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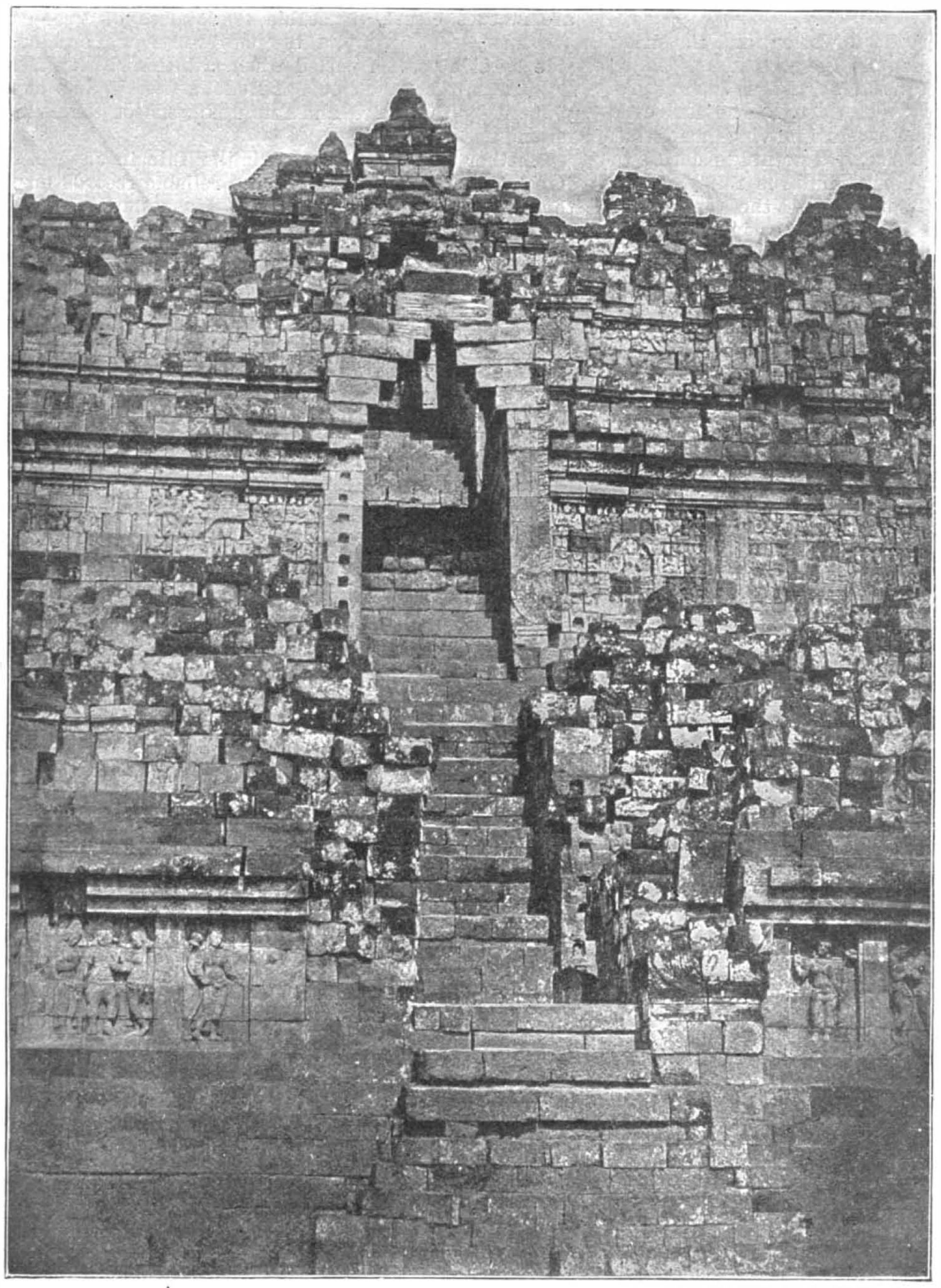
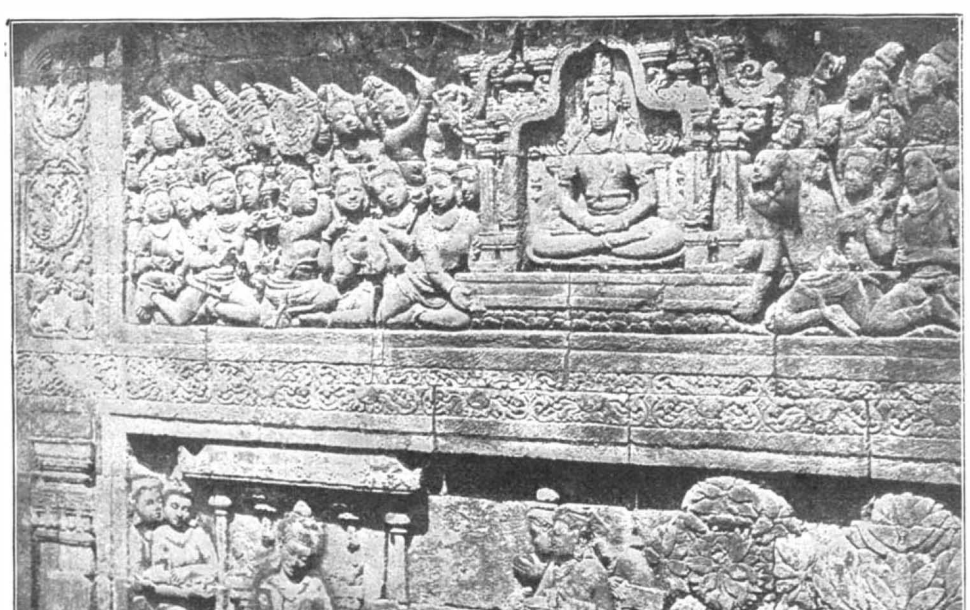


RUINS OF BORO BUDUR TEMPLE, JAVA.

GALLERIES IN THE TEMPLE OF BORO BUDUR.



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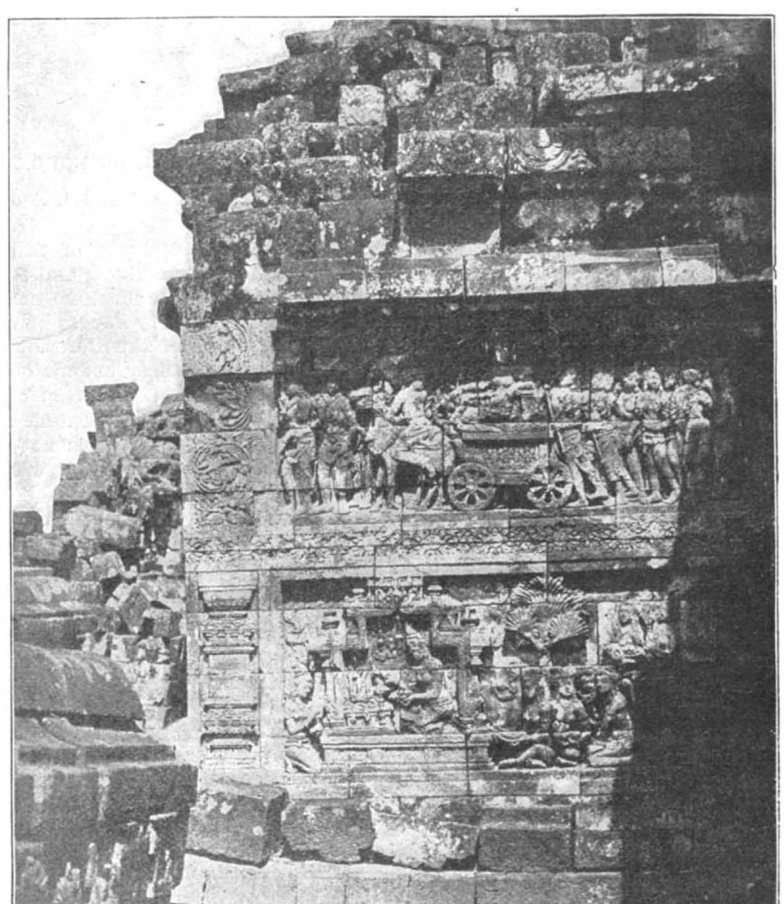


GALLERIES IN THE TEMPLE OF BORO BUDUR.

THE BORO BUDUR TEMPLE OF JAVA.

THE BORO BUDUR TEMPLE OF JAVA.*

By CLARENCE B. MOORE.

IT could doubtless be asserted with perfect truth that to the great majority of cultivated persons to whom the Acropolis, the Colosseum, and the Pyramids are almost household words, the name even of the wonderful lava temple in the heart of Java, the Boro Budur, is entirely unknown. Yet, perhaps in certain respects the Boro Budur fully equals any now-existing monument of bygone ages; and it is difficult to explain the general lack of information concerning it, except that travelers to Java rarely get beyond Batavia, or possibly Buitenzorg, and then hasten away to Singapore to continue the beaten track of the tourist. Moreover, it is almost as hard to obtain information of these ruins in Batavia as it would be in New York.

Batavia is an interesting town, mainly in that one can there best see the very free and easy customs and costumes of the East Indian Dutch. All over the houses and hotels, until time to prepare for dinner, 4 or 5 P. M., the women go about clad in camisoles of linen, with the sarong, or short skirt, reaching half way to the ankle, with stockingless feet thrust into slippers and hair hanging loosely down the back. The sarongs are of the most gaudy colors, and the wearers seem to vie with each other in selecting patterns striking and bizarre to the last degree, in which snakes, dragons and devils play a prominent part. The retail trade of Java is monopolized by the Chinese, and the hotel is haunted by these people, pack in hand.

From Batavia to Samarang is a two days' sail, and fortunate it is that the weather is usually calm, for those having a tendency toward seasickness and a consequent horror of tobacco smoke *pro tem.* would otherwise have a hard time. From morning to night, on deck, in the cabin and staterooms, the smoking goes on, a tumbler upside down serving as a rest for the cigar, while the smoker between puffs snatches time to masticate his food. On deck a long piece of lighted punk lies upon a stand in the form of a gilded dragon, and, like the sacred flame of Vesta, is never permitted to die out; a native stands by, ever ready to answer the demand for *api* (fire in Malay) and to carry the punk to any one wishing a light. At Samarang there was almost no one able to give information as to the itinerary to pursue, but it was explained that an interpreter would be absolutely necessary, inasmuch as nobody in the interior could speak anything save Dutch or Malay. After a long search, the services of a lad about seventeen, the son of a German tailor, were secured.

Less than three hours by rail from Samarang is the town of Solo, with a much better hotel than one might expect under the circumstances. About two hours more by rail brings the traveler to Brambanan, which place next to the Boro Budur contains the most interesting ruins in Java.

The ruins at Brambanan cover a comparatively large area and are mainly interesting for what they must have been, since great havoc has been wrought by the roots of trees, which, extending in all directions, have torn apart the masses of masonry. The stones composing the walls of the various temples are grooved, and fit each other, no cement being used. A number of statues are scattered around, which the traveler from India readily recognizes as representing various gods belonging to the Brahminical pantheon.

In the ruins of Chandi Sewu, or the Thousand Temples, which form part of the remains at Brambanan, are a number of figures apparently of Buddha; though it has been asserted that such is not the case, and that these effigies of stone represent simply votaries in the act of devotion to the Brahminical gods of the place. These figures are the same as all those found at the temple of Boro Budur, and have all the attributes seen in effigies of Buddha elsewhere.

From Brambanan to Djokjokarta is a journey of only half an hour, also by rail. The town of Djokjokarta is the capital of a native sultan, and has an interesting "water palace" and a large collection of leopards all huddled together into an enormous wooden cage. These beasts are the property and the pride of the sultan, and are entirely untamed, to all appearance, as they do not hesitate to spring at any outsider whose curiosity draws him into too close proximity to the bars of their wooden home.

If desired, the journey to the Boro Budur can be made in a coach-and-four, the distance being twenty-five miles over a fine broad road, as smooth as a floor and lined with native villages, shaded by towering cocoanut and palm. If a market day, the villagers can be seen, either squatting by the road-side offering for sale small heaps of food or merchandise, or moving from trader to trader making purchases here and there as their fancy prompts.

It is a journey never to be forgotten, and the drive is all too soon over, when at length the temple of Boro Budur looms in sight. The traveler, having previously in all probability met no one who has ever seen this wonderful structure, and having heard but the vaguest hints as to its size, and nothing relating to its wealth of statues and bas-reliefs, is fairly dazed. Upon him who has previously seen the temples of Egypt, of Greece, and of India, Baalbec in Syria, and the wonderful ruins of Girgenti, if ruins they may be called, where the ravages of time are scarcely apparent, and the altar and stairways stand intact—to those who have lingered among the baths, aqueducts and amphitheatres of Italy and the South of France—it is doubtful if the first impressions of these wonders of architecture in any way equal the effect produced by this lava temple in the heart of Java. When one has seen pictures of famous ruins and photographs in great numbers, and for years read and heard descriptions of the most enthusiastic kind, it is seldom that the reality very far surpasses the preconceived idea. The effect of the Boro Budur is most amazing, so unexpected is the grandeur of the sight presented.

On the top of an eminence, which has been leveled to some extent to receive it, is the temple of Boro Budur. It is not quite square, but nearly so, each side being about 620 feet in length; it is entirely built of blocks of black lava, excessively hard, to which quality doubtless it owes its excellent state of preservation.

It consists of seven ranges of walls and terraces decreasing in size until they culminate in a level space, in the center of which stands a species of dome about 50 feet in diameter, containing a gigantic statue of Buddha. This dome is surrounded by three circles of towers constructed of lattice work of stone, each enshrining an image of Buddha, seventy-two in all. Descending, one passes to successive terraces, the walls of which on the inside are covered with bas-reliefs illustrating everything pertaining to the life of the forgotten race which flourished when the temple was built. These bas-reliefs are executed in a high style of art, and are altogether over two miles in length. On the outside of the terraces at regular intervals are sitting images of Buddha which certainly number not less than four hundred and possibly double that. These figures are somewhat over life size, being three feet in height as they sit. The height of the building is about 100 feet exclusive of the dome, which is in a partially ruinous condition, and of which about 20 feet still stands. The temple is not one solid mass of masonry, but is built around the conical hill until the base of the dome is reached. Leading up to the temple is a broad avenue with animals of stone on either side, while two lions stand guard at the foot of the stairway of lava.

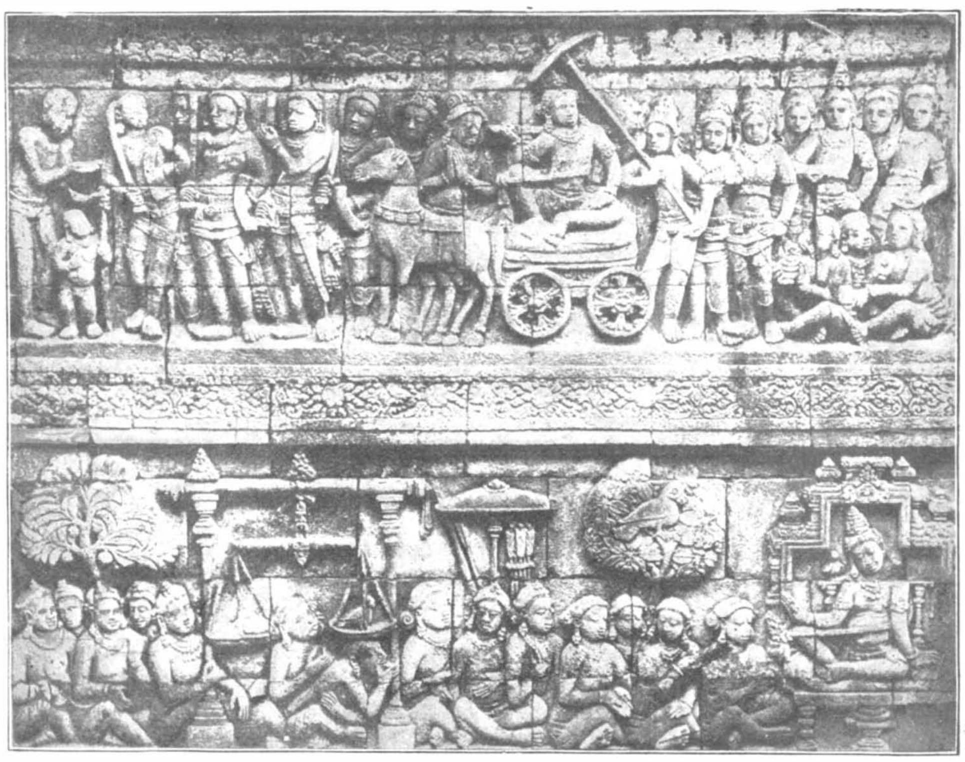
Who built the Boro Budur? At what era did it first swarm with priests and devotees? We have no records of any sort to guide us. It is asserted by some that the temple derives its name from Boro, the district in which it is situated, and Budur, ancient; while others think it is a corruption of Bara, great, and Buddha. The latter is most probably correct, and the district has taken the name from the temple. The statues at Boro Budur are, to all appearance, images of Buddha; and no statues of undoubted Brahminical origin are to be seen in the building, although one was once discovered in an adjacent field; and in ruins at no great distance are many armed figures, evidently of some Brahminical god.

It is hard to mistake an intended likeness of Buddha, for even the most inferior artist throughout the East seems successful in imparting to the countenance that smile of utter contempt for human affairs, which all, and Buddha most of all, must feel in Nirvana. At Brambanan, about 35 miles distant, as we have seen, are statues clearly traceable to votaries of Brahma. We know that in India the two religions flourished side by side until a period when, a bitter rivalry having arisen, the milder cult of Buddha was forcibly supplanted by the weird and fantastic gods of the Brahmins.

Whether Buddhism met a similar fate in Java it is impossible to say, there being no reliable records until the conversion of the people to Mohammedanism in the fifteenth century. Some writers have conjectured that the sway of the Hindoos was extended to Java in the sixth century of our era; but this is conjecture only, and probably the people and religions of continental India had gained a foothold in the island at a far earlier period.

The appearance of the ruins in Java can in no way aid us in forming an estimate of their age, since the uniformity of climate and absence of frost leave nothing to injure the temples of lava beyond the rank vegetation and an occasional earthquake. The inhabitants of Java are now Mohammedan and have no traditions relating to the temples of their island, though they still regard the images with a certain reverence. When we consider the mighty mass of masonry, the extreme hardness of the lava, and the great extent and endless variety of the bas-reliefs, it becomes a question whether any architectural remains now existing can compare, in the amount of labor expended, with these wonderful ruins in the interior of Java.

The great Buddhist temples of Ankor, in Cambodia, are so difficult of access and so far removed from the beaten track, that a failure to visit them may readily find excuse; but for the antiquary or the traveler of cultivation reaching Singapore, it is surely a mistake of magnitude to omit a journey to the lava temple of Boro Budur.



BAS-RELIEFS IN THE TEMPLE OF BORO BUDUR.

THE BORO BUDUR TEMPLE OF JAVA.

* From Records of the Past.

OILS FROM SEALS, WALRUS, ETC.*

By CHARLES H. STEVENSON.

THE blubber or fat lying between the skin and the muscular tissues of the various members of the Pinnipedia yields oil of much importance for technical purposes. The principal varieties on the market are from the common seals or hair-seals of the North Atlantic, the walrus, the sea-elephant, and the sea-lions. Each of these will be discussed separately.

SEAL OILS.

Seals are found in various northern waters, and especially off the coast of Labrador and Newfoundland, in the waters of Greenland, the Arctic Ocean north of Europe, the Caspian Sea, along the Nova Scotian and New England coasts, in the Northern Pacific, and to a much less extent in the Antarctic seas. The principal fisheries are in the Arctic and North Atlantic oceans, especially off the coasts of Newfoundland, Greenland, and Northern Europe. The Caspian Sea also affords an important seal fishery.

The blubber of seals ranges in thickness from 1 to 3 inches, according to the species, age, and condition of the animals. It is removed from the pelts usually as soon as the latter are landed. If the weather is warm, considerable oil of prime quality flows from the blubber during the process of separating it from the pelt, and provision is made for this free oil to flow into suitable receptacles.

The oil may be at once extracted, or the blubber may be stored for a more convenient season, especially if the weather be cold, as it is much easier to extract the oil during warm weather. If the blubber is stored, it should be in well-ventilated apartments, so arranged that the oil forced out by compression and warmth may run into suitable reservoirs. In the best-arranged storage rooms the reservoirs are oak-wood casks, lined with lead in some instances, with capacity for a thousand or more gallons. These are placed at intervals in the floor, which is so inclined as to cause the oil to flow into the receptacle. The oil which flows under these circumstances is usually clear, sweet, and of prime quality.

There are several methods of extracting the bulk of the oil from the blubber, the one adopted depending to some extent on the proposed use of the product, and also on the amount of capital available for equipment and the quantity of blubber to be handled. The methods may be divided into three principal classes, viz.: (1) by maceration exposed to solar heat, (2) by cooking in open kettles, and (3) by the application of steam.

The simplest method of extracting oil is by exposing the minced blubber in a mass to the weather.

* From United States Fish Commissioner's Report for 1902.

The blubber is heaped up in large tanks and—when the temperature is suitable—clear, pale oil flows from the mass. As putrefaction advances and the cellular texture is destroyed, the mass yields oil of a reddish yellow and then a dark brown color, with somewhat disagreeable odor and flavor, owing to the decomposition products evolved. When the oil ceases to flow, usually at the end of two or three months, the mass of fat is boiled in water with the fleshy or fat-lean portions. During this boiling the oil rises to the surface and is skimmed off. The residue is evaporated by pressure and drying, and is used for fertilizer. This was formerly the usual method employed in rendering seal oil in Newfoundland, but during the last twenty-five or thirty years the steam process has been generally adopted.

In treating a small quantity of blubber for extraction of the oil it is usually more convenient to mince it finely and cook it in a kettle over a fire. The oil rises to the surface and is skimmed off and placed in casks or other suitable receptacles. This is the method commonly employed by the shore hunters whose catch is small.

At the large sealing ports, as St. Johns, Tönsberg, Dundee, Astrakhan, etc., the oil is usually rendered by means of steam. The minced blubber is exposed to the action of steam in large inclosed tanks. The oil flowing therefrom passes through pipes into large reservoirs, of which there are usually three or more, the overflow from the first passing into the second, and the overflow from the second into the third. This furnishes the first quality of steam-refined oil. By pressing the steamed blubber, a second quality of dark-brown oil is obtained.

The steam process of rendering has the advantage of rapidity in operation, also the oil is free from disagreeable odor and is of superior burning qualities. However, for use in mines the sun-extracted oil is preferred, especially that of young seals, owing to its greater freedom from smoke, the odor being of little consequence to miners. According to Mr. Carrol,* oil from old seals is more smoky than that from young ones; it is also of greater specific gravity, and when the blubber of both are rendered together, the young seal oil comes out first.

Although the catch of seals in the Newfoundland fishery in 1901 was almost as large as in 1900, being 345,380 in 1901, as compared with 353,276 in 1900, the yield of oil was about 120,000 gallons less, representing a difference in value of about $50,000. This was principally because the average weight of the seals was small, owing to the fact that in 1901 the seals whelped some days later than in 1900, and furthermore, they were taken two or three days earlier than usual, the absence of pack ice enabling the vessels to reach them promptly after leaving harbor. In 1900 the average weight of the seal pelts was about 46 pounds, whereas in 1901 it was but 38 pounds. The young seals gain daily two or three pounds in weight of blubber, and if the vessels had been three or four days later in reaching the herds, the yield of oil in the Newfoundland fishery in 1901 would probably have been approximately the same as in 1900.

The decadence of the seal-oil industry, especially in the waters north of Europe, has been gradual but certain, owing to the introduction and adoption of cheaper substitutes for the relatively high-priced seal oil. Every year shows a decrease in the number of vessels employed in the fishery, and when a vessel is lost or sold it is rarely replaced. Comparatively little seal oil is imported into this country, the quantity in some years amounting to less than 1,000 barrels. The price in bond approximates 45 cents per gallon. The Newfoundland oils are marketed principally in St. Johns, Glasgow, London, and Leith; those from the waters north of Europe, at Dundee, Copenhagen, Hamburg, and Archangel, and that from the Caspian seal fisheries at Astrakhan.

Seal oils vary in specific gravity from 0.915 to 0.930 at 59 deg. F. According to Brannt, they are composed principally of glycerides of physetoleic acid, of palmitic, stearic, and a small quantity of oleic acid and traces of butyric acid, valerianic acid, etc. They show a slight acid reaction when fresh, the acidity increasing with age. Instead of the albuminous substances present in vegetable oils, the seal oils contain a small quantity of glue which can be precipitated with tannin and metallic salts. They are very slightly soluble in alcohol, and require almost an equal volume for solution in ether. Mixtures of equal volumes of nitric and sulphuric acids produce a reddish color, quickly changing to brown. The adulteration of seal oils is detected principally by the incomplete saponification if resin oil be the adulterant, and by the degree of solubility in alcohol if other blubber oils are employed.

In addition to the pure oils there are several well-known compound seal oils on the markets, the best known being the "three crowns." Greenland "three crowns" is a mixture of several varieties of blubber oil, chiefly seal oil, or rather seal-oil foots, and small quantities of whale and walrus, combined with oil from shark livers, the fluidity and low specific gravity of the shark oil imparting the special qualities to this compound. Swedish "three crowns" oil is a compound of various seal oils with herring oil.

The principal use for seal oil is for burning in miners' lamps, and it is also employed in currying and to a very small extent for miscellaneous purposes, especially fiber-dressing. About 2,500 barrels are used annually as an illuminant in the lighthouses in the British North American provinces. Owing to its sluggish nature it is usually improved by the addition of mineral colza. An excellent miners' lamp oil is said to be composed of seal oil, 40 per cent; whale oil, 25 per cent; lardine (0.980), 10 per cent, and mineral colza, 25 per cent.

* The Seal and Herring Fisheries of Newfoundland, by Michael Carrol, Montreal, 1873, p. 30.

SEA-ELEPHANT OIL.

The sea-elephant or elephant-seal has furnished a large quantity of oil to the American markets during the last eighty years. The whalers operating in the extreme South Atlantic, and also the fur-sealers sailing to Falkland, South Georgia, and the coast of Patagonia, secured odd lots previous to 1803, but the first vessel specially fitted out for securing this article appears to have been the ship "Alliance," which sailed from New Bedford in 1803 for Patagonia, and returned home in 1804 with a full cargo of oil. This was the pioneer of a large number of vessels sailing to the Patagonian coast for sea-elephant oil. That coast seems to have been abandoned about 1820 for the South Shetland Islands, which for seventeen years furnished many cargoes to the fur-sealers sailing from Stonington. Since 1837 Desolation or Kerguelen Island has furnished the great bulk of the sea-elephant oil. Heard Island has furnished many cargoes since 1857, but on account of the exposed situation of that island vessels do not usually go there when a cargo is obtainable elsewhere. South Georgia, South Shetlands, and the Patagonian coast also have many sea-elephants and are occasionally visited by the hunters, but the great bulk of the catch has been obtained at Desolation Island.

Although the taking of sea-elephant oil originated with the Nantucket whalers, it has been peculiarly a New London industry since 1820, the neighboring ports of Stonington and Mystic furnishing a number of vessels during certain seasons. From 1820 until the present time 94 per cent of all the voyages have been made by vessels from these three ports, and 80 per cent have been made by the New London vessels. The fleet was largest in 1858 and 1859, 18 vessels, with an aggregate tonnage of 4,527 tons, being employed in 1858, and 20 vessels, with 4,461 tons measurement, in 1859.

The last vessel to return with a cargo was the brig "Leonora," which arrived in 1902 with 2,900 barrels of oil and a quantity of hides. In 1900 the schooner "Robert S. Graham" brought 2,600 barrels of oil and 70 hides, the oil selling at 38 cents per gallon, and the hides at $2 each. In 1898 the bark "Swallow," of Boston, returned with 2,000 barrels of oil, the product of 4,000 sea-elephants secured during the three months of the summer of 1897-98.

According to Capt. James W. Budington, of Groton, Conn., to whom we are indebted for most of the subjoined data relative to methods of capture and of oil-rendering, sea-elephant blubber is somewhat whiter than whale blubber, and ranges in thickness from 1 to 8 inches, according to the size and condition of the individual. It is thickest on the males, especially the "March bulls," from the neck of which 10-inch blubber has been secured. On the cows the thickness is from 2 to 3 inches, and on the pups it is much less.

Much variation exists in the yield of oil from sea-elephants. The quantity secured from the March bulls taken shortly after they land is very large, amounting sometimes to 220 gallons from a single individual. Only a small number of this variety is secured. The November bulls yield from 100 to 120 gallons each early in the season, but after remaining on the shore for months, abstaining from food, they become emaciated, and yield scarcely more than 30 gallons. The product from females and pups is much smaller, some of the pups yielding only 4 or 5 gallons, especially when the season is well advanced, thus greatly reducing the average take, which probably does not exceed 12 or 15 gallons to each individual throughout the season. The cargo of 2,000 barrels secured by the bark "Swallow" in 1898 represented an average yield of 15.75 gallons per individual. Another cargo of 600 barrels secured late in the season, when the animals were in poor condition, represented the capture of 2,000 individuals.

The hunters endeavor to arrive at the islands as soon as the sea-elephants come ashore, usually the early part of November. The animals are found in herds or pods varying in number from 20 to 300 or more each, the favorite resort apparently being the numerous mud puddles. The largest and fattest are selected for killing, females and pups being unmolested if a sufficient number of large bulls is obtainable. The bulls are sometimes of enormous size, frequently 16 feet or more in length and 12 feet in circumference. The females are very much smaller, probably one-third the size of the bulls, but generally they are fatter for their size and their blubber is somewhat more yellowish. A number of seals of various species, especially the leopard-seal, are frequently met with and are driven out and slaughtered when sea-elephants are scarce; otherwise they are not molested, as they are not nearly so fat as the sea-elephants. Rifles and lances are the weapons commonly employed in the slaughter.

After killing a sufficient number the skin is roughly and quickly gotten out of the way and the blubber taken off in horse-pieces of suitable size for handling, say about 18 inches wide and 2 feet long, or less, this varying according to the thickness. The horse-pieces are strung on a pole and carried down to the shore, 15 or 20 making a good load for two men. At the shore the pieces are strung on raft-tails or ropes, 18 or 20 feet long, and towed to the ship. The long immersion in the water soaks off the sand and blood and cleanses the blubber.

The oil is extracted in much the same manner as in the whale fishery. The blubber is lifted on deck, cut into strips about 2 inches wide, and these are minced or partly cut through at intervals of about 1 inch and placed in try-pots, precisely as in the case of whale blubber. The cooking is only slight, much less than applied to the whale blubber, being continued for only about 15 minutes. The fuel consists of the dry scrap, supplemented with wood procured on the islands. After cooking for about 10 or 15 minutes and dipping off all the oil on the surface, the scrap is placed in a receptacle and subjected to considerable pressure, in the manner customary in the right-whale fishery already described. The oil does not run as freely from the blubber as whale oil; especially is this the case with the fat of the pups, which is fine-grained and "milky." Occasionally the oil is tried out on shore in a manner similar to that aboard the vessel, the try-works being erected near a running stream wherein the blubber may be washed free from sand and blood.

The product from all the southern islands from 1803 to 1900, inclusive, amounted to upward of 242,000 barrels, or 7,643,000 gallons, worth $5,420,000, apportioned as follows:

Decade ending June 30.	Barrels.
1810	2,500
1820	9,000
1830	9,500
1840	23,000
1850	38,000
1860	62,754
1870	48,783
1880	34,015
1890	8,150
1900	6,300

This oil is classed as whale oil and has been included in the product of that article, although it is usually sold for 3 or 4 cents per gallon more than the latter. The process of refinement is precisely the same as in case of whale oil, the foots yielded amounting to 5 or 6 per cent of the original bulk. Its principal use has been in the dressing of morocco leather.

WALRUS OIL.

When the whalers entered the North Pacific, walrus were found in great numbers, but were not disturbed, owing to the abundance of cetaceans. At times when whales were not to be found and many walrus were met with, a number of these were killed and the blubber tried out, and this practice extended with the increasing scarcity of whales. About 1863 the northern whalers began to make a business of taking walrus during the first part of each season, some vessels securing upward of 500 barrels. Mr. A. Howard Clarke estimated that, during the eleven years ending in 1880, 1,996,000 gallons of walrus oil were secured by the whaling fleet in the North Pacific, the value of which was about $1,000,000.* The hunt was carried on with much waste. It is stated that on one occasion 1,600 walrus were killed on a sand bar in one day, and the whole number were washed into the sea by an unusually high tide and thus lost. Since 1880 the quantity secured has decreased, and at the present time not more than 100 walrus are obtained annually by the entire North Pacific fleet, representing an oil product of less than 2,000 gallons.

The blubber of walrus averages 2 or 3 inches in thickness, and usually it is not detached from the skin until after the removal of the latter from the carcass. In case the hide is to be saved for tanning, the pelt is placed on a flensing board or platform, skin-side down, and the blubber is cut off in irregularly shaped horse-pieces of 10 or 15 pounds' weight each. During the height of the Pacific walrus fishery the hides were not used, and then the skin and blubber were removed from the animal in horse-pieces of convenient size, say about 10 by 14 inches, and these were separated aboard the vessel.

The horse-pieces are next prepared for the try-pots. They are placed on the mincing-horse and scored or minced precisely in the manner described in the treatment of whale blubber. The cooking must be slow, the pot being well spaded during the boiling to prevent the blubber from sticking and burning to the bottom or side.

The individual yield of oil varies considerably, walrus being much fatter in some years than in others. But in general it is small in proportion to the size of the animal, an individual weighing 1,500 pounds yielding only as much blubber as a seal of 600 pounds. An old bull weighing 2,500 pounds might yield 600 pounds of blubber, but it is seldom more than 450 pounds, and the average for the entire catch is probably not in excess of 200 pounds. Nor is the blubber as rich in oil as is that of the seal, 100 pounds of walrus fat yielding an average of 10 gallons of oil, whereas an equal weight of seal blubber yields about 11¼ gallons. In 1869 the ship "Progress" secured 565 barrels of oil from 700 walrus, an average of 25.42 gallons each. This was considered an extra good yield. One thousand walrus secured by the ship "Onward" in 1874 yielded 600 barrels of oil, and 2,000 taken by the "Mercury" in 1877 produced 1,100 barrels of oil.†

Walrus oil is usually of a yellowish color, with greater fluidity than seal oil, and has a specific gravity of 0.925 at 59 deg. F. according to Brannt. It is more difficult to refine than the oil of the right whale. Although classed roughly as "whale oil" in the United States, it is usually kept separate from the oil of the right whale and sold for 2 or 3 cents per gallon more

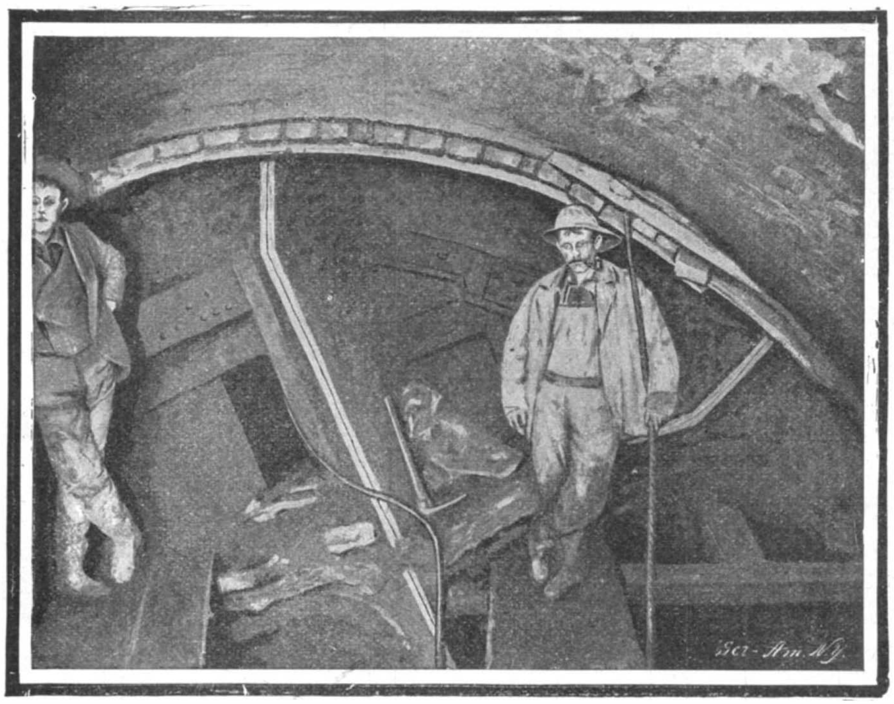
* The Fishery Industries of the United States, Sec. V, Vol. II, p. 318.
† The Fishery Industries of the United States, Sec. V, Vol. II, p. 318.

than the latter. It is stated that the product in the fisheries north of Europe is generally mixed with and sold as seal oil.

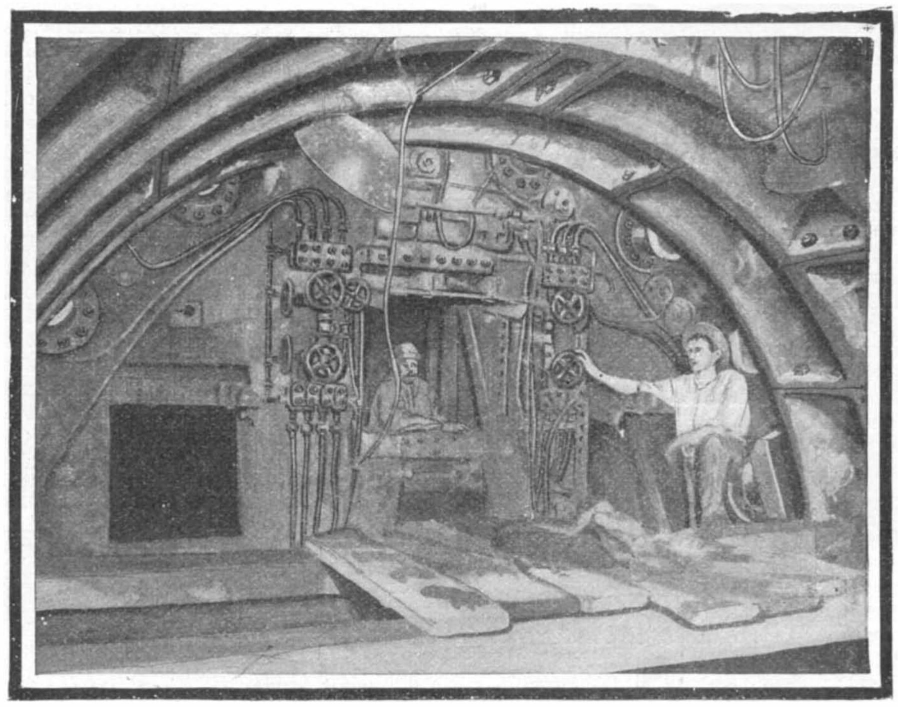
OIL FROM SEA-LIONS AND FUR-SEALS.

The blubber of the sea-lion is from 1 to 4 inches thick, and that on each individual yields from 6 to 20 gallons of oil. Thousands of barrels of this oil were formerly secured along the coast of California, but owing to the decrease in number of these animals, comparatively little is now prepared. It is somewhat inferior to sea-elephant or walrus oils, but much better than fur-seal oil.

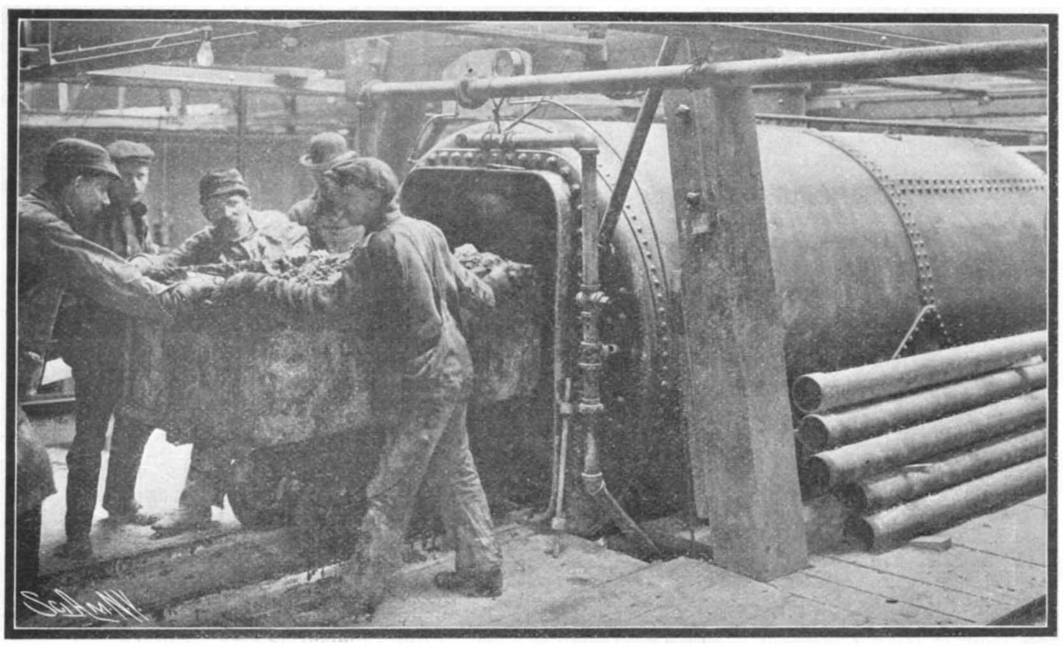
A number of years ago when whale and seal oils were quoted above a dollar per gallon, there was some sale in this country for oil prepared from the blubber of the fur-seal; but owing to the small quantity available, the cost of production, and the technical inferiority of the product, there has been no market for it for many years. The blubber may average 1½ inches in thickness, varying according to the time the animal has been on shore. The oil is of a yellowish-brown color, gummy, and possesses an offensive odor. According to the terms of the lease of the fur-sealing rights on the Pribilof Islands to the North American Commercial Company, the United States government is entitled to receive 50 cents per gallon for all fur-seal oil produced there. This is in excess of the market value of the article, leaving nothing for the cost of production and transportation, and, needless to state, there is no revenue whatever from this item.



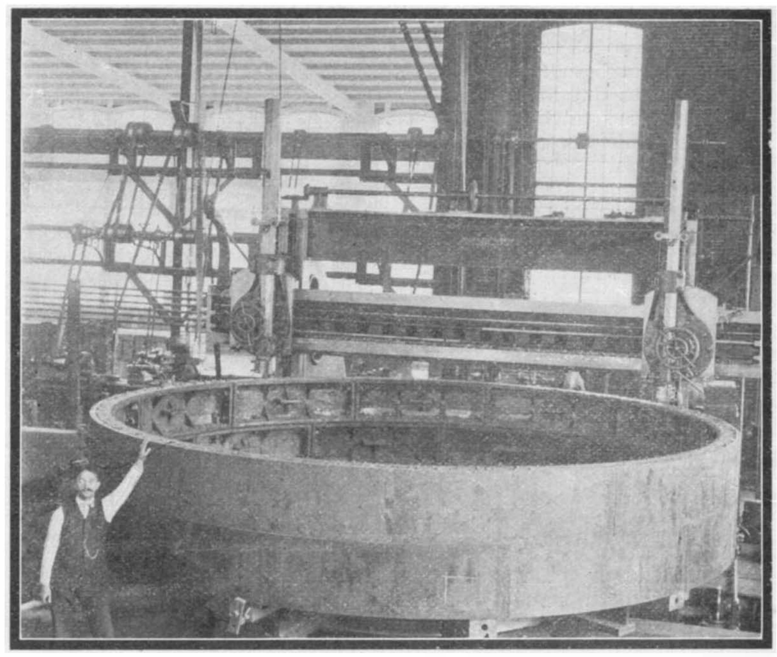
JUNCTION OF THE TWO SECTIONS, SHOWING ALSO THE TILTED POSITION OF THE SHIELD.



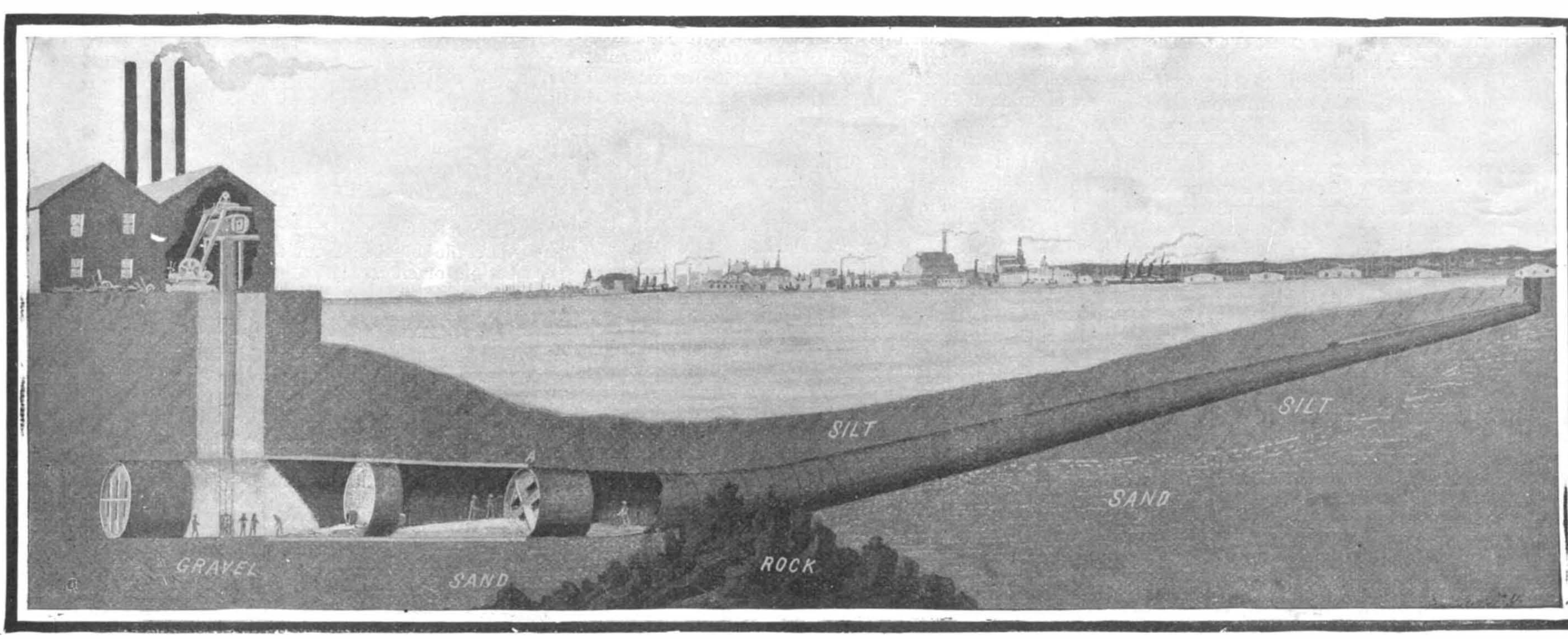
THE NEW SHIELD AT MORTON STREET, WHICH IS TO CONTINUE THE TUNNEL UNDER THE CITY.



THE AIR LOCK AT THE TOP OF THE NEW YORK SHAFT. A CARLOAD OF DIRT BEING REMOVED.



THE TUNNEL SEGMENTS SET UP AND PLANED BEFORE LEAVING THE FACTORY.

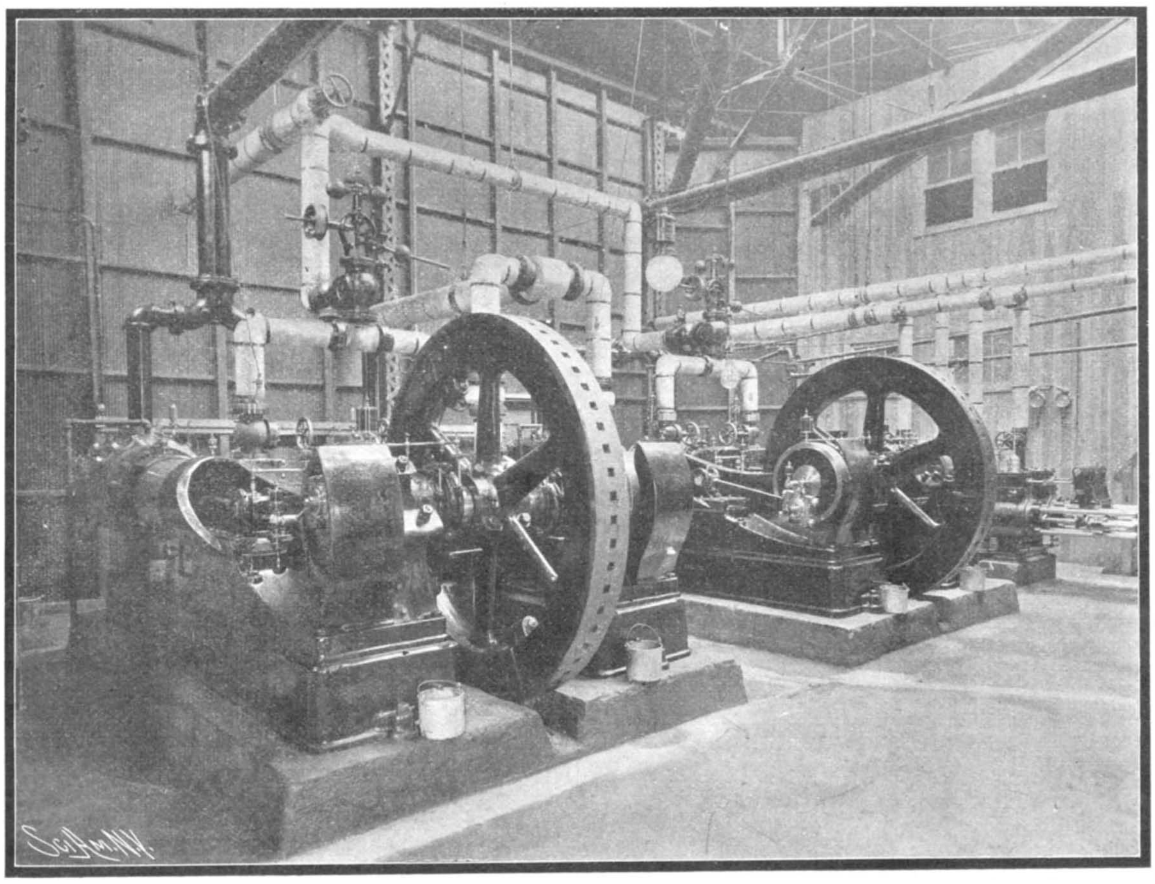


SECTIONAL VIEW, SHOWING THE COURSE OF THE TUNNEL UNDER THE HUDSON RIVER.

THE HUDSON RIVER TUNNEL.

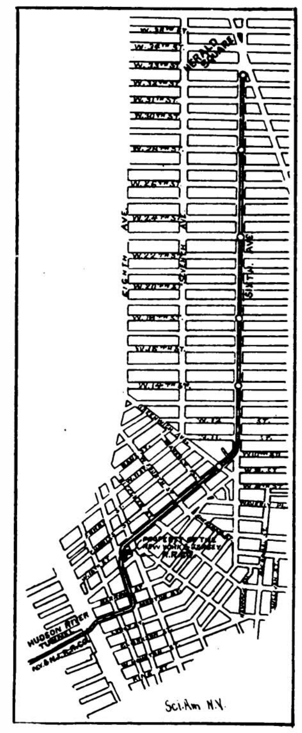
THE HUDSON RIVER TUNNEL.

March 11, 1904, marks the successful culmination of the work begun thirty years ago on the Hudson River tunnel. On that day the junction was made between the New Jersey heading and the old New York section of the north tube and Mr. William G. McAdoo, president of the New York and New Jersey Company, was accorded the honor of being the first man to pass from Jersey City to New York under the Hudson River. The progress of this tunnel from its inception up to the present time has been periodically chronicled in these columns, so that our readers will not need a lengthy account of the undertaking, but a brief *résumé* of the principal events which mark the history of this great engineering enterprise may be in order.



DUPLEX CONDENSERS AT THE NEW YORK STATION, EACH DELIVERING 1,361 CUBIC FEET OF AIR PER MINUTE INTO THE TUNNEL.

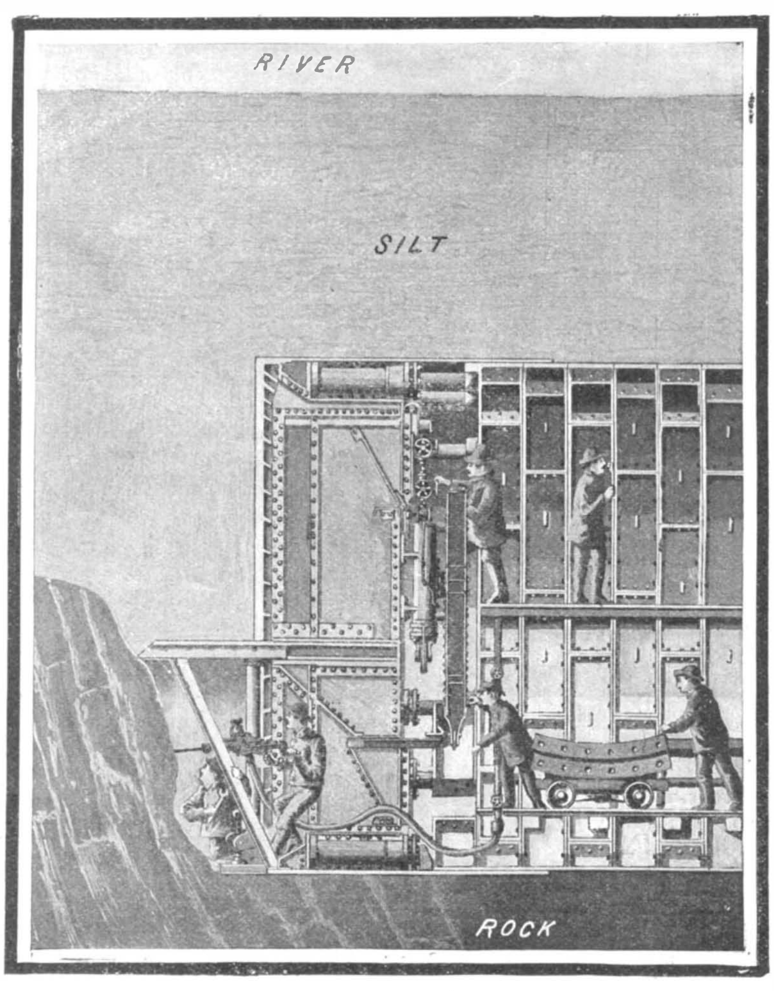
The original projector of the tunnel was Mr. Dewitt Clinton Haskin, under whose direction the work was begun in 1874. A shaft was sunk at Fifteenth Street, Jersey City, and at the foot of Morton Street, New York, and from the bottoms of these shafts twin tunnels were run out under the river. In carrying out this work no excavating shield was used, as it was thought that the silt was sufficiently compact to hold its position until the two-foot brick lining was set in place. This surmise proved incorrect, and it was found necessary to use a five foot pilot tube, which was pushed ahead of the main tunnel and used as a center for radial braces, which supported the tunnel wall under construction. The work was carried on without serious accident until in July, 1880, the shallow layer of silt between the tunnel roof and the river gave way under the pneumatic pressure in the tunnel, and the inrushing water drowned twenty of the workmen. The work was then continued half-heartedly for two years, when, with 2,000 feet of the north tunnel completed, it was abandoned. In 1890 an English company took up the work, using an excavating shield, and working from the Jersey end carried the tunnel forward to within 1,500 feet of the old New York heading. Again the work was abandoned until 1896, when the New York and New Jersey Company took charge of the work, and in 1902 began the work which has since been carried out to its present successful issue. This magnificent engineering achievement of Jacobs and Davies, engineers of the New York and New Jersey Company, in accomplishing that which had twice before been attempted and abandoned, is deserving of highest praise, particularly in view of the fact that difficulties were met and successfully overcome, which the other companies did not encounter and which, in fact, the engineering world has never before been called upon to master. The work had progressed only a few hundred feet when rock was encountered in the lower part of the tunnel. The excavating shield in use, the one that the English company had installed, was designed to be forced through silt, and it would merely have crumpled into a shapeless mass if it had been forced against this rock barrier. It was necessary, therefore, for the workmen to advance beyond the cutting edge of the shield, and blast out this rock before moving the shield forward. If the rock had covered the entire face of the shield, this would have been a comparatively easy matter; but the engineers were confronted by the unique problem of driving the floor of the tunnel through rock and the roof through silt. To meet these conditions, it was found necessary to build an apron out in front of the shield, which would protect the workmen from the silt above. This apron, as shown in one of our illustrations, extended from side to side of the tunnel shield near its center line, and projected forward about 6 feet. It was built of ¾-inch steel plates laid on brackets formed of 12-inch I-beams. This apron enabled the workmen to attack the rock without fear of being smothered by an avalanche of the soft silt above. Even with this protection the work was not without danger, as the rock varied in height from 1 to 16 feet. Fortunately, no casualties resulted, and the passage was slowly but steadily forced through



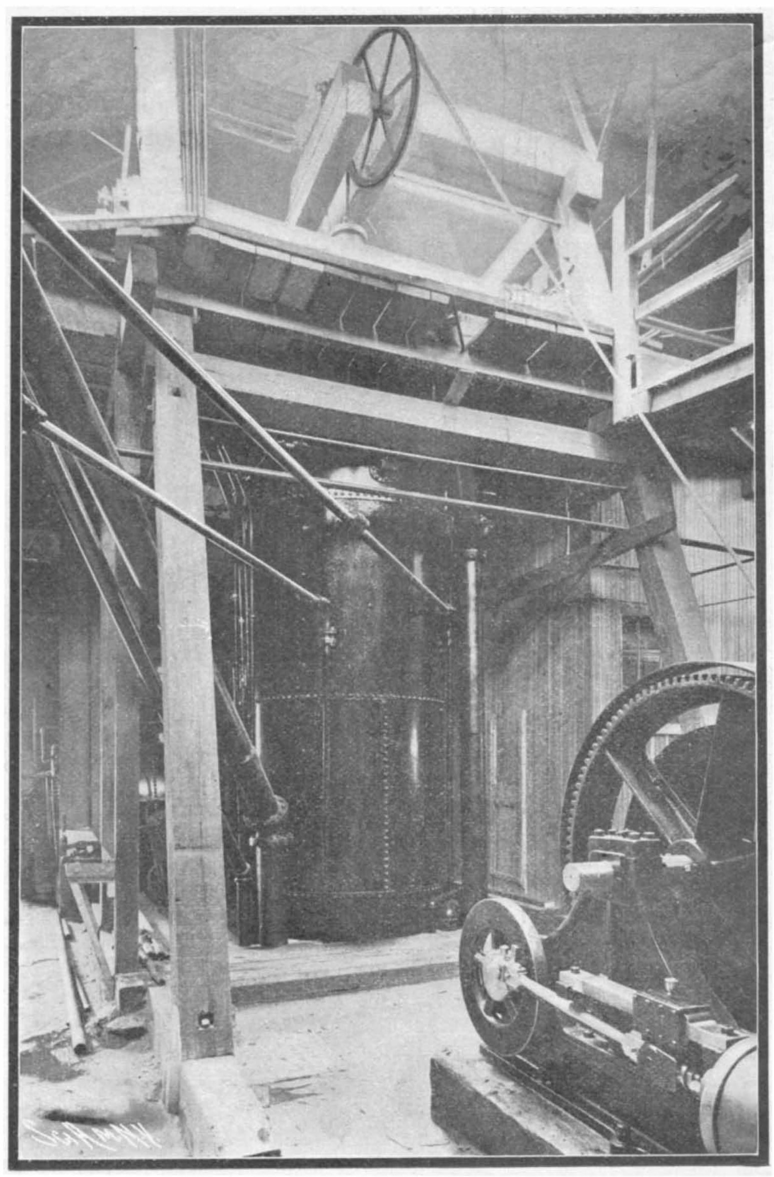
PROPOSED EXTENSION OF THE HUDSON RIVER TUNNEL.

the rock reef. With this danger past, the remainder of the work was comparatively simple, and the tunnel was rapidly pushed on to the New York heading.

As the work advanced, the course of the tunnel was carefully plotted out, and the excavating shield was steered by increased pressure in one or another of the hydraulic jacks, in order that it should be brought into perfect register with the brick lining of the New York heading at the point of juncture. So careful were these calculations, that when the shield met this heading, the lateral alinement was found to be almost perfect; but vertically, an error of a few inches was made. This break is temporarily sealed with blocks of wood driven into the silt above the shield, as shown in one of our photographs. This photograph also reveals a very peculiar feature of the work. While the



BLASTING OUT ROCK UNDER THE PROTECTING APRON.



ELEVATOR SHAFT AND ELEVATOR HOISTING ENGINE.

THE HUDSON RIVER TUNNEL.

shield was being operated by the English company, it was noticed that instead of remaining stationary on its axis, it was gradually turning clockwise as viewed from the front. Every effort was made to stop this movement; but it continued, until now, having traversed 3,400 feet of silt, it presents the appearance illustrated, with the vertical plates lying almost horizontal. This curious action was probably due to a slight deflection of the plates in front of the diaphragm of the shield, which tended to turn the shield through an imperceptible angle every time it was jacked forward, and these slight deflections gradually accumulated until they became quite noticeable.

The tunnel has an internal diameter of 18 feet 1½ inches, and is lined with cast-iron segments 1½ inches thick, braced with webs and formed with inwardly-projecting flanges, which provide means for firmly bolting the sections together. These segments were cast at the Bethlehem Steel Plant, and before leaving the factory were bolted together in rings. Each ring was then planed to fit the next adjacent one, so as to make sure of close joints in the lining when it was set in place. The planing was done on a large boring mill, a machine provided with a table which rotates in a horizontal plane, carrying the work which is strapped thereto against the cutting tool.

A considerable air pressure is still required in the greater part of the north tunnel, to prevent water from seeping through the joints of the lining which have not yet been calked. The air pressure for the two tunnels is supplied by six compressors. At the New Jersey station there are two straight-line high-pressure single-cylinder compressors and one duplex compressor. The former have 22-inch steam cylinders and 26½-inch air cylinders with a stroke of 24 inches, while the steam and air cylinders of the latter measure 16 inches in diameter and the stroke is 20¼ inches. At the New York station there are two of these duplex compressors, which are shown in the accompanying illustration, and they each are capable of forcing 1,361 cubic feet of air per minute into the tunnel. Aside from these there is a single high-pressure compressor, not shown in our illustration, which delivers the volume of 1,540 cubic feet of air per minute. This compressor has a 20-inch steam cylinder and 22½-inch air cylinder, and a stroke of 24 inches. In the background of our photograph will be observed one of the duplex hydraulic pumps, which furnish the power for operating the hydraulic jacks on the shield. There are two of these pumps at each side of the river. They have 16-inch steam cylinders and 2-inch water cylinders with a stroke of 12 inches, and furnish a pressure of 5,000 pounds to the square inch.

Some further work remains to be done on this tunnel before it will be finally completed. The shield must be dismantled, and the cast-iron sheathing or lining run out to join the brick lining of the old heading. The shell of the shield, however, cannot be removed, and will be buried behind the cast-iron lining, a final sacrifice to the work it has served so long and faithfully.

The English company, in order to save the cost of cartage, spread the silt, as it was excavated, over the floor of the completed section, and as a consequence a large part of the tunnel on the Jersey side is more than half filled with this material, and it must all be removed before the work of laying car tracks can be commenced.

The south tunnel, which is being run parallel to the completed tunnel, is also being excavated from the New Jersey side, and is now well under way. A distance of three-quarters of a mile remains yet to be tunneled. A new shield was built for this work, and in anticipation of the difficulties encountered in the north tube, it was provided with an apron, which can be moved out in front of the shield to permit blasting out rock in front of the cutting edge.

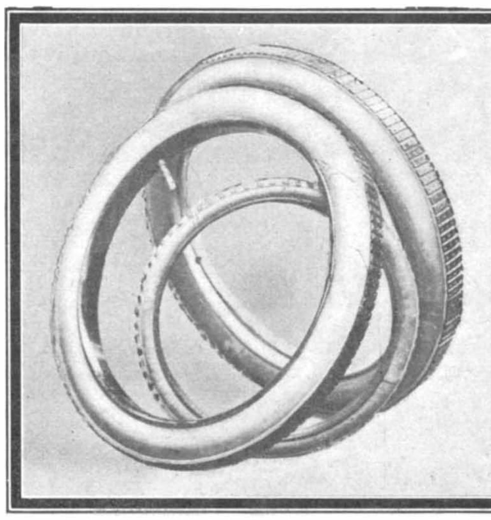
We illustrate herewith a new shield, now in position, which will continue the north tunnel through the city under Morton Street and Ninth Avenue to Tenth Street, where the New York station is to be built. The course of this tunnel, together with the proposed extension, is shown in the accompanying map. The purpose is to continue the tunnel up Tenth Street to Sixth Avenue, and thence up to Herald Square, with intermediate stations at Greenwich, Fourteenth, Eighteenth, Twenty-third, and Twenty-eighth Streets.

These tunnels are intended only for the use of electric cars, and not, according to the popular misapprehension, for heavy railway trains. It is the opinion of the engineers that the silt foundation is too soft to permit the passage of heavy weights through the tunnel. The silt, though very compact under the weight of the water above, nevertheless has the properties of a viscous fluid, and it is feared that it would yield under the impact and weight of a heavy steam or electric locomotive. Such yielding, though but little, would place a tremendous bending strain on the cast-iron lining above that it could bear, and ever so slight a rupture would result in dire consequences.

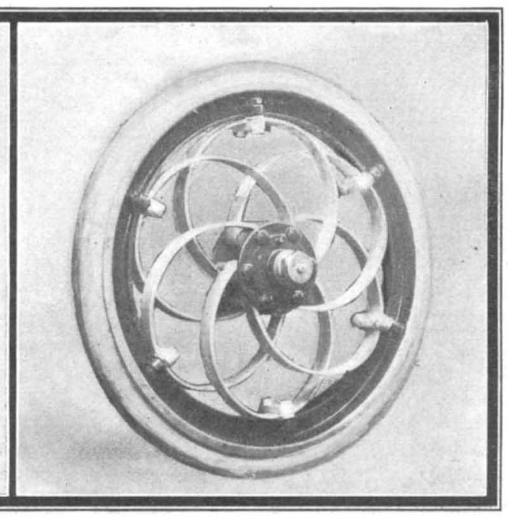
A combined elevator and air lock is in use at the head of the New York shaft. The elevator shaft ends in an air lock at its upper end, and the circular platform of the cage, when in its highest position, completely closes the mouth of the shaft, and forms the bottom of the air lock. As the compressed air is released from the lock, this platform is forced snugly in place, making an air-tight closure. The cable by which the elevator is suspended must, of course, pass through the top of the air lock, and to prevent leakage of the compressed air it is incased in a long stuffing box. The movement of the cable through this stuffing box is so slow as not to seriously wear the packing.

ANTI-SKID AND PUNCTURE-PROOF BANDS AND ENVELOPES FOR PNEUMATIC TIRES.

There has been a great deal of interest taken of late, especially abroad, in protecting pneumatic tires from puncture and also in making them less liable to skid and slip sideways on slippery pavements or muddy roads. So numerous have the anti-skid devices become, that the Automobile Club of Seine et Oise recently held a competition to thoroughly test the various makes and determine which is the best.

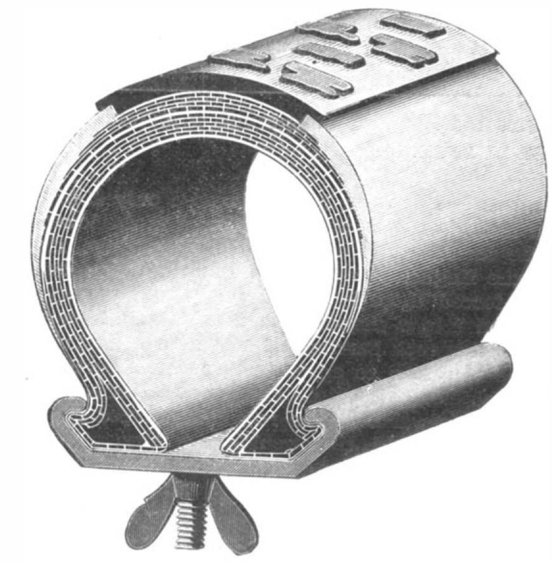


"DIAMANT" STEEL-PLATE NON-SKID TIRE.



ROUSSEL SPRING WHEEL.

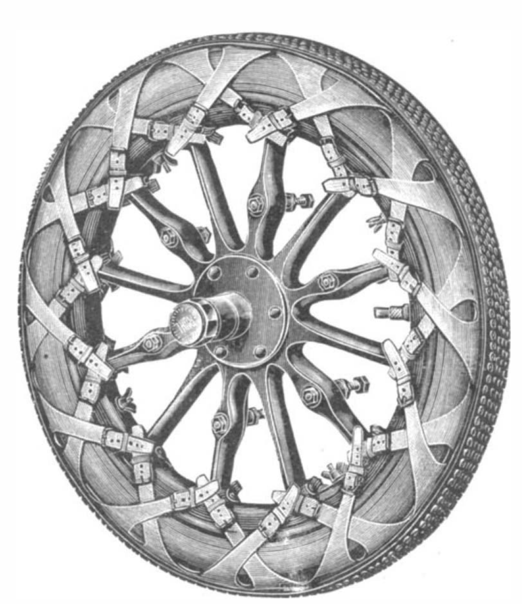
The tests consisted of a 500-mile run, over bad roads, of the vehicles equipped with the different kinds of anti or non-skidders; a hill climbing test with and without these attachments; and tests of sudden stopping when turning a corner or following a sinuous chalk line on a muddy and greasy road.



DURAND NON-SKID TIRE WITH LEATHER TREAD CONTAINING STEEL RIVETS.

The tests were made in the vicinity of Versailles, and, as the weather was fair, it was necessary to soak the roads with water and make them as muddy as possible before making the tests.

The hill-climbing test was undertaken in order to determine whether more power is required to drive a vehicle when equipped with anti-skidding bands. Taking eight machines that covered a greater distance on their high gear without the anti-skidders than they did with them, the average greater distance covered without the bands was 183¾ feet, which would seem to show that some of these devices absorb more or less power. On the other hand, about an equal number of cars went further up the hill when fitted with the non-skidders, and four performed equally well with and without them.



HOUBEN DETACHABLE NON-SKID BAND WITH LEATHER STUDS RIVETED TO A LEATHER STRIP.

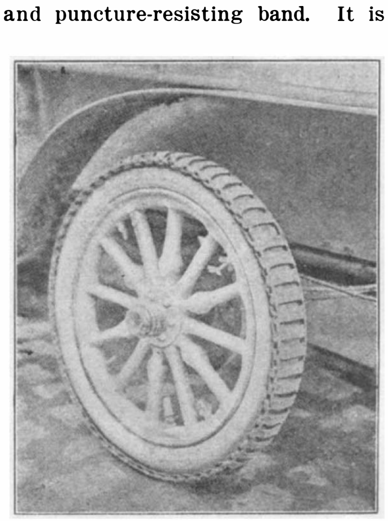
The endurance test of the anti-skidding bands lasted several days, the vehicles equipped with them being run 60 or 70 miles daily over all the worst roads in the vicinity. On one day the morning's run was over some 45 miles of the worst *pavé* (bad cobblestone roads) in France, at an average speed, however, of but 6¼ miles an hour. The machines themselves received a great racking, but stood the extraordinary strains very well. This part of the test was as much one of machines as it was of tires and their protecting bands.

The final test of the non-skidders was in the thick mud of a specially-prepared and well-soaked roadway. The cars, traveling at from 15 to 18 miles an hour astride a sinuous chalk line marked on the ground, were stopped as suddenly as possible upon signal, and the distance required for making the stop, the amount of side-slip and skidding, as well as the speed at the time the signal was given, were all noted.

DE FORNIER DETACHABLE NON-SKID TIRE ENVELOPE.

The non-skidders entered in the contest were of two varieties—the detachable and undetachable. The Houben band—the "Perfecta"—is an example of the former, while the Gallus steel-strip band (which took the first place, winning 395 points) is a good sample of the latter. Besides these two classes, there was a third one, consisting of devices other than bands or envelopes for use with a smooth tire, of which the chief example was the Sainsbury non-skidder.

The Houben "Perfecta" is a typical detachable non-skidding and puncture-resisting band. It is made of chrome leather, and is covered with studs of the same material, which are attached to the band with steel rivets. Numerous leather straps serve to fasten the band to the wheel. This is one of the lightest of the anti-skidders, but it takes nearly an hour to attach it. In the list of times taken to attach the various



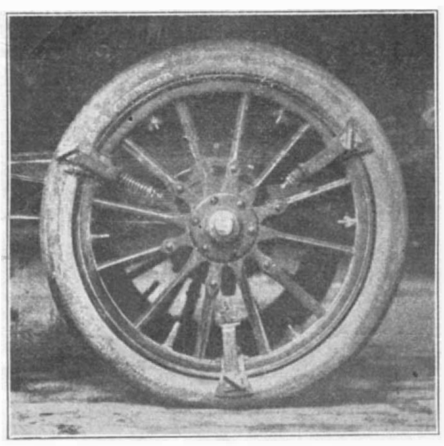
LEMPEREUR DETACHABLE STEEL-PLATE NON-SKID BAND.

makes of anti-skidders, there were but two others that took longer. These were the Clerget and the Desjardins, which required 1 hour and 5 minutes, and 1 hour respectively. The "Perfecta" required 57 minutes to attach. It took ninth place in the list of winners, gaining 284 points, and it was fifth in the classification of detachable anti-skid devices.

The Durand is another anti-skidder that is worthy of mention. The wood-cut of it shows plainly the method employed in its construction. A piece is cut out of the rubber tread of the tire, and into this is fastened a band of chrome leather, studded with hardened steel rivets of a special shape. A somewhat similar band of this make, arranged so as to be detachable, took seventh place among the winners of the competition, gaining 310 points.

The "Sampson" non-skidding band is of the undetachable variety. It is constructed similarly to the Durand, except that the chrome leather band forming the tread and from which the steel studs project is attached to a thinner band of the same leather, which is vulcanized or cemented to the tire. The Chameroy and Bergougnan tires are of much the same construction. The Sampson and Chameroy are to be given a longer and more severe test in a run to Nice and back.

The "Diamant" anti-skidding tire here shown, as well as the "Perfecta" already described, are of Belgian invention and manufacture. The "Diamant" undetachable anti-skidder is made as follows: To quadruple layers of canvas in the tread is securely fastened a flexible chrome leather band having attached to it narrow cross-strips of leather .157 inch thick, to which are riveted strips of tempered steel of the same thickness and of a width varying with the size of the tire. On account of its method of attachment, each strip remains always tangent to the tire, and yet accommodates itself freely to the movements of the leather band, without, however, making any great resistance to the rolling of the wheel. The rivets are so numerous and strong that there is little danger of the strips being torn off. A similarly constructed tire—the Gallus—won first and third places with 395 and 361 points respectively, while the Lempereur—an also similar arrangement of cross-strips of metal held on the tire by wire ropes—took second place with 368 points and a minimum time of attachment of only 4 minutes. The De Fornier envelope, which took fourth place, is also shown herewith. In this case the protecting envelope covers the tire almost completely, being attached to the rim and having its surface studded with rivets.



SAINSBURY ANTI-SKIDDERS ATTACHED TO A WHEEL.

The Sainsbury device consists of three spring-pressed forks that dig into the road slightly at each revolution of the wheel, and thus keep it from slipping sideways, should it attempt to do so.

The Roussel spring wheel is a French invention that is intended to do away with the pneumatic tire altogether, yet give all the easy-riding qualities of the tire.

Correspondence.

PARTICLES SMALLER THAN ATOMS.

To the Editor of the Scientific American:

Since the discovery of the X-rays, much has been said and written about the divisibility of the atom, and the general tendency is to infer that recent discoveries alone have furnished material for this line of thought. In reality, however, many facts have long been known which, when carefully analyzed, furnish the strongest kind of evidence that the atom is a group of smaller parts that may be called sub-atoms.

The divisibility of all bodies large enough to be recognized by our senses is one of the most certain of the established facts of nature. That this divisibility of bodies continues to hold true down to the atom is accepted by the scientific world as unquestionable, simply for the reason that many phenomena are utterly unexplainable by any other hypothesis.

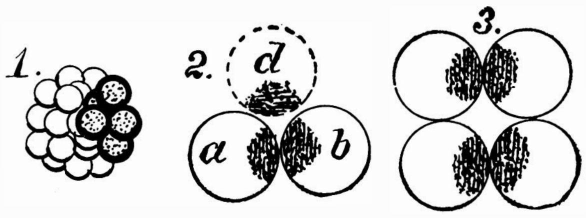
Analogously, the divisibility of the atom ought to be established just as firmly if it can be shown that many phenomena can thereby be explained without the assumption of arbitrary, extraordinary, and contradictory laws and properties of matter, which seem to be necessary with the hypothesis of an indivisible atom.

Following this line, let us consider some of those phenomena which can be consistently explained only by an atom which is a group of sub-atoms.

Let Fig. 1 represent an atom of chlorine made up of a group of sub-atoms of various masses and densities, these sub-atoms consisting of groups of still smaller parts. It is to be understood, however, that this figure and those that follow are diagrams, and not intended to show accurately the relative shapes and sizes.

By the attraction of gravitation within the atom alone, the sub-atoms tend to collect to form an approximately spherical group, but at the time of the formation of the atom, outside attraction caused more or less distortion, and drew the denser and heavier sub-atoms to one side, making that side of the atom denser and causing the center of mass of the atom to be near one side instead of at the geometrical center.

Evidently, then, two chlorine atoms *a* and *b* with their dense sides together, as shown in Fig. 2, will have a stronger attraction for each other than for any other atom as *d*.



Hence two chlorine atoms form the most stable group, and explain the long-known fact that a molecule of free chlorine consists of a pair of atoms.

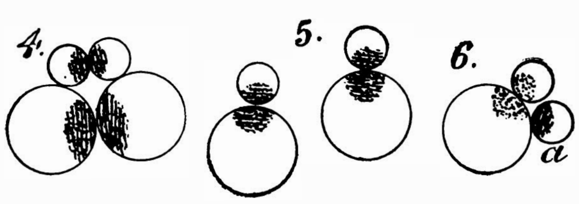
In a similar manner the atoms of hydrogen, oxygen, nitrogen, etc., are denser upon one side, and like chlorine their free molecules are pairs of atoms.

Although the atoms in the molecule of chlorine, Fig. 3, have a strong attraction for each other, the molecules have a comparatively weak attraction between them, because of the distance apart of the centers of mass. Hence a rather low temperature is necessary for them to collect indefinitely to form a liquid.

When free from disturbing influences, hydrogen and chlorine gases will not unite, for the centers of mass of the molecules, Fig. 4, are too far apart for sufficient attraction; but under the influence of heat or some other sufficient disturbing cause, the molecules are broken up and the separate atoms unite as in Fig. 5, forming two molecules of hydrochloric acid. The hydrogen and chlorine atoms now have their centers of mass close enough together to give sufficient attraction for a fairly stable group.

The fall in potential energy from the position of Fig. 4 to that of Fig. 5 is manifested in kinetic energy, or what is usually called the heat of combustion or combination.

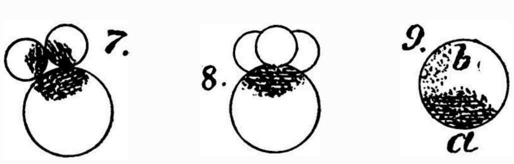
Under ordinary conditions only one atom of hydrogen and one atom of chlorine will unite, because no



other atom of hydrogen as *a* (Fig. 6) can be attracted so strongly, on account of the greater distance of the center of mass; that is, H_2Cl will not form a stable group, for the additional H atom will be dislodged by a slight disturbance. Thus under ordinary conditions hydrogen and chlorine will unite in no other proportions than equal parts of each. An atom of some other kind, as for example sodium, in the place of *a* could be attracted strongly enough, however, to crowd away the hydrogen atom, take its place, and form a molecule of NaCl, a group still more stable than the HCl.

The dense portion of the oxygen atom is larger than that of chlorine, and is able to hold two atoms of hydrogen, forming the water molecule, Fig. 7. In the case of the nitrogen atom the dense portion is still larger, and is able to hold three atoms of hydrogen in a stable ammonium molecule, Fig. 8. In atoms of other elements this dense part may be of still greater extent and hold still more atoms of hydrogen or an equivalent. This explains that property of atoms termed valency.

All these atoms in the single form are much more active than when in the double or molecular form; for in the single or nascent form the dense side is exposed



and in a position to attract strongly any other atom or molecule which may happen to be near. Thus hydrogen, chlorine, etc., are much more active immediately after being set free from their compounds than they are under ordinary conditions.

Ordinarily, chlorine is more active than the others, because the dense portion of the atom being smaller there is less attraction between the atoms in the elementary molecule, the molecule is more easily broken up to leave the atoms in the single form. Oxygen is less active than chlorine under ordinary conditions, for the dense portion of the atom being larger there is a greater attraction between the atoms, the molecule is more difficult to break up so as to leave the atoms in a position to unite with others, while in the nitrogen atom the dense portion is still greater, the attraction between the atoms is more considerable, making the nitrogen molecule still more difficult to break up to allow its atoms to unite with others. Thus the nitrogen is least active, or, as it is sometimes expressed, most inert.

Bromine and iodine resemble chlorine, inasmuch as they have atoms with a small dense side. Their atoms, however, having a greater mass and density, form molecules, whose mutual attraction is sufficient to cause them to collect indefinitely, at ordinary temperatures, to form respectively a liquid and a solid.

The sub-atoms in the atom of ordinary phosphorus are rather loosely put together. The atoms are not very dense, the attraction between them is comparatively weak, the molecule is thus easily broken up, and it is thus a chemically active substance. Under certain conditions the sub-atoms draw more closely together to form denser atoms with a stronger attraction between them. The molecules are then broken up with more difficulty, they are much less active. Furthermore, the molecules being denser, there is greater cohesion and hence a lessened solubility. This gives us the modification known as red phosphorus.

Under certain circumstances a still greater condensation of the atom may take place, the density of the atoms approaches that of metals, and the phosphorus exhibits metallic properties.

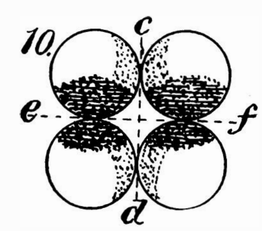
The allotropic forms of sulphur, carbon, etc., can also be explained by a change of density of the atoms. A change of density, however, can not be conceived in an indivisible atom.

The phosphorus atom seems to be like Fig. 9. A dense portion of larger extent but of lesser density in ordinary phosphorus than in nitrogen atom, since the molecule is more easily broken up, and yet it holds a greater number of hydrogen atoms. Furthermore, this density is greater at *a* than at *b*.

With an excess of hydrogen five atoms of the latter may be held by the phosphorus atom, three at *a* and two at *b*, forming PH_5, but the two at *b* are less strongly attracted and more easily dislodged than the others, leaving PH_3.

Four atoms unite as in Fig. 10 to form a molecule. Since the attraction along the axis *cd* is less than along *ef*, we would expect that at a high temperature this group of four would separate to two groups of two each, as is found to be the case in reality by the change in the vapor density at high temperatures.

The carbon atom has four dense parts near its surface, two of which are more considerable than the others, as is shown by its compounds. This strong attraction on four sides causes carbon atoms to collect indefinitely to form a solid, and requires a much



higher temperature to vaporize it than other substances even with a greater atomic mass. Also this attraction in four directions causes carbon atoms to be strong connecting links in binding themselves and other atoms together in complicated organic molecules.

A further study of details, which lack of space will not permit here, will show that all chemical phenomena can be explained by this structure of the atom and with no other attractive force than gravitation.

To those of our readers who maintain that it can be shown mathematically that molecular attraction and chemical affinity cannot be due to gravitation, we will suggest that your trouble lies in taking the law of gravitation to be

$$\int = K\frac{m_1 m_2}{d^2}$$

instead of that expressed by the equation

$$\int = K\frac{m_1 m_2}{d^{2+\frac{1}{d^n}}}$$

This latter form closely approximates the former for large values of *d*, and thus agrees with observations and experiment just as well, while for molecular and atomic distances it gives sufficient attraction to account for molecular attraction and chemical affinity.

The study of light will show strong evidence of the divisibility of the atom, but this must be reserved for another article.

Cleveland, Ohio. Arthur A. Skeels.

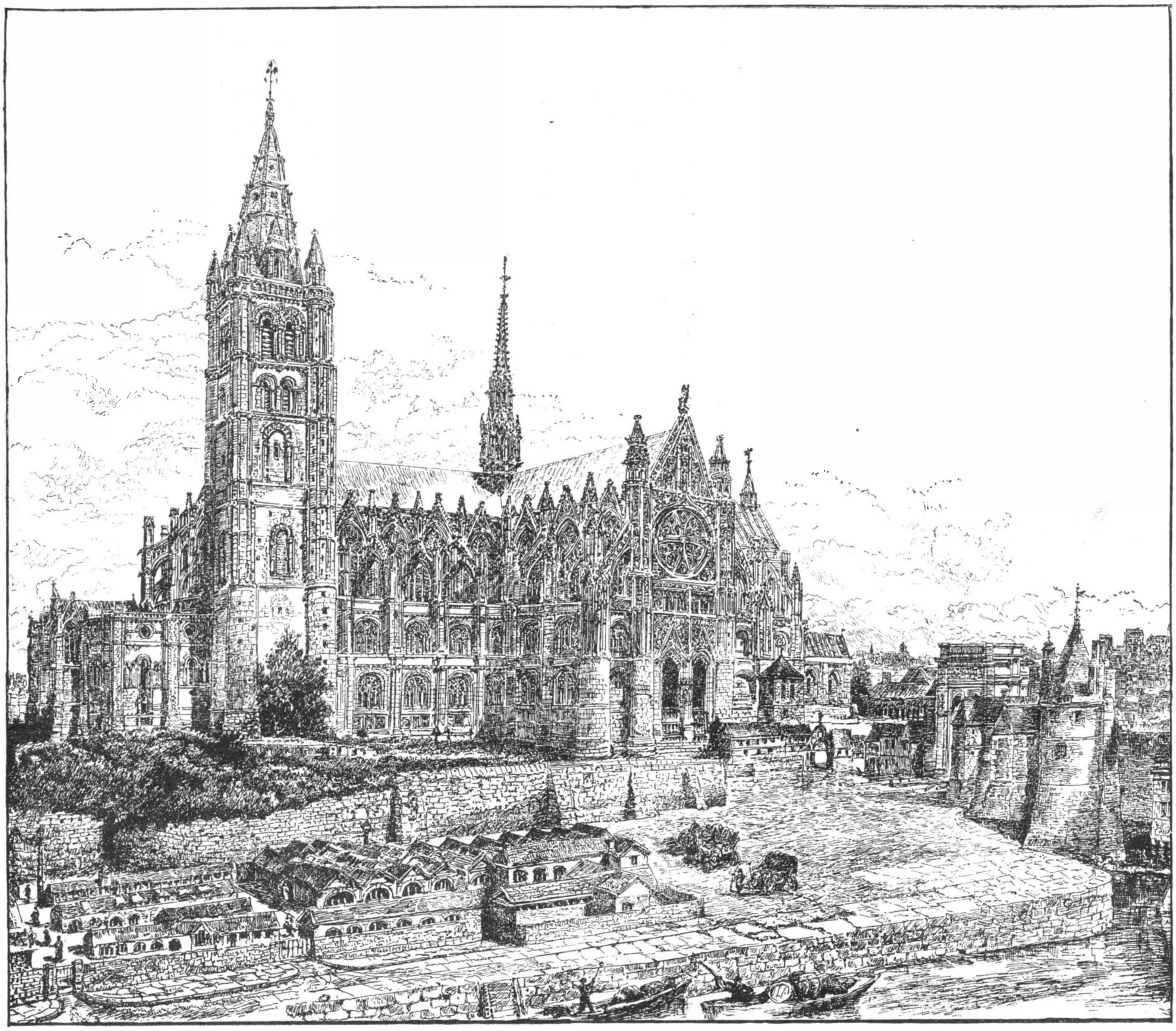
American Rolling Stock Abroad.—The Bavarian Railway has just completed an American palace railway carriage from material imported for this purpose two years ago from the Pullman factories in Pullman, Ill. This is the first railway car of the kind to be introduced into Germany and will no doubt be the forerunner of a regular system of luxurious railway carriages of this kind on German railways. The progressive character of the Bavarian Railway management is well known not only in this country, but in the United States. The chief of the bureau of railway management, General Director von Ebermayer, has visited the United States and is in thorough touch with American railway enterprises. The new ministry of railways took office on January 1, 1904, in the department of railways, under the management of a separate minister, Minister von Frauendorfer, a man of like energy and enterprise, and there is reason to look for a larger introduction of American locomotives and palace cars.—James H. Worman, Consul-General at Munich.

ABBEY OF ST. VICTOR AND PRIORY OF THE TOURNELLES, OLD PARIS.

THIS is the last of the drawings of the late Mr. H. W. Brewer which is in our possession, and in publishing it we feel very much the want of the valuable archæological notes with which Mr. Brewer always accompanied his drawings. As a Catholic, he was very well up in the history of the ancient mediæval establishments of London and Paris.

The locality is fixed by the name of the still existing Rue Tournelles, which runs into the Faubourg St. Antoine, just west of the Place de la Bastille. In later mediæval times there was on this site a Hôtel and Parc de Tournelles; the Place des Vosges is on the site of the Parc; probably the Priory preceded this. Of the Abbey of St. Victor we cannot find any record.

The Priory is (presumably) the low turreted building on the right, on the margin of one of the ditches, rather than streams, which intersected this low-lying portion of old Paris.—The Builder.



ABBEY OF ST. VICTOR AND PRIORY OF THE TOURNELLES, OLD PARIS.

THE CONSTRUCTION OF STEEL CARS.

AT a meeting of the Institution of Civil Engineers three papers were read, namely: "The Construction of Railway Wagons in Steel," by J. D. Twinberrow, Assoc. M. Inst. C.E.; "The Construction of Iron and Steel Railway Wagons," by A. L. Shackleford, Assoc. M. Inst. C.E.; and "Iron and Steel Railway Wagons of High Capacity," by J. T. Jepson. The following are abstracts of these papers:

The first paper, by Mr. Twinberrow, begins with a comparison of the physical qualities of timber and steel. The limit of elasticity of white oak is nearly equal to the ultimate strength, and the modulus of elasticity is low, so that a timber frame, by reason of the extent of its elastic deflection, has great capability of absorbing shock. The lateral stiffness of planking is greater than that of unstiffened steel plates of equal weight. The joints of wooden frames are a source of weakness. Rectangular sections are alone practicable for timber beams; the safe load on a rolled joist is compared with that upon an oak beam of similar depth, and the section and weight of beams of equal strength are compared.

In British practice colebars, headstocks, longitudinals, and transoms are usually of similar section; in Continental practice the inner members are shallower than the soles, crossing above or below each other, thus simplifying the joints at points of intersection. The ratio of the load gage to rail gage is considered; the inadequacy of the former is stated to be due to the restrictive influence of the design of rolling stock with rigid wheel-base.

The use of big trucks is considered to be desirable when the weight on the axles is increased; the adoption of bogie lead or apparatus to control the lateral and angular deflection of bogies is recommended. Bearing springs in series are to be preferred to single springs of greater flexibility. The practice of arranging the side frames of the bogie and the axle-box springs and axle guards in the vertical plane through the centers of the journals is preferred to the usual European practice of setting back the frames and axle guards to provide room for laminated springs over the axle boxes.

The designs may be considered as an embodiment of the idea that a steel wagon should be a complete structure, in which all parts necessary for containing the load contribute to the strength and stability of the whole, while the component parts are plain rolling-mill shapes of standard section, assembled without the aid of special forged or pressed work.

The sides of the wagons are formed of plate girders, of which the depth is so considerable, in relation to the span, that deflections under working load are quite inappreciable.

Special stress is laid upon self-discharging vehicles. on account of the great economy effected by their use in the manipulation of minerals and other bulk freight at terminals. The ends of these wagons and the lower parts of the sides converge to openings at a suitable height above the rail level. A special form of door which travels on horizontal guides is described; the prominent features of these doors are the facility they afford for providing a long base line for intersection of the end slopes, their security against accidental opening, and the ease with which they may be closed to retain any desired portion of the load.

Hand brakes are operated by means of a screw with pull-rods connected so as to transmit the pressure to each wheel of each bogie, and to permit of the coupling up of air or vacuum cylinders as required.

The defective action of ordinary side buffers with screw couplings on sharp curves is mentioned, and the conditions for eliminating it are noted; central couplers are referred to; and the capacity of friction draft gear is compared with that of the standard buffing and draw gear of private owners' wagons.

The practice of weighing long wagons on short weigh-bridges is also alluded to.

The second paper, by Mr. Shackleford, deals in the first place with the advances made in the construction of railway wagons during the last thirty or forty years, detailing the successive steps from the wagon built entirely of timber, which was in vogue at the commencement of that period, down to the latest form of wagon made entirely of iron or steel, and the advantages accruing from this form of structure. The author compares the strength of timber and metal, and shows that for a 10-ton wagon built to the English standard regulations, a steel frame can be made much lighter than a timber frame to carry the same load; while the strength of the timber frame is not to be compared with that of the steel frame.

He goes on to describe the changes that have taken place in the form of construction of steel underframes and bodies. A great advantage of steel frames is the ease with which the various members can be replaced, owing to all drilling and machining being done either with steel bushed templates, or by means of multiple drills and other modern metal-working machines, so that complete interchangeability is insured. Another point of great importance is the protection of iron and steel plates, channels, angles, etc., from rust and subsequent corrosion; and he points out that wherever practicable this should be accomplished by a coat of boiled oil, or of some suitable paint, as soon as possible after the metal has left the rolls. The omission of this precaution is frequently attended with disastrous results, as when once corrosion has been set up

the metal is very soon destroyed, and in a short time it is useless for all practical purposes. The author lays particular stress on this point, as the very existence of the wagon depends upon it. On the other hand, when a metal wagon has been well taken care of and properly painted from time to time, it has been proved that the loss through corrosion is insignificant, and the wagon may be expected to last several times as long as one built of timber, for no amount of attention and painting will preserve timber for anything like the same length of time. The author points out that although the cost of a metal wagon is at present somewhat higher than that of a timber wagon, the action of the Engineering Standards Committee in arranging certain approved sections will tend to reduce it greatly; and it may be expected that before long a wagon built of iron or steel will be produced at the same or even at a lower cost than one built of timber. With regard to the question of whether a large bogie wagon or a four-wheeled wagon would be more economical for carrying goods on English railways, the author gives his opinion in favor of the smaller wagon, pointing out that loads in England are frequently too small, and the distance to be run too short, to allow of the use of a larger wagon; in fact, the average load which it is convenient to put in an English wagon averages under 5 tons.

The paper also gives a short description of some of the couplings and buffers used in Great Britain and elsewhere.

The paper is accompanied by twelve sunprints and eleven photographs, and by appendixes giving descriptions of various wagons, including bogie high-sided goods wagons for South Africa, coal wagons, steel hopper wagons for coal, rolled channel and pressed steel underframing, types of underframe trusses, etc., and also a table giving a comparison of the ratio of load and tare for some of the principal wagons built under the author's supervision. This table shows that the tare of a wagon built entirely of steel is much lower per ton of load than that of a wagon built entirely of timber.

In the third paper, by Mr. Jepson, the wagon problem as affecting English railways is first considered, and a list is given of the companies which are using and experimenting with wagons of higher carrying capacity.

The advantages of high-capacity wagons for coal traffic are shown by the saving their use will effect in the tare or non-paying load, and in the lengths of trains; and the difficulties in the way of their introduction, both at the collieries and at the points of discharge, are dealt with.

The wagons described in the paper are designed for the conveyance of coal, and are suitable chiefly for traffic on the British railway systems. Several of the examples are of wagons already built and in traffic, which have proved in every way satisfactory, and have a lower tare than any other of the same class. They are all constructed of iron and steel, and are fitted with an either-side hand-screw brake, the self-discharging wagons having either-side door operating and locking gear.

The questions of the limit to the carrying capacity of bogie coal wagons for traffic in this country, and the most convenient size, are fully discussed, taking into consideration the limited load gage, the sharp curves, and the fact that the wagons have to be provided with corner buffers. The difficulty of using screw-couplings for these wagons is dealt with, and some examples are cited of large coal wagons of the bogie type in use in the colonies, and a tabulated list is given of the bogie coal wagons at present in traffic in Great Britain.

Proceeding next to details of construction, the first example, and that with the lowest tare compared with the measurement load, is a 40-ton coal wagon of the flat-bottomed type, arranged for discharging by hand labor through openings in the sides. Although fitted with laminated bearing springs, this wagon is shown to be the lowest in tare of various constructions, and at the same time exceedingly strong. Details are given of the body, underframe, bogies, buffers, brakework, and other fittings; also of the test load to which the underframes and bogies have been subjected.

Particulars are given of some 30-ton wagons constructed on similar lines to the 40-ton wagon, and comparisons are made with other constructions, both British and American.

The construction of 20-ton four-wheeled flat-bottomed wagons and of covered goods wagons of both the four-wheeled and bogie types is next referred to.

The remainder of the paper is devoted to the construction and details of self-discharging wagons for the conveyance of minerals. The general advantages of this type of wagon, the points to be aimed at in design, so that the wagon may be as short as possible and self-clearing, and may fulfill the requirements of the various railways, are discussed, and for each example particulars are furnished of the length, tare, percentage of tare to measurement load, net capacity (expressed as a percentage of that of a flat-bottomed wagon of the same over-all dimensions), inclination of the various parts of the floor, type of bogie, and clearance to be allowed for it when traversing curves.

The first example is a 40-ton wagon arranged so that the contents are discharged down a shoot between the rails, the mouth of the shoot being limited in length. A comparison is made between the work of receiving and discharging one of these wagons and wagons of the ordinary 10-ton type to carry the same amount of coal. Details of a test of two and a half times the maximum working load, which was carried out on one of these wagons, are given, and also the time taken to discharge 40 tons of coal.

Other examples are given of a 40-ton wagon of similar construction to the foregoing, but arranged to discharge its contents between the rails at three given points; an 80,000-pound wagon for a railway of 3½-foot gage, fitted with central buffers and arranged to discharge its contents outside the rails; a 100,000-pound wagon, arranged to discharge part of its contents near the center, and part near the ends of the wagon; and a 20-ton four-wheeled wagon arranged to discharge its contents between the rails at the center of the wagon; and having a 10-foot wheel base, and less tare than any 20-ton flat-bottomed wagon in use.

Designs for 60-ton and 70-ton wagons arranged to discharge their contents between the rails are also outlined, showing the load it would be possible to carry with an increased load gage, such as that adopted in the United States and other countries.

NEW APPLIANCES FOR RE-ROOFING SHOPS WITHOUT STOPPING WORK.*

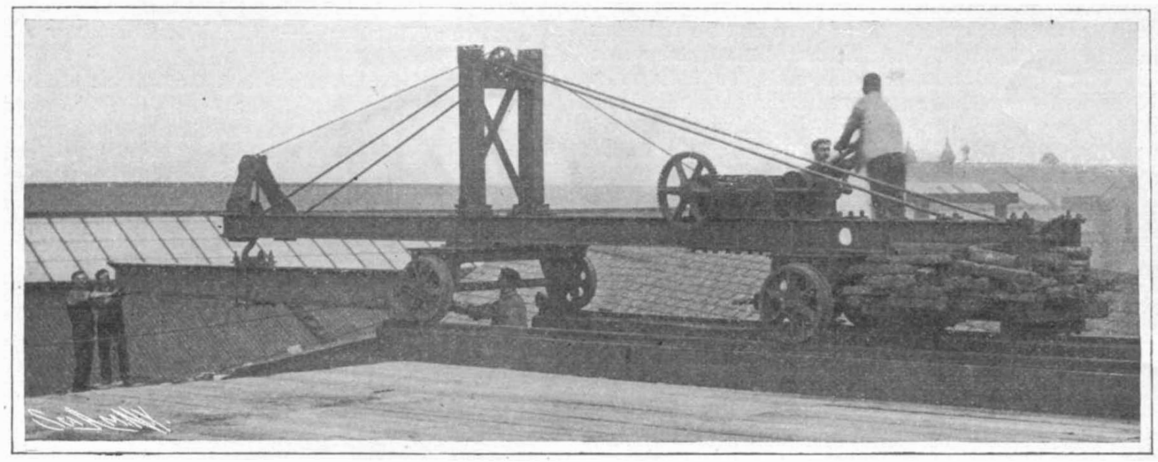
By the English Correspondent of the SCIENTIFIC AMERICAN.

PROBABLY there is no structural work in connection with an existing shop that interferes with, and inconveniences, work to such an extent as roof repair or renovation. In many shops it causes complete cessation of operations at certain periods while particular phases of the task are in progress. Yet it is imperative on occasions that the work should be carried out expeditiously and completely from above, thus obviating any necessity of hindering the workshop practice. Such an undertaking was recently accomplished with complete success in connection with the re-roofing of a section of the steam plow works at Leeds, with machinery especially designed for the purpose.

The scope of the undertaking comprised the re-roofing of the boiler shop and black store and fettling shop. The boiler shop was divided into two bays, each about 270 feet in length by 50 feet wide. The fettling shop was about the same dimensions.

It was imperative in this case that the work should be carried out without causing any cessation of work in the boiler shop, because the output of the works depends upon the supply of boilers. It was therefore impossible to adopt any plan of raising the parts of the new roof from the floor inside the shop. The *modus operandi* consequently adopted was to deal with one bay at a time, to construct a platform over the old roof for the full length of the shop, and to make this platform of sufficient strength to carry the tackle required for fixing the roof, and also the girders for carrying the roof, and to transfer this platform to the other two bays in succession.

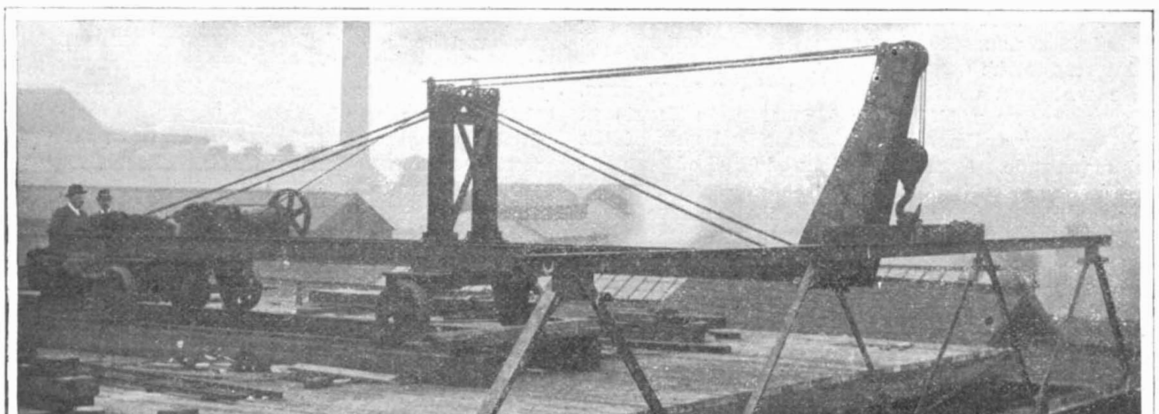
* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



THE TRAVELING CRANE WITH THE TRACKS ON THE ROOF.

At one end of the shop a steam derrick with a lifting capacity of four tons was fixed, and with a sufficient height radius to lift and place all the materials for the roofs on the platform, and with a jib of sufficient strength to place the first girder for carrying the platform in position. At the opposite end of this girder the first piece of platform was carried on an old brick wall of the shop. When this girder was fixed, the first piece of the platform was erected, on which the special cranes could be worked. On the bay of the boiler shop, which was the first one to be dealt with, it was necessary to erect a row of stanchions on each side; and as these stanchions had to be fixed in such positions as would not interfere with the existing walls and columns, the width of the shops had to be slightly altered. All the stanchions were made in two pieces to facilitate erection.

In order to erect the stanchions, holes were made through the old roofs, and each stanchion was erected by means of a single pole, the power for lifting being obtained from a winding forward drum on a traction engine. All the stanchions were put up during meal times, while the employes were absent. When all the stanchions for one bay were in position, the crane and roof girders were fixed. The special crane, by means of which it was rendered possible to carry out the task, was of the swiveling or traveling type. It was designed with an overhanging jib of sufficient length to carry the girders, 25 feet long when suspended from the center from stanchion to stanchion. This traveling crane was mounted on a track of 8½-foot gage, and of sufficient height above the platform to allow a narrow-gage railroad to run under it, on which the roof girders and crane girders were moved along on specially-constructed trucks. As the platform could not be constructed of sufficient width to allow this crane to be over the centers of the girders, it had to be made with a movable jib. As soon as a pair of girders, one on each side of the shop, were fixed, the trussed beams for carrying the platform were placed in position by means of a somewhat rough but very useful movable jib-crane, consisting simply of two balks of timber mounted on some old wheels, with a small crab at the rear end, and a fixed block at the end of the jib. The trussed beams were placed at a distance apart of 8 1-3 feet center to center, but this crane was made with such an overhang that the weight of the crane and the load it was lifting were distributed over not less than two trussed beams. This crane ran on a wooden track on the center of the platform. As soon as a trussed beam was fixed in position, the space between it and the one behind it was covered with 3-inch planks, all cut to dead lengths; the crane and track were then advanced, and another trussed beam put in position and covered over as before. Three trussed beams were fixed on each girder; consequently, when the platform from end to end was



THE CRANE LIFTING A GIRDER IN POSITION.

completed, it was composed of about thirty trussed beams, spaced 8 1-3 feet apart from center to center, and carrying a platform or deck 3 inches thick. By this method two roof girders, two crane girders, two trussed beams, and the platform were fixed in one working day.

With a view to facilitating the erection of the platform, two 20-inch gage tracks were laid, one on each side of the center crane. On these railroads all the planks and other requisite material were carried. The roof principals were lifted onto the platform by the steam derrick, in two halves; and each half was put on a trolley on the 20-inch gage railroad and conveyed to the far end, where the halves were riveted together. Upon the completion of the platform the wooden crane was taken away, and the crane used for lifting the girders was brought into the center of the platform, and employed for lifting the roof principals and putting them into their proper positions. This crane was also used for lifting out the trussed beams as the work proceeded. The roof principals were placed a distance of 12½ feet apart, and consequently one or two trussed beams had to be removed before each pair of principals could be fixed. As the principals of the new roof were erected, the planks that had formed the platform on the top of the trussed beams were then used in the construction of a scaffold or platform inside each of the four divisions of each roof. On this platform the glass, slates, and timber were placed. The whole of the task was completed with great celerity, and no interference was caused in any way with the routine work of the shop.

GIANT AND MINIATURE SUNS.

By J. E. GORE, F.R.A.S.

IT was at one time thought a probable hypothesis that the stars were in general of approximately equal size and brightness, and that their difference in brilliancy depended chiefly on their relative distance from the earth. On this apparently plausible hypothesis, we should have—taking the accepted "light ratio" of 2.512—an average star of the first magnitude equal in brightness to 100 stars of the sixth magnitude. As light varies inversely as the square of the distance, this would imply that a star of the sixth magnitude—that is one just steadily visible to average eyesight in a clear and moonless sky—would be ten times farther from the earth than a star of the first magnitude. For the same reason, a star of the eleventh magnitude would be at ten times the distance of a star of the sixth magnitude, and therefore 100 times the distance of one of the first magnitude. An eleventh magnitude star is about the faintest just steadily visible with a telescope of 3 inches aperture. For stars of the sixteenth magnitude, or about the faintest visible in a 25-inch refractor, the distance would be—on the above hypothesis—1,000 times the distance of a first-magnitude star.

Although this hypothesis was plausible enough at first sight, there never was any real evidence to show that the stars are of equal size and brightness, and modern researches have proved that they differ greatly in absolute size, and also in intrinsic brilliancy of surface. Measures of distance have shown conclusively that several small stars are considerably nearer to us than some bright stars, such as Arcturus, Vega, Capella, Rigel, and Canopus. These brilliant orbs must therefore be vastly larger than the faint stars which show a larger parallax. On the other hand, we have reason to believe that many stars are much smaller than our Sun. A consideration of some of these giant and miniature suns, as they may be termed, may prove of interest to the general reader.

We will first consider some of the "giant" suns. The well-known reddish star Aldebaran (α Tauri) in the Hyades may be taken as a standard star of the first magnitude. A small parallax of 0.107 of a second of arc was recently found for it at Yale College Observatory (U.S.A.). This makes its distance from the earth about seven times that of α Centauri (of which the parallax is 0".75). Now, as Aldebaran has the same spectrum (K 5 M, Pickering) as the fainter component of α Centauri (magnitude 1.75), the two stars may be considered as fairly comparable in intrinsic brightness. From the above data I find that Aldebaran is about 92 times brighter than the companion of α Centauri and its mass about 882 times greater. But the components of α Centauri are of equal mass, and each equal in mass to our Sun. Hence Aldebaran has probably a mass 882 times greater than that of the Sun!

The red southern star Antares (α Scorpii) is of magnitude 1.22, according to the most recent measures at Harvard Observatory, and its parallax, according to Sir David Gill, is about 0".021. Comparing it with Aldebaran, we have the latter 1.159 times brighter. But Antares is at five times the distance of Aldebaran. Hence the real brightness of Antares will be $\frac{5^2}{1.159}$, or 21.5 times greater than that of Aldebaran. The surface of Antares would therefore be 21.5 multiplied by 92, or 1,978 times the surface of the companion of α Centauri, and its mass about 88,000 times the mass of the Sun—a truly giant orb!

Betelgeuse (α Orionis) has a similar spectrum to Antares, but as it is brighter and its distance greater it is probably larger still.

Rigel (β Orionis). Assuming a parallax of 0".01 found by Sir David Gill, and comparing it with the *brighter* component of α Centauri, which is of nearly the same apparent (or stellar) magnitude, we have, since the parallax of α Centauri is 0".75,

Light of Rigel $= 75^2 = 5{,}625$ times light of the Sun (which is probably the same as that of α Centauri). But the spectrum of Rigel shows that it is hotter and brighter than our Sun. The two bodies are therefore not exactly comparable, and we must make an allowance for their difference in intrinsic brightness. If we assume that the Sun's light is reduced by absorption in its gaseous surroundings to one-fourth of its real light—which is probably a liberal allowance—we have,

$$\text{Surface of Rigel} = \frac{5{,}625}{4} = 1{,}406 \text{ times surface of Sun.}$$

From this it would follow that the volume of Rigel is about 52,000 times that of the Sun. Rigel is, however, probably of less density than our Sun, owing to its higher temperature. Comparing it with Algol, which has a similar spectrum, and of which the density and mass are known, we have the surprising result that the mass of Rigel is about 20,000 times the mass of the Sun! The parallax of Rigel is, of course, somewhat doubtful, but Sir David Gill is confident that it does not *exceed* the small quantity above stated.

For β Centauri, Gill found a parallax of 0".046. Placed at the distance indicated, the Sun would shine as a star of about 6.75 magnitude, and as the photometric magnitude of the star is 0.86, we have a difference of 5.89 magnitude, which would make β Centauri 227 times brighter than the Sun. This gives a volume 3,420 times the Sun's volume, and assuming the density at one-fourth of the Sun's, we obtain a mass for β Centauri equal to 855 times the Sun's mass!

α Crucis is of almost exactly the same brightness as Aldebaran, but it is at double the distance from us, a parallax of only 0".05 having been found by Gill. Its spectrum (of the "Orion type") indicates, however, that it is a much hotter and brighter body than Aldebaran. Taking its greater distance into account, we may perhaps conclude that it is comparable in size with Aldebaran, and therefore a sun of great size. The star β Crucis, whose stellar magnitude is 1.50, but which has no measurable parallax, must also be a giant sun. Its spectrum is the same as that of α Crucis.

Arcturus and Pollux have similar spectra (K. Pickering). The photometric magnitude of Arcturus is 0.24 and that of Pollux 1.21. The parallax of Arcturus, as found at Yale Observatory, is 0".026, and that of Pollux 0".056. From these data it would follow that Arcturus is 11½ times brighter than Pollux. The Sun placed at the distance of Arcturus would shine as a star of about the eighth magnitude, or about 7.7 magnitudes fainter than Arcturus appears to us. This would imply that Arcturus is about 1,200 times brighter than the Sun. It must therefore be a sun of gigantic size—probably one of the largest bodies in the universe. The above calculation would make Pollux about 100 times brighter than the Sun.

The bright stars Canopus and Procyon have very similar spectra, but the parallax of Canopus does not exceed 0".01, while that of Procyon is about 0".32. Still Canopus is a brighter star, its photometric magnitude being —0.86, while that of Procyon is +0.48, a difference of 1.34 magnitudes in favor of Canopus. From these data I find that Canopus is 3,500 times brighter than Procyon, and it follows that its volume is 207,000 times the volume of Procyon! If the densities are the same, the masses will be in this ratio, and as the mass of Procyon, as computed from the orbit of its satellite, is about five times the mass of the Sun, we have the mass of Canopus more than that of a million of suns! This is probably the largest sun of which we know anything. Sir David Gill's observations show that the parallax of Canopus does not *exceed* the hundredth of a second as above stated. A smaller parallax would, of course, further increase its size.

The observations of "spectroscopic binary stars" enable us to determine their mass, although their distance from us may remain unknown. As their actual orbital velocity can be measured with the spectroscope in miles per second, their distance from the earth is a matter of no importance in the computation of their mass. One of the most remarkable of these interesting objects is the southern variable star known as V Puppis. It is a variable of the Algol type, and also a spectroscopic binary. The plane of the orbit must therefore necessarily pass through the earth, or nearly so, and the mass of the system can be easily computed. The spectroscopic observations show the enormous relative velocity of 380 miles a second! and indicate a mass equal to about 70 times the mass of the Sun. The variation of the star's light shows, according to Dr. A. W. Roberts, that the component stars revolve round each other in actual contact, or nearly so, and that their mean density cannot exceed 1-50th of the Sun's density, or about 0.028 that of water. With such a small density and so large a mass the components must evidently be greatly expanded masses of gas, probably several millions of miles in diameter. The period of revolution is about 34 hours 54 minutes, a wonderfully short period for a pair of suns!

Let us now consider some suns of probably miniature size. The star Lalande 21,185 (7.5 magnitude) in the constellation Ursa Major has a parallax of about 0".47. At the distance indicated by this comparatively large parallax, the Sun would shine as a star of about 1.7 magnitude, or over 200 times brighter than Lalande's star. Another small star in the same constellation, Lalande 21,258 (8.5 magnitude), has a parallax of 0".24. This distance would reduce the Sun to about 3.2 magnitude, but it would still be 5.3 magnitudes, or over 130 times brighter than the star.

The small star Argelander-Oeltzen 17,415 of the 9th magnitude has a parallax of 0".25. The Sun, if placed in the same position, would be over 200 times brighter than the star.

Another small star with a comparatively large parallax is Lacaille 9,352. Its magnitude is 7.1, and the parallax about 0".29. The Sun, if placed at the distance indicated by this parallax, would shine as a star of about 2.7 magnitude. This gives a difference of 4.4 magnitudes, and implies that the Sun is over 50 times brighter than the star. This star has the very large proper motion of 7" per annum. It is a remarkable fact that the faint stars above mentioned are actually nearer to the earth than Aldebaran, which is one of the brightest stars in the sky.

The famous double star 61 Cygni is also probably of small mass. Taking its parallax at 0".39, the Sun, if placed at the same distance, would be reduced to a star of about 2.1 magnitudes, and as the photometric magnitude of 61 Cygni is about 5.1, we have a difference of 3 magnitudes in favor of the Sun. This makes the Sun nearly 16 times brighter than 61 Cygni, and would indicate that it has about 60 times the mass of the star. The spectrum of 61 Cygni is of the second or solar type, but not exactly similar to that of the Sun.

Some of the faint satellites to bright stars (mentioned in my paper on "Stellar Satellites") must be either bodies of small mass or slight luminosity. Take the case of Burnham's 14th magnitude satellite to Aldebaran. Assuming that its parallax is the same as that of Aldebaran, or about one-tenth of a second, we have the Sun reduced to a star of the 5th magnitude at the same distance. This would make the Sun 9 magnitudes, or about 4,000 times brighter than this faint star! It must therefore be either a comparatively small body, or else it must have proceeded a long way on the road to the total extinction of its light. If we suppose the density and surface brilliancy to be similar, the ratio of the masses would be about 25,000 to 1, and this small star would be less than 14,000 miles in diameter. It seems highly improbable that a body so much smaller than the planet Jupiter should continue for long in the sun-like stage. More probably it is a "cooled down sun." If its mass is not miniature, its light is certainly small.

The sun, if placed at the distance of Regulus, would shine with about the same brilliancy as the 8½ magnitude satellite to that bright star. This satellite has close to it a faint companion satellite of the 13th magnitude. As both are moving through space with Regulus they are evidently physically connected with the bright star and lie at the same distance from the earth. This 13th magnitude star is therefore 4½ magnitudes, or over 60 times fainter than the Sun. The accuracy of the small parallax found for Regulus (0".022) may perhaps be doubted, but there can be no doubt, owing to the common proper motion of all three stars, that Regulus and the faint satellite are at practically the same distance from the earth. The great difference in their light—nearly 12 magnitudes—indicates that Regulus is about 46,000 times brighter than its faint attendant. There must therefore be an enormous difference either in their size or the luminosity of their surface.

The measures of the double star α Ursæ Majoris show that it is a binary star. There is a difference of at least 9 magnitudes between the components, showing that one is at least 4,000 times brighter than the other. Considerable difference in size or great discrepancy in surface brightness is therefore absolutely certain.

The bright star γ Draconis (2½ magnitude) has a faint companion of the 13th magnitude, which seems to be traveling with it through space. The difference of 10½ magnitudes between the two implies that one is at least 10,000 times brighter than the other. Their disparity in mass or inequality in surface brightness must therefore be enormous.

Although calculation shows that the companions of Sirius and Procyon are each equal to the Sun in mass, still, as far as luminosity is concerned, they may be considered as miniature, or at least minor, suns. If the Sun were placed at the distance of Sirius it would shine as bright as the Pole Star, whereas the Sirian satellite is only of the 10th magnitude, or nearly 1,300 times fainter than the Sun. In the case of Procyon, the Sun placed in the same position would be over 16,000 times brighter than the faint attendant. These small stars are probably "cooled down suns" which are verging toward the total extinction of their light.

Another somewhat similar case is that of the binary companion to the star 40 (o^2) Eridani. This small binary star is of the 9th magnitude, while the primary star is about 4½. As both have a common proper motion through space, they are evidently physically connected, and therefore lie at practically the same distance from the earth. Prof. Asaph Hall found a parallax of 0".22 for the brighter star. Assuming this parallax for the binary pair, I find from Burnham's orbit a combined mass equal to 0.71 of the Sun's mass. Placed at the same distance, the Sun would shine as a star of 3.28 magnitude, that is 5.72 magnitudes, or 194 times brighter than the binary, which therefore seems to be another sun, or rather a pair of suns, on the road to extinction.

The globular clusters, composed as they are of such faint stars, suggest the inevitable conclusion that either the components are miniature in size, or else that these wonderful objects lie at a vast distance from

the earth. Even an approximate distance has not been found for any of them. If we assume a parallax of 1-50 to 1-100 of a second—163 to 326 years' journey for light—the component stars of most of them would be considerably fainter than our Sun would be if placed at the same distance. On this assumption they would be relatively small bodies. On the other hand, if we assume a parallax of 1-500 to 1-1000 of a second—from 1,600 to 3,200 years' light journey—the Sun would be reduced to about the 13½ to 15th magnitude, and this would make the component stars equal to or brighter than the Sun. That each of the stars which compose these clusters is equal to our Sun in size and brightness seems improbable, and perhaps the most likely supposition is that they are comparatively small bodies, and are not so far from the earth as is sometimes supposed.

A TRIP THROUGH ARIZONA.

Arizona is a singular country. If it suggests any one thing more than another to our mind, it is what we imagine the moon might be. The name Arizona is suggestive of what a large portion of it is, viz., the arid zone. This zone is in strong contrast to another portion of the region such as that around Phoenix, noted for its beautiful gardens and rich horticultural surroundings, as well as that around Flagstaff, noted for its fine pine timber. In the arid zone, too, there are occasional oases of great beauty. The country is part of a vast, lofty plateau in which, as it gradually arose from sea level, the present Colorado River gained the right of way by cutting a trench, which right of way it has held ever since; for it is a point of honor with rivers never to give up a right of way once formed, though mountains may rise and cross their path. So, proportionally as the plateau arose, the river cut down, till now the once surface-flowing stream is sunk over a mile deep in the profound depths of the celebrated Grand Cañon of the Colorado. This great cañon has underdrained the whole region over thousands of square miles. The old dry river courses, of which there are many visible, are suggestive that once this arid zone may have been a well-watered and probably fertile one, but the waters have long since drained off and down into the great underdrain of the plateau. The relics of erosion scattered profusely over the plateau in isolated tables, castles, and terraces of variegated colors, and picturesque forms, point to the same history as to the waters that formed and sculptured them.

The lack of water through this region is a conspicuous feature. You ride down through many a rugged cañon along the perfectly dry sandy bed of what evidently was once, or at fitful periods, a rushing torrent. A lone cottonwood here and there shows that some water does not lie far below the gravel, and in fact it can generally be found at a moderate depth by digging in the dry stream beds. Heavy showers are not unfrequent, especially in the rainy season (usually February). The water gathering from the surrounding hills rushes down these dry cañons in a sudden cloudburst, the waves of water often several feet high; then it is gone as quickly as it came and leaves no trace behind except that of bent bushes or dislodged rocks. Snow occasionally, but rarely, descends and then only in light falls. Water and grass for cattle are generally scarce. The cattle we saw looked wild and gaunt; they, together with herds of white goats running wild over the country, in drought times manage to chew and suck the succulent juicy leaves of the great prickly pear, which here assumes a gigantic size. It is hard to imagine how the noses and tongues of these poor brutes can attack so formidably armed a plant, the spines of which will penetrate the strongest buckskin leggings.

The striking feature of this weird region to the visitor is its vegetation, whose peculiar forms are in keeping with the general uncanniness. They form a subject of interest and diversion to the traveler as, either alone or with, it may be, a taciturn companion, he rides over these monotonous and repulsive wilds. Every plant, tree, and bush is armed with the most formidable spines and has an aspect of "Keep your distance, touch me if you dare." Thick leather leggings and high leather boots are advisable, for as you ride along, your horse may push your legs against one of the great cacti or other spine-armed shrub and your leg will be filled with spines as long and painful and far more numerous and difficult to extract than those of the common porcupine. Often these will penetrate the thickest leather. The leggings or boots are also a protection against rattlesnakes, tarantulas, scorpions and centipedes, which abound.

Among this strange thorny vegetation the cactus family predominates and assumes enormous proportions. Chief among these is the Sugarrow (pronounced Suwarrow), or giant cactus, attaining a height of from 30 to 50 feet with a trunk 18 inches to 2 feet in diameter. From this beautifully fluted, tapering column, extend gigantic arms like those of candelabra, generally pointing upward, but sometimes ramifying downward from the trunk and curling around like huge caterpillars; sometimes the trunk, especially of the younger ones, is simply a lofty cone tapering toward the root, wine-glass fashion; others may only have one or two mammillate buds extending from them. The stem and arms of the cactus have a soft velvety look at a distance. It is beautifully grooved and fluted with parallel grooves from top to bottom, and resembles velvet corduroy; the soft, velvety appearance is due to the fine spines with which its flutings are covered. These, when ignited by a match, blaze up quickly from top to bottom, and along the arms, enveloping the cactus in a column of flame and smoke. The Indians took advantage of this feature to make signal fires to one another. In early summer the top of the cactus column, as well as the ends of the arms of mammillate buds, are crowned by beautiful red flowers which later produce an eatable pearlike fruit.—Prof. A. Lakes in Mines and Minerals.

THE LARGEST MAP IN THE WORLD.

One of the largest maps in the world has just been installed in the office of Secretary Cortelyou, of the Department of Commerce. It is known as a commercial map of the globe, and it probably contains more information of a commercial character than any other map ever made. Its dimensions are 16 feet long by 7½ feet wide, and the sixteen sheets of the largest size handmade paper of which it is made were so delicately fitted together that they have the appearance of one huge sheet.

The map was prepared by the United States Coast and Geodetic Survey, under the direction of Secretary Cortelyou, with special reference to the needs of his department. Practically all the large maps and atlases published in recent years were consulted in the compilation of names, shore lines, and political subdivisions, with much additional information derived from detail charts, gazetteers and books of travel, the Congressional Library being drawn on for much valuable material.

The reports of the board of geographic names were taken as authority for the spelling of names, but thousands of names are given which do not appear in these reports. Names which were thought to be of little value for the purposes of such a map were omitted, however, in order that those given might stand out with greater distinctness.

A unique feature of the map is the location of the continents, which is different from that shown on any other map or atlas heretofore published. It has been the custom of all map makers to show the Western Hemisphere at the left end of the map, and the Eastern Hemisphere at the right, the Behring Sea being the dividing line. On this map the American continents occupy the center, thereby permitting the entire Pacific Ocean and the trans-Pacific steamship and cable routes to the Philippine Islands and Hong Kong to be shown without break in the center of the Pacific, as has always been the case heretofore. The eastern route via the Suez Canal to the Philippines is also continuously shown.

Cities having a population of between 10,000 and 40,000 are indicated in a distinctive manner. All the United States consulates are given, as well as most of the consular and commercial agencies, and in those parts of the world where international complications are likely to occur, all steamships ports are shown.

A special feature is the indication of the various lighthouses on the coasts of the United States. All places which are of international interest or importance are indicated.

All submarine cables are given, including the new cable between San Francisco and Manila, via Honolulu; the new cable between Victoria, B. C., and Brisbane, Australia, via Fiji Islands; the new cable between New York and Emden, Germany, via the Azores and Lisbon; the new cable between Port Natal, South Africa, and Perth, Australia; the new cable under construction between Seattle, Wash., and Sitka, Alaska, and the telegraph line from Vancouver, B. C., to different points in Alaska, as Juneau, Dawson City, Valdez, St. Michaels, and Nome. The Trans-Siberian Railway from St. Petersburg to Port Arthur and Vladivostok is given, as well as the route of the Cape to Cairo railway in Africa, as yet uncompleted, and the spur of the Manchurian Railway that is being built directly to the back door of Pekin via Rhaihr and Ralgan.

Colonial possessions are indicated by the same coloring as that of the mother countries. All the insular possessions of the United States are clearly shown. Persons who are not fully informed of our acquisitions in the Pacific will be surprised to learn of the number of islands in that ocean that are under our control.

The most difficult feature in compiling a map of this kind is in defining the political boundaries, which are as accurate as could be ascertained down to the very day the work was finished.

Among the recent changes in boundaries may be mentioned the new Abyssinian boundary, the new arbitration boundary between Chile and the Argentine Republic, the new boundary between Brazil and Bolivia, the Anglo-Turkish boundary at Aden, and the Spanish and French agreements on the west cost of Africa. There also is a question as to the political status of certain other countries, as for instance the province of Novibazar, between Austria and Turkey; the Egyptian Soudan and certain leased sections, as the locality of Lodi, between British East Africa and the Congo Free State.—New York Sun.

TO CENTRAL AFRICA BY WATER.

The French have just proved the existence of a navigable waterway from Lake Chad, in the center of Africa on the edge of the Sahara desert, to the Atlantic Ocean.

About four months ago Capt. Lenfant started up the Niger River and its great navigable tributary, the Benue, to ascertain if the reported water connection between the Chad and Niger systems really existed. News has just reached Paris of his safe arrival on the large Shari tributary of Lake Chad. He had successfully navigated the channel connecting the Benue and the Shari systems, thus proving the existence, during a part of the year at least, of through water communication between the ocean and Lake Chad. He carried his party and supplies in small boats. He says that the route may be used to carry a large quantity of freight in the flood season.

About 255 miles up the Niger, as the bird flies, the Benue, coming almost straight from the east, pours its waters into the great river. It is almost a second Niger in volume, and is navigable by steamers to Yola, more than 500 miles up the river. Following the windings of the streams, the Niger and its tributary afford about 900 miles of uninterrupted steam navigation from the ocean into central Africa. It is the only river system of the continent giving so long a stretch of water highway from the sea.

The region of the Benue's head streams has never been adequately explored, because, previous to the occupancy of the western Soudan by the British and French, it was dangerous for small parties of white men to venture among the fanatical inhabitants. A few whites, however, got into the country, and several of them, including the well known explorers Vogel and Hutchinson, reported that from what they saw and what the natives told them, they believed that during the season of floods the upper Benue was connected by a continuous line of channels with the Shari and Lake Chad.

Vogel discovered that the Tuburi swamps, about 225 miles directly south of the lake, occupy a long and narrow area that is almost exactly balanced on the water parting between the Mayo Kebbi, flowing to the Benue, and the Logone branch of the Shari River. He found that the superfluous waters of the swamps flow in one direction into the Logone, and in the other into the Mayo Kebbi.

Some years ago three representatives of the British Niger Company pushed up the Mayo Kebbi on a steamer. It was the flood time and the vessel was able to ascend almost to the Tuburi swamps, where the channel finally became too narrow for further progress. The steamboat was too large, and so the question of a through waterway to the Chad basin remained unsolved.

Capt. Lenfant has solved it, and the news he has sent home is of great importance for French colonial interests near Lake Chad. He was sent out for the particular purpose of solving this problem. He has proved that the Tuburi depression is filled with a series of lagoons which in flood time present a continuous navigable route that small boats may use to pass from one water system into the other.

The French have growing interests in their territory on the north and northeast shores of Lake Chad. They are maintaining a station there, and the Kanem district on the northeast coast has large fertile areas and a dense population. The cost, however, of carrying supplies to this region has been almost prohibitive, for it has been necessary to take them many hundreds of miles on the backs of men.

The French will utilize the new route to its fullest extent. It can be employed only for small boats and for three or four months in the year, but an enormous quantity of goods may be transported in that time; and they may be carried all the way by steamer from the ocean to Lake Chad except for the comparatively short stretch in the region of the swamps, where smaller boats to be poled or rowed will be necessary.—New York Sun.

Reference to Trevithick and his experiment of 1808, as given in the Engineer recently, reminds a correspondent of that journal of a still earlier trial in 1804. This occurred in Wales in February of that year, and was duly published in the Cambrian newspaper, Swansea, of that period, and was afterward referred to in the Mechanic's Magazine. The trial took place at Penydarran, Methyr, and was the outcome of a bet between two ironmasters—Richard Crawshay, the founder of Cyfarthfa, and Homfray, of Penydarran Works. Trevithick, it appears, had made himself known as an ingenious man to Homfray, and that worthy entered into a bet with Crawshay that Trevithick would convey a load of bar iron from the works to navigable water, nine miles away. The day came, February 12, and, in the presence of an immense crowd, the engine was brought forth to view, the work of Trevithick, aided by Rees Jones, engineer of Penydarran. The engine is described as a curiosity. It had a tall chimney stack, made of bricks, with a dwarf body, perched on a high framework, with large wheels; the cylinder was upright, and the piston worked downward. Attached to the engine were trams laden with 10 tons of iron bar and seventy persons. At a fixed hour the signal was given, a jet of steam burst forth, and with a great clang the wheels revolved, and slowly the mass moved along the track until a bridge over the line was reached, when away went bridge and stack. But Trevithick was a man of resource, and very soon the stack was built up again, and the terminus was reached, Homfray winning his bet. The rate of speed was given as five miles an hour. It was regarded as settling the possibility of locomotion, but the historian added that on account of curves and gradients it failed to bring the empty trams back, and thus the practical working of the engine for transport was left a question open for a future day.

[Concluded from SUPPLEMENT No 1473, page 23609.]

KOREAN HEADDRESSES IN THE NATIONAL MUSEUM.*

By FOSTER H. JENINGS.

THE royal chair-bearers are trained from youth to carry a palanquin with a quiet, swinging motion, free from jar. They wear one of the most peculiar of Korean hats (Fig. 12), made of several thicknesses of brown paper, covered with purple satin, the front decorated with designs in silver paper, and from the top hangs a piece of gauze silk 5 inches long by 4 inches wide. The hat is V-shaped, 10 inches high, 5 inches wide at the apex, and 4½ by 6 inches square at the base.

The official assistant's hat, or *pare muree*, shown in Fig. 13, is of delicately interwoven horsehair and strips of bamboo covered with black silk. It is cylindrical in shape, 6 inches high, 7 inches in diameter, and is known among the Koreans as the "fly's head." The position of official assistant, or *shu re*, can hardly be explained to the European. He is a kind of secretary, superintendent, and general factotum for his employer, and is far from being a popular person where he is known. Koreans consider the fly the personification of greed and shamelessness, for no matter how many times the insect may be driven away from food, it will return to finish its meal. As the *shu re* seems to be solicitous only about his pecuniary remuneration, and cares nothing for reprimand or abuse, he receives no more consideration than a fly, and must wear on his head his badge of servitude, which resembles a fly's head.

* From Smithsonian Miscellaneous Collections.

FIG. 12.—ROYAL CHAIR-BEARER'S HAT.

FIG. 15.—ROYAL SERVANT'S HAT.

FIG. 13.—"FLY'S HEAD" HAT.

FIG. 16.—HOUSE CAPS.

FIG. 14.—ROYAL MUSICIAN'S HAT.

FIG. 17.—BANDED HOUSE CAPS.

The hat of the royal musician (Fig. 14) is shaped somewhat like the official hat, but having a higher crown, and tassels of red silk hanging from the sides and back. The projecting wings are square at the extremities. This style of head-gear is worn only by the royal band detailed to furnish music in the palace.

The hat of the royal servant is of buckram, covered with brown silk. It is most ingeniously folded flat, and when open assumes the oblique outline shown in Fig. 15. This hat is worn with a suit of the same color and a blue sash.

The Korean is never hatless. When in the house his head is covered with a gauze skull-cap (Fig. 16), which is considered *en déshabille*, only intimate friends seeing it worn, and to appear with it on the street would be the height of impropriety. The house hats are sometimes made in veritable nests, one over the other (Fig. 17), varying in height, and in all of them the topknot can easily be seen through the meshes of the hat.

All of these hats are composed of bands of horsehair, of different heights, some wider at the top than at the bottom, some cylindrical, others square in shape, and nearly all open at the top.

There are a number of military hats, indicating different branches of the service, as shown in Figs. 18-21. The general's helmet (Fig. 18), is a very elaborate affair, ornamented with brass dragons, phenix, Sanskrit prayers for victory, red plume, and trident-shaped brass at the apex. The soldier's helmet (Fig. 19) is padded with cotton and stiffened with perpendicular bands of iron riveted through the cloth. Other military hats (Figs. 20, 21), are pot-shaped, visored, made of felt stiffened with buckram and ornamented with bright-red tassels and plumes of birds.

Hats appropriate to the season of the year are worn by different individuals, the gentleman's winter hood being an example in point (Fig. 22). This is of brocade, lined with red woolen cloth and bordered with otter fur, and is one of the few instances in which woolen cloth is used in Korea for any purpose.

The ornamental hood, an example of which is shown in Fig. 23, is placed upon the head of a very young child, and for its "protection" various characters are embroidered in the ribbon. The black ribbon at the back of the cap is removed when the child becomes able to speak.

The hat cover, or *kano*, is worn to protect the national hat from rain. It consists of a polygonal cone of oiled paper, folding like an umbrella (Fig. 24), and

is secured to the hat by a string of white paper, crossed under the chin and held by the hand. When not in use it is folded like a fan and carried in the sleeve. This is an interesting form of umbrella.

For the care of the hat, hat-boxes are used; these are woven of bamboo splints and covered with yellow oiled paper. An example is shown in Fig. 24.

Usually the women cover the face with their outer robe or dress, so that earlier writers about Korea affirm that the women wear no hats. In Fig. 25, *a*, is shown a small satin-covered cap, having an ornamental button of jade on top, worn by women of the official class; *b* represents a similar hat in white for mourning; and *c* is a winter hood of brocade, trimmed with fur and ornamented cords tied in fancy knots. In Fig 26 are shown methods of hair-dressing, and another style of hat with a streamer hanging down the back over the hair-knot, somewhat after the manner of the Tibetan woman.

As might be expected from the complexity of head-dress, Koreans display the utmost skill in such manufactures. Nowhere in the world can better horsehair work be found, some of the hats showing as many as five different styles of hand-weaving so fine that only with a powerful lens can the stitches be seen.

It is probable that the headband (Fig. 1) is the oldest style of head-dress in Korea, and that the more complicated forms have been evolved during centuries of culture. Much of Korean custom is a survival of the influence of the Ming dynasty in China, whose culture was widespread in Korea.

There is one specimen in the National Museum which shows the Korean conception of a European

FIG. 18.—GENERAL'S HELMET.

FIG. 19.—SOLDIERS HELMET.

FIG. 20.—*a*, SWORDSMAN'S HAT. *b*, SOLDIER'S AND CONSTABLE'S HAT.

FIG. 21.—MUSKETEER'S HAT.

FIG. 22.—GENTLEMAN'S WINTER HOOD.

FIG. 23—BABY'S CAP AND DETAILS OF SAME.

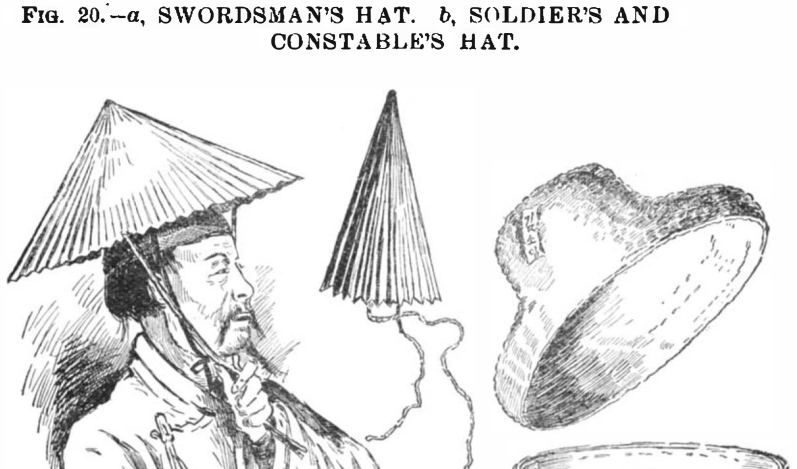


FIG. 24.—UMBRELLA HAT AND HAT BOX.

FIG. 26.—WOMEN'S HATS AND MODE OF HAIR-DRESSING.

hat. It has a high crown and is exquisitely made of horsehair and bamboo strips lacquered. It is an example of the revolutionary tendency of the reformers of 1895, and was one of the causes of the death and dispersion of those who would reform Korea in a year.

There are in all sixty-five different kinds of men's hats and about twelve different styles for children. Women are almost hatless, for they have only about half a dozen styles.

The people of Korea are rapidly adopting European ideas by introducing new laws, post offices, post roads, railroads, electrical plants, and many other improvements, and among the higher classes European dress has been adopted to some extent, yet changes of dress among the masses will come about but slowly; and it will be many years before the Korean hat will be relegated to the museum.

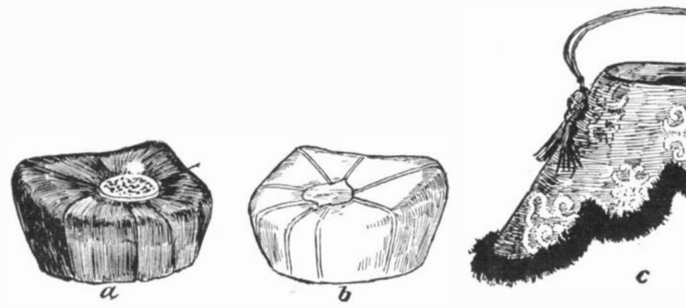


FIG. 25.—*a*, LADY'S SATIN CAP. *b*, LADY'S MOURNING CAP. *c*, LADY'S WINTER HOOD.

ELECTRICAL NOTES.

Interesting experiments were carried out for some time past on the Milan tramway, the cars being driven by a single-phase series motor, designed according to Dr. Finzi's data. The latter had as far back as October, 1902, shown by practical experiments the advantages of his motor; the extensive trial runs above mentioned also gave rather satisfactory results. On June 28 the Milan-Murocco tramway line was fed with monophase alternating current at 570 volts and 18 periods. Starting, accelerating, speed regulation, and electrical braking were shown to work very well. Under otherwise equal conditions, the Finzi system embodies a saving of energy as high as 30 per cent against the direct-current system, apart from the saving due to the absence of sub-stations, transformers, etc. The collector and coupling devices were left open in the course of the experiments, so as to enable those present to ascertain whether there was any sparking. These trials were carried on by night for three weeks. On July 21, a portion of the tramway system was fed with alternating current, the results being quite as satisfactory. On Vignole rails, the consumption of energy at a speed of 17 km. (10½ miles) per hour was 24 watt hours per kilometer-ton, and on Phœnix rails 24 watt hours the maximum speed being 45 km. (27.9 miles) per hour.

Among the most interesting papers read before Section G of the British Association meeting at Southport was one by Mr. James N. Schoolbred, in which he considered the possibilities of electrical propulsion as the general means of transport. The tendency of the last few years has been, in England and elsewhere, to introduce electric tractive power—on tramways, on railways, on road carriages, on canals, in automobiles, and in other ways. But these various groups have each been acting independently of the others—isolated, and in some cases actuated thereto by motives of jealousy, or of hostility, due to the dread of conflicting commercial interests. Besides the above proposed applications for electrical traction, there have sprung up in various directions what may be termed "universal providers of electricity," under the head of electrical power schemes, etc., to acquire a right—nay, even a practical monopoly—over very large areas to provide a supply of electricity for, within certain limits, all purposes, whether for locomotion or for stationary purposes. It is only reasonable to suppose, says the author, that if, instead of a number of conflicting interests, the various parties could be made to combine and fuse together the several portions of their common work, so as to avoid a repetition, and, in some cases, an antagonism of some portions thereof, there might then arise mutual benefit as well as economy, not merely to the operators themselves, but also to the community at large. One difficulty lies in the conflicting interests and in the jealousy among the various classes of operators. But another danger, to the public more especially, lies in the monopoly which virtually might thereby be afforded to the operators. An attempt has been recently made by the Liverpool Corporation, the Mersey Docks and Harbor Board, and the South Lancashire Electric Tramways to give expression to this tendency for co-operation among the various workers; and there are indications in Yorkshire and elsewhere of similar tendencies coming into operation. Although the result so far of the attempt above referred to has been rather to accentuate than otherwise the difficulties which beset a united undertaking of such a character, yet the benefits which would ultimately accrue to the public (say, in cheapening the cost of transportation by a more comprehensive and united action among the workers) fully warrants their being discussed. In the paper particulars are proposed tending to such a joint action and to the benefits arising therefrom.

ENGINEERING NOTES.

A suspended car ferry having a span of 393 feet is to be erected at Duluth, Minn. It is in effect a highly elevated bridge, the towers being 136 feet high, under which vessels freely pass, but the floor of the suspended car is only slightly elevated above the general street level. The motive power will be electricity, the motor operating wire cables attached to the trolley from which the framework and car are suspended. The car will carry a load of about 60 tons, which means that it can carry one street car, two or three teams, and altogether about 200 passengers. Its length will be 50 feet and the width 40 feet. It is pointed out that the suspended car ferry is superior to a drawbridge, as it practically does not interfere with navigation at all beyond that the vessels must avoid collision with the car, which, of course, is a duty devolving on both. The cost of the structure will be about $100,000. This is to be the first suspended car ferry built in this country.

Experience has demonstrated that the most convenient light for working in an office, shop, a school, or elsewhere, ought to be greater than that corresponding to fifty normal candles. Commencing with this datum, Engineer Wing, of Bonn, has contrived the following process, which from its simplicity may be employed anywhere. It consists in noting the light of a locality by the action on a photographic paper, which ought to be deeper in color as the light is the more brilliant. For this purpose sheets of paper treated with silver chloride are employed; they are exposed to the light for a given time, an hour, for example, at the point where the light is most important. They are then compared with the standard samples of the same paper, which have also been exposed for an hour to the action of a light of fifty normal candles measured by the photometer. All the localities where the test papers are darker than the standard paper should be judged suitable with reference to the light; those that are less so, are unfavorable. The papers in question, after having been fixed in the hyposulphite bath, may be collected in a portfolio for reference on occasion. These will serve for the information of parents, professors, school directors, manufacturers, and others. The inventor has been thus able to estimate the diminution of light resulting from trees planted, or buildings newly constructed, opposite the windows where work is carried on.

Hydraulic power does not figure so prominently in either foundry or machine shop as it does in boiler shops, in steel mills, and in many heavy stamping shops. The great wealth of hydraulic machines lies in the boiler and plating shops, where they have little rivalry. Elsewhere they are being hard pressed in consequence of the rapid advances of electricity and of compressed air. There is, nevertheless, a good field yet for the old and trusted agent—pressure water—in these two departments, from which there is at present no indication that they will be displaced.

The work of the hydraulic power in the machine shop and foundry lies in operations that must be performed slowly, steadily, with great precision, and backed up with considerable force. These operations include hoisting by fixed cranes, the work of cupola hoists, the molding of heavy work by machines, the various duties of wheel presses, arbor presses, shaft straighteners, test pumps, jacks, and allied forms of apparatus.

The advantages of an hydraulic installation for the foundry and machine shop are that its cost compares favorably with that of other power installations; that no water, and consequently no power, is wasted when not in service; and that the action is perfectly steady. When great energy has to be exerted through a small space, water, being practically incompressible, gives better results than any other agent. The mechanism, though massive, is simpler than that of the systems that are in competition with it.

To a considerable extent, doubtless, the choice of an agent must often be determined by the plant existing in a works or in a foundry. A firm that has a plant of a certain kind laid down will naturally try to adapt new machinery to the power-drive already on hand. That, probably more than any other fact, has been detrimental to the more extensive utilization of hydraulic power. The accumulator is a big and clumsy device. The difficulties of transmitting water at a pressure of, say, 750 or 1,500 pounds per square inch through jointed pipes are sufficient to prevent many firms from laying down a hydraulic plant after they have been accustomed to some other form of power. But where water power is already in existence and understood and worked properly, the hydraulic machines are, and will continue to be, highly appreciated. —Joseph Horner, in Cassier's Magazine.

TRADE NOTES AND RECIPES.

Waterproofing Paper.—Paraffin is frequently employed for the purpose. Wax may be used also but is more costly. Either may be applied by melting and drawing the paper through the liquid.—Drug. Circ.

To Remove Silver Stains from White Fabrics.—Moisten the fabric for two or three minutes with a solution of bromine 5 in water 500. Then rinse in clear water. If a yellowish stain remains, immerse in a solution of sodium hyposulphite 150 in water 500, and again rinse in clear water.—Drug. Circ.

Rosin Coating for Wooden Parts of Machines Exposed to Moisture.—Melt together rosin 375 grammes, flowers of sulphur 500 grammes, and fish oil 75 grammes. After the melting has been accomplished, add a small quantity of yellow or red ocher or a colored oxide crushed in linseed oil and stir the whole well so as to obtain a complete mixture. The result is a sort of paint, which is applied boiling hot in two coats, the second, however, only when the first has dried perfectly. This method is, of course, excellent as far as a paint goes, but naturally cannot compare with the advantages of impregnation.—Metallarbeiter.

Cleaning of Statuettes and Other Plaster Objects.—Nothing takes the dust more freely than plaster objects, more or less artistic, which are the modest ornaments of our dwellings. They rapidly contract a yellow gray color, of unpleasant appearance. Here is a practical method for restoring the whiteness. Take finely powdered starch, quite white, and make a thick paste with hot water. Apply, when still hot, with a flexible spatula or a brush on the plaster object. The layer should be quite thick. Let it dry slowly. On drying, the starch will split and scale off. All the soiled parts of the plaster will adhere, and be drawn off with the scales. This method of cleaning does not detract from the fineness of the model.—Moniteur Scientifique.

Firm Lubricating Fat.—A soap is produced in an emulsion of oil and tallow with heavy petroleum by addition of an alkali. For 500 kilogrammes of fat, heat together oleic acid (distilled olein), 40 kilogrammes; tallow, 8 kilogrammes; mineral oil, density about 900, 30 kilogrammes; colza oil, 28 kilogrammes. When the mixture is quite homogeneous, add to it in small portions milk formed of quicklime, 20 kilogrammes; lime slaked with water, 70 liters; soda lye of 20 Bé. 4 liters. Stir the whole, hot, until it thickens, and add mineral oil, the same as above, heated previously to 60 deg. C., 300 kilogrammes. Stir again until the mass becomes quite homogeneous, and add 100 to 150 kilogrammes of graphite in powder. An excellent fat will be produced, suitable for the axles of large vehicles.—Science, Arts, Nature.

Non-poisonous Colors for Sausage, Cheese, and Butter.—Sausage color.—To dye sausage red, certain tar dyestuffs are employed, especially the azo dyes, preference being given to the so-called genuine red. For this purpose about 100 grammes of dyestuff are dissolved in 1 to 2 liters of hot water; when the solution is complete, add a likewise hot solution of 45 to 50 grammes of boracic acid, whereupon the mixture should be stirred well for some time; then filter, allow to cool and preserve in tightly closing bottles. It is absolutely necessary in using aniline colors to add a disinfectant to the dyestuff solution, the object of which is, in case the sausage should commence to decompose, to prevent that the azo dyestuff should become resolved into its components by the disengaged hydrogen and in consequence become colorless. Instead of the boracic acid a solution of formaldehyde, known in commerce under the name of formalin, may be used as disinfectant. Of this formaldehyde solution 38 per cent add about 25 to 30 cubic centimeters to the cooled and filtered dyestuff solution. This sausage color is used by adding about 1½ to 2 tablespoonfuls of it to the preserving salt measured out for 100 kilos of sausage mass, stirring well. The sausage turns neither gray nor yellow on storing.

Cheese color.—To produce a suitable, pretty yellow color, boil 100 parts of orlean or annatto with 75 parts of potassium carbonate in 1½ to 2 liters of water, allow to cool, and filter after settling, whereupon 15 to 18 grammes of boracic acid are added to give keeping qualities to the solution. According to another method digest about 200 grammes of orlean, 200 grammes of potassium carbonate and 100 grammes of turmeric for 10 to 12 days in 1½ to 2 liters of 60 per cent alcohol, filter and keep in bottles. To 100 liters of milk to be made into cheese add 1½ to 2 small spoonfuls of this dye, which imparts to the cheese a permanent and natural yellow appearance.

Butter color.—For the coloring of butter there is in the market under the name of butter powder a mixture of sodium bicarbonate with 12 to 15 per cent of sodium chloride and 1½ to 2 per cent of powdered turmeric; also a mixture of sodium bicarbonate 1,500 parts, saffron surrogate 8 parts and salicylic acid 2 parts. For the preparation of liquid butter color use a uniform solution of olive oil 1,500 parts, powdered turmeric 300 parts, orlean 200 parts. The orlean is applied on a plate of glass or tin in a thin layer and allowed to dry perfectly, whereupon it is ground very fine and intimately mixed with the powdered turmeric. This mixture is stirred into the oil with digestion for several hours in the water-bath. When a uniform, liquid mass has resulted, it is filtered hot through a linen filter with wide meshes. After cooling, the filtrate is filled into bottles. Fifty to 60 drops of this liquid color to 1½ kilo of butter impart to the latter a handsome golden yellow shade.—Farben Zeitung.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Trade Opportunities and American Goods in Durango.—Trade Opportunities.—Trade opportunities not availed of are not worth dwelling on, which is another way of admitting the failure of our exporters at home to cultivate this field as they should have done. The Germans in business here and the Mexicans import largely from the United States, but it is because of their proximity to the United States and the convenience or relative cheapness of transportation, rather than of any intelligent efforts being made on our part to cultivate their trade. Many inquiries come to this consulate for the addresses of business houses here to which catalogues may be sent, and often these catalogues are in English. It does not matter very much, however, as "cataloguing" is a very poor way of extending trade at best. Commercial travelers from the United States, except for electric supplies, machinery, and similar lines, are comparatively few, and not many speak Spanish. That so large a proportion of the goods sold here are of American origin is due to force of circumstances mainly. The German merchants naturally favor their own country and buy there, except when competition and proximity compel them to purchase in the United States.

American Goods in Durango.—Perhaps 75 per cent of the imported furniture sold here is from the United States, but the percentage should naturally be greater.

Machinery, vehicles, etc., form a line of imports constantly growing in value as this district develops, and it is a line which is practically monopolized by the manufacturers of the United States. It is, however, not intelligently cultivated, and there seems to be no effort to consult the special needs of the market and manufacture products to meet them, while sales in the hands of unsympathetic German dealers are not cultivated as they might be.

A heavy trucking wagon suitable for bad roads—also good, heavy two-wheeled carts—might be sold here. One still sees in the city of Durango itself the ponderous old carretons, with their hubs, spokes, and uneven fellies hewn from solid logs.

Fifty per cent or more of the crockery, glassware, etc., sold here is imported from Europe; it is sold at high prices, and it would seem as if our manufacturers, with a little effort, could secure the trade.

Ready-made clothing has made very little headway here; yet the work of the local tailors is very crude, though fairly cheap.

Our woolen and cotton manufacturers get a fair proportion of the trade, but not so much as they would did they consider the customs and tastes of the people.

American-made hats are, as a rule, worn by the younger generation, as the "sombrero" is going out of use; but this market might be much more intelligently cultivated than it is. The hatters are Germans, Belgians, Frenchmen, and Mexicans.

The trade in American shoes is steadily increasing. Even the poorer classes aspire to have shoes from the United States, as they are far superior to the ordinary product of the Mexican shoemaker, which does not keep its shape and, being crudely sewed to the sole, with no protecting last, wears out in a month or so of heavy use. American shoes sell here at exorbitant prices, considering the moderate tariff and comparatively low cost of transportation. A pair of men's shoes costing $3.50 to $4 in the United States retails in Durango at the equivalent of $6 to $6.50. A well-conducted branch of one of our firms should do well.

In the line of groceries, etc., American canned goods hold the field, so far as regards fruits and meats, but the trade conditions are not so favorable in biscuits, crackers, etc.

Petroleum.—There is one American enterprise which cannot be accused of neglecting its opportunities in this part of Mexico, and that is the Standard Oil Company. It operates in Mexico as the Waters-Pierce Oil Company, and as such runs a number of large refineries in various parts of the Republic, importing its crude oil from the United States at a low rate of duty and enjoying the benefit of a very goodly differential placed by the Mexican government on refined petroleum.

Most of the crude petroleum now comes from the Texas oil fields. Finds of oil are, however, often being reported in the southern part of Mexico. Cheaper fuel for steam-making purposes would be of great importance to this country. Several of the engines on the International Railroad running into Durango are equipped to burn oil.

The highest grade of illuminating petroleum is retailed in Durango at $4.95 Mexican per 20 liters in bulk (41½ cents United States per gallon) and at $10.55 Mexican ($4.41 United States) in cases of two 5-gallon cans, a slightly increased charge for the cans. These are the prices at which the oil is retailed at the company's branches, and also the prices at which they sell at wholesale to the smaller traders, who, however, deal in the lower-grade brands, of which there are three in illuminating oil.

Under energetic management the sale of oil in this district has perhaps doubled during the present year, and a large number of places have been added to the list of those in this State, where the company's products are on sale. The most notable gain has been in lubricating oils, due both to the constant improvement in mining equipment in this region and to the increased activity in behalf of the American concern, which in this line (lubricating oils) has to meet German competition. But no small part of the increase is due to the way in which here, as elsewhere in the less advanced portions of the world, refined petroleum is replacing the cruder ways of illumination. It is an old story, but repeated continually in the more remote towns of this district, how the Standard Oil Company first invades a backwoods village with a supply of little tin lamps, which are given away filled with oil. Once tried every ambitious peon family must thereafter have an oil lamp, at least for festal occasions. Nor does the corporation overlook any chances for its by-products here more than elsewhere; in some places it manufactures candles, and in others, as here, sells the material to Mexican candle factories.

Gas Engines.—The Waters-Pierce Company also sells here a 74-per-cent gasoline at 32 cents Mexican per liter, or about 53 cents in United States currency per gallon. Gasoline forms a small but rapidly increasing proportion of its sales. Some of the smaller towns are using gasoline burners for street lighting. Gasoline engines are becoming common, but their use might be considerably increased with proper pushing on the part of the American manufacturers.

Race Prejudice a Trade Drawback.—Some general remarks upon a common American tendency which militates against us in this country may not be out of place. Americans who come out here to invest, to push business connections, or to locate and make their own way are too prone to show contempt for the people of the country. It is a narrow, short-sighted idea of "patriotism" and a not-well-founded race prejudice, which is, speaking of this particular district at least, a drawback to the extension of American commerce. Whatever Americans may choose to think of the Mexican peon class, it is undoubtedly progressing, even in relatively backward parts of Mexico. A well-defined middle class is already apparent, and the building of factories, railroads, etc., and the work of the schools are constantly increasing it.—James A. LeRoy, Consul at Durango, Mexico.

Ready-Made Clothing in Mexico.*—Manufacturers of ready-made clothing in the United States do not appear to have made any effort to secure a market for their goods in this or adjoining States. Although the duties are high, there ought to be a good demand for moderate-priced ready-made clothing of light texture and attractive patterns. A small assortment of well-made clothing distributed and carefully displayed among the leading dry-goods stores here would no doubt produce good results; these stores carry a very inferior and coarse quality of cheap pants and separate pieces of clothing, without any pretension to shape or fit. The clothing should be of light material—drill, duck, serges, and cheviots. Colors should be light, but not gaudy, for the better grades; lower and cheap grades should have bright, striking patterns and colors. For winter-season wear, same goods are suitable, but a trifle heavier weight and darker shades.

With proper attention and a reasonable desire to cater to the tastes of the people, quite a large trade could be secured in this line of business.

Ladies' and children's ready-made dresses and clothing—not too expensive—of plain, light silk, calicoes, and other light material, would also find a good sale here and in the numerous small towns scattered throughout this State.† Such articles have never been introduced here, and if properly displayed would be very popular.

How to Secure Trade.—As it is almost an impossibility for manufacturers to send full samples of their manufactures, and as the cost of maintaining a sales room with attendants, where their goods could be satisfactorily displayed, would be out of all proportion with the orders they might obtain, especially in small towns, it might be advisable for those wishing to secure a market for their wares in this country to send illustrated catalogues and price lists, printed in Spanish, as well as photographs of articles which were desired to be specially brought to the notice of buyers, and to the consuls located at the different points in the republic. If consuls could, with the approval of our government, set aside sufficient space where such catalogues and photographs could be properly and attractively displayed it would give the people in the different sections of the country a permanent and practical exhibit of American products and facilities for obtaining the addresses of all manufacturers, merchants, and dealers throughout the United States. Aside from the great assistance rendered to American interests by carrying out this plan, it would bring about more intimate relations between our consuls and the Mexican people, enable them to learn their wants and wishes, overcome prejudice, which generally only requires very little reasoning to overcome, etc. This would be a decided gain to the manufacturers, who could dispose of their regular goods without undergoing expense and trouble of often making costly changes.—A. J. Lespinasse, Consul at Tuxpan, Mexico.

How to Enlarge Trade in South Africa.—Agricultural Implements.—I wish to emphasize in the strongest terms the necessity which exists for good American representatives to introduce our products into South Africa. The inroads being made in the trade of this colony by American agricultural implements and the fact that the South African farmer recognizes their excellence and will have them if he can secure them reasonably has excited a good deal of jealousy in the minds of the British merchants here. The mere fact of a British brand on an implement or machine will not capture the farmers here. They want the best regardless of where it is manufactured. As I do not live in an agricultural district I am not able to say to what extent the different agricultural implements could be sold, but I am told the American hand and sulky plows are very much admired by farmers in the Orange River Colony and Natal, and I am safe in saying that the only requirement to make them popular is a proper introduction by an intelligent American salesman. It is of little use to try to introduce complicated machinery by selling it on mail orders to the British merchant here, who does not understand how to manipulate it or demonstrate its good qualities, which should be done by the expert salesman. Stock must be kept on hand here.

I give the names of the leading importers of machinery and implements in Cape Town:

R. M. Ross & Co., Strand Street.
Lloyds & Co., 40 Burg Street.
White, Ryan & Co., 18 Burg Street.
George Findlay & Co., Spin Street and Boom Street.
L. H. Twentyman & Co., 18 Burg Street.
De Wall & Co., 18 Burg Street.

The following is a list of goods of American manufacture which should be on the market here:

Automobiles; axles—wagon and carriage; binder twine, buggies, binder sickles, binder sections, binder guards and guard plates; binders, grain; belting, leather; cultivators; corn planters—hand and other; carriages; castings, malleable; carts; cornshellers, hand; drills—seed, grain, and corn; delivery vans; engines—traction and other; farm trucks; fencing wire—woven and other; horse-drawn harrows, hayrakes; harrows—spring, disk, spade, etc.; harness; lawn swings; link belting, detachable; locomotives; mower knives; machinery—harvesting, mower sections, mowers, grain-seeding, flour-mill, brickmaking, refrigerator, threshing, and fence-making; metal wheels, plow blades; plows—wheel and walking, gang, sulky, and shovel; pumps—force and iron; phaetons, plumbers' supplies, reapers, scales, surreys, shovels and spades, scoops, spring wagons and carriages, scythes, steel tanks, umbrellas, warehouse trucks, wheel scrapers; windmills, and towers and regulators; wagons—spring, express, freight, and road; wheelbarrows, well-drilling machines, and tools; wheels, carriage.—W. R. Bigham, Consul-General at Cape Town.

Austrian Skins for the United States.—Trieste exports a considerable quantity of sheep and goat skins to the United States. These skins, a large portion of which is bought in the Balkan States, have to be specially assorted for the American market, as our tanners will not accept inferior goods. Attempts made by a number of irresponsible dealers to underbid old and reliable firms in the American market and then recoup themselves by sending indifferently assorted goods have been the cause of considerable friction between sellers and buyers. Unusually favorable offers in this line of business should always be viewed with suspicion by American tanners.—Frederick W. Hossfeld, Consul, Trieste, Austria.

What is called a triple typewriter is being manufactured by a concern in Cincinnati. The machines are built principally for use in large shoe manufacturing concerns in making out their order tickets for the factory. Nearly all such factories are divided into three departments, each of which requires separate tickets, and as these tickets are made of heavy cardboard, carbon paper cannot be used to make duplicates. The triple typewriters are made from three single typewriters, so joined together that they operate with the one keyboard. The operator finds it no more difficult to operate one machine of this kind than a single machine.—Modern Machinery.

American Goods in Liberia.—After careful investigation, I find that the feeling here among the people is a preference for American manufactured goods. Our shoes, lawns, and calicoes, when they can be had, are bought in preference to those of other countries. The merchants here cater to the native trade, and cloths are manufactured to suit their fancy in grade and color. There is not an American merchant in Monrovia. The trade is divided up between England and Germany in the main, the merchants being Liberians, Englishmen, and Germans.—Ernest Lyon, Consul-General, Monrovia, Liberia.

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

* Vol. 22, part 1, pp. 45 to 69 of Special Consular Reports, is made up of reports on ready-made clothing in Latin America, pp. 46 to 56 dealing with ready-made clothing in Mexico.

† Tuxpan, on the Tuxpan River, 7 miles from the Gulf of Mexico, in the State of Veracruz.

SELECTED FORMULÆ.

Shoe Polish.—Black paste dressings for shoes are produced by the following:

I.

Bone black	2 pounds
Molasses	1½ pounds.
Lard oil	¼ pint

Vinegar, enough to make a paste.

II.

Tragacanth	1 ounce
Water	4 ounces

Dissolve and add

Neatsfoot oil	2 ounces
Bone black	4 ounces
Prussian blue	1 ounce
Sugar	4 ounces

Glycerin is sometimes used in making such pastes and, we are told, answers a good purpose.

The paste dressings used on russet leather consist of mixtures of wax with oil and other vehicles which give a mixture of proper working quality.

A simple formula is:

Yellow wax	9 parts
Oil of turpentine	20 parts
Soap	1 part
Boiling water	20 parts

Dissolve the wax in the turpentine on a water bath and the soap in the water, and stir the two liquids together until the mixture becomes cold enough to remain homogeneous.

Another formula in which stearin is used is appended:

Wax	1 part
Stearin	2 parts
Linseed oil	1 part
Oil of turpentine	6 parts
Soap	1 part
Water	10 parts

Proceed as above.

It is said that carnauba wax is used by manufacturers of such dressings instead of beeswax, as it is harder and takes a higher polish.

These dressings are sometimes colored with finely ground yellow ocher or burnt umber. If the leather be badly worn, however, it is best to apply a stain first, and afterward the waxy dressing.

Suitable stains are made by boiling safflower in water, and annatto is also used in the same way; the two being sometimes mixed together. Oxalic acid darkens the color of the safflower. Anilin colors would also doubtless yield good results with less trouble and expense.

By adding finely ground lampblack to the waxy mixture instead of ocher, it would presumably answer as a dressing for black leather.—Druggists' Circular.

Clothes Cleaners.—When the fabric is washable and the color fast, ordinary soap and water are of course sufficient in removing grease and the ordinary attendant dirt; but special soaps are made for clothes cleaning, which may possibly be more effective.

We here reprint several formulas for such preparations.

I.

Powdered borax	30 parts
Extract of soap bark	30 parts
Oxgall (fresh)	120 parts
Castile soap	450 parts

First make the soap bark extract by boiling the crushed bark in water until it has assumed a dark color, then strain the liquid into an evaporating dish, and by the aid of heat, evaporate it to a solid extract; then powder and mix it with the borax and the oxgall. Melt the Castile soap by adding a small quantity of water and warming, then add the other ingredients and mix well.

About 100 parts of soap bark make 20 parts of extract.

II.

Castile soap	2 pounds
Potassium carbonate	½ pound
Camphor	½ ounce
Alcohol	½ ounce
Ammonia water	½ ounce

Hot water, ½ pint, or sufficient.

Dissolve the potassium carbonate in the water, add the soap previously reduced to thin shavings, keep warm over a water bath, stirring occasionally until dissolved, adding more water if necessary, and finally, when of a consistence to become semi-solid on cooling, remove from the fire, and when nearly ready to set, stir in the camphor, previously dissolved in the alcohol, and the ammonia.

The addition of the last-named drugs is probably a survival of "shotgun" practice in making mixtures. The soap will apparently be quite as efficacious without them.

If a paste is desired, a potash soap should be used instead of the Castile in the foregoing formula, and a portion or all of the water omitted. Soaps made from potash remain soft, while soda soaps harden on the evaporation of the water which they contain when first made.

A liquid preparation may be obtained, of course, by the addition of sufficient water, and some more alcohol would probably improve it.

A strong decoction of soap bark, preserved by the addition of alcohol, would also form a good liquid cleanser for fabrics of the more delicate sort.

Gloves if not too much soiled may be cleaned by rubbing with fuller's earth.—Druggists' Circular.

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