bromide when isolated in the highest vacuum.—Crookes and Dewar, Proc. Roy. Soc., July 31, 1903.

ELECTRIC RESONANCE OF METAL PARTICLES.—R. W. Wood has continued his interesting researches on electric resonance as adopted to explain the very brilliant colors of films made up of metal granules of the order of magnitude of light waves. He has succeeded in obtaining the colored films in prismatic form, and has established the fact that they exhibit anomalous dispersion for waves longer and shorter than the ones which are refused transmission. This was observed for electric waves passing through a prism built up of tin-foil resonators by Garbasso and Aschkinass. The author describes the formation of the silver films in detail, as they make a brilliant lantern experiment. A 30 per cent solution of ferrous sulphate, a 40 per cent solution of sodium citrate, and a 10 per cent solution of silver nitrate are prepared. Fourteen cubic centimeters of the citrate are mixed with 10 cubic centimeters of the ferrous sulphate, to which is then added 10 cubic centimeters of the silver nitrate solution. The black precipitate is washed with not more than 10 cubic centimeters of distilled water to remove the salts. Then about 25 cubic centimeters of water is poured into the filter, and the blood-red solution is collected. A sheet of glass is washed clean and the wet surface rubbed over with some shreds of gelatine. It is then dried on a hot plate. A little of the red solution is flowed over the plate while hot. The solution precipitates a gorgeous red film, which may be made violet by a few drops of alcohol. The depth of color varies with the amount of solution used.—R. W. Wood, Phil. Mag., August, 1903.

CHARGE OF CANAL RAY PARTICLES.—J. Stark gives an explanation of an effect which presents a serious problem to the electron theory. It is that, as W. Wien has shown, canal rays subjected to simultaneous magnetic and electrostatic deflection are drawn out into a continuous "spectrum," producing a straight slanting line on a fluorescent screen. This might be due to the various canal ray particles possessing different velocities, or different masses, or different electric charges. The first explanation is canceled by the fact that the most deflected particles are shown to have the maximum velocity. The second explanation, based upon a variation of mass, might be taken to mean that different numbers of neutral atoms had attached themselves to the positive ion; but then a discontinuous spectrum would have to appear. Lastly, a variation in the elementary charge would take away the whole foundation of the electron theory, and leave unexplained all the striking agreements which have led up to it. The author shows, however, that there is a fourth possible explanation. It is that neutral atoms receive the impact of the positively charged atoms and proceed in a tangential path to the screen, or that positive particles take up negative electrons, and proceed in a similar path without further deflection. There would thus be, statistically, a continuous transition from one velocity to another, which would explain everything and contradict no observed fact.—J. Stark, Phys. Zeitschr.

CURRENT CONSUMED IN CATHODE AND CANAL RAYS.—F. Leininger has, in accordance with a prize question put by the Würzburg Philosophical Faculty, determined the ratio between the energy of cathode and canal rays and the energy of the current which gives rise to them. For this purpose he used a net cathode mounted in a brass ring, and caught the cathode rays and canal rays respectively on aluminium disks. Corrections were made for the reflection of the cathode rays and the obstruction of the canal rays by the meshes of the net. The proportion of current absorbed in the formation of the two kinds of rays was found to vary greatly with the E. M. F., which was supplied by a Wimshurst machine. Thus, at 1,000 volts the proportion going to the production of cathode rays was 23.5 per cent, and at 4,000 volts 43 per cent. The corresponding percentages absorbed by the canal rays were 43 and 56 respectively. These unexpectedly high values, which would show that at high voltages practically the whole of the current is used up in the formation of canal rays, led the author to believe that the correction for the obstruction of the net is not proportional to the obstructing area, a supposition which was confirmed by using different nets, and finding that the energy supplied to the rays sometimes apparently exceeded the total energy of the current. His final conclusion is that the current energy is equally divided between the positive and negative ions, and is almost entirely consumed in separating them and projecting them in opposite directions.—F. Leininger, Phys. Zeitsch., August 1, 1903.

SELF-HEATING OF RADIUM PREPARATIONS.—P. Curie has recently shown the development of heat by radium preparations to a large audience by means of ordinary mercury thermometers. He used two heat-insulating vessels of the Dewar type, in one of which 0.7 gramme of radium bromide were placed, while the other contained a barium salt. A thermometer was placed in each vessel, and the mouths of the vessels were closed with cotton wool. Under these circumstances, the thermometer placed next the radium always showed 3 degrees more than the thermometer adjoining the barium salt. When a radium salt is freshly prepared it does not give off as much heat as it does about a month afterward. If a radium salt is dissolved in water, and the solution is inclosed in a sealed tube, the quantity of heat disengaged is feeble at first. It increases gradually, and attains a constant value in about a month. That constant value is the same as it is in the solid state. The author supposes that part of the heat disengaged is due to the destruction of the emanation. The amount of heat given off can be readily measured by using it for evaporating a liquefied gas such as methyl chloride, oxygen, or hydrogen. An amount of 0.7 gramme of radium bromide is capable of steadily evaporating 73 cubic centimeters of hydrogen per minute.—P. Curie, Bull. Soc. Française de Phys., July 3, 1903.

N-RAYS.—R. Blondlot has continued his researches on N-rays, and has obtained some remarkable results. It appears that the increase of luminosity observed in a small electric spark, in a small gas flame, and even in a glowing solid is not due to a rise in temperature. There is, in fact, a luminous effect unconnected with heat. This apparently paradoxical fact has been established beyond any possible doubt by several series of experiments along different lines, conducted under sensitive conditions. A platinum wire 0.1 millimeter in diameter and 15 millimeters long was brought to a dull red heat by means of an electric current. A beam of N-rays from an Auer burner was transmitted through screens of wood and aluminium, and concentrated upon the wire by means of a quartz lens. The wire was viewed through a piece of ground glass. On cutting off the rays by means of a plate of lead, the luminosity of the wire was perceptibly reduced. The same was observed in the case of a plate of platinum heated by a gas flame. The resistance of the platinum, measured at the same time, showed no change. A thermo-electric pile, exposed directly to the rays, showed no effect. The luminous effect was observed on both sides of the platinum simultaneously. This would mean that the rays penetrate hot platinum though intercepted by cold. Experiments made to test this showed that the rays do penetrate incandescent platinum.—R. Blondlot, Comptes Rendus, July 20, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

CELEBRATION OF THE TWENTY-FIFTH ANNIVERSARY OF THE INVENTION OF THE EDISON INCANDESCENT LAMP.

AT a banquet held in the Waldorf-Astoria Hotel on February 11 by the American Institute of Electrical Engineers, the fifty-seventh birthday anniversary of Thomas Alva Edison and the twenty-fifth of his invention of the electric incandescent lamp were celebrated with *éclat*. Although Mr. Edison could not be prevailed upon to make a speech, he sent a telegraphic message from the guest-table by means of an instrument like that he first used when a telegraph operator years ago. This message was received on one of the latest receiving instruments, located in an adjoining corridor, by the president of the Postal Telegraph Company, Mr. A. B. Chandler; and it was afterward read to the diners. In it Mr. Edison thanked all the members who had stood by him and aided him in their various ways in perfecting and introducing his great invention. If, in the early days, when electrical knowledge was scant, the pioneers had been able to accomplish so much, Mr. Edison said that he expected from the young men of the future, with all their advantages of electrical training in our schools and colleges, the carrying forward to hitherto undreamed of triumphs, of the principles and applications of electricity. He rejoiced in the founding of the Edison medal by the Society, and hoped that it would act as a stimulus to harder study.

A new Edison medal will be purchased yearly out of the income from a fund of $2,000 contributed by the members of the society, and will be awarded to the student in electrical engineering whose thesis or recorded research shall be deemed most worthy of

honor. At the same time that Mr. Edison sent his message over the wires, he sent a wireless message from one end of the room to the other. The great feature of the evening, however, was the entrance of the waiters with the ices, each one of which was in the shape of an incandescent lamp bulb and was placed in a miniature reproduction of some Edisonian invention, such as a motor, phonograph, switchboard, battery, or the like. Small ivory boxes with the figure of a woman holding aloft a light mounted upon them, and inscribed "The Genius of the Lamp," were given as souvenirs, as were also stick pins carrying a miniature electric light. Elaborate menus with the reproduction of a bronze bust of Edison and his original autograph, were at every plate. Among the many congratulatory telegrams received were messages from President Roosevelt and Andrew Carnegie, the latter of whom hailed Mr. Edison as the "King of Telegraphers" and signed himself "Liegeman to King Edison the First."

FOREIGN AND AMERICAN TYPES OF ELECTRICALLY-OPERATED HORIZONTAL BORING-MACHINES.*

By Frank C. Perkins.

One of the most important classes of machine tools operated by electric motors in the modern shops of to-day are drilling, boring, and milling machines. A large proportion of these tools are operated by independent motors, thus doing away with the usual overhead line shafting and numerous belts formerly employed. Some of the foreign as well as American types of horizontal boring-machines are equipped with electric motors mounted upon the tops of the tools; while in a majority of cases the motors are mounted on the extended bases of the machines and drive them through belt and gear transmission.

From carefully collected data on the transmission of power in shops and factories by belts and shafting, it has been found that of every 500 horse power developed by the steam engine, not more than one-half is utilized by the machine tools, and in many cases even less than this, the wasted power being used in the transmission belts, pulleys, and shafting. Where the power is transmitted electrically and individual motors are employed, directly connected to the horizontal boring-machines and other tools, there is a considerable saving over the belt transmission. For with the transmission of power by shafting and belts the loss is nearly constant, regardless of the amount of power used less than the normal. With electrically-driven tools, the losses in transmission are reduced with every machine not in operation, while with belt transmission the entire installation of shafting must be driven continuously.

With motors installed aggregating a capacity of 500 horse power, it has been demonstrated that the power actually used is very much less than half of the capacity installed. It is, therefore, perfectly safe to install at least twice the capacity of the power plant in motors connected with the various machine tools about the shops.

The accompanying illustration, Fig. 1, shows an electrically-operated horizontal boring-machine at the works of the Elektricitäts-Actiengesellschaft, formerly Schuckert & Co., of Nurnberg, Germany. This tool was constructed at Bielefeld, by Droop & Rein, and is driven by a three-phase motor, mounted on top of the machine.

The horizontal boring-machine of Swiss design, noted in the illustration, Fig. 2, was constructed by the Maschinenfabrik Oerlikon, of Oerlikon, near Zurich. This machine is operated by a 3-horsepower electric motor,

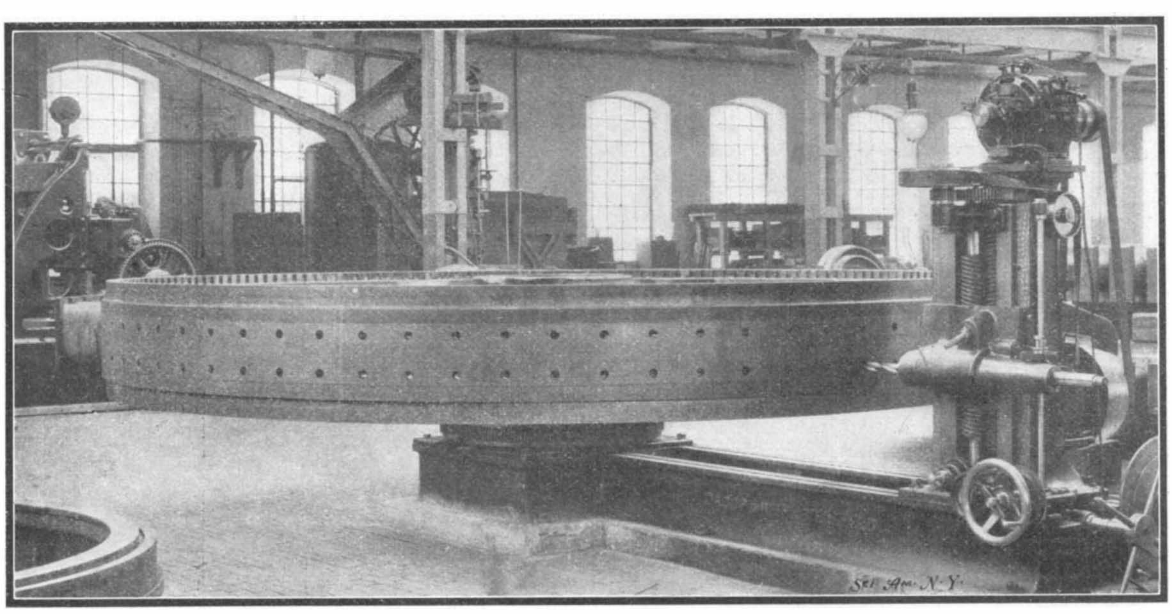


Fig. 1.—GERMAN ELECTRICALLY-OPERATED, HORIZONTAL, BORING-MACHINE.

mounted upon a bracket located on the base of the machine. This is an electric three-phase alternating-current motor, and is belted to a cone pulley near the top of the machine. This tool is designed to bore holes up to 11.811 inches in diameter and a depth of 3.937 inches, and it has a vertical traverse of 47.244 inches. The diameter of the boring-spindle is 3.449 inches, and the controlling switch is located at the right on the traverse. The base of this machine is 157.48 inches in length and 46.06 inches in width. An American horizontal boring-machine for similar work is shown in Fig. 3. This tool is driven by a 7½-horsepower Elwell-Parker motor, of the direct-current type, mounted on an extension of the base of the drilling machine. The tool has a 16-foot column and a 10-foot saddle, with a spindle traverse of 6 feet. It is provided with a floor plate 20 x 20 feet and a compound table 8 feet square.

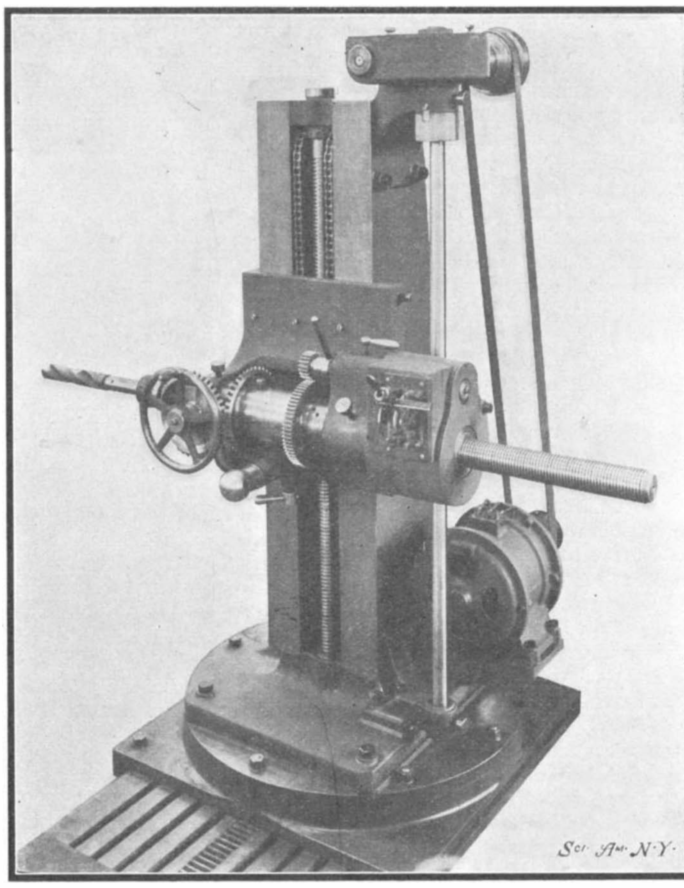


Fig. 2.—SWISS ELECTRIC, HORIZONTAL, BORING-MACHINE.

At the shops of the Fraser & Chalmers Company there is in operation a horizontal boring, drilling, and milling machine, a general view of which is seen in Fig. 4. This tool was designed for boring cylinders up to 60 inches, or even larger in diameter, and for milling engine trains. It is also capable of drilling down to 1½ inches in diameter, the speed range of the motor being 2 to 1 by field control. The spindle is 9½ inches in diameter, and has a traverse of 72 inches, the range of speeds being from 1 to 50 revolutions per minute. It may be operated either by a small gear, which is covered by gear guards, or by a face-plate gear to which boring bars and large milling cutters may be bolted. The counterweighted saddle has a vertical adjustment, by power, of 8 feet, and the column has a traverse of 12 feet on the bed, while both the saddle and column have electric power milling feeds with quick power traverse and automatic stops.

The spindle, saddle, and column feeds may be changed or reversed, the quick traverse of the saddle or column may be controlled, and the spindle may be started, stopped, or its direction of rotation reversed, all from the operator's platform, which is attached to the saddle.

The machine is self-contained, in that the motor and all the driving gear move with the column. The bed may be made of any length.

Attached to the bed of the machine is a floor plate carrying an outboard column and a square table upon which turns an 8-foot octagonal table. The octagonal table has a circular base graduated in degrees, and is provided with four stops in quadrature. These stops can be brought into contact with a test indicator reading in thousandths of an inch, which insures absolute squareness of work being milled.

* Specially prepared for the Scientific American Supplement.

THE PRESENT POSITION OF THE THEORY OF ELECTROLYSIS.

To the engineer who left school twenty years ago the language of modern electro-chemists is somewhat bewildering. In his days, not even trained chemists talked of the solution pressure of metals, or of means of increasing the dissociation of a compound in solution. The speculations of a very small number of professors upon the absolute velocities of the ions were regarded with no more practical interest than the theorizing of certain astronomers on the relations between the color and the age of fixed stars. The very term "electrolytic dissociation" was unknown, in fact. At present everything electrolytic is more or less dissociated in any respectable chemical patent specification.

The chemist of the old school objects scornfully that the whole dissociation is confined to the brain of the patentee, where it may be fairly complete. The idea of the spontaneous dissociation of a substance like chloride of sodium appears to him to be absurd. He knows chlorine as a gas exceedingly unpleasant to breathe. He knows sodium as a metal possessed of a remarkable energy, quite ready to cause explosions in the presence of water. He knows common salt as a perfectly harmless, indeed, salubrious compound, resulting from the combination of those two elements. Nobody has ever denied that a solution of salt in water is salt, that it tastes like salt, and that the solid salt can be recovered from the brine as many times as we desire. And now people come and tell him that, in brine, we have ions—whatever they be—of chlorine and of sodium roaming about, under certain restrictions, yet independently of one another. He declines to entertain these new-fangled notions which pretend to explain phenomena that chemistry has duly labeled and shelved, by an imposing array of new terms and arguments which become the more involved the further they are developed. These objections are not unjustified. There is no doubt that some modern electro-chemists recklessly brandish new weapons and defend themselves, successfully, with their aid, until they are vigorously attacked. And then they retire and declare that their arms are not perfect yet, and that the great trials must only be considered as preliminary experiments.

But if some modern electro-chemists have run where cautious walking was advisable, the charge can by no means be brought against the whole movement. When we find our old devices deficient, we need to improve them. The old views left much obscure that seems to become clear to further research and speculation. We are probably just as far removed from any ultimate explanation as ever. Yet the new arguments were not advanced without good reason. The development of electro-chemistry as a science could not but lay bare weak spots. There are many unsolved problems affecting the steam engine. The electric motor—a mere child compared to the venerable steam engine—is regarded as almost perfect now. How that perfection has been attained we all know. It has taken years before the confusing mass of experiments and papers and theories could be cleared of what was erroneous and useless in them. A future generation may smile at the blindness that prevented our recognizing the possibly simple principles underlying the apparently complicated chemical phenomena. Meanwhile we can rejoice at the splendid work that is being done, which we owe directly to the impetus given by the new theories.

In such periods of interregnum the engineer who

has no leisure to follow up special lines of research outside his own vast domain, has reason to be thankful to the men who will present him with a general review of what the modern hypotheses really signify, and tell him in how far they may be accepted. This summer the British electro-chemists, following the example given by the German electro-chemists nine years ago, have united in a society. Before the first meeting of this new Faraday Society, Mr. W. C. Dampier Whetham, F.R.S., of Cambridge, placed a report on "The Present Position of the Theory of Electrolysis." A better selection for an opening communication could not have been made, and Mr. Whetham's masterly exposition of the modern theories deserves the fullest attention. He has himself done good work in this field, and we may safely be guided by his line of argument.

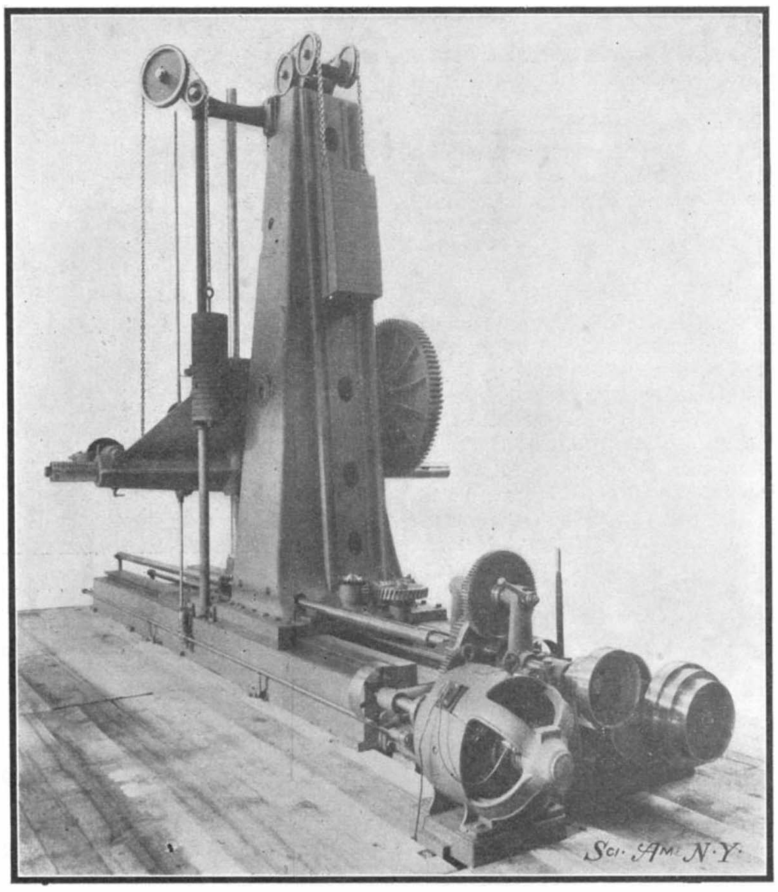


FIG. 3.—AMERICAN HORIZONTAL BORING, MILLING, AND DRILLING MACHINE.

16-foot column; 10-foot saddle; 6-foot spindle traverse; 20-foot by 20-foot floor plate; 8-foot square compound table.

Early in the nineteenth century it was observed that in the newly-discovered electrolytic phenomena the decomposition products appeared at the electrodes only, while the body of the solution was unaltered. A continual passage of the constituents of the electrolyte seemed to be going on in opposite directions, which Grotthuss (of Leipzig), in 1805, tried to explain by his chain theory. That chain theory meant that if we imagine a chain of molecules of some salt between the electrodes, all the molecules, say, A_1 B_1, A_2 B_2, A_3 B_3 being equal, of course, then A_1 would become free at the anode; its B_1 would unite with the A_2 of the next molecule; the B_2 would in its turn be bound by the A_3, and so on; and, finally, B_3 would be liberated at the cathode. The theory did not explain how the molecules were successively split apart, and the neighbors reunited, nor did it take any notice of the solvent water. But it did explain why the decomposition products were confined to the neighborhood of the electrodes. About 1830 Faraday proved that a definite electric transfer of positively electrified cations and of negatively charged anions accompanied a given amount of chemical decomposition. In 1853, Hittorf—still at work in Münster, Westphalia—noticed that the electrolyte became diluted to an unequal amount round the two electrodes. That could be explained by the existence of complex ions, dragging some of the unaltered salt or solvent with them, or by an unequal velocity of the opposite ions. When no complex ions may be assumed to be present, as in the case of compounds of monovalent elements like K Cl, the ratio of the velocity of the cation and anion will be that of the amounts of salt lost from the neighborhood of the respective electrodes (*Ueberführungszahlen*, or transfer numbers). F. Kohlrausch (Reichsanstalt) pointed out that, on the convective idea of electrolysis, the total electric transfer per unit of time through the solution, or the current, must be equal to the product of the number of ions, the charge on each of them, and their relative velocities—that is, the sum of their opposite absolute velocities. Kohlrausch had previously established that when the reverse electromotive forces at the electrodes are eliminated, the electrolytic conduction conforms to Ohm's law. We had therefore a measure for the current, as equal to the product of the conductivity and the potential gradient, and thus a relation was deduced between molecular conductivity and the sum of the opposite ionic velocities under unit potential gradient, quantities which are known as ionic mobilities. These mobilities were found to increase in general with further dilution of the solvent. The mobility of the chlorine ions, for example, which proved different for different alkali salts at moderate concentrations, became uniform at high dilution; and chlorine has therefore a definite ionic mobility, which, at sufficient dilution, is independent of the other ion present—the metal with which the chlorine is combined in the dissolved salt.

Rates of migration of the ions, confirming Kohlrausch for monovalent ions, were actually measured, with the aid of colored gelatines and other expedients, by O. Lodge, Whetham, Orme Masson, and Steele, and others. When the color difference is due to the cation, the color boundary travels with the current from the anode to the cathode. For divalent salts, discrepancies are observed at higher concentrations, indicating the existence of complex ions. Ions, therefore, seemed really to be transported in opposite directions. How they acquire their freedom of motion, we do not understand. In the salt the two ions appear to be bound to a stable compound. It is apparently not the electromotive force which splits them up; the electromotive force only exercises a directive force, and has to overcome nothing but the viscous friction in the medium; any electromotive force, however small, will produce a current in an electrolyte according to Ohm's law. If the ions passed through a chain process according to Grotthuss, in a succession of decompositions and reformations of molecular aggregates or of collisions between the dissolved molecules, the ionic velocities should depend upon the frequency of the collisions, and hence on the square of the concentration, while the conductivity, being itself proportional to the product of the mobility and concentration, should vary with the cube of the concentration. But the conductivity increases only with the first power of the concentration—moderate concentrations always presupposed. The chain theory, therefore, breaks down, and the electrolytic dissociation theory steps in. That theory assumes the ions in any solution—aqueous to be understood for the present—to be able to migrate independently of one another. That does not imply, Mr. Whetham emphasized, that they are free from all chemical combination. The dissociation theory says that when salt is dissolved in water, we have in the solution obviously not solid particles of salt (Na Cl) separated by water; nor have we all the salt in the liquid state; but a certain portion of the Na Cl will be split into the ions Na and Cl. These ions are not free elements. It is not suggested that the Na ion has any resemblance to the Na molecule or particle, which would at once decompose water, any more than we find any resemblance between metallic sodium or chlorine and chloride of sodium. The ion carries an electric charge; when it has given off that charge, it is a free molecule. We may have very complex ions as we speak of complex radicals; the two terms have different meanings, however. The ion may act on the solvent and upon other ions. All that is difficult to grasp, and indefinite and obscure to the chemist, but it helps us on a little. In support of these views we might refer to the color phenomena, the power possessed by electrolytes of coagulating colloidal solutions, as recently studied by Whetham and Hardy, and to other considerations.

The dissociation theory was, in fact, reached by an entirely different line of reasoning. Biologists first noticed that water seemed to be urged by a peculiar force into the living cell through the membranes. Pfeffer observed in 1877 that a solution of cane sugar contained in a cell with semi-permeable walls—i. e., walls permeable to the water into which the cell was lowered, but not to the sugar—indicated an osmotic pressure in that solution which at constant temperature was proportional to the strength of the solution. Following up similar researches thermodynamically, Van't Hoff taught some years later that the gas-pressure laws apply to very diluted solutions. Rayleigh later confirmed this conclusion, which had so far been disregarded in this country. Treating the subject from the fundamental standpoint of the molecular theory, Willard-Gibbs, Helmholtz, and Larmor arrived at the same conclusion.

According to the latter molecular method with which Mr. Whetham dealt, the solute is distributed throughout the solvent in discrete particles which can affect, in some unknown manner, a minute volume of the solvent around them. At high dilution, any further addition of solvent will only increase the separation of the spheres of action, and the change of available energy can no longer depend on any interaction between solvent and solute. The osmotic pressure should finally become independent of the nature of the solvent, and should have the same value in fact if no solvent were present. That sounds paradoxical; but it signi-

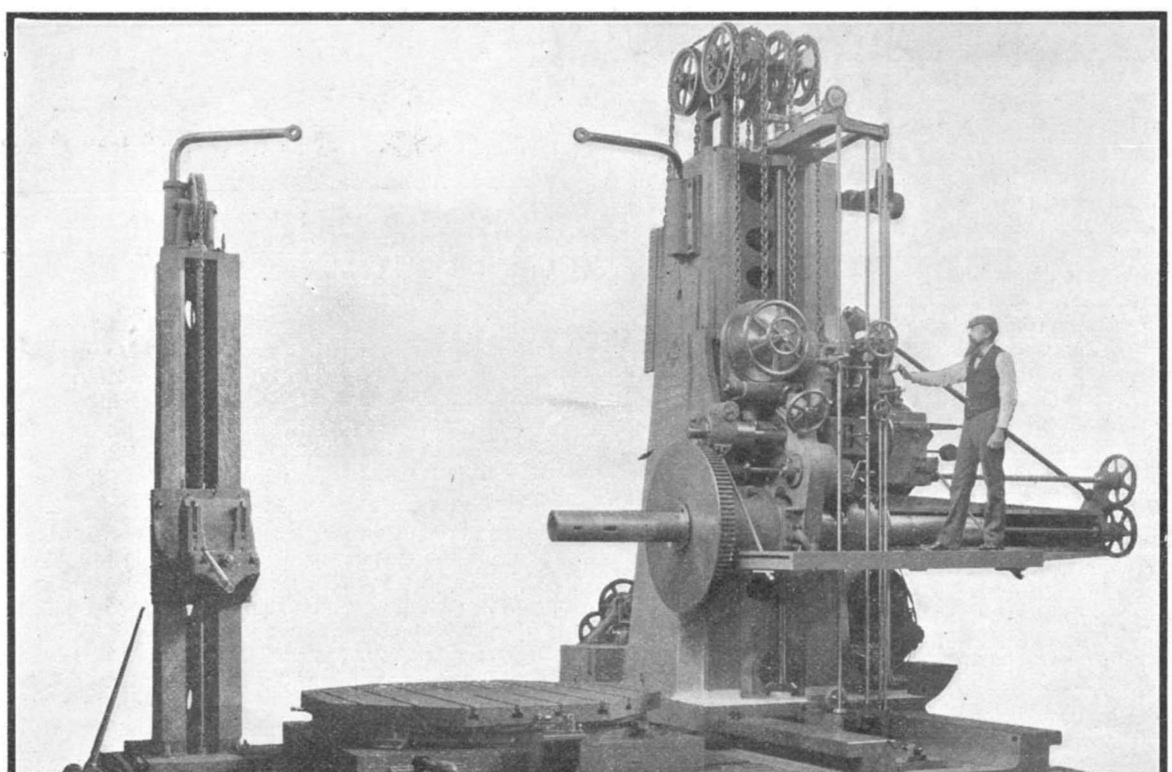


FIG. 4.—HORIZONTAL BORING, MILLING, AND DRILLING MACHINE CAPABLE OF DRILLING DOWN TO 1½ INCH AND OF BORING CYLINDERS UP TO 60 INCHES.

Spindle, 9½ inches diameter; speed range of motors, 2:1 by field control.

fies that for volatile solutes the osmotic pressure must be equal to the gaseous pressure corresponding to the same concentration. In this way the gaseous laws for the osmotic pressure can be shown to apply to volatile solutes, and, as most substances seem to be somewhat volatile, to substances in general.

Satisfactory direct measurements of the osmotic pressure have been made in a good many instances. But as those experimental determinations are very tedious, we rely more frequently on cognate phenomena—the depression of the freezing point and the lowering of the vapor pressure resulting in a solvent when some substance is dissolved in it. These depressions were found to be abnormally high in the case of electrolytic solutes, and this circumstance suggested to Arrhenius and Planck the idea of dissociation. For thermodynamically the osmotic pressure of dilute systems depends upon the number, and not upon the nature, of the particles; and when too high depression values were obtained, it would appear that we have not to deal with one particle of K Cl, but with two particles—one of K and one Cl. The dissociation need not necessarily yield electrolytic ions, such as would call forth electric conductivity. Kahlenberg has observed pronounced dissociation in organic compounds dissolved in organic solvents which were nevertheless non-electrolytes.

The conductivity of a solution increases with the concentration, and decreases on dilution, while the equivalent conductivity increases with dilution and approaches on extreme dilution a constant value, corresponding apparently to complete dissociation. We have very few measurements at extreme dilution. The best freezing point determination by E. H. Griffiths gave 1.858 as molecular depression for cane sugar solutions; the gaseous value of the osmotic pressure would be 1.857. In the case of K Cl, Griffiths found 3.720; twice 1.857 would be 3.714, so that here dissociation into two ions seems to be demonstrated. For binary compounds, the agreement is less good, and on these and other considerations are based attacks on the whole dissociation theory. Complex compounds are, however, possible even between monovalent elements; the halogens chlorine and iodine combine with one another, and in the alkali hydrides we have several atoms of metal or of hydrogen joined to one another. We must, therefore, not be surprised if the osmotic and dissociation laws do not strictly hold for all monovalent elements. Secondly, we must always bear in mind that the gaseous pressure law is only valid for very dilute systems, in which inter-ionic forces may be assumed to vanish. It must not be forgotten, finally, that in the determination of the coefficient of dissociation, the assumptions are commonly made that no complex ions are present, and that the ionic viscosity of the solvent is constant for all concentrations; both these assumptions are unjustified. We may imagine a non-dissociated molecule as a bipolar system; two molecules correspond to two magnets at great distance apart, and the mutual translational forces vary as the fourth power of the distance. In dissociated ions, on the other hand, we have isolated particles acting upon one another with forces varying as the square of the distance. These forces will hence remain active on dilutions at which the former forces, decreasing with the fourth power of the distance, no longer exert much influence. This, in Mr. Whetham's opinion, may be one of the reasons why the mass law and Ostwald's dilution law do not hold when good conductors like strong acids (in distinction from weak acids) are diluted.

Since chemical activity seems to depend much on ions, some electro-chemists have concluded that chemical action was possible only in the presence of ions. In that they have gone too far, and brought down sharp criticism on the whole theory. Kahlenberg has observed, e. g., that a precipitate of copper chloride is instantaneously produced when hydrochloric acid—itself a non-electrolyte when absolutely dry—is passed into a non-conducting solution of copper oleate in benzine, and has for this reason, and on account of the behavior of solutions in other solvents but water, attacked the theory. We need not interpret these considerations in the sense that dilute solutions behave differently from concentrated solutions, and that the latter have to be treated again in a special way. The theory can fully account only for phenomena taking place under certain ideal conditions; under other conditions it affords a partial guidance. A considerable amount of experimental work on solutions in non-aqueous solvents has been collected within recent years. but the matter is not ripe yet for generalizations. To a certain extent the data are in accord with the dissociation theory; where they are not, we could hardly expect complete agreement. There are great experimental difficulties, and association of molecules often seems to take place in solvents like alcohols, acetone, pyridine, etc., and to complicate matters. That would not exclude the co-existence of ions, which could conduct the current in the modern sense. It is, further, not necessary that the many fused salts which are electrolytes are electrically dissociated. Osmotic data are not available, other experimental investigations are very difficult. Mr. Whetham points out that a fused salt consists of a collection of molecules all of the same kind, that hence arguments from the frequency of collisions between dissolved molecules, isolated from each other by comparatively vast spaces of solvent, cease to hold, and that there is, therefore, no real resemblance between the electrolyses of fused salts and of aqueous solutions.

It has been objected that thermodynamical deductions do not support the modern views as regards the theory of the galvanic cell. Thermodynamics alone can in that case, however, not furnish any evidence either for or against any electrolytic or ionic hypothesis. But the simple concentration cell, in which the total potential difference is that due to the contact of two solutions of the same substance at different concentrations, can be explained by the hypothesis of independent ionic diffusion, as Nernst has shown theoretically and experimentally.

Attention may, in conclusion, be drawn to another circumstance. Since the development of the dissociation hypothesis as applied to liquid electrolytes, a vast increase has occurred in our knowledge of the discharge of electricity through gases. This process has been satisfactorily explained as a convective electrolytic action, the ions being in some cases dissociated molecules, in others isolated corpuscles which may represent the ultimate units of negative electricity, perhaps even the common constituents, aggregates of which make up the different chemical atoms. Such results give a presumption in favor of a general applicability of such theories. It is only a presumption. For, as Mr. Whetham points out, had the gaseous conduction phenomena been first in the field, we could not have extended a dissociation hypothesis, framed to explain them, to the much more complicated systems which are formed by electrolytic solutions. But for all solutions which conduct electricity the presumption in favor of a similarity of explanation is great. With this we must rest satisfied for the present, though we feel tempted to allude to catalytic processes. It looks as if two pure substances or elements were unable to act upon one another in the absence of some third body to start the reaction. That third body may, in pure water, be the ions to which the pure water owes that exceedingly small amount of conductivity which

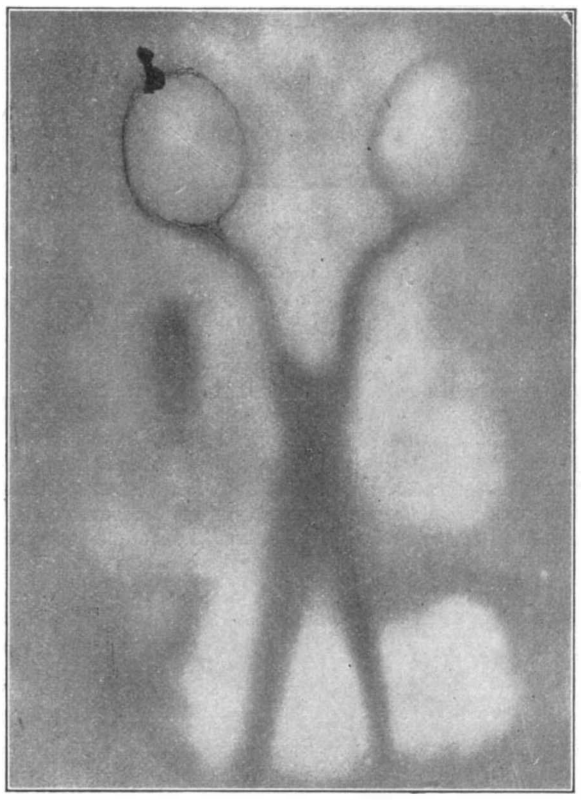


FIG. 1.—THORIOGRAPH TAKEN IN A DARK CLOSET WITH THREE BROKEN WELSBACH MANTLES.

Time of exposure, 72 hours.

Kohlrausch has found it to possess. We do, of course, not wish to comprise all the varied catalytic phenomena under this point of view.—Engineering.

THORIUM: A RADIOACTIVE SUBSTANCE WITH THERAPEUTICAL POSSIBILITIES.*

By SAMUEL G. TRACY, B.Sc., M.D., New York.

THE marvelous properties of radioactive substances have made them a matter of great interest to all scientists, but to the medical man their possible value as therapeutic agents renders them objects of special and peculiar importance.

There are but four known elements which are radioactive. These are radium, thorium, polonium, and actinium. The latter two I will not consider here, as they are the least known, extremely rare, and almost beyond the power of purchase. Radium I have already dwelt on in previous papers.† Thorium is one of the rare metals, and was discovered in 1828 by Berzelius. Until the past few years, it has been too rare and expensive to be used commercially or in medicine. It is now, however, more abundant, and is found in certain sands in North Carolina, in Brazil, and in Norway and Sweden. The most active thorium is obtained from the minerals cleveit, broggeri, monazite, in the order given. During the past ten years it has been used as the principal chemical for the production of incandescence in the Welsbach mantle.

Since the discovery of radium by Prof. and Mme. Curie, renewed interest has been excited in thorium, because it has been found, by Prof. G. C. Schmidt, to possess the property of radioactivity. That thorium is, in fact, radioactive, is susceptible of demonstration in two ways: First, by means of a delicate electroscope, such as is used in demonstrating electrical induction; and, second, by means of the sensitized photographic plate. With the first method, when a prepara-

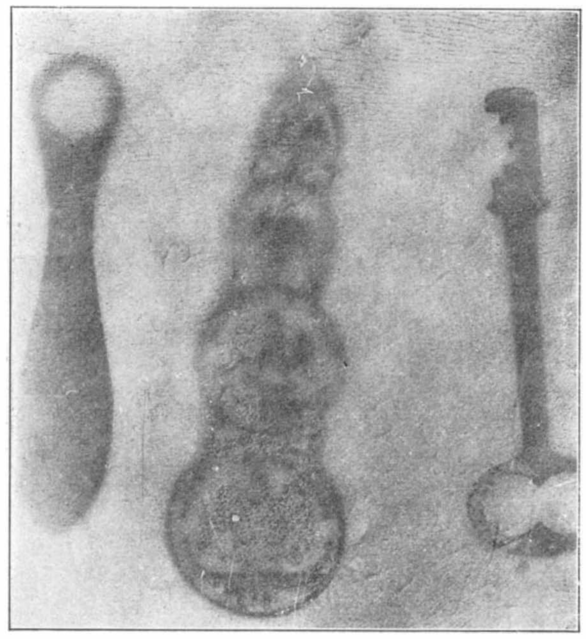


FIG. 2.—THORIOGRAPH TAKEN IN A DARK CLOSET BY OXIDE OF THORIUM SCREEN.

Time of exposure, 48 hours.

tion of thorium is brought near the wire attached to the two gold leaves in the electroscope, the leaves fall together, thus indicating the presence of radioactivity. The greater the rate of the discharging power of the leaves, the greater the radioactivity.

The second test—that with the photographic plate—takes a much longer time for its accomplishment, viz., from twenty-four to forty-eight hours, if a screen made from the nitrate of thorium is used; but when hot emanations from the oxide of thorium are the excitant, a photograph may be obtained in one hour. Among the first thoriographs that I obtained was one taken by three Welsbach mantles. In a dark closet I placed a photographic plate. Upon this was laid a pair of scissors, as appears in Fig. 1, and on top thereof, three old Welsbach mantles, rich in thorium oxide. In seventy-two hours I obtained a good negative. In other thoriographs I have taken, I employed a screen of thorium oxide—using simply a piece of pasteboard—to which I added mucilage and dusted on it a thin layer of thorium. Thoriographs were taken by this method in from twenty-four to forty-eight hours. Figs. 2 and 3.

The most penetrating Becquerel rays are those obtained from hot thorium oxide. The thoriograph shown in Fig. 3 was obtained by taking a photographic plate, covering it with thick black paper, and placing on it keys, a glove buttoner, etc. Then this plate was exposed to the warm emanation of thorium, and the accompanying photograph was obtained in one hour.

The photographs that accompany this article—thoriographs I have called them—were produced by various methods and with varying degrees of exposure. The data concerning them will be found under each cut.

Prof. Ernest Rutherford, of McGill University, was among the first to investigate the properties of thorium. His researches in this field have done more, perhaps, than has been effected by anyone else toward solving some of the mysteries of this remarkable radioactive substance. In 1900 he discovered that tho-

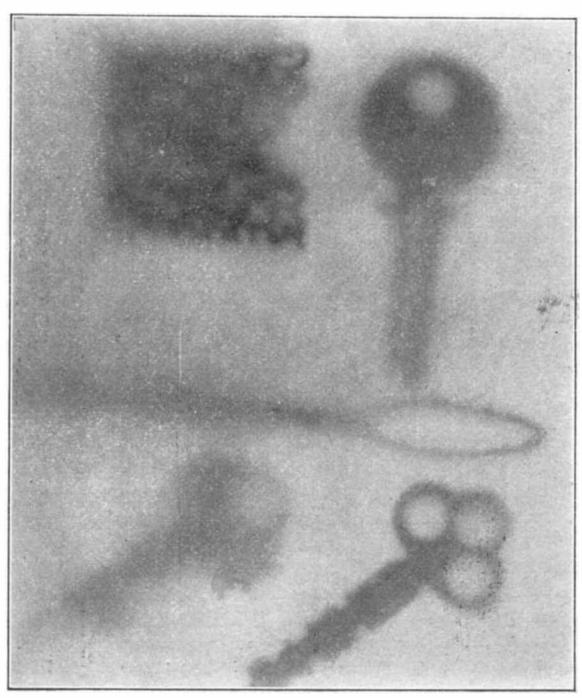


FIG. 3.—THORIOGRAPH TAKEN WITH THE EMANATIONS OF HOT THORIUM OXIDE.

Time of exposure, 1 hour.

rium gave off an inert and highly radioactive gas, which he termed an emanation." It diffuses through gases, liquids, and even through porous substances.

* From the Medical Record.

† New York Medical Journal, October 24, 1903; New York Journal of Advanced Therapeutics, December, 1903, and New York Medical Journal, January 9, 1903.

Rutherford considers the emanation to be the result of successive chemical changes in the thorium. By chemical action the thorium atom produces a substance which he calls thorium X, and by a further chemical change, this thorium X produces the emanation. The emanation expels from itself a negatively charged body, which constitutes the Becquerel rays. These rays are the same as those produced by radium, polonium, actinium, and uranium.

It has been recently proved by scientists who have experimented with thorium, that its radioactivity and emanations are antiseptic, antifermentative, and inimical to germ life. In conjunction with Hugo Lieber, we have shown that grape juice, when exposed to radioactive matter, will not ferment for a month, even though it is kept in a warm room, with the bottle uncorked. In other experiments the oils of juniper and erigeron were used. These oils ferment and decompose in a few days if left exposed to the light. But after treatment with thorium emanations, even in the presence of light, they nevertheless were preserved in their original state for several weeks.

The antifermentative property of thorium emanations is further shown by the following experiment:

Two bottles were taken, each containing agar-agar, starch, and mold (such as may be obtained from fermenting fruit). The contents of one of these bottles were subjected to the radioactive emanations of thorium, and those of the other were not. In the first bottle the growth of the mold was greatly inhibited, whereas, in the second bottle, the mold grew abundantly and soon filled the bottle. From these observations it is evident that thorium has a marked effect on micro-organisms and fermentation, a fact suggestive of a vast field of usefulness in medicine.

The radioactivity emanates from thorium in every form, whether in powder, solution, paste, or ointment. The best results, however, are likely to be obtained from the gaseous emanations when used as an inhalation. This form of emanation may be obtained, either by making a solution of thorium nitrate, or, better still, by heating the oxide in a glass receptacle, on a sand bath. For external application thorium may be made into a paste or a 25 per cent ointment, and used as an antiseptic in chronic skin diseases, particularly those of parasitic origin.

Thorium in Tuberculosis.—Dr. Soddy, of London, and Prof. Rutherford, of Montreal, have suggested the use of thorium inhalations for tuberculosis. Certainly, from its antiseptic and antifermentative actions, it would appear to be a desirable agent to apply directly to the tissues affected in the fight against the tubercle bacillus.

As I have previously stated, there are two methods of obtaining these radioactive emanations, for use in the treatment of tuberculosis. One method is to use a saturated solution of nitrate of thorium in a large shallow receptacle. The larger the area of the vessel, the greater the amount of the emanations. A slight current of air can be caused to pass over the solution from a compressed air tank, while the patient is inhaling. With the nitrate of thorium there may be more or less free nitric acid; this must be neutralized by passing the emanations, before inhalation, through a wash-bottle containing a saturated solution of sodium bicarbonate.

The other, and by far the best, way of obtaining the emanations, is by heating the oxide of thorium. The apparatus I am using for this method of inhalation is the invention of Hugo Lieber. The accompanying cut shows the various parts of the apparatus, and the method of administering the thorium emanation.

The radioactivity of thorium is many thousand times less than that of pure radium, but thorium is also many thousand times cheaper ($7 a pound), and it can be used for a longer period of time at each treatment, thus making up by the increased duration of the treatment what it lacks in potency.

Rutherford states that "when thorium nitrate is changed into an oxide by heat, it temporarily loses its radioactivity. However, when it is exposed to the air, it soon begins to regain its activity. In four days it is one and a half times more active; in twelve days, two and a half times; and at the end of two weeks it reaches its maximum radioactivity, which is four times as great as was the original nitrate of thorium."

In using Lieber's thorium apparatus, the inhalation of the emanations leaves in the lung cells a fine film of radioactive matter, which, in turn, produces the phenomenon of induced radioactivity in the same parts. This "induced" radioactivity will remain in the air-cells long after the original emanations have been exhaled. In most cases it lasts for from one to two days, after which it gradually disappears. In this connection it is interesting to observe that the radioactivity of thorium can be proved, even after it has entered the lungs. If a patient inhales the thorium emanations, and then, while in a dark room, exhales, allowing the breath to come in contact with a photographic plate, the exhalation affects, and partly decomposes, the silver salts on the plate.

As the induced radioactivity of the thorium emanations lasts from twenty-four to forty-eight hours, this acts as a guide to indicate the proper frequency for the treatments. An inhalation given every day or every other day would keep the lung cells constantly in a radioactive and antiseptic condition. While the thermometer in the Lieber apparatus should indicate a temperature of from 250 deg. to 300 deg. F., the emanations are partly cooled by passing through the glass and rubber tubing, and may not be much above the normal body temperature at the moment of inhalation. These inhalations may be taken for a period of fifteen minutes at the outset, which period may be gradually increased to half an hour.

This method of treating tuberculosis will not interfere with other measures, such as dietetic, hygienic, and even drug treatment.

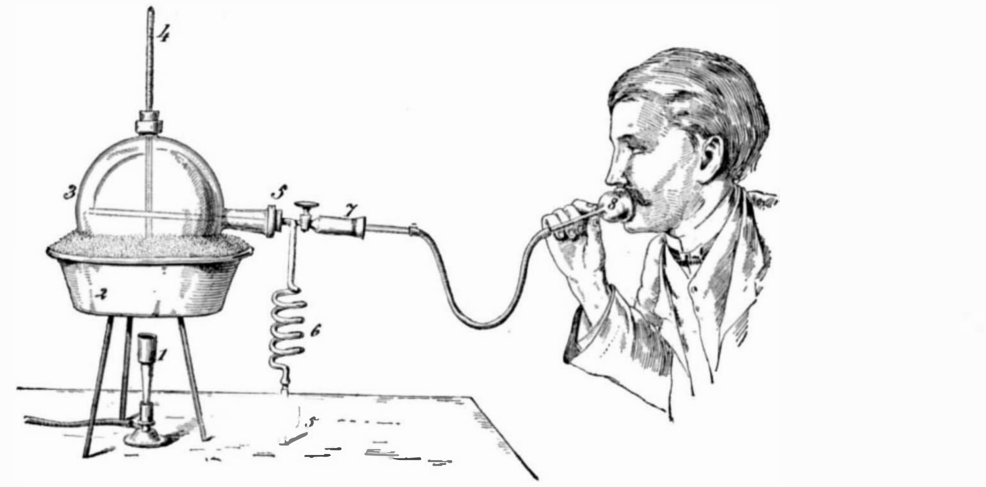


FIG. 4.—LIEBER'S APPARATUS FOR THORIUM INHALATIONS.

1. Bunsen burner. 2. Tin vessel containing white sand. 3. Glass vessel containing thorium oxide. 4. Thermometer. 5. Inlet for air. 6. Spiral glass tube to prevent escape of emanations. 7. Outlet for emanations. 8. Mouthpiece for inhalations.

CONDUCTIVITY OF DIELECTRIC LIQUIDS UNDER THE INFLUENCE OF THE RADIUM RAYS AND OF THE ROENTGEN RAYS.*

From the French of M. P. CURIE.

I HAVE ascertained that the rays of radium and the Roentgen rays act on dielectric liquids as on the air, communicating to them a certain electric conductivity. The experiment is performed in this way: The liquid experimented with is placed in a metallic vessel, in which a thin copper tube is inserted. These two metallic pieces serve as electrodes. The vessel is kept at a given potential by means of a battery of small cells, of which one of the poles is earthed. The tube is connected with an electrometer. When a current traverses the liquid, the electrometer is kept at zero with the aid of a quartz piezo, which gives the measurement of the current. Another copper tube connected with the earth serves as a protection for preventing the passage of the current through the air. A bottle containing the radium-bearing salt is placed at the bottom of the first copper tube. The rays act on the liquid after passing through the glass of the bottle and the walls of the metallic tube. The radium will also act by placing the bottle beneath the vessel.

In order to act with the Roentgen rays they are introduced through the bottom of the vessel.

The increase of conductivity by the action of the radium, or the Roentgen rays, seems to be produced for all dielectric liquids; but in order to note this increase it is necessary that the conductivity peculiar to the liquid should be quite small in order not to conceal the effect of the rays. By operating with the radium and the Roentgen rays I have obtained results of the same order.

When the conductivity of the air or of another gas under the action of the Becquerel rays is studied with the same arrangement, it is found that the intensity of current increases proportionally with the difference of potential between the electrodes, when this difference of potential is slight, a few volts with the apparatus referred to; but when the difference of potential increases more and more, the intensity of the current no longer increases proportionally. The effect of an increase of tension goes on diminishing, and for high tensions (100 volts) the intensity of the current increases only to a small part of its value when the difference of the potential is doubled.

The liquids studied with the same apparatus and the same very radiant product behave differently. The current is proportional to the tension when this varies between 0 and 450 volts, even when the distance of the electrodes does not exceed 6 millimeters. The conductivity occasioned in different liquids by the radiation of a radium salt acting under the same conditions may then be considered. The numbers of the following table, multiplied by 10^{-14}, give the conductivity in ohms per cubic centimeter:

Carbon sulphide	20
Petroleum ether	15
Amylene	14.
Carbon chloride	8
Benzine	4
Liquid air	1.3
Vaseline oil	1.6

It may, however, be supposed that liquids and gases behave in a similar manner, but that for liquids the current remains proportional to the tension up to a much higher limit than for gases. The law of proportionality in the preceding series of experiments ceases to be verified only for tensions above 450 volts.

By analogy with what occurs for gases, the limit of proportionality may be lowered by employing a much weaker radiation. Experiment has verified this supposition. The product employed was one hundred and fifty times less active than that made use of in the first experiment. For tensions of 50, 100, 200, and 400 volts, I have obtained currents, which may be respectively represented by 109, 185, 255 and 335. The proportionality is no longer maintained, but the current still varies a great deal when the difference of potential is doubled.

Some of the liquids examined are nearly perfect insulators when sheltered from the action of the rays and kept at a constant temperature. Such are liquid air, petroleum ether, vaseline oil, and amylene. It is then quite easy to study the effect of the rays.

Vaseline oil is much less sensitive to the rays than petroleum ether. It is perhaps correct to refer this fact to the difference of volatility between these two hydrocarbides. Liquid air in a state of ebullition for some time in the experimental vessel is more sensitive to the action of the rays than that which has just been poured in. The conductivity produced by the rays is a quarter greater in the first instance.

I have studied the action of the rays on amylene and on petroleum ether at temperatures from +10 deg. to —17 deg. C. The conductivity due to the radiation becomes feebler by a tenth part only of its value when the temperature descends from +10 deg. to —17 deg.

In the experiments in which the temperature of the liquids has been varied, the radium can be kept either at the surrounding temperature, or carried to the same temperature as the liquid; the same result is obtained in both cases, from the fact that the radiation of radium does not vary with the temperature, and still preserves the same value even at the temperature of liquid air, as I have verified directly by measurement.

* Paper presented to the Academy of Sciences.

A CALORIMETER FOR COAL AND OIL.

IT is of interest in the industries always to know with certainty the caloric capacity of any given variety of coal and oil, and for determining this there have been devised a certain number of calorimeters, the use of which, however, requires precautions and manipulations that are often very delicate. In many manufactories there are laboratories in which all experiments that require a little care and study are performed, but such is not the case in the minor industries, in which simple and practical apparatus are indispensable. The want of such instruments is frequently the cause of expenses that might be avoided by manufacturers if they were provided therewith. It is evident that it is very important to know perfectly the quality of the coal employed, since coal that is well adapted for use in one case may prove inferior in another.

The calorimeter devised by Mr. Campbell Houston, of the Technical College of Glasgow, marks a progress in this line, and requires but a few manipulations, while the experiment proceeds under the eyes of the operator. The apparatus consists essentially of a large test-glass, which is filled with water into which is inserted a thermometer. The specimen of coal to be examined is reduced to powder in a mortar, and 30 grains of it are then put into a crucible, which is placed in a glass vessel that may be hermetically closed. This vessel is provided with an aperture to permit of the entrance into the interior of a tube for introducing oxygen taken from a reservoir. It is always well to employ the oxygen that is sold in the market in special cylinders. It may be manufactured upon the spot, but that is a complication.

After the powder has been put into the closed vessel, the latter is placed in the test-glass, into which has previously been poured two quarts of water, that is to say, a weight of about four pounds. The temperature indicated by the thermometer having been noted, the current of oxygen is allowed to enter, and the coal begins to burn. The entrance of the oxygen is regulated by a valve placed at the outlet of the cylinder containing the gas. At the beginning of the experiment, the extremity of the tube should be at the upper part of the vessel, and afterward be gradually and gently made to enter the interior until it reaches the lower part, at the end of the experiment, the duration of which is about ten minutes. After the combustion has terminated, the current of oxygen is maintained for a few seconds, and then interrupted. Then, after the water has been well stirred, in order that it shall be of the same temperature in all its parts, the graduation of the thermometer is read. The operator has now all the data necessary for the determination of the calorific power of the specimen submitted to exper-

iment. It suffices to make a calculation according to the following formula:

$$\text{Calorific power} = \frac{\text{The weight of water} + \text{the weight of the apparatus reduced to water}}{\text{The weight of the fuel burned}} \times \text{the elevation of the temperature.}$$

The operation is performed without any disengagement of smoke from the coal used, and this is one of the advantages of the method, since it permits of noting exactly the end of the experiment.

The process with oil is absolutely identical with that employed with coal. As may be seen, the use of the calorimeter is very simple—two weighings and two readings of a thermometer furnishing all the elements for the calculation.

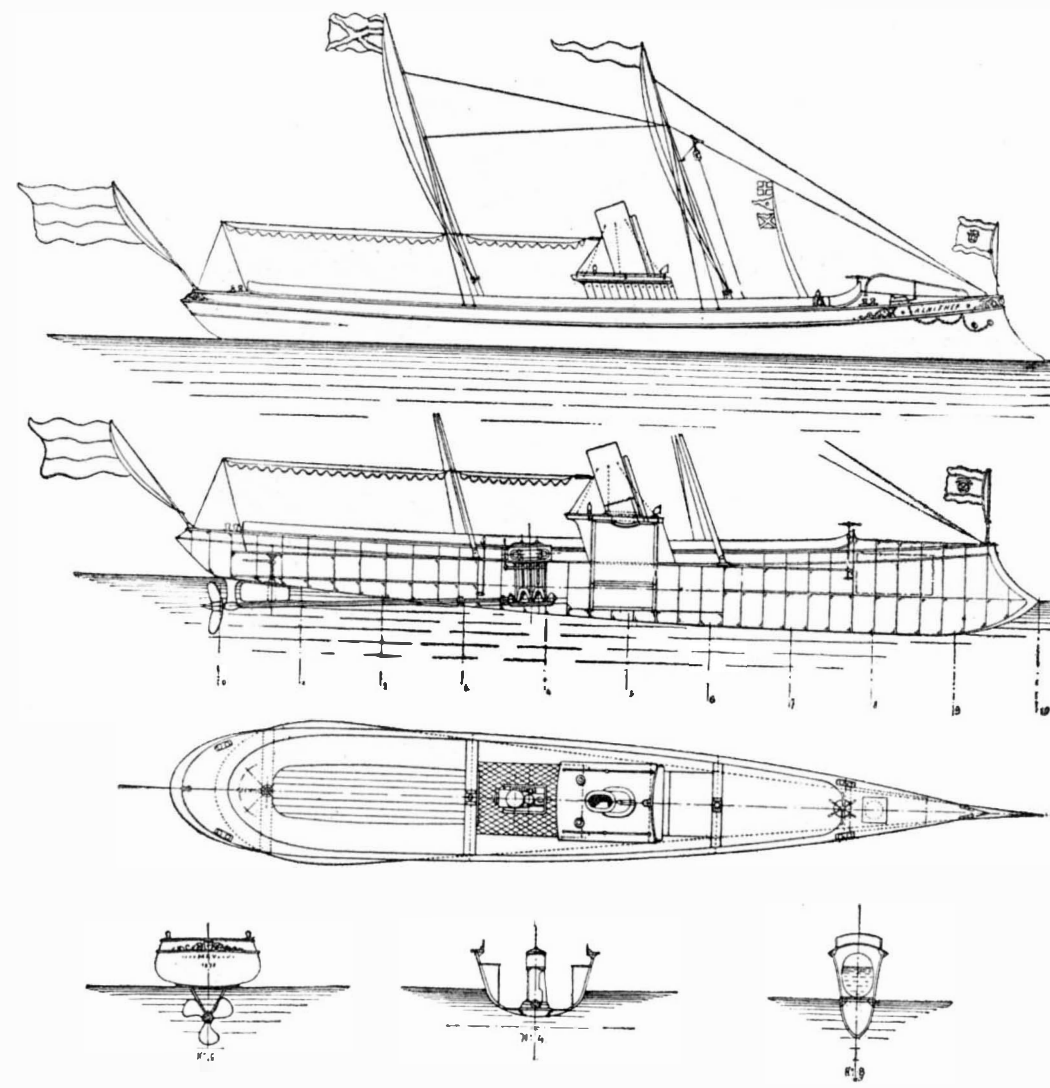
In certain cases it may be impossible to make use of oxygen, but nothing is easier than to remedy such an inconvenience. For so doing, chlorate and nitrate of potash are mixed in the proportion of 3 parts of the former to 1 of the latter, the mixture is put into the crucible with the powdered coal, and the whole is ignited when the receptacle is placed in the water of the calorimeter. The combustion then proceeds in a visible manner under the eyes of the operator. In practice, the effects of radiation may be neglected, since, as temperature of the room, the mean temperature between the beginning and end of the experiment is taken.—Translated from La Nature for the Scientific American Supplement.

THE LAUNCH "MOGUNTIA" OF THE MAINZER RUDDER-VEREIN.

The vessel is built of galvanized mild steel, and measures 11 meters (36 feet) over all; 2.1 meters (6.8 feet) beam. The maximum draft of the vessel is to be found forward, and measures 0.5 meter (1.6 feet). At the stern, where the greatest beam is to be found, the vessel lies absolutely flat upon the water. The submerged portion of the boat resembles in form that of an aquatic bird, and not of a fish.

The displacement of the "Moguntia," completely equipped, when the boilers are filled and petroleum enough is stored for a journey of 12 hours, is 3.8 tons.

The builders of the vessel, Escher-Wyss & Co., of Zürich, guarantee a speed of 20 to 21 kilometers per hour (12.42 to 13 miles). During the trial trips, not only was this guaranteed speed maintained, but far exceeded; for the launch in a one hour's endurance run made 24.7 kilometers (13.4 knots). With forced draft in deep water, the maximum speed of 26 kilometers (14 knots) was attained. The attainment of the guaranteed speed was a matter of no little importance to the Mainzer Rudder-Verein (Mainzer Boat Club), since the vessel was to be used in the shallow waters of the Rhine and the narrow channel of the Main (where the boat club has its still-water training course). When forcing the engine, it was necessary for the launch to be capable of following the fastest eight-oared shell. The club, in imposing its conditions laid particular stress upon the fact that the launch should not only be adapted for the purpose of training crews, but also that it should not unnecessarily agitate the water; that it should be stable and seaworthy; that it should be capable of so readily obeying its helm that it could be turned in the narrow Main channel without the use of boat hooks and the like. The training of crews necessitates a constant change of speed. It was necessary, therefore, that the vessel should be not only frequently stopped and often propelled very slowly, but be also capable of towing a shell with the utmost care. The boat club consequently required variability in speed and the ability to reach full speed with the utmost rapidity after each stoppage. These rigorous requirements prohibited the use of an explosion motor of the automobile type. Since in training crews it is of particular importance that the coach should be able to act independently of the crew, and to control the entire launch and its motor with one hand, the further condition was imposed that the motor and its controlling mechanism should be of the simplest possible construction. In selecting a motor, it was necessary to consider the fact that little or no noise should be produced either in starting or stopping the boat, so as not to interfere with the giving of commands. For this reason automobile explosion engines could not be used.



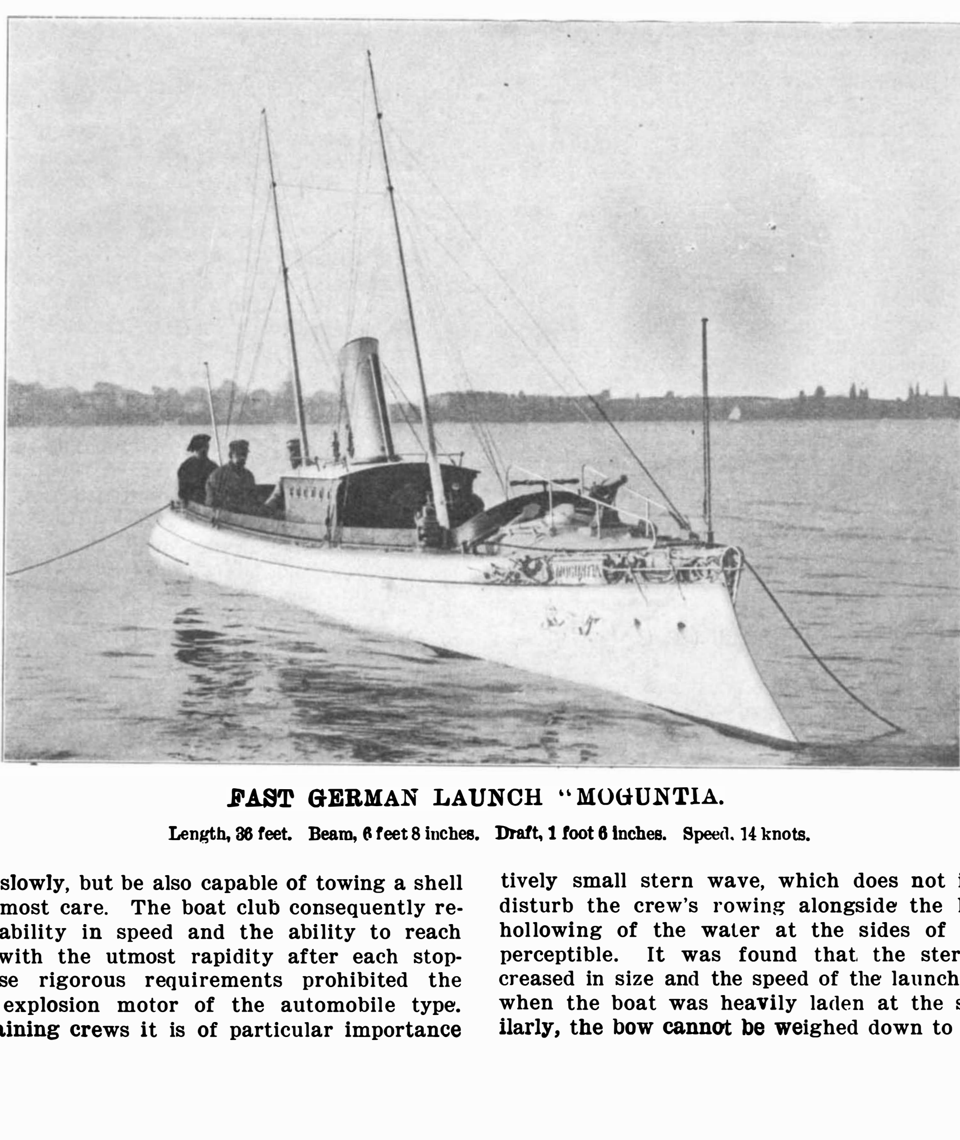
FAST GERMAN LAUNCH DESIGNED ON NEW "TETRAHEDRAL" LINES.

It was furthermore stipulated that at full speed, with four men on board, the launch should not draw more than 3 feet. After much corresponding with boat-building firms in every country of Europe, the boat club was about to give up the problem, when the new construction of Naval Constructor Kretschmer was brought to their attention. After examining plans which were prepared in accordance with his tetrahedral construction, the club decided to have a boat built of this type.

The boat fully met all expectations. Driven at full speed, no great bow wave is formed, but only a relatively small stern wave, which does not in the least disturb the crew's rowing alongside the launch. No hollowing of the water at the sides of the boat is perceptible. It was found that the stern wave increased in size and the speed of the launch diminished when the boat was heavily laden at the stern. Similarly, the bow cannot be weighed down to any extent; otherwise, the boat ships water over the bow and refuses to obey her rudder. The same phenomena are to be observed in all launches, but the tetrahedral forms seem to be particularly sensitive in this respect. The waterline of the boat is absolutely straight, and the bow angle at the waterline is twice as sharp as that of a boat of equal length and beam of prismatic plan. The sharp angles of the waterline and the fact that the waterlines are straight for the entire length of the boat may be regarded as the cause of the inappreciable wave formation, since the currents are not subjected to a constant change in direction as in ordinary boats. The flat, broad stern formation enables the water to reach the propellers unobstructed in quantity. The launch can be completely turned end for end in a circle of about two boat-lengths. It can be driven astern, and obeys its helm as well as a paddle boat. Screw-driven boats, as a general rule, swerve from their course when the engines are reversed. Despite the great sharpness of the lines, the boat has a greater beam than vessels of like sharpness, built on ordinary lines, and hence a greater superficial area above water. From this it follows that the launch has an almost unprecedented stability. As a result of this great stability, a liberal above-water hull and broad, comfortable seats are provided for passengers.

In order that the boat might have sufficient lateral support under the energetic action of the rudder when turned at full speed, the hull above water, at the greatest beam, which is at the stern, was provided with a large reserve displacement. This marked outward extension of the form of the stern over the waterline prevents the ship from sinking too much when forced draft is used. It was not necessary to provide fins in order to secure lateral stability in turning.

The broad, flat stern of the tetrahedral boat renders it particularly necessary that the designer should calculate the center of gravity with nicety, in order that the vessel may preserve her proper trim. The ordinary boat can be easily trimmed by shifting ballast, and runs quite smoothly, even though it be not in absolutely proper trim. The tetrahedral boat, on the contrary, cannot be so readily trimmed, and is at a marked disadvantage if its trim be not properly preserved.



FAST GERMAN LAUNCH "MOGUNTIA.

Length, 36 feet. Beam, 6 feet 8 inches. Draft, 1 foot 6 inches. Speed, 14 knots.

FRENCH AUTOMOBILE RAILROAD.

As of interest to American inventors, United States Consul B. H. Ridgely, of Nantes, France, sends the following translation of an article which recently appeared in the columns of L'Illustration descriptive of a French "automobile railroad:"

One of the most striking novelties of the automobile salon is the road train of continuous propulsion of Col. Ch. Renard, director of the Park Aerostatique de Chalais-Meudon. This train is designed to transport passengers and merchandise at a moderate speed. Up to the present, automobilism has been, above all, synonymous of speed. Each manufacturer has bent his every effort to construct a type more rapid than his competitors. As to vehicles destined to carry heavy loads at slow speeds; these have disappeared from the eyes of the public before the greater number of rapid carriages. If this means of transportation which re-

sponds to real needs has not been more fully developed, it is largely due to divers difficulties of a technical order. There are two ways of solving the problem—either to use isolated vehicles, or to hitch a locomotive tractor to a train of coaches or wagons. The first solution is evidently the most expensive, since it exacts a motor for each vehicle and a machinist to conduct it, besides it only permits of transporting a relatively light load, unless the vehicles are made of weight and dimensions too great to be practical. As to road trains, they have encountered grave difficulties.

In this train there is, so to speak, no tractor. One of the carriages, the head one, is furnished with a motor—steam or gasoline—sufficiently powerful to draw the entire train at the desired speed. The power engendered by the motor is distributed to all of the vehicles of the train, and each one of them is provided with an arrangement by the aid of which the energy that is due to it is employed to work a pair of wheels, so that each carriage is a "motrice" to the same degree as the first, with the difference that the first is at the same time a "factory of energy."

Each carriage works itself with the same facility as an isolated automobile. The adherence is therefore no longer due to the weight of the tractor, but to the weight of the entire train. One can thus make the tractor as light as an ordinary carriage and hitch it to as many carriages as desired without fearing the least slipping. The automobile at the head of the train, provided with a gasoline motor of 50 horse power, weighs only 1½ tons, and it suffices to furnish the necessary energy to draw a mixed train—passenger and merchandise—formed of seven or eight light vehicles, carrying a load of 10 tons, at the rate of about 12 miles an hour. The method of transmission of the energy from the motors to the divers carriages is purely mechanical. It consists of a longitudinal shaft running from one end of the train to the other. This shaft is jointed in a manner to permit the train to follow the most complicated curves.

The parts uniting the different carriages are easily uncoupled to permit the separation or reunion of the carriages at will. Under each carriage there are cogs which transmit the rotary movement of the shaft to an arrangement similar to that used in automobiles and working one pair of wheels. All of this obeys the manipulation of one machinist on the locomotive carriage at the head of the train. To conduct such a train involves no more difficulty than that of running an ordinary automobile. The second principle applied by Colonel Renard is that of "correct turning." It consists of a special disposition by means of which each carriage of the train follows exactly the track of the preceding one.

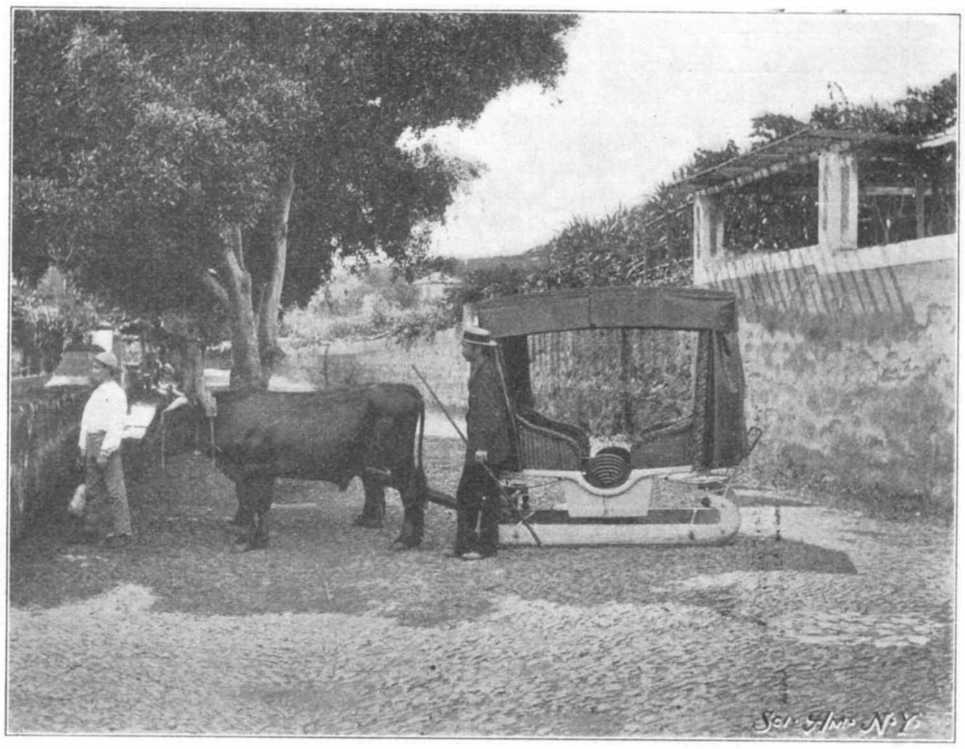
The automobile train furnishes a practical solution of industrial transportation over interior roads and highways. It will, in many cases, do the services of railroads in regions not yet reached by railway or tramway lines. It is, in short, a tramway without rails and opens up a great prospect of practical possibilities in the field of transportation.

TOBOGGANING IN A BASKET.*

By LAURA B. STARR.

IMAGINE, if you can, a large willow basket 4 x 6 feet, fitted with two seats facing each other, shaded by an awning-top and curtains on all sides, set on low wooden runners, and drawn by two huge bullocks, and you have the "carro," or Madeira bullock cart, which carries you up and down the hills over the bare pebble stones with far more comfort than one would at first suppose.

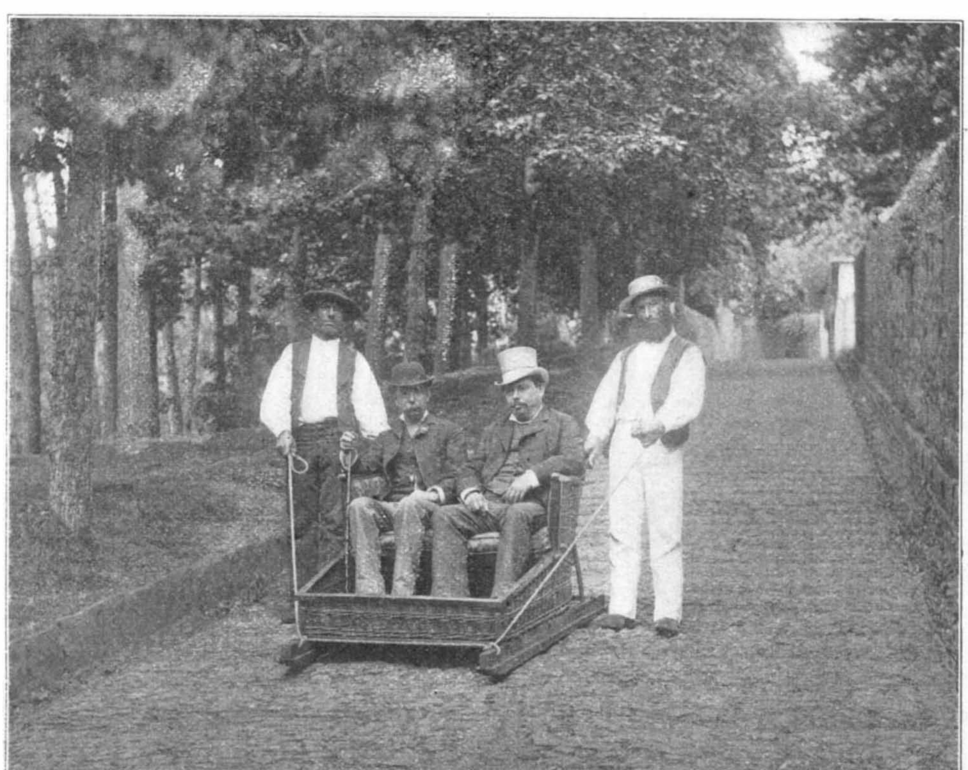
The streets of Funchal are paved, to use the words of another, with "rounded pebbles of basalt brought from the beach." In front of the house doors and in garden paths this black pavement is often diapered with limestone pebbles brought from Porto Santo, a neighboring village. The natives seem not to mind these "kidney" pavements, and skip over them as rapidly and easily as we move over smooth flagging, but they travel barefoot, or else wear a queer sort of top boot made of light-colored soft leather dressed like chamois skin. These boots, which are worn by men and women, have very pliable soles, which give to the shape of the feet and make walking over the stones less a labor and a pain.



A MADEIRA BULLOCK CART.

The bullocks have thongs of leather tied into the tip of each horn, by means of which a small boy leads them in the way they should go. The driver walks beside the "carro," and shouts to the bullocks in a voice that wakens all the echoes of the hillsides. He opens his mouth, and sends forth a volume of sound which the initiated translate into "Ca-para-mim-boi-ca-ca-ôa" ("Come to me, oxen, come, come, come").

Occasionally a halt is made, and the driver surreptitiously lays a "greased rag" underneath the runners one by one; he takes care that there isn't a "bobby" in sight when he does this, for there is a law prohibiting the use of the "trapo," as it makes the stones as smooth and slippery as glass, rendering foot traffic almost impossible; but the drivers say that if they didn't use the "trapo" now and again, their "carros" would take fire from the constant friction. To add to the roughness of the streets, all the steepest places are paved in ridges like corduroy, so that one is never certain as to how or where to plant his footsteps.



A BASKET TOBOGGAN CHAIR.

But the real tobogganing is done when you pay a visit to the Church of our Lady of the Mountain, a great domed building which rests in a crevice in the mountain side about 1,900 feet above the level of the sea. The ascent is made by a funicular railway, which makes the return journey every hour. The train travels rather slowly, so that one has time to see a bit of the landscape on the hillside. At the foot of the sixty-five steps which lead up to the church door is the sledge station, and here the fun begins.

A wickerwork chair with broad seat for two is mounted as a sledge, and used only to come down the mountain steps, never on the level. These "carros," as they are also called, are propelled or guided by two men, who push with one foot behind when the sledge needs an impetus, and who stand immovable on the rear runners as the basket-chair sweeps down the steeper declivities.

The sledge is steered by a rope which is fastened in front, one end being carried back on either side to the men, who by pulling one way or the other guide the little bark as occasion requires. It is a curious sensation to find yourself whisked over the roughly-paved slippery road at the rate of twenty miles or more an hour; and one is apt to breathe a little quickly at the sharp turns the car makes while going at this breakneck speed, still it is a delightful mode of traveling, and I for one should enjoy a much longer trip if it were possible; one feels as if he were running a race with time, and almost winning it, too.

The hammock, or *ride*, is another curious conveyance peculiar to Madeira and the Canaries. It consists of a long piece of stout linen of native manufacture attached to each end of a strong bamboo pole; it is carried on the shoulders of two men after the manner of the Sedan chair and *kagos* in China and Japan. Only two bearers can be used at a time; for journeys of any length a relay of fresh men always accompany the hammock.

Invalids and delicate people find the hammock a most convenient and comfortable conveyance, though occasionally some one complains that the swinging motion is conducive to a feeling akin to seasickness. The hammock is fitted with a hood which shelters the head, and there are curtains on either side and a mattress cushion. The brown linen is sometimes trimmed with bands of colored striped goods, which give them a very gay appearance. The burden bearers as a rule wear a uniform of white linen, spotlessly clean, and a broad sash of blue. The hammocks are used for mountain trips and other long and difficult excursions, as the bearers are able to make their way where the clumsy bullocks could not find a passage. The old-fashioned palanquin, which was the favorite conveyance in former times, is seldom or never seen nowadays.

ON THE HEAT GIVEN OFF FROM RADIUM.

PROF. P. CURIE and A. Laborde some time ago observed that radium chloride would give off continually amounts of heat as high as about 100 gramme calories per second and per gramme of pure radium. In a note recently read before the Berlin Academy of Sciences, Prof. C. Runge and J. Precht tried to ascertain whether the kinetic energy of the electrically-charged particles which are projected from the radium salts is a quantity of the same order of magnitude. To this effect, the authors repeated the experiments of the two French experimenters, comparing the amount of heat given off by the radium salt with the heat given off from a small platinum spiral traversed by an electric current. On the other hand, having inclosed the sources of heat in a lead capsule, the walls of which were about 3 millimeters in thickness, they once more compared the amounts of heat. The results thus obtained go to confirm the experiments of Curie and Laborde, showing on the other hand that the kinetic energy of the particles positively and negatively charged and projected from the radium, as far as they are stopped by the lead walls, is only a small fraction of a total heat evolved by the radium. On account of the noticeable absorption which all the effects of ra-

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

dium will undergo under the action of lead walls, it is safe to state that by far the greater part of the particles projected is arrested by the lead capsule.

In order to show how it is possible that a substance should continually give off such high amounts of energy, the author draws attention to the laws of electrolysis, whence may be inferred the rather considerable magnitude of the forces of attraction and repulsion as acting between the electrically charged atoms and electrons.—A. G.

SCIENCE NOTES.

Dr. H R. Mill, of London, before the British Association, dealt with some difficulties experienced in the preparation of the rainfall charts for the United Kingdom which he exhibited. Many observers were wanted. The organization installed by the late Mr. Symons had splendidly developed, and they had now over four thousand, mostly voluntary, observers, of which 300 might change every year. The records extended over thirty and more years, but in some parts, especially in the north, they had very few gages. To arrive at average mean rainfalls over large areas, they had to allow for the different distribution of the stations, for the different lengths of the records, and the configuration of the country. It was very difficult to determine the average fall for any particular day; in that case the hours of readings and the methods of entering had to be considered, in addition to other points. When averages for the whole year were computed, some of those difficulties became less serious; but the unequal lengths of the periods of observation, and the absence of raingages in certain districts, made the results uncertain. There were such gaps in Wales, and, though he understood the prejudice against piling up data, we wanted more information. Collective continuity helped us over inaccuracies. Dr. Mill suggested several methods, including composite photography, for compiling his new maps, and it was the methods which he hoped to have discussed.

Prof. R. A. Sampson, F.R.S., of Durham, before the British Association, dealt with one of our celestial timekeepers. We had so far only the moon, he said, which had a very complex theory; the eclipses of the Jupiter satellites should give us another check. The Greenwich and Paris eclipse data differed by as much as ten seconds, however, and that might be due to faulty tables or faulty theories. It was known that the eccentricity of the third satellite of Jupiter was variable, owing to disturbances by the fourth satellite. That did not suffice to explain the discrepancies between the tables of Delambres and Damoiseau, which affected all the satellites. Taking first the Harvard records of photometric observations, Prof. Sampson found longitude values which differed from both tables. He then took the ordinary observations of 360 disappearances and 304 reappearances made during the last sixty years, with very different instruments of different reliability. Eliminating manifestly doubtful data, he finally confirmed his first figures. It would therefore result that there was a fault in the theory. It had been assumed that the satellite would suddenly disappear when its center came into line with the sun and the shadow of Jupiter. But there was really a gradual diminution of light; hence the discrepancies as to the moment of obscuration. He would recommend photometrical observations of the reduction of brightness with the aid of a wedge photometer, which was less complicated than Pickering's method; the wedge photometer obscurations checked one another. It is, perhaps, not uninteresting to mention that there were in the reception-room two pictures of the first observation of a Venus transit, taken by the Rev. J. Horrox, of Much Hoole, near Southport, in 1639.

W. R. Dunstan publishes a summary of the present results of an unfinished inquiry into the reactions involved in the rusting of iron. While both liquid water and oxygen are necessary for the formation of rust, the presence of carbonic acid is not essential, although it may accelerate the action. The well-known effect of alkalies and alkaline salts in preventing oxidation of iron has been hitherto attributed to the withdrawal of the carbonic acid. It has been found, however, that the phenomenon is not due to this cause, but to the establishment of conditions in which the production of hydrogen peroxide is inhibited. When highly purified iron, containing mere traces of impurity, is left in contact with dry gases (oxygen, carbon dioxide, mixtures of oxygen and carbon dioxide), rusting does not take place. In the presence of the same gases and water vapor, no rusting occurs so long as a constant temperature (34 deg. in the actual experiments) is maintained, but if the temperature is allowed to fluctuate, liquid water condenses on the surface of the iron and rust is produced. It is thus shown that pure iron is not oxidized in presence of gases and water vapor only, but that the presence of liquid water is necessary for rusting to take place. In another series of experiments, pieces of iron were left in contact with water saturated with a particular gas and with an atmosphere of the same gas above the solution. When hydrogen, carbon dioxide, or nitrogen which had been carefully freed from oxygen was employed, rusting did not occur, but if oxygen or a mixture of oxygen and carbon dioxide was used, oxidation took place. From these results, it is evident that for the formation of rust both oxygen and liquid water are required. In the experiments in which a mixture of oxygen and carbon dioxide was used, the results observed indicated that in this case a secondary action proceeds simultaneously.—Proc. Chem. Soc.

ELECTRICAL NOTES.

According to the Electrical Review, the development of water power for electro-chemical and electro-metallurgical purposes has made more progress recently in Italy than in any other country in Europe. Since 1897 eleven electro-chemical companies have been organized, with a total capitalization of $6,000,000. French and German capital is largely interested in these ventures. The Italian Electro-chemical Company owns two water power concessions in the southern provinces; one at Bussi, on the river Ticino, is rated at 6,000 horse power, and the other, on the Pescara River, at 38,000 horse power. Caustic alkalies and bleach are produced. Owing to insufficient capital the company has become involved in financial difficulties, and it has been necessary to write down the original value of the shares by 40 per cent, and to issue a large amount of new stock. It is believed by competent authorities that with proper attention to the technical and financial sides of the business the ventures will eventually prove successful.

The Indian Textile Journal, in describing the electric plant at Calcutta, says it is the best electric supply system in Asia. The total output of the generating station is over 2,400 kilowatts, the largest set being rated at 713 kilowatts at 550 volts. There are two of these at present installed, besides six other sets of smaller dimensions, and they are stated to be the largest in the East. They consist of Belliss and Willans engines direct connected to the generators. The distributing mains, of which there are 23, are laid underground, there being 80 miles of cable. The three-wire system has been adopted. There is apparently a good power load, as the station operates night and day, with three shifts of attendants. The charge for electrical energy varies for lighting from 8d. to 3¼d. per kilowatt-hour. For power, the rate varies from 4d. to 2d. It may be added that, in spite of the conservatism of the natives, the use of electric lighting and electrical power in Calcutta is on the increase.

The Western Electrician illustrates an ingenious modification of the expulsion-type fuse. The fuse proper is contained in a hollow insulating tube of fiber in the middle of the insulating handle. The fuse, made of an alloy of metal, is short, and is connected by copper wires to the base of the knife contacts on each end of the handle, and fastened there by a screw. The blades at the ends are made to slide into contacts similar to the ordinary knife switch contact, which in turn are mounted on binding posts extending through the switch mounting and forming terminals on the other side for the attachment of the leads. Lignum vitæ is used to insulate the contacts and binding posts, and there are no exposed parts to come in contact with the hands. The safety feature of the fuse lies in the fact that it is impossible for the attendant, when making an examination or putting in a new fuse, to pull both of the blades from the contacts at the same time before the current is turned off.

Before the American Institute of Electrical Engineers at the end of last month, Mr. A. H. Armstrong described in detail the construction of a graphic recording ammeter for use on electrical cars. It seems that a dynamometer construction is employed, in which the current to be measured is carried by the fixed element, and the moving element carries a constant current supplied preferably by a small storage battery. The moving coil is a small rectangle made up of several turns of wire, surrounding an iron core of cylindrical shape, carrying about one ampere. This coil and core are inclosed in the fixed coils. The moving coil is suspended by a control spring, and held in position by this spring at the top and by a small steel shaft at the bottom. The bottom bearing is so made that when in use the moving system hangs freely from the control spring, but its vertical motion is so limited that any excessive vibration cannot damage the instrument. Current is led into and out of the moving coil by two spiral conductors of negligible elasticity in comparison with the control spring. The latter is adjustable by changing its length. The ampere-turns in the fixed coil of the ammeter are about 2,400, the ampere-turns in the moving coil about 80, and by this combination a torque at the end of the scale of about 200 gramme-centimeters is secured. This is from 80 to 200 times the torque usually employed in measuring instruments in which the indications of a pointer on a scale are observed, and from three to fifteen times that employed in the usual integrating or curve-drawing instruments. With this high torque, the friction due to the pen moving over the paper is practically negligible. The pen used consists of a capillary tube supplied by a siphon filled from an ink reservoir carried some distance from the recording point toward the axis of the instrument. In testing with such instruments it is usual to employ at least two, an ammeter and a voltmeter, and in order that the line can be accurately marked on the paper, a time-marking clock is employed. It is thus possible to obtain simultaneous readings by the instruments placed upon different cars in a train, a valuable feature where the different cars are each equipped with their own motive power. The recording instrument in this service is estimated to replace the labors of several men required by the old method of two-second readings, and gives results of greater accuracy. The following general data with which the author concludes the paper are of considerable interest: Length, 32½ inches; width, 13½ inches; height, 11¼ inches; approximate weight, 100 pounds; torque of ammeter, 210 gramme-centimeters (full scale 24 deg.); torque of voltmeter, 200 gramme-centimeters; period, 0.33 second for complete cycle; ampere-turns in fixed coil ammeter, 2,400; ampere-turns in fixed coil of voltmeter, 950; ampere-turns in moving coil of ammeter, 80; ampere-turns in moving coil of voltmeter, 189; watts consumed in moving coil of ammeter, 1; watts consumed in moving coil of voltmeter, 3.3; watts consumed in fixed coil of ammeter, 130; watts consumed in fixed coil of voltmeter, 33.

ENGINEERING NOTES.

A turbine operated with gas-engine exhaust is described in Mech. Eng. The turbine consists of a pair of disks, the one fixed and the other revolvable, the latter having a single ring of semicircular, under-cut pockets; the fixed disk is secured against the machined face of an intermediate casting provided with a saddle adapted to bear upon the heat-conducting ribs of an internal-combustion engine. The engine's piston is arranged to overrun a port admitting the exhaust gases to passages in the intermediate casting, and thence to the pockets in the revolvable disk. From these pockets the gases pass to an intermediate chamber, and then through an exhaust passage to the atmosphere. The circumference of the rotating disk is provided with ventilating vanes suitably located to cause a suction of air, through specially arranged annular apertures, to the cooling jacket of the cylinder. The description is accompanied by illustrations.

A coke-drawing machine has been invented by Mr. John A. Hebb, who conceived the idea of drawing coke by machinery in 1894. At that time he built a wooden model which he showed to one of the most prominent coke men in the Connellsville field; but the model was in such a crude form that it failed to impress this party favorably. Undaunted by this discouragement, Mr. Hebb proceeded to revise his model to meet the criticism made against it, and the first trial of the new machine was made at the Stewart mines, near Uniontown, Pa., in the summer of 1900. However, his machine failed to do its work satisfactorily, and he at once applied himself to remedy the defects which presented themselves. The next test was made at Smock, Pa., in the fall of 1900; this trial was fairly successful, about twenty ovens being drawn at Smock. Then the machine was broken up, remodeled, and rebuilt, and taken to Brownfield, in September, 1901. This last machine was much larger than the one tried at Smock, while the friction was not increased sufficiently to correspond with the weight and strength of the machine. It was not as successful as anticipated and the machine was remodeled, after which it was taken to the Oliver plant of the Oliver & Snyder Steel Co., in the spring of 1902. The best time made in drawing the coke from an oven with a 32-inch door at this plant was 28 minutes; and with a 40-inch door, 18 minutes. It was then decided to rebuild and remodel the machine, and a 9-ton or 10-ton machine was built and taken to the Continental No. 1 plant of the Frick Company in the spring of 1903. It was operated by electricity. Several of the Frick ovens were provided with a 40-inch door, so that the machine could be thoroughly tested; and a record was made on September 19, 1903, when three ovens were drawn in 38 minutes. —Mines and Minerals.

The Simplon tunnel, when completed, says Engineering Record, will have a length of about 12.3 miles, and the heading from the Swiss side has been advanced 5 miles. In order to secure an adequate supply of air to the men working at the face, two parallel tunnels about 50 feet apart had to be driven, the ultimate intention being to have one for the "up" and the other for the "down" traffic, but for the present, one bore will easily carry it, so that only one (No. 1) tunnel is now being completed. These two parallel tunnels are connected by cross-passages every 200 meters, though, as the heading advances, only the nearest cross-cut to the face is kept open. In No. 2 tunnel, that is, the tunnel not at present being completed, all the water pressure and air pipes are situated; it also carries the water flowing from the face of both tunnels. In advancing the heading, No. 1 tunnel is kept ahead of No. 2, so there is always a dead end beyond the nearest cross-cut to be ventilated. This ventilation is secured by laying a 14-inch pipe from the cross-cut air-current to the face, and using a high-pressure water injector, directed into the ventilation pipe, to force or induce air right into the face. The tunnel headings have an area of about 8 square meters, that is, about 7.5 by 10.5 feet, and at the time of my visit the rock through which they were advancing was *antigoro* gneiss. This rock, though very hard in places, is much split up and breaks easily; so much so, that in the face ten holes suffice for a round. A two-hole cut is sufficient, and the remaining holes are arranged symmetrically around the cut holes. Each hole is charged with 2 kilogrammes, or 4.48 pounds, of blasting gelatine, which is practically the same in composition as the explosives in use on the Rand. The actual work of drilling is performed by a set of three Brandt hydraulic drills, mounted on a horizontal hydraulic rack bar 12 inches in diameter, which is carried at the end of a pivoted lever, mounted on a four-wheeled lorry. By this arrangement the complete fixing, drills and rack bar, can be run into position, the rack bar set at any convenient height across the tunnel and parallel to the face, and the latter firmly fixed in place, after attaching the valve of the rack bar to the pressure pipe and placing wood blocks at each end of the bar, by simply opening a valve.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Products in Liege.—Liege stands to-day as one of the greatest industrial cities in Europe, and, while world-renowned for the quality of its firearms and gun barrels, has entered into the steel export trade and is placing orders for steel rails and structural bridge material not only in the United States, but in Cuba, Porto Rico, and the Philippines. There seems to be a general increase in the output of all manufactories in Liege, and I am told by business men that the outlook for a steady and substantial increase in all branches of trade is very good.

While Liege industrials have established a market in the United States for their products, I note a reciprocal feeling here toward American goods. The demand for American goods can frequently be heard, but it is impossible to locate such goods here to any great extent. Whether the scarcity of American goods comes from the antipathy of the local business men or the indifference of American manufacturers I am unable to say. Some of the business men inform me that the fault lies with the American exporter. Many American houses have their resident export agents in London and the goods are distributed from that point, but only when the merchant himself looks them up. It is a rare thing to see a representative of an American house in Liege, the business and wealth of which should command the attention of any firm desiring trade, it matters not how extensive it may be.

The catalogue system of advertising does not in any sense appeal to the merchant here. The buyer wants to see the goods in bulk or large sample, to examine the fabric and texture, and to listen to the arguments of the American drummer. While on the subject of advertising, I will say that the American tourist is unconsciously a drummer for American products. His patriotism induces a system of contrast and comparison decidedly in favor of his home manufactures. This disposition of the American traveler is oftentimes productive of much good, and while the foreigner receives these laudatory exclamations with astonishment, nevertheless his curiosity causes him to investigate, with the result that he finds the articles as proclaimed by the traveler.

I believe that arrangement whereby American goods could be exposed in foreign markets, extending all facilities for minute examination, would fully justify any expense. Only yesterday a thrashing machine of German make was being exhibited before one of the largest cafés in Liege, and at a time when the place was filled with people from the country, the occasion being bourse day. The machine was taken through various streets and the merits of the same were being explained by a demonstrator.

It is readily conceded by all that American farm implements and machinery are superior to those of German or English manufacture, but I am informed that Liege has no representative of American farm machinery.

English and German manufacturers have captured the markets of Liege as far as commodities are concerned.—James C. McNally, Consul at Liege, Belgium.

How to Build up American Trade in Russia.*—Warsaw is said to be the gateway for the introduction of foreign manufactures into Russia. Conditions here are favorable to the introduction of foreign goods, not only on account of the location geographically, with all the attendant facilities for shipment, but more particularly because of a deep prejudice against German manufactures which exists to the extent of almost a boycott of all German articles. The French, British, and Austrian manufacturers have been able to take advantage of this, and their salesmen cover this territory frequently and with success.

The American representative, except in the interest of the agricultural-implement manufacturer, is a rarity. In general, the American manufacturer seems to think the ground covered when he has appointed a general agent for the whole of Europe, and this agent, at least so far as Russia is concerned, is usually located in some great German city. I firmly believe that the time has come when, to satisfactorily increase our trade in Russia, local agents must be maintained and personal representation secured where possible.

In the main, credits may be said to be good, and yet here again is where personal representation is of service. That the Russian general agent of a foreign manufacturer, except in the case of goods destined for the Siberian market, should be located here in Warsaw is a point conceded.

Of the increase or decrease of trade in the principal articles in which Americans are interested it is impossible to obtain figures, as the only statistics published (which appear two or three years after date) do not show which of the goods passing through the thirteen custom houses situated in the district are merely in transit to or from other parts of the empire.

Agricultural implements.—American interests are chiefly centered here in the agricultural-implement field, and with the exception of motors and thrashing machines—with Germany second—we practically control the trade, which is ever on the increase.

Typewriters.—Typewriters are sold here, but at figures which prevent general adoption.

Other American goods are on the market here, but for the most part they are imperfectly introduced or reach this trade through Hamburg and Berlin commission houses.

Any and all of the following articles could be either increased in sale or introduced with profit, viz.: Wringers, meat choppers, hair clippers, mechanics' tools of all kinds, cotton and cotton waste, rubber shoes, machine tools, and all labor-saving devices. The latter would find a particularly responsive market at Lodz, the "Manchester of Russia," where are located numerous woolen, linen, and cotton mills whose owners are alive to every opportunity and who are progressive in every sense.

Any improvement in machinery would be accorded a careful and intelligent investigation and the American manufacturer should make the attempt to reach these people. In fact, there is hardly a line produced by the inventive American manufacturer which cannot, with effort and regard for local needs, be brought to profitable sales.—Clarence Rice Slocum, Consul at Warsaw, Russia.

* Extract from Consul Slocum's annual report on the trade and commerce of his district for 1902.

American Products in Switzerland.—Fruit.—The imports of fresh fruit into Switzerland during the first six months of 1903 amounted to 3,329,480 pounds, valued at $88,650. This was in the dull season; the imports for the year will probably be three times as much. In these imports the United States had absolutely no share, the largest proportion coming from France, Germany, and Italy.

With dried fruits the United States has done better, for out of a total importation of 1,907,400 pounds it furnished about 21 per cent, but could certainly furnish much more if the business were properly organized.

Corn.—Switzerland imported 105,353 bushels, valued at $747,842. Of this amount the United States supplied only a little more than 8 per cent, while the Danubian Provinces furnished 43 per cent, Russia three times and La Plata over twice as much as the United States.

Flour.—Flour was imported to the amount of 30,552,940 pounds, valued at $497,000, of which the United States furnished only one-half of 1 per cent. France, Germany, and Russia have the bulk of the trade.

Cigars and Cigarettes.—The importation of cigars and cigarettes amounted to $200,000, of which the United States furnished 2½ per cent, the balance of the importations coming, in the order named, from Germany, Russia, the Netherlands, Turkey, and Egypt.

Horses.—There were 6,200 horses imported, valued at $833,997, or an average of $134.51 per head. Of this number not one is credited to the United States, Germany and France taking the bulk of the trade.

It would only require a little organization on the part of our breeders and dealers to find a good market in Switzerland for their horses. Let them write to the consular officers describing the character of the horses they offer and stating the price, landed at Basel (freight charges can be ascertained from any of the steamship companies); the consular officer will then make it his business to find reliable agents competent to furnish necessary information as to the kind and character of horse that would sell best in Switzerland.

Shoes.—Switzerland imported shoes valued at $400,000. Of this amount American manufacturers furnished a little over 3 per cent, the balance of the trade going to Germany, France, Austria-Hungary, and Italy. There is one trouble connected with the sale of American shoes which should be corrected. The American manufacturer, when he makes his contract with his foreign agent, should stipulate that he should not charge above a certain price for the article at retail. As it is now, every town in Switzerland has a different price, and I may say that every store in every town has a different price; this is not conducive to business.

Machinery and Tools.—In machinery and tools we rank next to Germany, which out of a total import of 1,563,760 pounds furnished 804,320 pounds, while the United States furnished 539,880 pounds. The total value of the machinery imported is given at $107,000.

Petroleum.—The importation of petroleum amounted to 64,675,160 pounds, of which the United States furnished 48,575,340 pounds. The total value of petroleum imported is given at $765,000.—Thomas Willing Peters, Consul-General at St. Gall, Switzerland.

American Goods in Honduras.—This district has experienced a great decrease in the volume of business, owing to the revolution in the early part of the year. The mercantile pursuits are nearly all in the control of Honduraneans, there being only a few foreigners (Germans) with large stores. The shipping of imports at the port of Amapala is entirely in the hands of Germans, who conduct all the great commission houses. Each one of these does a very profitable business.

We cannot expect to increase our market in this district until we can overcome the excessive entry expense at the ports, which compels merchants here to sell at prices which are beyond the reach of the common people. American goods are much sought for and their qualities duly recognized, but their prices are prohibitive to the large majority of the people, who are, in general, very poor. It will be readily granted that even in the United States there are few persons who could afford to buy flour at the rate of $3.25 per 50 pounds; the same holds true of other merchandise. Only the most inferior class of all kinds of merchandise can be sold cheap enough to reach the people. Under more favorable conditions a great market could be established here for American cotton fabrics and general merchandise. Our goods need no advertisement to sell—they are simply beyond the reach of most buyers; nor do the people of this district require peculiar widths or patterns. Implements and tools of all kinds used in manufacture or agriculture should find a ready sale, if properly brought to public notice—that is, by practical demonstration of their usefulness. American hardware and farm implements are not so well known as our other merchandise.—Alfred K. Moe, Consul at Tegucigalpa, Honduras.

Popularity of American Goods in England.—United States Consul F. B. Keene, of Florence, Italy, under date of October 17, 1903, sends a translation of part of an article which appeared October 17 in Il Corriere Italiano, one of the leading papers of Florence. The article is based upon a diagnosis of England's condition, by Mr. MacKenzie:

"Mr. MacKenzie, making a diagnosis of the ailment of his country, has written the following suggestive sentence:

"The Englishman in easy circumstances, on rising in the morning, shaves himself with Williams' soap, with a safety razor of Yankee make. He puts on North Carolina stockings and shoes from Boston, and throws over his shoulders suspenders from Connecticut. Into his pocket he puts a Waltham or Waterbury watch, and sits down to his 'dejeuner.' He congratulates his wife on having a corset from Illinois and a bodice that comes from Massachusetts. He eats bread made from American flour ground in the mills of the Great Lakes. He eats bacon from Kansas City and oysters from Baltimore, while his wife cuts a beef tongue from Chicago. And while eating his luncheon he reads his paper, printed by an American machine on American paper with American ink, and probably edited by some lively journalist from New York."

American Machinery in Canada.—I cannot secure from the customs officials the exact value or character of the goods imported into this (Moncton, New Brunswick) district, but find the majority of merchants carrying more or less of our goods, some of which, however, are not imported direct, but are purchased from wholesale houses at Montreal and Toronto. Among the goods imported direct I may mention boots and shoes, raw cotton, hardware for plumbing, millinery, cotton and rubber clothing, hats and caps, agricultural implements, oil-boring and mining machinery, etc. During the first five months of the present year the imports into Canada of this kind of machinery were valued at $478,303 ($451,391 non-dutiable and $26,904 dutiable), of which the imports from the United States amounted to $474,109 (free, $447,411; dutiable, $26,698), leaving for all other countries $2,343. The preferential tariff, it would seem, is not much of a stimulant to British trade in mining machinery, the imports therefrom amounting to only $1,851.—Gustave Beutelspacher, Consul, Moncton, Canada.

Advance in Brazil-United States Freight Rates.—The united steamship companies which control the carrying trade between the United States and Brazil—the Lamport & Holt Line, the Prince Line, the Robert M. Sloman Line, and the Chargeurs Reunis—have agreed to raise their rates on coffee from Santos and Rio de Janeiro from 30 cents and 5 per cent primage per bag of 133 pounds to 35 cents and 5 per cent. This rate will go into force in October, but as the cargoes for the steamships "Byron," "Catania," "Bellarden," and "Soldier Prince" have already been in large part purchased, these steamers, leaving in the early part of October, have been excepted from this tariff and will carry their cargoes at the old rate.—Eugene Seeger, Consul-General, Rio de Janeiro, Brazil.

Opportunity for American Investment.—United States Consul Neal McMillan, of Port Sarnia, Ontario, under date of October 7, 1903, says:

This country is not traversed by electric roads (trolleys) to the same extent as is the United States. An excellent opportunity, in my opinion, presents itself for some company to build a road from Port Sarnia to Beaches, on Lake Huron; from Beaches to Petrolia, an inland town of some 10,000 inhabitants; and thence back to Port Sarnia, passing through several villages and the best farming country in Canada. No grading is necessary and there are no streams to bridge. Such a line would be a paying investment.

Practical Introduction of American Machines.—As showing a tendency to accept any marked American improvement, even in conservative France, the proprietors of a paper plant at Rives, in the Isère, have recently contracted with an American inventor for the control of a patent covering a machine for the quicker and more economical drying of paper. The inventor, a practical engineer, has been on the ground explaining and proving the superiority of his machine—a method which seems to be the most successful for the introduction of new trade and even for the enlargement of trade already established. This same inventor has in a short time succeeded in disposing of the rights to manufacture his machine to special paper manufacturers in England, Germany, Holland, Sweden, Switzerland, Austria, and Russia.—C. F. H. Nason, Consul, Grenoble, France.

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Other Reports can be obtained by applying to the Department of Commerce and Lab r, Washington, D. C.

SELECTED FORMULÆ.

Casein Cement.—

Borax	5 parts
Water	95 parts
Casein, sufficient quantity.	

Dissolve the borax in water and incorporate enough casein to produce a mass of the proper consistency.—Drug. Circ.

Cement for Glassware.—"Jewelers' cement," also known as "diamond cement" for fine glass and china ware, is made according to the following formula: Isinglass, 1 ounce; water, 4 ounces; alcohol, 4 ounces; mastic, in tears, ½ ounce, dissolved in alcohol, 4 ounces; gum ammoniac, ¼ ounce. Soak the isinglass in the water for a few hours and stand in a warm place to hasten solution; then heat up, to evaporate all unabsorbed water. Keep the isinglass mucilage hot, so that it shall not set solid. Separately dissolve the mastic resin in the other 4 ounces of alcohol, to which add the gum ammoniac. When the two preparations are ready, add 4 ounces of alcohol to the hot isinglass mucilage, and mix that with the mastic varnish, and heat the whole until it liquefies, standing the vessel in a water bath. For use, it is remelted over a water bath and used hot.—Pharm. Era.

Kalsomine.—

Sodium carbonate	8 parts
Linseed oil	32 parts
Hot water	8 parts
White glue	12 parts
Whiting	160 parts

Dissolve the sodium carbonate in the hot water, add the oil and saponify by heating and agitation. Cover the glue, broken into small pieces, with cold water and let soak over night. In the morning pour the whole on a stout piece of stuff and let the residual water drain off, getting rid of as much as possible by slightly twisting the cloth. Throw the swelled glue into a capsule, put on the water bath and heat gently until it is melted. Now add the saponified oil and mix well; remove from the bath, and stir in the whiting a little at a time, adding hot water as it becomes necessary. When the whiting is all stirred in, continue adding hot water until a liquid is obtained that flows freely from the kalsomining brush.

The addition of a little soluble blue to the mixture increases the intensity of the white.—Drug Circ.

Liquid Soaps.—Liquid soaps, or, as they are sometimes called, soap essences, are made from pure olive-oil soap by dissolving it in alcohol and adding some potassium carbonate. Tallow or lard soaps cannot be used, as they will not make a transparent preparation. The soap is finely shaved and placed with the alcohol and potassium carbonate in a vessel over a water bath, the temperature slowly and gradually raised, while the mixture is kept in constant agitation by stirring. The soap should be of a pure white color and the alcohol gives the best product when it is about 80 per cent strength. After about three-fourths of an hour, to one hour, solution will be complete and a perfectly transparent article obtained. This can be scented as desired by adding the proper essential oil as soon as the mixture is removed from the water bath.

If an antiseptic soap is wanted the addition of a small amount of benzoic acid, formaldehyde, or corrosive sublimate will give the desired product. Liquid soaps should contain from 20 to 40 per cent of genuine white castile soap and about two to two and a quarter per cent of potassium carbonate.—Drug. Circ.

Composition of Various Washing Materials—The Zeitschrift für Untersuchung der Nahrungsmüttel gives the following:

Grosser's Washing Brick.	
Water	54 parts.
Sodium hydrate	38.21 parts.
Sodium biborate	6.61 parts.
Sodium silicate	1.70 parts.

Haenkel's Bleaching Solution.	
Water	36.15 parts.
Sodium hydrate	40.22 parts.
Sodium silicate	23.14 parts.
Residue (soap?)	0.48 part.

Luhn's Washing Extract.	
Water	34.50 parts.
Sodium hydrate	25.33 parts.
Soap	39.40 parts.
Residue (salt, silex, etc.)	0.77 part.

Menlo's Washing Powder.	
Water	38.09 parts.
Sodium hydrate	53.50 parts.
Soap	2.65 parts.
Sodium silicate	4.55 parts.
Impurities	1.30 parts.

Water Glass as a Cement.—When water glass (sodium or potassium silicate) is brought into contact with calcium chloride, a calcium silicate is at once formed which is insoluble in water. It seems possible that you might utilize this reaction in binding together masses of sand, etc. Whether the material could be successfully manipulated in this way we are unable to say. The process indicated has long been used in the preservation of stone which has become "weathered." The stone is first brushed with the water glass and afterward with a solution of calcium chloride. The conditions here are of course different.

Calcium chloride must not be confounded with the so-called "chloride of lime" which is a mixture of calcium hypochlorite and other bodies.—Drug. Circ.

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